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A Goal-Oriented Way to Define Metrics for Enterprise Architecture Program.	Hämäläinen Niina and Kärkkäinen Tommi	In Journal of Enterprise Architecture (vol.4, nr. 1), 2008.
Analysis of the Current State of Enterprise Architecture Evaluation Methods and Practices.	Martin Hoffmann	In Proceedings of the European Conference on Information Management and Evaluation (ECIME 2007), September 20-21, 2007, Montpellier, France.
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Enterprise Architecture Work Overview in Three Finnish Business Enterprises.	Niemi Eetu	In WSEAS Transactions on Business and Economics (vol. 3, nr. 9), 2006.
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Towards a Generic Evaluation Model for Enterprise Architecture.	Ylimäki Tanja	In Journal of Enterprise Architecture (vol. 3, nr. 3), 2007.

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Analysis of the current State of Enterprise Architecture Evaluation Methods and Practices

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Abstract: Today, more and more organizations adopt enterprise architecture (EA) processes to cope with the changing environment and to improve their performance and competitiveness. However, the evaluation of EA regarding its quality and benefits is rather difficult. The studies of previous research resulted in the recognition that there is no methodology for enabling the EA evaluation by considering the whole EA. Therefore, this paper presents and analyses the current state of methods and practices to evaluate EA from different viewpoints. The introduced approaches focus especially on performing an assessment mainly based on architectural descriptions. All methods, standards, and measures address EA related concerns and evaluation needs regarding business, information, systems, and technology. All of the presented techniques have been developed or tested and validated in a practical environment.

Keywords: Enterprise Architecture evaluation, evaluation methods, analysis

1. Introduction

Enterprise Architecture (EA) is an approach for supporting the management and development of an organization through a set of architectural models, usually including the viewpoints of business, information, information systems and technology. These views should transfer knowledge about the organization towards involved stakeholder roles. Furthermore, they give a guideline for the necessary architectural descriptions of the current architecture and also a future one.

The enterprise architecture is focusing on the realisation of the organization’s goals and vision though fulfilling so called *needs*. A need captures those stakeholder’s concerns that will drive key decisions by the architect, such as decisions pertaining to performance, technology or cost drivers (Hilliard, Kurland et al. 1997). The architecture must be assessed regarding the fulfilment of these needs which are also called *evaluation needs*.

The evaluation results are a useful basis for the system's improvement concerning the achievement of the organization’s goals and vision. Furthermore, the evaluation supports the definition of the target EA.

This paper aims at presenting the current possibilities to evaluate EA and focusing especially on performing an assessment mainly based on the descriptions of architectural decisions and solutions. The essential research questions investigated in this paper are:

- What kind of methods for EA evaluation exists?
- What are the strengths of these methods?
- What evaluation needs are addressed by these methods?

The research for this study was conducted in four steps:

1. Review of Literature to identify the current state of EA evaluation methods and practices
2. Identification of evaluation needs based on the study of (Niina Hämäläinen 2007)
3. Investigation and analysis of modelling standards and quality evaluation methods from business process, data modelling and software architecture research areas
4. Selection of techniques which could be applied on the identified evaluation needs

The studies of previous research resulted in the recognition that currently used evaluation approaches mainly assess the EA management and development processes but there is no methodology for enabling the EA evaluation by considering the architectural decisions and solutions.
Therefore, methods, standards and measures for the assessment of certain architectural concerns of enterprise architecture are presented. The presented techniques address the concerns of business, information, systems and technology separately. All of the introduced techniques have been developed or tested and validated in a practical environment.

The paper is structured as follows. The second section describes the currently wide-spread EA evaluation approaches *enterprise maturity models* and *IT-Business-alignment*. In the third section, methods which can be applied to evaluate the architectural decisions and solutions are presented and their strengths and application areas are introduced. Finally, the fourth section concludes the paper.

3. Current State of EA Evaluation

In this section, the current state of EA evaluation and especially methods which can be applied to carry out an EA evaluation are discussed.

Existing EA assessment techniques basically focus on the improvement of enterprise architecture management and the management process which means that new EA development targets are identified and development priorities are set. Therefore, enterprise maturity models and IT-Business-alignment evaluation are utilized.

One of the first capability maturity models, Capability Maturity Model for Software (CMM), was developed by the Software Engineering Institute, Carnegie Mellon. It enables the assessment and the control of IT-related processes as well as the assessment of organization's development competence. According to (Paulk 1993), architecture maturity involves an organization's ability to organization-wide manage the development, implementation and maintenance of architectures on various levels – e.g. business, information, applications and infrastructure.

Most of the assessment models have been developed by consulting firms such as Gartner (Gartner 2002) and METAGroup (META Group Inc. 2000), and federal agencies or organizations, such as the US Office of Management and Budget (OMB) (OMB 2004), the US department of commerce (DoC) (DoC 2003), and the National Association of State Chief Information Officers (NASCIO) (NASCIO 2003). These models generally work the same way as the early CMM. Basically, they use a number of criteria to assess architecture maturity. Typical criteria are, for example, process, governance, communication, technology, and business alignment. For each criterion five maturity levels exist and they are provided with a description of aspects. The maturity models differ in the amount of criteria which are investigated. However, no matter which model is applied, they all support the identification of insufficiencies and areas of improvement in the enterprise architecture development process.

Another approach to assess the EA management and development processes is IT-Business alignment. There is a general agreement what alignment entails: the fit between business strategy, IT strategy, organizational structures and processes, and IT structures and processes (Luftman 2000). The aim of alignment is for IT activities to support those of the entire business (Chan 2002).

One well-known model is Luftman's strategic alignment assessment model which presents an approach for determining a company's business-IT alignment based on six criteria: communications, competency/value measurements, governance, partnership, skills, as well as scope and architecture (Luftman 2000). This last criterion is used to evaluate IT maturity. According to (Luftman 2000), each of these six variables is assigned five levels of alignment. The model provides a short description of the aspects of each level.

3 The Evaluation of Architectural Decisions in EA Context

The evaluation of the architecture is rather challenging because there seems to be no coherent view on enterprise architecture. Many different concepts, modelling techniques, tools, and visualisation techniques are utilized (Jonkers 2003). Sometimes the architectural decisions are not even documented at all. Moreover, predicting the fulfilment of goals through certain architectural decision in a changing and highly-dynamic environment is difficult. The literature review in the area of architecture evaluation methods resulted in the recognition that obviously there seems to be a lack of evaluation methodologies. While there are many approaches for the assessment of software architecture (Clements, Kazman et al. 2001), (A. V. Corry 2005), (H. Grahn 2003) (Bosch 2005), (Bosch and Molin 1999)) there is nothing equivalent for the EA domain. According to (Hilliard, Kurland et al. 1997), an architecture evaluation methodology must include the following tasks:

- Analysis of Needs, Goals and Vision
- Gather relevant documents and other artefacts related to the architecture
- Evaluate documentation against measures and score results
- Interpret results and identify architecture-related risks

- Documentation of results.

So far there is no method which fulfils these tasks for the entire EA. That is why we decided to follow the structure given by most of the enterprise architecture frameworks (Zachman 1987), (The Open Group 2006), (CIO Council 1999), (Defense 2003) and analysed techniques that could be applied to evaluate the different views of EA: business architecture, information architecture, systems architecture, technology architecture. All presented assessment techniques are either based on standards or are developed or validated in a practical environment.

Many of the introduced techniques rely on conceptual modelling to improve the architectural knowledge among different stakeholders from different domains such as managers, business analysts, and developers. These conceptual modelling standards enhance the architectural understanding, knowledge sharing and the analysis of the structure and behaviour of the organization, are also considered as evaluation approaches. Furthermore, review methods, simulation approaches, and measures for assessing quality attributes are presented. In the following, the suggested approaches are briefly introduced.

3.1 Business Architecture Evaluation

According to TOGAF (The Open Group 2006), the Business Architecture embodies the descriptions of business goals and objectives, business functions, business processes, business roles, and business data model. They all have to be documented in an appropriate manner which enables the analysis and evaluation. Since the business architecture transfers this essential knowledge about the organization to all kinds of stakeholders like business users, business analysts, and technical developers it is strongly relying on conceptual modelling to be understandable for people from different domains. In the following approaches for the Business Architecture evaluation are presented. These approaches are also described regarding their strengths and the evaluation needs which they address in Table 1.

3.1.1 Business Motivation Modelling

Vision, goals, objectives are the motivation behind an organization's strategies which result into actions to transform the enterprise's as-is status into the desired to-be status. Since this motivation is the foundation for the organizational structures, processes and behaviour it should be documented within the models describing EA. Usually, enterprises only capture the means to achieve goals in models (E. Yu 2006). That makes the traceability, analysis and evaluation of goals rather difficult.

Modelling the corporate governance would bring several benefits to the organization:

- Vision, goals, objectives are made explicit
- Transparency of transformation drivers (E. Yu 2006)
- Tracing of decisions and responsibilities
- Conflicts, points of improvement, and level of fulfilment become clearer though visualization
- Basis for planning and changing strategies and processes (linking *why*-knowledge to *how* (E. Yu 2006))

One of the few notations that can be used for modelling the business governance is the Business Motivation Model (BMM). It is a meta-model of concepts for modelling the business governance. It has been standardized by the Object Management Group (OMG) in August 2006.

3.1.2 Business Process Modelling and Simulation

A quite common means to gain a competitive advantage, regarding costs or innovation, is the optimization of an organization's business processes. The optimization embodies the assessment of necessary infrastructure and applications, and comparison of expected benefits (D. I. Vidovic 2003). Business process modelling and simulation are the approaches to achieve the optimization of processes (Ali Bahrami 1998).
Business process modelling is the visualization of processes regarding relationships, dependencies, and effects between processes and their activities and resources. This visualization increases the understanding about the processes and supports the validation and improvement for many stakeholders (Ali Bahrami 1998). Business process modelling aims at clarifying the organization's

processes to its employees. Usually, even the documentation of processes discloses redundancies and points of improvement. According to (D. I. Vidovic 2003), 80% of process advancements are achieved by modelling the current status. There is several business process modelling approaches available. Three wide-spread approaches are:

1. Event-Driven Process Chain (EPC)
2. Business Process Modeling Notation (BPMN)
3. Unified Modeling Language (UML)

While modelling is the visualization of business processes, simulation brings them alive. On the one hand, it is possible to evaluate the current processes (*as-is* state) regarding costs, performance and to analyse the simulation data referring optimization. On the other hand, dynamic simulation is a way to analyze *what-if* scenarios, obtain cost and performance predictions, and validate processes (Ali Bahrami 1998). The predictions, gained from the simulation, support the decision making regarding organizational change and future investments. Naturally, simulation requires high effort on architectural documentation which is rather cost and time consuming.

3.2 Information Architecture Evaluation

The Information Architecture is a high-level model of information which an organization needs in order to make decision referring the future and required changes and also to perform its operative processes (Halttunen 2002). The organization's data is organized in a *corporate data model* (D. L. Goodhue 1992) which is a conceptual and structured data model.

The quality of the Information Architecture depends on the conceptual data models' quality. However, there is a lack of quantitative methods to assess the quality of data models. Several frameworks for evaluating a data model's quality have been suggested in (O. Lindland 1994), (D. L. Moody 1994), (Kesh 1995), (R. Schuette 1998). However, most of these frameworks suggest criteria that may be used to evaluate the quality of data models but an evaluation that is based only on criteria is quite difficult because criteria may be interpreted differently (D.L. Moody 1998). While studying the previous research, only the *Moody's Framework* for the evaluation of the quality of data models (Entity-Relationship diagrams) was found.

The Moody's Framework was developed in practice and has been applied on a wide range of organizations (D.L. Moody 1998). The evaluation framework defines necessary quality factors which are illustrated in Figure 1. Furthermore, the assigned stakeholder roles are shown for each of the quality factors. To assess these quality factors the framework embodies a number of evaluation methods, which in some cases are measures (e.g. data model complexity) and in other cases are processes for carrying out the evaluation (e.g. user reviews). The strength and addressed evaluation needs of the Moody's Framework are presented in Table 1.

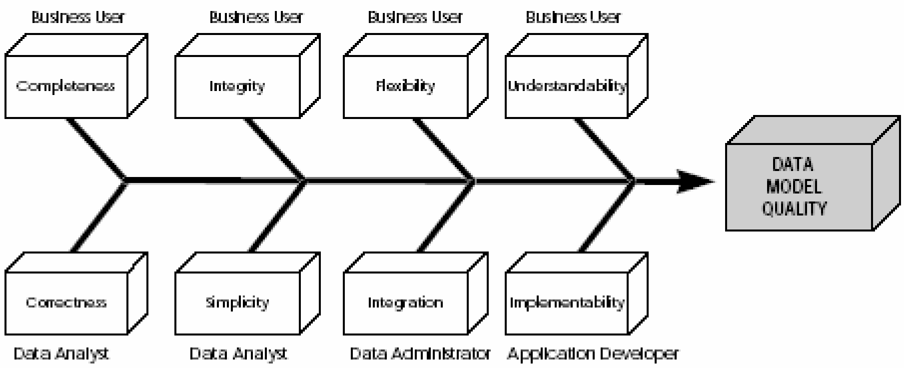

Figure 1: Data Model Quality Factors (D.L. Moody 1998)

3.3 Evaluation of utilized ICT

The ICT infrastructure includes the used systems and technology which are described through the system/application architecture and the technology architecture. The systems/application Architecture defines the software systems which is necessary to process the data and support the business. The software system is described by the *software architecture*. The software architecture basically must describe the software system's components. That means their structure as well as their behaviour and interaction with each other because the whole software system's behaviour results from its components' behaviour and interaction (Bass, Clements et al. 2003).

Since the technology which allows the deployment of software applications is also part of the software system, it can be evaluated within the software architecture evaluation. The methods concerning the software system evaluation enable predictions regarding the whole system life cycle. Especially, characteristics, such as performance, cost, reliability and maintenance are essential characteristics in the enterprise architecture context. Methods for evaluating the software architecture are:

- Questionnaires and checklists
- Scenario-based methods
- Architectural metrics
- Mathematical modelling
- Simulation and prototyping

These methods are only applied if within the EA software systems are used which have to be developed inside the organization. A selection of scenario-based methods for the evaluation of software architecture and the benchmarking approach are presented concerning their strengths and addressed evaluation needs in Table 1. The presented scenario-based methods have been chosen because they seem to be the most effective in the early evaluation of the software architecture.

Components used within ICT infrastructure are quite often commercial-of-the-shelf (COTS) components and their quality characteristics are described by the supplier. However, it is necessary to integrate different components with each other and different implementations have different behaviour concerning runtime characteristics. Therefore the infrastructure can be evaluated by using benchmarking.

Benchmarking primary evaluates performance, scalability and reliability of the used infrastructure. The evaluation results gained from benchmarking can be compared to the expected costs which are connected to different COTS components. That cost/benefit consideration supports decision making regarding the questions which COTS components suit best the organization’s software systems. Benchmarking is also described in Table 1.

3.4 Financial methods for assessing the business value of IT investments

The financial measures costs and benefits of ICT related investment decisions should be evaluated to make and justify those decisions.
Organizations use several measures to assess business value, such as return on invest (ROI), net present value (NPV), internal rate of return (IRR), payback period, and economic value added (EVA). According to (Symons 2006), these measures have five main disadvantages regarding their utilization to measure the business value of IT.

- There are too many measures available and within a single organization different groups use different measures; furthermore, some measures have multiple interpretations which lead to inconsistency.
- These measures generate a value which leads to a wrong credibility because the value is actually based on assumptions and the value itself is only a prediction for the estimated benefit.
- These measures do not take intangible benefits, such as customer satisfaction, into account. Since it is difficult to measure intangible benefits they are completely ignored.
- The financial measures only estimate the direct benefit of an investment but they are not able to calculate further future benefits or opportunities.
- Perhaps the biggest flaw in most financial measurements is the underestimation of risks or even the failure to incorporate any risk at all.

Since, measuring the value of IT-enabled business change will be critical to almost every organization as technology becomes embedded in virtually every business process (Symons 2006), more efficient measurement tools are needed. Four methodologies which have been developed to overcome the problems of the standard financial measures are:

1. Business Value Index (BVI)

2. Total Economic Impact (TEI)
3. Val IT
4. Applied Information Economics (AIE)

The techniques are described regarding their strengths and addressed evaluation needs in Table 1.

Table 1: Overview of EA Evaluation Methods

Method Name	Technique	Strengths	Addressed Evaluation Needs
Business Architecture			
Governance Modelling	conceptual modelling and review	- vision, goals, objectives are made explicit - transparency of transformation drivers - tracing of decisions and responsibilities - basis for analysis and evaluation (conflicts, improvement, level of fulfilment) - basis for planning and changing strategies and processes	- observation that ICT-architecture do not correspond to company's business's requirements - enhances the understanding of company's business/ICT - enhances the understanding of responsibilities in the company - make sure that organisational choices are suitable - An effort towards long-term technical solutions and need to argue for the long-term technical solutions
Business Process Modelling	conceptual modelling and review	- visualization of processes regarding relationships, dependencies, and effects between processes and their activities and resources - visualization increases the understanding about the processes and supports the validation and improvement for many stakeholders - 80% of process advancements are achieved by modelling the current status	- change need in the business or ICT (e.g. a need to move from one solution to another) - observation that ICT-architecture do not correspond to company's business's requirements - enhances the understanding of company's business/ICT - enhances the understanding of responsibilities in the company - make sure that organisational choices are suitable - distribution of work - Business process planning - need to find the best possible system solution and a need to understand the aspects relating the solution - An effort towards long-term technical solutions and need to argue for the long-term technical solutions
Business Process Simulation	simulation	- the current processes (*as-is* state) regarding costs, performance - analyze *what-if* scenarios, obtain cost and performance predictions, and validate processes - support the decision making regarding organizational change and future investments	- change need in the business or ICT (e.g. a need to move from one solution to another) - observation that ICT-architecture do not correspond to company's business's requirements - make sure that organisational choices are suitable - Business process planning - need to find the best possible system solution and a need to understand the aspects relating the solution - An effort towards long-term

Method Name	Technique	Strengths	Addressed Evaluation Needs
			technical solutions and need to argue for the long-term technical solutions
Information Architecture			
Moody's Framework	reviews and metrics	- evaluates data model's quality - provides quantitative measures - coverage of many data model quality aspects	- information / data models of good quality - understanding information managed in company
Software Systems Architecture			
SAAM	scenario-based review aims on scenario validation	- knowledge transfer about architectural decisions - identification of areas of high potential complexity	- understanding the state of the company's application portfolio - understand the current state of technical infrastructure - need to find the best possible system solution and a need to understand the aspects relating the solution
ATAM	- scenario-based review - regarding system's quality attributes - including scenario validation, trade-off and risk identification	- identifies risks and points of trade-off - enables evaluation of structural and behavioural system characteristics - improves architectural knowledge sharing	- change need in the business or ICT (e.g. a need to move from one solution to another) - need to enhance the understanding of company's business/ICT - understanding the state of the company's application portfolio - understanding quality aspects relating to the company's application portfolio - understanding the current state of technical infrastructure - need to find the best possible system solution and a need to understand the aspects relating the solution - An effort towards long-term technical solutions and need to argue for the long-term technical solutions
CBAM	scenario-based review with focus on cost and benefits	- measurement of design decisions with cost and benefit metric - makes uncertainty explicit associated with the estimates	- change need in the business or ICT (e.g. a need to move from one solution to another) - understanding quality aspects relating to the company's application portfolio - effort to drive investments to follow up architectural principles - An effort towards long-term technical solutions and need to argue for the long-term technical solutions
Technology/Infrastructure Architecture			
Benchmarking	Measures performance, reliability, and cost	- enables the collection of metrics regarding the system's performance, reliability	- understanding the current state of technical infrastructure

Method Name	Technique	Strengths	Addressed Evaluation Needs
		and cost - supports decision making	
Financial methods for assessing the business value of IT investments			
Business Value Index (BVI)	priority-based assessment of future investments	- supports the prioritization of investment options - tangible and intangible value can be measured	- change need in the business or ICT (e.g. a need to move from one solution to another) - effort to drive investments to follow up architectural principles - change need in the business or ICT (e.g. a need to move from one solution to another) - understanding quality aspects relating to the company's application portfolio
Total Economic Impact (TEI)	Risk-adjusted Return on Invest calculation	- measures cost, benefits, flexibility, and risk impact on business - risk-adjusted ROI	
ValIT	Value governance, Portfolio management, and investment management	- Value governance - Portfolio management - Investment management	
Applied Information Economics (AIE)	IT investment assessment through mathematical and scientific methods	- mathematical models - Developing financially-based quality assurance measures - Developing a strategic plan for information systems	

4. In conclusion

The evaluation of the EA is rather challenging because predicting the fulfilment of goals through certain architectural decision in a changing and highly-dynamic environment is difficult. Most of the evaluation needs in (Niina Hämäläinen 2007) are related to the enhancement of knowledge and understanding of the business and ICT concerns and to the recognition of necessary changes in the current EA.

The result of the conducted literature review was that there seems to be a lack of methodologies evaluating EA. Currently; the most wide-spread approaches are maturity models and IT-Business-Alignment assessment methods. However, they address primarily the enterprise architecture management and development process and not the evaluation of architectural decisions and solutions concerning the achievement of the organization's goals. Since there is no method for the evaluation of the entire EA we analyzed techniques from the areas of business processes, data modelling, software architecture evaluation, and benchmark testing. Furthermore, also methods to measure cost and benefits of ICT investment have been investigated. These measures are always a relevant basis for managerial decision making.

Most of the introduced evaluation techniques are based on reviews of the architectural descriptions. Therefore, EA evaluation depends strongly on conceptual models as input and the basis for analysis and discussion because they support sharing and communicating the architectural knowledge among different stakeholders from different domains. Furthermore, also more quantitative techniques like simulation and measuring can be applied but they require more detailed architectural descriptions.

One of the major advantages of all of the presented techniques is that they have been developed or tested and validated in a practical environment. All methods are summarized with their strengths and the evaluation needs which they address in Table 1. However, it is difficult to predict the extent of satisfaction for certain needs because the needs definitions in (Niina Hämäläinen 2007) are rather general. Only the application of the methods to the specific EA can answer the question how well the suggested methods satisfy the evaluation needs of a specific organization. Furthermore, a combination of methods might be necessary to improve the fulfilment of certain needs.

Still, the complexity of enterprise architecture and the related variety of concerns complicates reaching an established overall evaluation approach. The problem of developing methodologies enabling the enterprise architecture evaluation in a coherent, efficient, and practical way should be overcome in future research and work.
So far it is only possible to apply different techniques on only single architectural views of EA. Integrating these introduced techniques into the EA evaluation process of a company might be difficult. These techniques are independent of each other and they refer to different standards, description models, and tools which are not compatible to those already used within in the organization.

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A Framework to Support Business-IT Alignment in Enterprise Architecture Decision Making

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Abstract

Business-IT alignment is one of the key concerns of general management and chief information officers. It is commonly recognized as an important instrument for realizing organizational effectiveness. Achieving business-IT alignment requires often change in the way managers regard IT and it demands co-operation between general and IT management. The challenge of aligning business- and IT-related concerns and requirements in architecture decision making situations is the focus of this study. As one possible solution, we present a framework of architecture decisions. This framework defines decision making aspects and business and architecture plans. Decisions are suggested to be compared against these plans at each aspect. In addition, long-term and short-term decisions at each decision making aspect are defined. This framework is meant to support creation of shared domain knowledge (especially long-term alignment) through the use of enterprise architecture plans in decision making situations. Furthermore, it can be used to support the alignment of business and IT through decision making and to assist in the evaluation of decisions. The framework was evaluated in a focus group interview by practitioners.

Keywords

Enterprise architecture, Decision making, Business-IT alignment, Framework

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Introduction

Features of the current business environment are quarterly economy, organizational changes (e.g. mergers, acquisitions, structural changes, outsourcing), pressures for aligning the business and information technology (IT), cost-effectiveness, changes and improvements in technologies and practices (e.g. service-oriented architecture). The rapidly changing environment all organisations must operate creates a situation where an architecture approach such as an enterprise architecture (EA) is seen as an imperative to success (Ashmore et al., 2004). Architecture helps in achieving essential business objectives. Furthermore, a good architecture shows the relation of the architectural decisions to the business objectives of the enterprise (Lankhorst et al. 2005). EA is a hierarchical approach to aligning business and ICT (Langenberg & Wegmann, 2004). Business-IT alignment is commonly recognized as an important instrument for realizing organizational effectiveness (Lankhorst et al. 2005).

The need to make good decisions is a perpetual issue for all organizations. Management decision makers are especially concerned at profitability, growth, and increasing the market share. They participate in the strategy process and in defining the values of the company. Taking the management viewpoint affects the decisions and choices that the managers make. On the other hand, IT governance and development personnel are concerned about quality (e.g. security, performance), agility, cost-effectiveness and avoiding or reducing complexity in IT environments. Currently, company and business managers make also decisions relating IT governance and development. This means that the value of IT decisions or decision proposals must be demonstrated from the business perspective. However, especially far-sighted, long-term architectural decisions maybe difficult to justify in the quarterly minded business environment. This has led into decisions that are good from the management point of view but at the same time they, for example, might increase the complexity and costs of IT environment in the long-term. Because of that, fragmentation and silo-based solutions in IT environment may be increased. It is not explicit how to align business- and IT-related concerns and aims in decision making situations. Our paper studies this question from the viewpoint of architecture decision making.

This paper considers the problem of aligning business- and IT-related concerns and requirements in architecture decision making. As one possible solution, we present a framework of architecture decisions. This framework defines decision making aspects. Decisions are suggested to be compared against business and architecture plans at each aspect. In addition, long-term and short-term decisions at each decision making aspect are defined. This framework is meant to support creation of shared domain knowledge (especially long-term alignment) through the use of enterprise architecture plans in decision making situations. Furthermore, it can be used to support the alignment of business and IT through decision making and to assist in the evaluation of decisions. The framework was evaluated in a focus group interview by practitioners.

This article is organized as follows. In the second chapter, concepts related to business-IT alignment, enterprise architecture and decision making are described. The third chapter explains the research method. The fourth chapter presents the framework for architecture decisions and reports the empirical evaluation of the framework. The last chapter summarises and discusses the results.

Previous Research

There are several areas of research that are related to our work. We do a short overview of the key literature in the areas of business-IT alignment, enterprise architecture and decision making. We also describe the use of architecture plans in decision making situations.

Business-IT alignment

Business-IT alignment has consistently been reported as one of the key concerns of general management and chief information officers (see for example Reich & Benbasat, 2000). There is also some evidence that Business-IT alignment has beneficial effects (Henderson & Venkatraman, 1993, Reich & Benbasat, 1996, Chan et al., 1997, Avison et al., 2004, Gregor et al., 2007) and it is commonly recognized as an important instrument for realizing organizational effectiveness (Lankhorst et al. 2005). Although, business-IT alignment is a desired and beneficial state it is not always achieved, since it often entails a radical change in the way general managers regard IT (Henderson & Venkatraman, 1993). Alignment requires an intense communication process whereby organizations strategic goals and IT goals are shared with organizational members (Reich & Benbasat, 2000). This requires co-operation between the business and the IT department and it is uppermost important to consider the business and IT objectives together (Avison et al., 2004).

Alignment allows organizations to apply information systems and information technology to the business delivery tasks and operational activities (Gregor, Hart & Martin, 2007). Reich and Benbasat (1996) define alignment as: *“the degree to which the IT mission, objectives, and plans support and are supported by the business mission, objectives, and plans”*. Aligning the relationships between the business and IT infrastructure makes it possible to take advantage of IT opportunities and capabilities. Alignment can be beneficial at least in three ways: maximises return on IT investment, helps to achieve competitive advantage through IS, and provides direction and flexibility in reaction to new opportunities (Avison et al., 2004).

We use the alignment model of Reich and Benbasat (1996, 2000) as a basis for our study. They distinguish intellectual and social dimension of alignment. We focus on the latter. According to Reich and Benbasat (1996) social dimension of business-IT alignment is: *”The state in which business and IT executives within an organizational unit understand and are committed to the business and IT mission, objectives, and plans”*. They identify two aspects of social alignment: short-term and long-term. Short-term alignment refers to shared understanding of short-term goals and long-term alignment is having a shared understanding of IT vision. Reich and Benbasat (2000) state that the shared domain knowledge between business and IT management influences long-term alignment. They define shared domain knowledge as*: ”The ability of IT and business executives, at a deep level, to understand and be able to participate in the others’ key processes and to respect each other’s unique contribution and challenges”* We suggest that using enterprise architecture plans in decision making situations is one method that can support the development of shared domain knowledge within an organization.

Organization’s enterprise architecture can enable the alignment of business strategy and information technology (Gregor, Hart & Martin, 2007). For example, EA can help alignment by drawing viewpoints of general and IT management together under a common organizational framework. This integrates the two managerial viewpoints and makes them more visible. EA can also be used to define and describe the current and future state of the organization's business and IT. (Gregor et al., 2007) Next we examine the concept enterprise architecture in a more detailed manner.

Enterprise architecture

Enterprise architecture capabilities are typically developed to be used as an instrument in managing an organization's daily operations and future development (Lankhorst et al., 2005). Enterprise architecting is seen as "*a planning, governance, and innovation function that enables an organization to progress toward its vision of its future state*" (Leganza, 2007). Usually enterprise architecture deliverables are closely aligned to the strategic enterprise plan of the organization (Subramanian et al., 2006). Enterprise architecture is an adopted means for coping with companies' ever-increasing complexity and for ensuring that companies appropriately use and optimize their technical resources (Shah & Kourdi, 2007).

Definition for EA is presented by Lankhorst et al. (2005, 3): "*enterprise architecture is a coherent whole of principles, methods and models that are used in the design and realisation of an enterprise's organisational structure, business processes, information systems, and infrastructure."* An enterprise architecture explains how all the information technology elements in an organization – systems, processes, organizations', and people – work together as a whole (Morganwalp & Sage, 2004). EA commonly has four viewpoints: business architecture, information architecture, application architecture and technology architecture. These viewpoints are promoted in many widely used frameworks such as E2AF (2005) FEA (2002), and TOGAF (2003). Implementation of an enterprise architecture offers, for example, a way forward in integrating independent ICT silos across inter-organizational units.

Enterprise architecture management is a continuous and iterative process identifying company's business strategy needs and controlling and improving the existing and planned IT support for an organization (Ernst et al., 2006). The enterprise architecture work not only thus considers the information technology (IT) of the enterprise, but also business processes, business goals, strategies, etc. are considered in order to build a holistic and integrated view on the enterprise (Ernst et al., 2006). Thus EA management is the discipline of managing the whole enterprise architecture and the artifacts building the enterprise architecture.

Organisations' drivers for and expectations of benefits of an enterprise architecture vary. Both business- and IT-related benefits are expected to be achieved. In addition, the expected benefits are different depending on viewpoint. For example, the benefits expected by general management and IT governance management (e.g. CIO) vary. IFEAD (2005) has investigated why enterprise architecture is important for companies. Expected benefits of EA approach are that EA delivers insight and overview of business and IT, it is helpful in mergers and acquisitions. EA supports out-/insourcing and systems development as well as manages IT portfolio and delivers roadmaps for change. In addition, EA is expected to assist in decision making, managing complexity, and in business, as well as, IT budget prioritization. More precisely, business-related benefits are, among others (Shah & Kourdi, 2007):

- reduction in impact of staff turnover: capture knowledge from employees and consultants and provide business solutions from third party organizations consistently so they can conform to the current models,

- faster adaptability: facilitate knowledge acquisition necessary for changing systems and adopting new components,
- operating procedures improvement: understand and model business processes, review and reengineer processes,
- decision making: represent enterprise layers and components modularly to let the organization make business decisions in the context of a whole instead of a stand-alone part.

IT-related benefits are among others (Shah & Kourdi, 2007):

- complexity management: facilitate the scoping and coordination of programs and information systems projects, manage complexity and describe the interdependencies in a usable manner,
- technical resource oversight: identify and remove redundancy,
- knowledge management: manage and share knowledge modularly so it can be visualized across different levels
- IT visibility: IT resources and systems are more aligned to business strategies and are better placed for responsiveness.

Decision making

A large amount of literature and studies exist on decision making practices and processes (e.g. Drucker et al, 2001, Welch, 2001, Gray, 2006, Bhushan & Rai, 2004, Cook et al., 2007, Qudrat-Ullah et al., 2007, and Shapira, 2002). In addition, there are some scientific journals in the field of decision making such as ‘Journal of behavioral decision making’, ‘Judgement and decision making’ and ‘Information Sciences for Decision Making’.

Commonly, decision making seems to be understood as a cognitive process leading to the selection of a course of action among variations. Every decision making process produces a final choice, which can be action or an opinion. Decision making consists of a group of phases. A general model of basic phases of decision making is presented in the next figure.

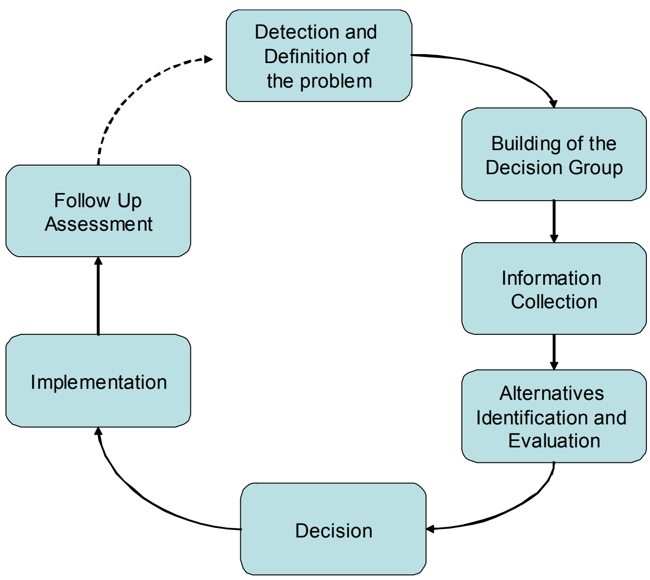

Figure 1. A general decision process model (Power, 2002).

Decision making processes and practices in companies relate among others to the strategic management, portfolio management (e.g. IT project portfolio and application portfolio management), and project management.

Decision making challenges relate especially to information based on which decisions are made and process of decision making. The essential challenges are (Ullman, 2006):

- The information may be uncertain.
- There exist different interpretations of the information that exist and different things are important.
- There exist no a good decision making strategy and it is not clear what to do next reach a decision.
- In addition, the risks associated with each alternative are not understood.
- In addition, it must manage alternative and criteria evolution and it musts get buy-in on any decision it is made.

Decision making is especially a reasoning process which can be rational or irrational, can be based on explicit assumptions or tacit assumptions. Architecture descriptions and plans and information included in them can be used in reasoning. The focus of this study is the use of architecture plans in the following decision making phases: detection and definition of the problem, information collection and alternatives identification and evaluation (see Figure 1).

Architectures plans and decision making in organisations

Literature and guidelines have been published relating architecture decisions (e.g. Clements, 1995, Jansen & Bosch, 2005) and decision making (e.g. Asundi et al. 2001, Cullen & Hoppermann, 2006, Johnson et al., 2004, Linstone, 1999, Meszaros, 1995, Pulkkinen, 2006, and Jansen & Bosch, 2005). Some studies have also tackled how to relate architecture planning to companies' other decision making processes (Ekstedt, 2004 and Johnson et al., 2004).

Plans can be used to support decision making. Decisions can be made about these and/or these can be source information for the decision making. Decision making can be about the selection of a plan. Executing a plan usually requires many actions, but may not require any new decisions (Krantz & Kunreuther, 2007). Sometimes, a plan leaves open a choice of subplans at some critical juncture, and in that case, there is an additional decision that has to be made (Krantz & Kunreuther, 2007).

Architecture descriptions and plans that are produced and used to support the decision making are e.g. baseline architecture descriptions, target architecture plans, architectural roadmaps, transition plans, architecture vision and system architecture plans. The baseline architecture encompasses the different layers and existing enterprise components (Shah & Kourdi, 2007). This description servers as a starting point for identifying relationships between different components as well as gaps that should be filled to improve organizational performance (Shah & Kourdi, 2007). The target architecture plan specifies the new enterprise architecture components and strategic initiatives that should perform to bridge the existing gaps and ensure the competitive advantage (Shah & Kourdi, 2007). Architectural roadmaps represents the baseline architecture's intermediary alternatives while mitigating the risks and analyzing existing gaps during the shift to the target architecture (Shah & Kourdi, 2007). Roadmaps highlight the architectural milestones performed prior to reaching the target architecture (Shah & Kourdi, 2007). Transition plans document the activities undertaken during the shift from the baseline to the target architecture (Shah & Kourdi, 2007). These are specifications of the baseline (as-is) and target (to-be) architecture views in terms of managing the architectural transition's feasibility. Such plans could include risk assessment, gap analysis, and resources supporting transition. Architecture principles are goals, constraints and guidelines for any information system developed in an organization (Subramanian et al., 2006). Architecture vision describes the ideal or the desired state of the organization. Information system/software architecture plans describe structures of an information system.

Next we apply the literature in construction of a framework to support business-IT alignment in enterprise architecture decision making. Avison et al. (2004) have done a somewhat similar study. They applied their strategic alignment model to an EA framework. In comparison to our study, their framework is aimed at investigating and interrelating different strategies of general and information management. Our framework concentrates more on the decision making situations where enterprise architecture plans are used.

Research Method

Aim of this research was to develop a framework 1) to support creation of shared domain knowledge (especially long-term alignment) through the use of enterprise architecture plans in decision making situations, 2) to help the alignment of business and IT related concerns and requirements in decision making, and 3) to support the evaluation of decisions suitability for the plans and requirements of business and IT.

In the development of the framework, the following research phases were carried out:

1) Gathering information about decision making, business-IT alignment and enterprise architecture planning.
2) Construction of the framework based on the literature.
3) Evaluation of the framework in a focus group interview.
4) Development of the framework based on results of the focus group interview.

The companies and interviewees are described in the table 1.

Companies	*Number of personnel (year 2005)*	*Number of interviewees*	*Viewpoints of interviewees*
Banking, finance and insurance company	11 974	2	enterprise architecture
Telecommunication company	4989	1	enterprise architecture
Business & IT consulting and development organization	a part of a large international company with 329 373 employees in total	2	enterprise architecture, software architecture

Table 1. Interviewees in the focus group interview.

Interviewees in the focus group were practitioners from three different companies. They were managers and specialists of the management of enterprise and software architectures in their organizations. The participants were interviewed as one group in order for group members to influence each other by responding to ideas and comments of others (Krueger & Casey, 2000). The use of group interview did have an impact, bringing out new aspects. However, it is possible that the interviewees did not discuss some aspects due to confidentiality reasons. The interview was tape-recorded and notes were written during the interview session. Based on the data, the framework was improved. This framework is presented in the next chapter.

A Framework for Architecture Decisions

In this chapter, we present a framework of architecture decisions. This framework consists of decision making aspects and plans/information. Decisions are suggested to be compared and evaluated against business- and IT-related information and plans. These are introduced in Table 2. The chosen decision making aspects are identified to be relevant from enterprise architecture planning point of view.

Decision Making Aspects	**Plans / information against to which decisions to be made on this aspect are suggested to be compared**
EA Planning: • Target architecture and transition plan development • Architecture visioning • Road mapping • Development of architecture principles	- Company strategy - Business environment changes - Business trends and forecasts - …
Portfolio planning: • Project portfolio • Application portfolio	- Business plans, drivers and needs - Long-term enterprise architecture plans: target architecture plans, road maps, transition plans, architecture vision - …
Project / solution design	- Business requirements for the project - Architecture principles and guidelines defined for any information system developed in the organization (e.g. Goals, constraints, and guidelines) - (Long-term architecture plans) - …

Table 2. Decision making aspects relevant from architecture planning point of view.

Table 3 presents the framework developed for architecture decisions. In addition this framework describes the difference between long- and short- term architecture decisions.

Traditionally, long- and short-term architecture decisions have been frequently used concepts by practitioners in architecture planning (especially by IT governance and system developers).

Decision Making Aspects	**Short-term architecture decision**	**Long-term architecture decision**
EA planning	Suitable for near-term strategy, near-term business environment change and near-term business trends and forecasts	Suitable for long-term strategy, business environment change and business trends and forecasts
Portfolio planning	Suitable for current business plans, drivers and needs BUT Does not support long-term enterprise architecture plans	Suitable for current business plans, drivers and needs AND Supports long-term enterprise architecture plans
Project – solution design	Suitable for the defined business requirements for project BUT - Non-compliant with architecture principles and - Does not support and realize the long-term enterprise architecture plans.	Suitable for defined business requirements for project AND - Compliant with architecture principles and - Supports and realize long-term enterprise architecture plans.

Table 3. A framework for architecture decisions.

The framework was evaluated by practitioners from a group of companies in a focus group interview. The framework was developed based on comments. Examples of comments and observations are presented in the following.

The decision making aspects were accepted by practitioners. These aspects were thus seen as a suitable approach from practice point of view. In addition, it was seen that short- and long-term architecture decision may be a good decision. For example, a comment was presented in the focus group interview: “*Sometimes a short-term decision may be needed to be done when there is no time to define and plan a long-term decision*.” In addition, in some cases, it may not be clearly known which of decisions are long-term and which short-term. For example, information related to business environment change may be uncertain. Uncertainty of information, against to which decisions are evaluated, affects to the reliability of evaluation results. Therefore, the decision that is expected to be long-term may turn out short-term decision and vice versa. As an interviewee stated: “*Future shows if the decision is long- or* *short-term.*” Sometimes it may be needed to make an exception to the accepted architecture plans and principles. These exceptions should be recognized and explained. Several needs for making exceptions, for example to architecture principles, may be a sign of a need to change architecture principles.

Practitioners were also asked to mention examples of short- and long-term decisions. An example of short-term decision is the choice of other technology than it is regarded as a long-term technology choice. Reasons for this may be a lack of resources or skills for the long-term technology and immaturity of long-term technology. Another example is the use of point-to-point solution in integration solutions when longer-term integration technology solution is not wanted or is not able to be introduced yet. In addition, as a short-term decision from the architecture point of view is seen the focusing projects only serving business needs heedless of what kind architecture these projects build. Projects developed thus new services and products without looking after whole architecture they build. Long-term decisions are for example technology infrastructure projects that focus on the building the basis infrastructure according to the enterprise architecture plans and consolidation projects.

Conclusions

This study focuses on how to carry out and improve business-IT alignment using enterprise architecture plans in decision making situations. In addition, this study aims to increase the understanding of short- and long- term decisions as well as the difference between them. Our framework for architecture decisions supports the creation of shared domain knowledge. This comes through the use of enterprise architecture plans in decision making situations. Communication between general and IT management in decision making situations increases the level of understanding about others’ viewpoint and work processes. Enterprise architecture advances the creation of shared domain knowledge by giving general and IT managers a common language and tools for co-operation. Use of the framework for architecture decisions increases particularly long-term alignment between business and IT.

This study contributes both to the practice and research. The results of this study help to understand and align the requirements and objectives of the business and IT in decision making. In addition, this study increases the understanding of long- and short-term architecture decisions as well as the difference between them. From practitioners’ point of view, the developed framework is suggested to be applied in the enterprise architecture decision making and especially to support the communication between general and IT management. This study contributes to the research on enterprise architecture decision making. Especially, results of this study focus on how to carry out and improve business-IT alignment in the enterprise architecture –related decision making. Research on this area is lacking.

There are some limitations in our study. The focus group interview was done from the viewpoint of enterprise and software architects. It would be beneficial to have another focus group where the participants would be business and IT decision makers. This would give more knowledge about decision making from the architecture plans’ users viewpoint. After this the framework should be evaluated and developed further if necessary. There is a need for empirical studies on how organizations use enterprise architecture plans in decision making.

Based on the results, we suggest that both business- and IT-related concerns should be taken better into account in decision making, although, these concerns may be conflicting. Architecture plans are suggested to be used to support communication between general and IT management in decision making situations.

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a|EA JOURNAL **Article**

POTENTIAL CRITICAL SUCCESS FACTORS FOR ENTERPRISE ARCHITECTURE

Tanja Ylimäki

ABSTRACT

During the past few years, enterprise architectures (EAs) have garnered considerable attention from both practitioners and academics in the fields of information systems and business management. It is suggested that EA is an approach for controlling the complexity and constant changes in the business environment of an organization. Research has mainly focused on the development and modeling of EA, while quality aspects of EA have gained less attention. The aim of this study is to provide insight into the critical success factors for EA representing issues that have to be done exceedingly well in order to achieve a high-quality EA, which in turn, enables the business to gain more success.

KEYWORDS

Enterprise Architecture, Critical Success Factors, Quality, Maturity, Evaluation, Assessment

INTRODUCTION

During the past few years, enterprise architectures (EAs) have garnered considerable attention from both the practitioners and the academics in the fields of information systems (IS) and business management. It has been suggested that EA is an approach for controlling the complexity and constant changes in the business environment of an organization, enabling a real alignment between the business vision, business requirements and information systems (Armour et al., 1999a; 1999b; Kaisler et al., 2005). EAs are generally seen as blueprints which identify the focal parts of the organization (such as people, business processes, technology, information, and information systems), as well as the means that identify how these different parts collaborate to achieve the desired business objectives (Hoogervorst 2004; Kaisler et al., 2005). An ideal EA provides a holistic, enterprise-wide and consistent view of the organization instead of looking at it from the point of view of a single application or system (Kaisler et al., 2005; Lankhorst, 2005).

It seems that EA studies have mainly focused on the development and modeling of EA (Zachman, 1987; Armour et al., 1999a; The Open Group, 2002; Lankhorst, 2005; Halttunen et al., 2005; Pulkkinen & Hirvonen, 2005), while the quality and assessment aspects have only recently gained attention, especially in the form of maturity models and assessments (U.S. Department of Commerce, 2003; U.S. Government Accountability Office, 2003; Industry Advisory Council, 2005; National Association of State Chief Information Officers, 2003; Office of Management and Budget, 2003). The maturity models do have their roots in the field of quality management (Fraser et al., 2002; Chrissis et al., 2003), but it seems that they are considered as simpler tools than the “traditional” quality management systems to assess the stage of the organization’s EA and to enhance its maturity.

The maturity of the EA refers to the organization’s capability to manage the development, implementation and maintenance of architecture that consists of various viewpoints (van der Raadt et al., 2004). Usually, these viewpoints include business, information, systems, and technical architecture (e.g., The Open Group, 2002). Furthermore, the idea of these maturity models is that the maturity evolves over time from one level to the more advanced level – without skipping any level in between – towards an idealistic ultimate state (Klimko, 2001). Therefore, we consider these maturity models as one means of advancing the quality of EA by providing at least an initial EA quality management system.

What does high quality mean in the context of EA, then? There seems to be a lack of scientific studies in which the quality of EA has been discussed. In our research project we have suggested that a high-quality EA conforms to the agreed and fully understood business requirements, fits for its purpose (e.g. a more efficient IT decision making), and satisfies the key stakeholder groups' (the top management, IT management, architects, IT developers, and so forth) expectations in a cost-effective way understanding both their current needs and future requirements (based on Lecklin, 2002 and Dale, 2003). In addition, the quality of EA may also refer to the quality of EA specifications or the quality of the EA development or governance processes.

Additionally, the concept of critical success factor (CSF) has been utilized in Total Quality Management (TQM) (Badri et al., 1995, Claver et al., 2003; Lecklin, 2002; Tarí, 2005) to indicate those issues that must be done exceedingly well in order to succeed. Originally, the CSFs were used to determine precisely what information is most needed by the top management representing the "key areas where things must go right in order to successfully achieve objectives and goals" (Bullen and Rockart, 1981; Rockart, 1982). In order to ensure that favorable results have been gained in these key areas, it is important that the current status of performance in each of the areas should be measured on a continual basis (Bullen and Rockart, 1981). While the idea of CSF has later on found its way to many other areas as well (such as project management), it awakened our interest for studying the CSFs in the context of EA: what are the factors that have to be carried out exceedingly well in order to attain a successful EA – a high-quality EA – which in turn enables the business to reach its objectives and gain more value.

In this article, we present a study which aims at determining the potential CSFs for EA – a set of potential key areas from which the organization should choose the most critical factors of its own based on its business objectives, the role of EA in the organization, and so forth. These factors, when carefully addressed, should enable the achievement of a high-quality EA. In the next section, we describe the research process. Following this, the set of potential CSFs for EA are presented. Finally, the last section summarizes the paper.

RESEARCH PROCESS

In order to identify the potential CSFs for EA the following steps were conducted:

1. Literature Review: There seems to be a lack of scientific research on CSFs for EA. Fortunately, CSFs have been studied in some other domains, closely related to EA, such as TQM (Badri et al., 1995; Claver et al., 2003; Tarí, 2005), business-process re-engineering (Al-Mashari and Zairi 1999), business-IT alignment (Luftman et al., 1999), project management (Clarke, 1999), enterprise resource planning systems (Nah et al. 2001) and software architectures (Bredemeyer Consulting, 2000; Hämäläinen et al., 2006). Based on reviewing these domains in addition to numerous EA literature including, for instance, the existing EA maturity models (U.S. Department of Commerce, 2003; U.S. Government Accountability Office, 2003; Industry Advisory Council, 2005; National Association of State Chief Information Officers, 2003; Office of Management and Budget, 2003), the initial list of CSFs for EA was defined. The list of factors was analyzed in order to organize similar factors into groups (see Figure 1).

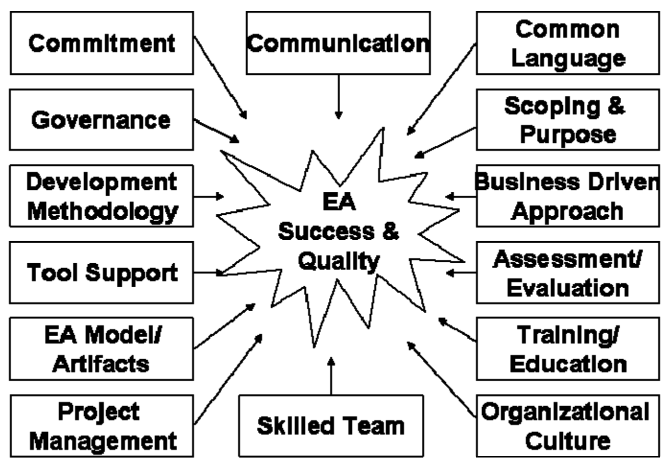

Figure 1. Initial Set of Potential Critical Success Factors for EA.

2. Empirical Research: A focus group interview (Krueger & Casey, 2000) of five architecture practitioners from three IT user and service provider organizations was organized. The objective of the interview was 1) to assess the literature review results, and 2) to collect additional CSFs from the practitioners, based on their personal experience. A group interview was considered as a means to stimulate the discussion by allowing the participants to respond to and comment each others' ideas and

opinions. The downside of this approach would be that the group influence would likely leave confidential information undisclosed. In the interview conducted by two researchers, the results of the literature review were presented, and the interview was structured according to them. In addition to the notes taken, the interview was also tape-recorded and videotaped.

3. Consolidation of the Results: The results from both the empirical study and the literature review were combined and a set of twelve potential CSFs was accomplished (Figure 2). In this step, some factors were also combined. Because 'Communication' is supported by a 'Common Language', these two factors were combined. In a similar basis, also the 'Development Methodology' and 'Tool Support' were combined, as well as 'Skilled Team' and 'Training and Education'. Additionally, even though 'IT Investment and Acquisition Strategies' (U.S. Department of Commerce, 2003; U.S. Government Accountability Office, 2003; State of North Carolina Office of Enterprise Technology Strategies, 2003) can be seen as a part of 'Governance', we positioned it as a separate CSF to highlight the primary objective of EA: the need to develop IT systems that enable and support the organization to achieve its business goals and objectives successfully. Furthermore, the characteristics of each CSF were formulated as questions.

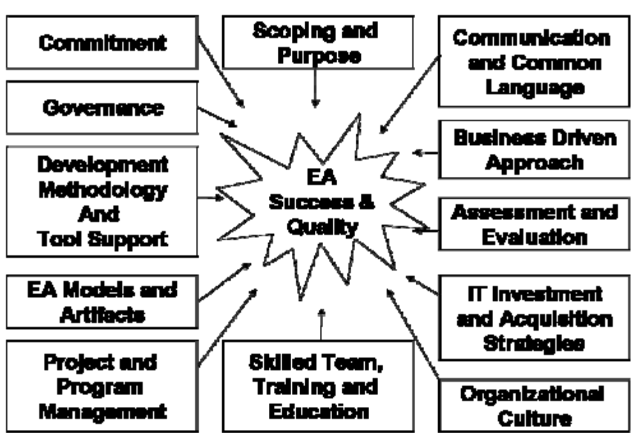

Figure 2. Updated Set of Potential Critical Success Factors for EA

POTENTIAL CRITICAL SUCCESS FACTORS FOR EA

In the following section of this article, the characteristics of the potential CSFs for EA are described in the form of key questions assigned to each factor. With the help of this set organizations can select the limited set of CSFs suitable for their purposes, and to assess the extent the CSFs have been taken into consideration in the EA development. While the focus group interviewees agreed on all the CSFs for EA resulting from the literature review, only the interview results that add some information or characteristics to the CSFs for EA are referred to as (Interview, 2005).

Scoping and Purpose

Scoping and Purpose relate to the extent the organization has addressed the following issues right from the beginning of the EA development:

- Holistic EA (Lankhorst, 2005), specific to the enterprise (Ashmore et al., 2004): What is the definition of EA in the organization? Are all the key EA stakeholder groups defined and documented?
- A clear mission, goals and direction (Belout & Gauvreau, 2004; Pinto & Mantel, 1990; Reel, 1999; Turner & Müller, 2005) and the declaration of will (Interview, 2005): Why the organization wants to apply the EA approach (definition of the business case)? What are the organization's objectives (Somers & Nelson, 2001)? What are its EA objectives? What are the existing problems (Bredemeyer Consulting 2000) or future problems (Interview 2005) it wants to solve through EA? To what extent are the objectives and importance of EA understood and approved by the organization members (also other than IT organization)?
- Value and benefits of EA (Ambler, 2005; Boster et al., 2000; Buchanan & Soley, 2003): What benefits (financial or other) are to be reached via the EA approach? Do different stakeholder groups have contradictory or competing opinions about the possible benefits? To what extent are the benefits of EA understood and approved in the organization?
- A clearly defined EA scope (Clarke, 1999; Lam, 2005): How wide organizationally, how deep and detailed, and how fast an EA should be developed (Industry Advisory Council, 2005)?

Communication and Common Language

Effective communication is essential in sharing knowledge, achieving a common understanding, agreement and a shared view of the EA scope, vision, and objectives, as well as of the developed models and other artifacts. Furthermore, communication is an important means of gaining commitment to the EA effort. Focal issues to be considered about Communication and Common Language are as follows:

- A common, well-defined vocabulary of terms and concepts (Lankhorst, 2005; Motwani et al., 2005; Ylimäki & Halttunen, 2005): Are the key architectural concepts defined, documented and used? On what sources are they based? Which viewpoints do they cover? Are other concepts, such as the (system) development methodology concepts, or concepts related to the development and investment processes of the enterprise defined, documented and used (Interview, 2005)?
- Communications plan and strategy (META Group Inc. 2000; Coronado & Antony 2002; Rehkopf & Wybolt, 2003; Industry Advisory Council, 2005): Is the communication plan or strategy for architectural communication defined and documented? What issues are defined in it?
- Various communication channels (Rudawitz, 2003): What means and possibilities of communication are used? Has the architectural communication been successful? Have any problems been detected?
- Timing: In which phases or situations does architecture-related communication exist? How is the communication timed? Is the communication regular, frequent and proactive (Al-Mashari & Zairi, 1999, Nah et al., 2001; Porter & Parker, 1993)?

Business Driven Approach

Business linkage is elementary in EA development (Baker and Janiszewski, 2005; Carbone, 2004; U.S. Department of Commerce, 2003; META Group Inc., 2000; The MITRE Corporation, 2004; Ramsay, 2004). Business Driven Approach is about ensuring that EA initiatives are traceable to the business strategy indicating clear alignment between business and IT (Schekkerman, 2004; Van Eck et al., 2004).

Key questions, thus, relate to the definition of the business requirements and ensuring that they are also met:

- How are the business strategy and the business requirements taken into account in architectural planning?
- How are the business requirements for the architecture recognized? Are they documented?
- How and when is the equivalency between the requirements and architecture assured?
- Are also the requirements set by external stakeholders (such as legislation, standards, even business owners and partners) taken into consideration in addition to the business requirements (Interview, 2005)?

Commitment

Without long-term top management commitment (also referred to as leadership, sponsorship or involvement) an EA effort will not succeed (Al-Mashari & Zairi, 1999; Badri et al., 2005; Basu, 2004; Bolton, 2004; Perkins, 2003; Quazi et al., 1998). Quarter-based-economy impedes the long-term thinking that EA requires; it is sometimes difficult to justify the top management that the investment that seems expensive at the moment will save money in the future (Interview, 2005). The key questions related to the Commitment are as follows:

- Top management commitment (U.S. Government Accountability Office, 2003; National Association of State Chief Information Officers, 2003; Industry Advisory Council, 2005; Interview, 2005): To what extent is the top management committed to the EA approach? How is the top management commitment expressed? To what extent is the top management involved in the EA development?
- Organizational buy-in (Bredemeyer Consulting, 2000; Industry Advisory Council, 2005; Office of Management and Budget, 2005; Interview, 2005): To what extent are the other stakeholder groups of the organization (such as the CIO, software developers, maintenance, and project managers) committed to the EA approach? How is their commitment expressed? To what extent are they involved in the EA development?

Development Methodology and Tool Support

A lot of requirements for methods to develop and maintain an EA in the ever changing business environment are suggested. Methods should be structured, well-defined and documented including, for instance, processes, guidelines, best practices, drawing standards and other means to promote the quality of architectures, as well as support for tracking architectural decisions and changes (Lankhorst, 2005). Moreover, the architecture process should be, among other things, business-strategic-driven, practice-oriented, situational, model-based, disciplined, rigorous, repeatable, and widely usable with reasonable costs (Perkins, 2003; Morganwalp & Sage, 2004; van der Raadt et al., 2004), as well as iterative and incremental (Ambler, 2005; Armour et al., 1999a; Ramsay, 2004). The key questions are as follows:

- Established architecture framework (Office of Management and Budget, 2005; National Association of State Chief Information Officers, 2003; Carbone, 2004; Interview, 2005): Is the framework defined and documented? What views or levels it includes? Is it based on some existing frameworks, such as TOGAF (The Open Group, 2002), Federal EA Framework (FEAF) (Chief Information Officers Council, 1999) or the Zachman Framework (Sowa & Zachman, 1992)? Has it been communicated to the key stakeholders? Is it understood, accepted and complied by them?
- Established architecture process or methodology (U.S. Government Accountability Office, 2003; Lankhorst, 2005): Is the development methodology defined, documented and used? What characteristics does the methodology have (see examples mentioned above)? Does the method include guidance for architectural decision making and documentation? Does the method provide support for the reuse of the processes, instructions, models or other artifacts (Kaisler et al., 2005)?
- Architecture principles (Armour et al., 1999a): Have the architecture principles been defined to guide the architecture development? Are they communicated, approved and used?
- Visualization techniques (Lankhorst, 2005): Which modeling languages are used in the EA development? Are they dependent on the tools used?
- Effective tool support (Chief Information Officers Council, 2001; U.S. Government Accountability Office, 2003; Industry Advisory Council, 2005; Perkins, 2003; Kaisler et al., 2005; Lam, 2005; Lankhorst, 2005): To what extent are tools used in the EA development; are they used in modeling, documenting, communicating or managing the architectures? What kinds of tools are used (data stores, modeling tools, documentation tools, communication tools, and so forth)? How well do these tools fit the needs the organization has? Are the tools compatible with each other or with other tools, such as BPR tools and system development tools (Interview, 2005)?

Several existing methods (processes), frameworks and tools for EA are described, for instance, by Ylimäki et al. (2005).

EA Models and Artifacts

The development method guides the creation of EA models and other artifacts. As the models are a valuable help in communicating the architecture to the various stakeholders, it is important that the following issues are addressed:

- Documentation plan (Kartha, 2004): Does a documentation plan exist? Is it communicated to the key stakeholder groups, approved and followed?
- Business and architectural requirements (van der Raadt et al., 2004; Armour et al. 1999b; Erder & Pureur, 2003): Are both the business and architectural requirements defined, documented, communicated and approved? Are the requirements extensive enough?
- Models provide a coherent and concise picture of the enterprise (National Association of State Chief Information Officers, 2003; van der Raadt et al., 2004; Kaisler et al., 2005; Lankhorst, 2005): Are all the necessary levels or views of the architecture (such as business, information, application and technology) modeled? Are these models communicated to relevant stakeholder groups (Interview, 2005)? Is the ownership of the models defined indicating who to contact if more information is needed (Interview, 2005)? Are they up to date? Are they extensive and finished enough? Are they clear, readable, comprehensible and including dependencies (Bredemeyer Consulting, 2000; The MITRE Corporation, 2004; van der Raadt et al., 2004)? Do the models address both the current situation (as-is descriptions) and the future situation (to-be descriptions) (Armour et al., 1999a; Industry Advisory Council, 2005; Office of Management and Budget, 2005)? Do models conform to the architecture principles and standards (Armour et al., 1999b; van der Raadt et al., 2004)?
- Traceability: Does the traceability between the business requirements and EA models exist (Armour et al., 1999b), as well as between the business requirements and architectural decisions (Erder & Pureur, 2003)?
- Transition plan (Armour et al., 1999a; Industry Advisory Council, 2005; Office of Management and Budget, 2005): Is there a transition plan telling how and when to get to the target architecture? Is it communicated and approved?
- Architectural decisions: Are the architectural decisions documented?

Even though the list of requirements for successful models and artifacts seem to be exhausting, in practice they do not need to be 100 % perfect, they just need to be good enough (Ambler, 2005), and simplification, clarification and minimization are key to long-term architecture success (Dikel et al., 1995).

EA Governance

Governance and management have various definitions in the literature. In general, governance deals with the management and organizational aspects of architecture (van der Raadt et al., 2005), but it can also refer to "how an organization makes decisions, sets priorities, allocates resources, designates accountability, and manages its architectural processes" (Baker & Janiszewski, 2005). Key questions related to EA Governance are as follows:

- Established governance structure (META Group Inc., 2000; Carbone, 2004; Industry Advisory Council, 2005): Is the architecture governance structure defined, documented and complied? Are the roles, responsibilities and authorizations defined, documented and complied?
- Effective governance processes and activities (Rehkopf & Wybolt, 2003; Control Objectives for Information and related Technology, 2000; van der Raadt et al., 2005): Are the processes, activities or tasks (such as definition of the architecture policy, principles or architecture compliance strategy) defined and documented? Does an 'EA Statute Book' exist guiding the EA work (Interview, 2005)? What communication and coordination means are used (e.g. feedback channels, discussion, reports of progress) (The Open Group, 2002; Industry Advisory Council, 2005)?
- Effective change management environment (Bolton, 2004; Kaisler et al., 2005; Office of Management and Budget, 2005): Are the practices for managing both architectural (The Open Group, 2002) and organizational (Dale, 2003; Hermanssen & Caron, 2003) changes defined, documented and complied? Has a consensus been reached on those possible future changes in the business environment (e.g. a future merger) or in the business requirements that need to be taken into account in the ongoing architecture design (Interview, 2005)?
- Effective risk management (Al-Mashari & Zairi, 1999; Belout & Gauvreau, 2004; Pinto & Mantel, 1990): Are the architectural risks defined, documented and complied? Are the risk management practices defined, documented and complied?
- Integration into the organization's business management processes (Ashmore et al., 2004; Control Objectives for Information and Related Technology, 2000): To what extent is the EA governance processes integrated to the organization's business management processes, such as investment process or strategy refinement process?

Project and Program Management

EA development is usually conducted through projects and project management skills play a crucial role in project success (Pinto & Kharbanda, 1996). Other issues regarded important are as follows:

- Program management (Interview, 2005): How is the coordination between various EA development projects organized and conducted? How is it assured that the projects are compliant with the EA? How is the inter-project communication conducted?
- Milestones and check points (Interview, 2005): Are the project milestones defined? How are they utilized? Is any kind of architectural evaluation done on the milestones?
- Lessons learned (Interview, 2005): Are the lessons learned (best practices), related either to the project work and project management, or to the architectural work and architectures, systematically collected by the end of the project?
- Realistic budgets and schedules (Belassi & Tukel, 1996; Coronado & Antony, 2002; Nah et al., 2001; Turner & Müller, 2005): Is the project budgeting successful? Is the project scheduling successful?

Assessment and Evaluation

Assessment and Evaluation of EA is undertaken as a part of the EA governance. What makes the EA evaluation challenging, is the fact that it may take years before the effects and consequences of, for instance, an architectural decision, can be measured (Interview, 2005). Essential issues in evaluation planning and implementation are, especially, as follows:

- Evaluation targets (Lopez, 2000; Taylor-Powell et al., 1996): What is evaluated? In the following some examples are suggested (Curran, 2005; Hilliard et al., 1996; Industry Advisory Council, 2005; Morganwalp & Sage, 2004; National Association of State Chief Information Officers, 2003): EA models and artifacts, EA processes, EA maturity, value of EA, business value added by EA (business-IT alignment), effectiveness of EA, completeness and correctness of EA, EA adoption (utilization or usage of architectures), people (competency and skills), or work environment (culture, leadership, structure).

- Purpose and audience of evaluation (Taylor-Powell et al., 1996): Why are these objects evaluated? By whom and how are the evaluation results used?
- Evaluation process and criteria (Lopez, 2000; Taylor-Powell et al., 1996): How and when is the evaluation done? Is the evaluation conducted in each step of the development process (Bredemeyer Consulting, 2000)? Is it a continuous process (Claver et al., 2003, Tarí, 2005)? Which evaluation methods are used? Which metrics or criteria are used? Which tools are used – benchmarking, reviews, quality function deployment (Erder & Pureur, 2003), scenarios (Interview, 2005), maturity models or other tools?

IT Investment and Acquisition Strategies

IT Investment and Acquisition Strategies refer to the extent to which the EA influences the IT investment and acquisition strategy of the organization; whether EA guides IT investments or not (U.S. Department of Commerce, 2003; U.S. Government Accountability Office, 2003). Key issues that need to be addressed are as follows:

- Investment process in the organization: What sort of investment process model is used? How are IT investments executed?
- Architecture decisions vs. IT investment decisions (U.S. Government Accountability Office, 2003): What is the relationship between architectural and investment decisions? Is an investment decision unavoidably also an architectural decision? Do architectural plans have an effect on investments? Are investments done on the basis of architectural planning? How and when are architectural plans used in the investment planning and execution?

Skilled Team, Training and Education

EA development requires teamwork between the key stakeholder groups; architects, business domains, top management, and even business partners (Schekkerman 2004). The following issues to be addressed are as follows:

- Architecture team (Chief Information Officers Council, 2001; U.S. Government Accountability Office, 2003): Is the architecture team established? How many persons are working in the team? Are the roles and responsibilities of the team members defined, documented and used? Has a chief architect been named (Akella & Barlow, 2004; Passori & Schafer, 2004)? Is the team working full-time? Does the team have necessary facilities and equipment (Reel, 1999)?
- Sufficient training (Chrissis et al., 2003): To what extent are both the team members and other key stakeholder groups trained in architectural work? Has a training plan been done for these groups? Do the architecture team members have the necessary skills; both business and technical skills (Boster et al., 2000; D'Souza & Mukherjee, 2004)? Is the competence of the team members evaluated? To what extent do the architects train other stakeholders (Interview, 2005)? Is the training considered as a continuous process allowing people to receive appropriate information and training courses at appropriate level of detail for their need (Al-Mashari & Zairi, 1999; Porter & Parker, 1993; Tarí, 2005)?

Training and education are needed at least in the following levels: 1) General EA information, including the strategies of the organization, the common EA framework, the EA vision and objectives, and the target architecture, should be provided to all stakeholders (Interview, 2005), 2) training in new technologies, best-practices, methods, tool usage, and so forth should be provided for architects (Basu, 2004; Coronado & Antony, 2002; Curran, 2005; Interview 2005), 3) IT information should be provided to business managers, and 4) business information should be provided to the IT managers (Morganwalp & Sage 2004).

Organizational Culture

While developing an EA, the organizational culture should also be taken into consideration aiming at good organizational and cultural fit (Lam, 2005; Sumner, 2000) because in many cases cultural changes are inevitable (Coronado & Antony, 2002). Especially, the organization's readiness to develop and utilize the EA is an essential issue (META Group Inc., 2000). It includes aspects like attitudes towards changes both by the management and the employees, communication environment, risk management and so forth (Mann & Kehoe, 1995; Motwani et al. 2005; Rudawitz, 2003). Moreover, the organization culture, particularly the organizational structure, has an impact on the success of an EA; if the EA issues are discussed only within a department or other profit center the perspective is too narrow to accomplish good and sustainable architecture solutions (Interview, 2005). Key questions related to cultural issues are as follows:

- Attitudes towards architecture approach: What is the role of the architecture within the organization; is the EA seen as a mentor and a guide helping business and IT decision making, or merely as an auditing or controlling mechanism (Interview, 2005)? How are the attitudes towards architectures and architects?
- Attitude towards changes (Luftman, 2000; Rudawitz, 2003; van der Raadt et al., 2004; 2005): How is the organization's capability to accept and adapt to changes in general? How are the attitudes towards architecture-driven changes?
- Trusting environment (both socially and politically) and open communication (Rudawitz, 2003; van der Raadt et al., 2004; 2005): Are different opinions or criticism allowed to be expressed within the organization? Are the architects encouraged to challenge each others' views and opinions and to debate the possible architectural solutions with each other (Interview, 2005)? Do the architects have the courage to question things without being branded as troublemakers (Interview, 2005)?
- Organizational constraints: Have any organizational constraints for architectural work been detected? How are they handled and resolved? Particularly, silo thinking and strict profit responsibilities may be barriers to EA success, if each department in an organization acts on a stand-alone basis, not interacting or co-operating with other departments, focusing only to the departmental bottom line (Interview, 2005).

CONCLUSIONS

In this study, we described the potential CSFs for EA derived from the literature review and the focus group interview. When evaluating our study, it should be remembered that the empirical data was collected during a single group interview session participated by five practitioners from three companies and, as such, strong generalizations cannot be made. Additionally, the literature review results presented to the interviewees may have influenced their response. We believe, however, that our study has exposed some important aspects of reaching a high-quality EA.

First, the quality of EA is a concept that does not yet have an established definition. We suggested a preliminary definition for the quality of EA. To put it simply, an EA has high quality if it is understood, accepted and used, and the EA is measured in order to ensure that the quality requirements are met. Furthermore, we consider the maturity models as one means of advancing the quality of EA.

Second, the success and quality of EA are influenced by several – and to some extent interrelated – factors. For instance, communication can be regarded as a focal issue, because it enables carrying out many of the other factors successfully. Especially, commitment seems to be dependent on communication (and the common language): if the communication practices are just about shaping up, it is unlikely that a strong top-management commitment, or organizational buy-in, has yet been reached. It also seems that if the EA objectives are defined and they support the business objectives, it will be easier to gain both the top management commitment and the organizational buy-in. The detailed dependencies between the potential CSFs, however, were not analyzed in this study.

Third, the potential CSFs for EA provide a selection of important issues to be taken into consideration in EA efforts. From this set, as suggested by Bullen and Rockart (1981) a limited set of the most critical factors for a particular organization at a particular point of time can be determined depending on the needs of the organization: in different organizations different factors may be regarded as the most critical ones.

Fourth, the potential CSFs can also be used as a checklist by which practitioners both in the IT user and service provider organizations undertaking, or planning to undertake, EA efforts can ensure that the efforts are comprehensive, well-implemented, and have the minimum chance of failure. Additionally, CSFs can be regarded as possible targets for which EA evaluation criteria, metrics and methods can be developed.

Consequently, this study raises some additional research questions, such as:

- What kind of dependencies there are between the CSFs? How interrelated the factors are? Furthermore, an interesting question is, whether there are any contradictory factors.
- How can an organization prioritize or weigh the CSFs to select the most critical factors of its own? How the phase of the organization's EA development, or the maturity of its EA, affects the prioritization needs and possibilities?
- How can the CSFs for EA be utilized in evaluating the maturity, and thus, the quality of

EA, in the organization? Which simple and usable evaluation criteria and metrics are suitable to measure the extent each CSF has been taken into account? Are there any other possible targets for which the criteria and metrics should be defined? How many criteria and metrics should be used in evaluating the organization's EA? How can an organization choose the most suitable ones for its purposes among these different criteria and metrics? Which metrics suit to a particular EA maturity level?

The next steps of the research project will focus on studying 1) how well the set of 12 CSFs for EA can be utilized in the initial EA assessment – how holistic and extensive view of the state of the organization's EA do they provide?, 2) whether these factors are the essential targets for evaluating an EA?, and 3) which metrics are suitable for each factor? Answering these questions will result in a more detailed EA evaluation model.

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Enterprise Architecture Benefits: Perceptions from Literature and Practice

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Abstract

Enterprise Architecture (EA) is considered a means for acquiring a multitude of benefits in organizations by most academic literature and practitioners alike. However, academic research has almost omitted the domain of EA benefits and value realization, and thus more research on the subject is needed. This paper describes a study which aims to chart the benefits of EA by a comprehensive literature review and a focus group interview of practitioners. As a result, a categorization of the EA benefits is composed and analyzed.

1. Introduction

Enterprise Architecture (EA) includes all the models needed in managing and developing an organization, and takes a holistic view of its business processes, information systems and technological infrastructure [see e.g. 1-3]. It has become one of the major interests of both business and academia. It is claimed to provide a vehicle for aligning and integrating strategy, people, business and technology, and enabling an agile enterprise – continually evolving within the ever-changing environment [see e.g. 4, 5].

However, investments need to be made in organizational, cultural and technical infrastructure to support the EA program [see e.g. 2] and be justified by demonstrating the positive effects of EA to key stakeholders [see e.g. 5]. Still, presenting the benefits of EA is difficult since measuring its effects comprehensively is demanding and the architecture itself is constantly changing [5]. Academic research has almost omitted the subject of EA benefit and value realization, focusing instead mostly on EA frameworks [see e.g. 6-8], and EA development methods and tools [see e.g. 9-11]. Recently, a few contributions have been made in the domain of EA evaluation [see e.g. 5, 12-16]. However, the evaluation and measurement – and even the definition of – the benefits and value of EA seem so far to have escaped the attention of academic research.

Nevertheless, the need for defining the potential benefits of EA is evident – it might even be the prerequisite for the selection of objectives for an EA program, measuring the realized benefits and value of EA, and thus providing a rationale for key stakeholder support and investments in EA [see e.g. 17]. Therefore, this study aims to chart the benefits of EA and EA work (EA planning, development and management) by an extensive literature review and a focus group interview of practitioners.

This paper is organized as follows. In the next section, the research method is described. In Section 3, the literature on EA benefits is discussed. In Section 4, the benefits of EA are categorized and in Section 5, the categorization is analyzed. Section 6 includes a discussion of the study's contribution and agenda for further research. Finally, Section 7 concludes the paper.

2. Research Method

To identify the benefits of EA, the following steps were conducted.

1. *Literature review*. Literature on EA and architectures in general was charted for references of benefits using both academic and general search engines on the Internet, using keywords such as benefit, objective, value and evaluation with terms enterprise architecture and architecture. Moreover, additional literature was found by studying the references sections of the found papers. Literature by both academia and practitioners was included in the review for a more diverse view of benefits. Academic journal articles and conference papers, magazine articles, books, research reports by institutions, industry white papers, published government documents and electronic sources were reviewed, and the found EA benefits listed. Subsequently, closely related benefits were combined for a more compact list of benefits by the discretion of the author. Based on reviewing the literature, a preliminary list of 27 EA benefits was composed.

2. *Focus group interview on the literature review results*. A focus group interview [see e.g. 18] of seven practitioners from five Finnish or international organizations, either information and communication technology (ICT) users or service providers, was organized in August 2006. The organizations were either independent companies, or divisions, subsidiaries or other parts of domestic or global enterprises. Furthermore, they represented different industries and employed from 14 to several thousand people. All of the organizations were conducting EA work and thus employed specialists who could contribute to the study. Each organization provided one or two persons to the interview. In four of the organizations, the interviewees had an EA-level viewpoint of the enterprise, and in one, they were more focused on the system architecture level. The objectives of the interview were 1) to review the literature review results, and 2) to collect additional, experience-based information. The interview was carried out in a group, because group influence was thought to stimulate the discussion. However, confidential information may thus have remained undisclosed. The interview was moderated by one researcher, while the other two took notes. In

addition to the notes taken, the interview was also audio-recorded.

3. *Composing a categorization of the EA benefits*. The results from the literature review and the focus group interview were analyzed and combined into a categorization of the EA benefits.

3. Literature on EA Benefits

Even though the number of academic research papers exclusive on the benefits of EA is very low, a greater number of studies mention several EA benefits or objectives. Generally, the benefits are not the main topic of the papers. On the contrary, they are typically briefly disclosed in the introduction section. Journal articles (7) and industry white papers (8) seem to dominate the area, added with a number of conference papers (5) and government documents (4), such as EA evaluation frameworks and reports. Moreover, a few research reports (3) by various institutions, books (2), magazine articles (2) and electronic sources (1) exist.

While the literature focuses on listing a multitude of benefits, it does not clearly define and describe them. Furthermore, there does not seem to be an established model for classifying the benefits in the EA context, despite some categorizations have been proposed [see e.g. 5, 19, 20]. Moreover, the literature does not generally differentiate between benefits at different levels of abstraction; particularly, between abstract, high-level benefits such as integration or agility of an enterprise [see e.g. 4, 21], and more concrete, lower-level benefits such as shortened cycle times or cost savings [see e.g. 5, 19]. Additionally, it does not commonly distinguish between the benefits, the characteristics of EA, and the areas of EA work from which the benefits could be gained. For example, standardization and integration activities may lead to cost savings [see e.g. 22], and all of these are mentioned as EA benefits [see e.g. 14, 23]. Furthermore, the causes, effects and other relationships between various EA benefits, EA characteristics and EA work activities are not clearly defined in the literature.

In addition to the deficiencies mentioned above, the literature does not normally provide academic research results of any kind to quantify the argued benefits or value of EA, with the exceptions of a few case studies [see e.g. 17, 24] and survey-based studies [see e.g. 19, 25, 26]. Even these provide mainly qualitative information of the gained benefits. While this kind of EA research is arguably carried out in the industry, the majority of the results do not become published.

4. Categorization of the EA Benefits

This section presents a categorization of the EA benefits identified in the literature review and the focus group interview. First, the benefits and their representative sources are listed on Table 1. Second, the benefits are categorized according to a Information Systems (IS) benefit classification model [27]. The seven most cited benefits and the benefit categorization are analyzed in the next section.

The focus group generally agreed with the preliminary list of EA benefits, and considered several of them especially important in their work. These benefits are listed on Table 1 as a reference number 45. Considering the challenges mentioned in the previous section, a sufficient magnitude of benefits was preserved to represent as much of the whole range of identified benefits as possible. However, a number of closely related benefits were combined to maintain clarity.

As can be seen from Table 1, the range of benefits is extensive and without proper categorization, it is difficult to comprehend. For this reason, a IS benefit classification model [27] was selected and applied to the domain of EA. The basis for selecting this model was its clarity, applicability and suitability: it is reasonable to categorize the EA benefits on the basis of their measurability and the potential to attribute them to EA or EA work.

The horizontal axis of the model distinguishes between quantifiable and non-quantifiable benefits, and the vertical axis between benefits that can be accounted to EA or EA work, and those that significantly depend on other organizational or environmental factors as well. In the model, the benefits are categorized into the following categories:

Hard benefits can be objectively quantified (e.g. in monetary terms, time or other numeric values) and attributed to EA or EA work. They could be related to possible cost and cycle time reduction and economies of scale. Moreover, they could include increased standardization attained by utilizing the standards defined in EA, increased reuse of architectural models, descriptions and documentation, and increased interoperability between systems constructed according to EA. Hence, they can potentially be attributed to EA.

Intangible benefits cannot be easily quantified, but they can be attributed to EA or EA work. These benefits can be realized, particularly, from the development and usage of architectural models and descriptions, leading to better insight of the enterprise and thus supporting e.g. decision making.

Indirect benefits can be measured in quantifiable terms, but cannot be attributed to EA or EA work. They are related, especially, to an enterprise's better position in the market, improved management and customer orientation, and more efficient business processes – factors that can be quantified by various metrics but only partially attributed to EA.

Table 1: the identified benefits of EA

Benefit	[1]	[3]	[4]	[5]	[8]	[12]	[13]	[14]	[17]	[19]	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[28]	[29]	[30]	[31]	[32]	[33]	[34]	[35]	[36]	[37]	[38]	[39]	[40]	[41]	[42]	[45]
Evolutionary EA development & governance				X																						X				X			
Provides a holistic view of the enterprise	X	X	X	X				X			X	X		X		X			X		X				X	X		X	X		X	X	X
Improved alignment to business strategy				X			X	X		X			X	X						X	X					X	X			X	X		
Improved alignment with partners	X			X				X			X		X			X										X		X	X				
Improved asset management				X				X							X	X									X	X							
Improved business processes									X	X							X			X										X			
Improved business-IT alignment			X	X				X	X	X	X		X	X			X		X		X				X	X				X		X	X
Improved change management	X	X					X	X				X				X	X	X	X	X	X	X	X		X							X	X
Improved communication		X		X				X		X	X		X	X				X	X	X						X						X	X
Improved customer orientation	X					X		X	X	X				X								X								X			
Improved decision making	X	X		X									X			X			X	X						X							
Improved innovation	X			X	X			X	X	X							X				X					X				X			
Improved management of IT investments	X				X			X					X	X	X	X		X	X			X							X	X		X	
Improved risk management				X	X			X		X	X		X	X	X				X	X	X			X		X				X	X		
Improved staff management									X		X		X	X														X	X	X		X	
Improved strategic agility	X		X	X				X	X	X	X	X								X						X							
Increased economies of scale																			X									X	X				
Increased efficiency				X		X							X	X	X		X					X	X										
Increased interoperability and integration			X		X	X	X	X		X		X	X	X	X				X	X	X	X	X										
Increased market value								X						X										X									
Increased quality						X								X					X	X		X						X	X		X		
Increased reusability				X	X	X		X			X		X	X							X					X	X				X	X	
Increased stability	X																															X	X
Increased standardization						X	X	X					X	X	X				X	X	X						X						X
Reduced complexity					X			X					X		X	X	X		X		X				X								X
Reduced costs				X	X	X		X		X	X		X	X	X		X				X	X	X			X		X	X	X	X		X
Shortened cycle times				X	X	X		X	X	X	X			X			X		X			X				X		X	X	X			

Strategic benefits are positive effects that are realized in the long run and are typically affected by a multitude of factors. Therefore, they generally cannot be objectively quantified or completely attributed to EA or EA work. These benefits may include, for example, increased stability of an enterprise in an environment of constant change, better strategic agility, and improved alignment with business strategy.

The benefits of EA were categorized into the model by using the author's discretion (see Figure 1). For this reason, the categorization is merely meant to be suggestive of the potential types of the EA benefits. Because of this rather subjective nature of the categorization, the relative positions of the benefits inside the categories were not specified. Therefore, the order of benefits inside the categories is horizontally alphabetical.

5. Analysis of the Categorization

In this section, the seven most cited EA benefits are selected for discussion and analysis. Subsequently, the categorization of the benefits is analyzed.

The most cited benefits from the literature and the focus group interview include 1) *reduced costs*, 2) *providing a holistic view of the enterprise*, 3) *improved business-IT alignment*, 4) *improved change management*, 5) *improved risk management*, 6) *improved interoperability and integration*, and 7) *shortened cycle times*. From these, *reduced costs* seem to be related to a great number of other benefits: the costs could be lowered by reducing duplication and overlapping in technologies and processes, reusing components, integrating systems, increasing standardization, and rationalizing procurement [see e.g. 5, 14, 22, 23]. *Shortened cycle times* also seem to be related, at least, to reuse and standardization [see e.g. 14, 22]. Realizing these benefits, on the other hand, can lead to increased efficiency [see e.g. 22].

Improved alignment between business and IT seem to be a vaguer concept, but is stated to be contributed at least by defining a common business vision by EA [see e.g. 14, 42] and performing governance over projects for EA compliance [see e.g. 31]. *Integration and interoperability* seem also to be related to alignment, and thus could be improved by increasing collaboration between organizational functions with the aid of integrated IT systems [see e.g. 4]. *Change management*, on the other hand, could be improved by documenting the current state, the target state, and transition plans to EA [see e.g. 31, 42]. Moreover, EA documents could also be used for the improvement of *risk management*, by e.g. providing a description of the current state for preparing an enterprise for unplanned changes [see e.g. 14], defining common standards, guidelines and principles that the IT organization can use for decision making, and providing information to projects for assuring EA compliance [see e.g. 31]. Finally, most of the benefits seem to be contributed by a *holistic view of the enterprise* that a high-quality EA can provide.

Recent EA surveys [25, 26] from the industry, as well as the focus group interview results, also indicate that *change management*, *reduced IT costs* and *alignment between business and IT* are among the most important EA-related concerns for practitioners. Moreover, providing a *holistic view of the enterprise* seems to be a self-evident benefit of EA in literature. However, *managing the complexity of IT assets* is considered equally important in the surveys and was also one of the concerns of the focus group, but was not among the top-10 most cited EA benefits in this study.

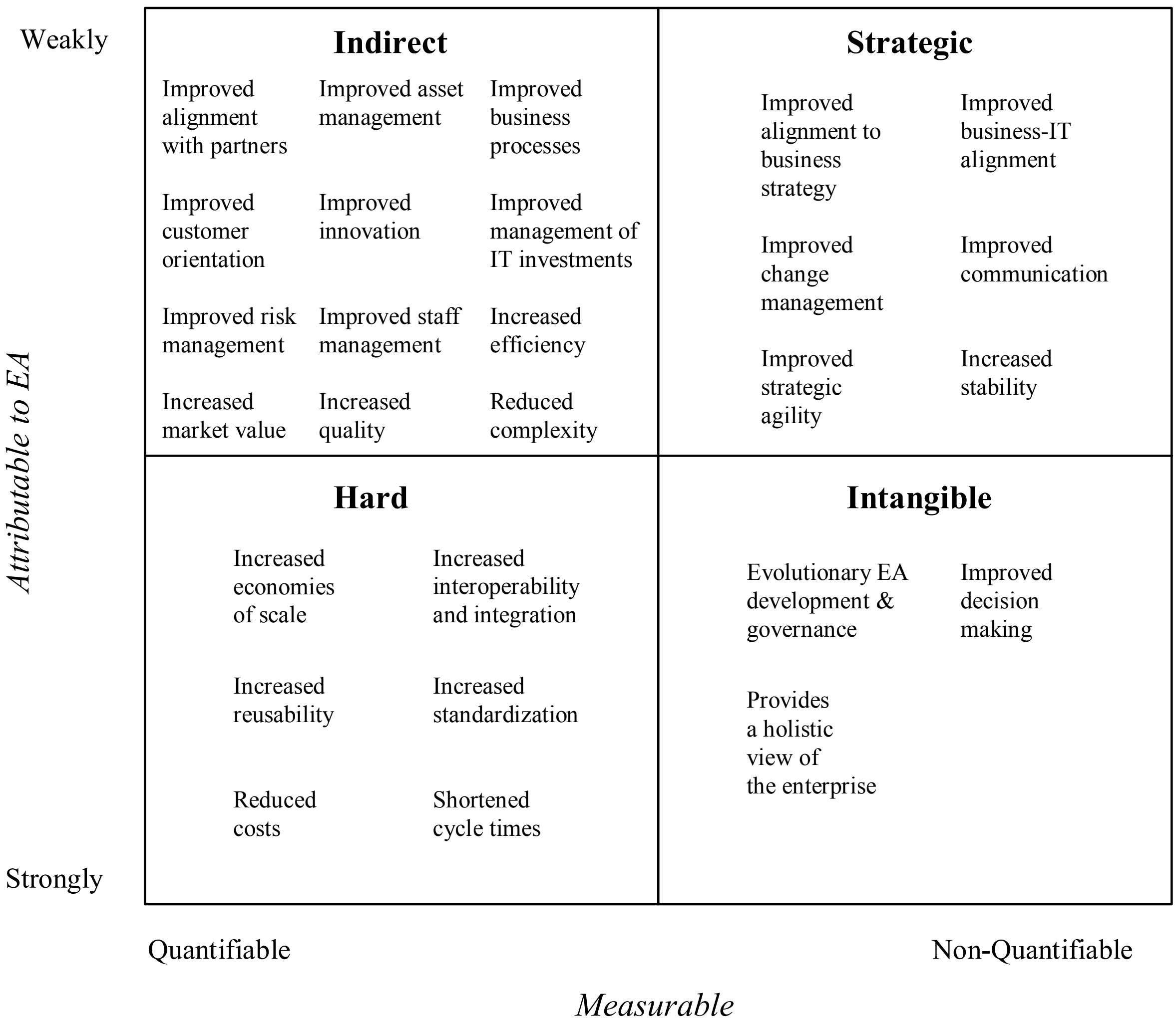

Fig 1. The EA benefits categorized according to the Giaglis et al. model

According to the categorization, the challenge of evaluating and measuring the benefits seems to be that most of the benefits are indirect or strategic – even if they can be clearly quantified, they are difficult to address to EA or EA work. Moreover, the relatively large amount of strategic benefits impedes the evaluation as well. Consequently, in the initial stages of EA maturity, applicable evaluation criteria and metrics for hard benefits could be developed for showing “quick wins”. In higher maturity levels however, metrics for other types of benefits should be developed as well to quantify the value of EA more comprehensively. Even the indirect and strategic benefits might include elements which could be evaluated and addressed to EA.

6. Discussion

This section includes a discussion of this study’s contribution to research and practitioners, limitations of the study, and agenda for further research.

Contributions to Research

This study contributes to research in several ways. Firstly, it provides researchers with a perception of what benefits can be received from EA and EA work. Secondly, it provides one potential categorization for the benefits. Thirdly, the categorization can be used as a basis in determining what kind of evaluation criteria and metrics could be used in measuring the realization of the benefits.

Contributions to Practice

Practitioners may use the results of this study to select a certain set of benefits to act as objectives of their EA programs. Moreover, the research provides practitioners with a variety of potential EA benefits for rationalizing EA work initiation. Practitioners may also find the categorization useful in developing metrics for quantifying the benefits in later stages of EA work.

Although the benefits of EA could be used by practitioners to define a set of EA objectives to be pursued, the focus group advised that conducting EA work by merely aiming at the selected objectives could result in a failure, because factors external to the objectives (e.g. business environment changes and undisclosed business goals) may also have a considerable effect on EA work. Moreover, the interview showed that in enterprises initiating EA work, the risk of failure is greater and the benefits acquired cannot be clearly addressed to EA because of the less established position and influence of the EA program in the enterprise.

Limitations of the Research

There are a few limitations in this study, which could impede generalizing the results. Firstly, EA benefits are organization-specific at least to some extent. There could be differences between enterprises depending on e.g. the geographical area, the enterprise type, the industry, the EA maturity, the size of enterprise and the EA program, and the market situation and position. Naturally, the selection of EA objectives and thus the direction of the EA program also have an effect on the benefits received. Secondly, the categorization of the EA benefits is based only on the author’s discretion. Thirdly, the study is primarily based on the extensive literature review, supplemented only by a small amount of empirical data (the focus group interview). However, the literature review already provides a valuable contribution, which is strengthened by the validation and practical viewpoint of the focus group, and clarified by the categorization of the benefits.

Agenda for Further Research

This study provides a number of important themes for further research. Firstly, the benefits itself should be unambiguously and consistently defined, and their categorization empirically validated. Secondly, a valid and consistent model should be constructed to illuminate the relationships between EA benefits, EA characteristics and EA work activities on different levels of abstraction. Thirdly, metrics and evaluation criteria should be charted and developed for measuring the realization of the benefits. Fourthly, the benefits should be empirically quantified by applying these metrics and criteria to provide a rationale for adopting an EA approach or making further investments in EA. In the near future, we aim at identifying metrics and evaluation criteria for assessing EA value and the realization of the benefits.

7. Conclusion

In this paper, the benefits of EA were charted by an extensive literature review, supplemented by a focus group interview of practitioners. Subsequently, the benefits were categorized according to a IS benefit classification model [27]. Furthermore, seven of the most cited benefits and the categorization were analyzed.

It is worth noting that EA should be communicated effectively to realize the benefits [see e.g. 22]. Even then, EA does not guarantee long-term value because a multitude of factors affects the realization of benefits [see e.g. 43, 44]. Moreover, distinguishing the contribution of EA from all the potential factors affecting the realization of the benefits is a significant challenge. Naturally, the benefits identified in this study are only suggestive of what kind of value an EA could provide to an enterprise. Nevertheless, the results can be used by practitioners to build a business case for EA. On the other hand, enterprise decision-makers should note an opposite argument: EA should be seen as an asset, not an expense, and that the expenses are actually realized by not investing in EA [see e.g. 22, 42].

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Enterprise Architecture Compliance: the Viewpoint of Evaluation

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Abstract: Enterprise Architecture (EA) provides a holistic view of entire organization, including various viewpoints such as business, information, systems and technology. It is of interest for academics and practitioners alike. It has been suggested that EA is an approach for controlling the complexity and constant changes in the organization and its business environment, assisting organizations in realizing a multitude of positive business impacts. As the organization transforms from the current EA state towards the improved target state through a set of projects, at least the compliance between the projects and EA should be examined to assure that the organization is moving towards the desired direction. The concept of EA compliance has not been a target of academic research, but practitioners have addressed the concept more extensively in the form of compliance evaluation method descriptions, checklists, white papers and standards. The concept has especially been addressed in the US Government. Nonetheless, the area of research is fragmented, lacking a comprehensive perception of EA compliance and its evaluation, stressing only the regulatory and corporate governance connotation of the term, and focusing mainly on the EA compliance of projects. However, we consider this perception to be too narrow, and want to study if there are any other aspects that should be addressed. Therefore, in this paper, we address the concept more extensively, aiming to develop a broader, unbiased understanding of the concept of EA compliance. Particularly, based on a literature review and a focus group interview of EA practitioners from both information technology (IT) user and service provider organizations, we describe the various possible perspectives of EA compliance, and discuss various areas of its evaluation. Especially, EA compliance evaluation goals, evaluation targets and evaluators are addressed. This extensive view to EA compliance enables organizations to assure that the transition towards the target state is controlled more systematically, for example by guiding investments and development projects to comply with EA.

Keywords: Enterprise Architecture (EA), Enterprise Architecture work, compliance, evaluation

1. Introduction

Enterprise Architecture (EA) is an approach for supporting the management and development of an organization through a set of architectural models, usually including the viewpoints of business, information, information systems and technology (see e.g. de Boer et al. 2005, Kaisler et al. 2005, Jonkers et al. 2006). As well as the current architecture, EA also includes a description of the target architecture and a transition plan (Armour et al. 1999, Lankhorst 2005). A multitude of organizations are in the process of implementing the approach, seeking to realize several important business and information technology (IT) related benefits. Hence, EA is considered highly interesting by both academics and practitioners.

Typically, the transformation from the current EA towards the target EA is carried out through a set of projects (see e.g. The Open Group 2006). Therefore, these projects should be guided and controlled by EA to ensure that the projects and their output actually move the organization towards the target EA (see e.g. The Open Group 2006). In other words, the projects have to be compliant with EA.

Despite its importance, the concept of EA compliance has not received the attention in academia thus far – academic literature on the subject is extremely rare. Literature on the subject mostly consists of practical sources, such as US Government and other public administration method descriptions, industry white papers, and standards. Mainly, these sources deal with tools and procedures for supporting or conducting EA compliance evaluation, such as evaluation process descriptions (Eurocontrol 2006, The Open Group 2006, CIO Council 2001, NIH 2006, GAO 2003) or checklists (NIMA 1998, The Open Group 2006) developed by practitioners. Also, definitions exist for the levels or “amount” of compliance (The Open Group 2006, BTA 2006).

Currently, many organizations are actively developing their EA processes, and EA compliance related activities as a part of these processes. This indicates the importance of the concept of EA compliance in practice. The downside of the existing literature is that the concept of compliance seems to be vague, especially in the context of EA. In addition, it does not seem to be completely clear how to evaluate EA compliance. Hence, we consider EA compliance as an important area of further scrutiny: does EA compliance encompass only the compliance between projects and EA, or are there other aspects that should be addressed? Therefore, this paper aims to develop an extensive perception of EA compliance. Particularly, we want to describe the various possible perspectives of EA compliance, and clarify its evaluation by addressing the following issues: 1) what are the goals of EA compliance evaluation, 2) what are the specific targets of EA compliance evaluation, and 3) who should evaluate EA compliance.

The study consisted of the following steps:

- *Literature review* was carried out systematically. First, a keyword search in four high-quality academic databases (Academic Search Elite, Electronic Journals Service, Science Direct and Web of Science), Google Scholar and Google was carried out by keywords such as "compliance" and "conformance" to investigate the concept on a general level. Second, keywords such as "architecture and "enterprise architecture" were added to the search to scrutinize it in the EA context. On the basis of the review, the concept of EA compliance was described, and the selected aspects of EA compliance evaluation addressed.
- *Focus group interview* (see e.g. Krueger and Casey 2000) of seven EA practitioners representing five Finnish or international IT user and service provider organizations, employing from 14 to several thousand people, was arranged to validate the literature review results and to supplement additional, experience-based information. Two researchers conducted the interview; one moderated the discussion and the other took notes. The interview was also audio-recorded for reviewing and completing the notes.
- *Analysis and consolidation of the results* of both the focus group interview (later referred as interview) and the literature review was carried out with the help of the recordings and notes. Specially, the description of EA compliance was revised, and practical views on EA compliance evaluation targets and evaluators constructed on the basis of the interview results.

The paper is organized as follows. Next, we discuss the concept of EA compliance. Following this, EA compliance evaluation is discussed from the practical viewpoint in terms of evaluation goals, targets, and evaluators. Finally, the last section concludes the paper.

2. Concept of EA Compliance

In literature, compliance mainly refers to the conformance with rules – standards, regulations, laws, contracts and so forth (Quality Assurance Project 2006, PEER Center 2006, Internal Auditing Standards Board 1995, Allman 2006), but no single well-defined definition seem to exist. The same applies in the EA context as well. Instead, the literature review gave us the following perspectives.

First, it is suggested that EA compliance aims to ensure the compliance of individual projects with EA, which can be assessed with the help of two processes as described in TOGAF (The Open Group 2006):

- *Architecture Compliance Review Process* evaluates a single project against the agreed "architectural criteria, spirit, and business objectives" and
- *Project Impact Assessment* evaluates the "project-specific views of the enterprise architecture that illustrate how the enterprise architecture impacts on the major projects within the organization".

Second, EA compliance may refer to the compliance between EA and standards, reference models, or principles, which can be evaluated via a compliance assessment process (The Open Group 2006). Third, EA compliance may also aim to the use and enforcement of EA in the every day decision making by the organization (Spurway and Patterson 2005). In order to ensure that real value is gained through EA, both *proactive and reactive compliance processes* are needed. The former is concerned with how and when EA artifacts are used in IT projects, and the latter is related to EA reviews and assessments carried out in IT projects. (Spurway and Patterson 2005) Fourth, it has been suggested that compliance between EA and organization's procurement policies should also be considered (Aziz et al. 2006, GAO 2003, CIO Council 2001). Therefore, it seems that EA compliance is related to projects and investment processes alike.

Deriving from the various perspectives above, EA compliance encompasses at least three aspects:

- Compliance between organization's projects or investments and agreed boundaries set by EA,

- Guidelines and constraints induced to projects or investments by EA, and
- Compliance between EA descriptions and standards, reference models, or principles.

Finally, although literature generally considers it to be self-evident, we want to stress that EA should reflect the business strategies and objectives of the organization as closely as possible (see e.g. GAO 2003). Therefore, EA compliance should also take the aspect of business-drivenness into account.

The above perspectives of EA compliance were discussed by the interviewees, who brought out that they provide a too limited view of the concept. Instead, it was suggested that there could be two types of EA compliance:

- *Internal compliance* refers to the compliance between investments – as well as the projects that implement the investments – and EA with its policies and guidelines.
- *External compliance* is about the compliance between EA and business – are the EA guidelines and target state descriptions in line with the business vision, mission, objectives, strategies, and action plans. External compliance may also refer to EA's ability to react to the changing environment of the organization, as well as to the compliance of EA with the laws and regulations the organization needs to obey.

Next, these types of EA compliance are addressed from the evaluation viewpoint.

3. Evaluating EA Compliance

In this section, the evaluation of EA compliance is discussed in terms of main goals of compliance evaluation (why to evaluate EA compliance), more precise evaluation targets (what is compared to what), and evaluators (who conducts the evaluation). These first two issues are discussed because they are the first aspects to begin any evaluation planning with (see e.g. Niemi and Ylimäki 2007). Evaluators are addressed because they have been disregarded in literature, and the diversified nature of compliance suggests that multiple evaluators may be required.

3.1. Key Goals of Evaluation

In literature, three major goals for EA compliance evaluation are suggested:

- *Directing a project or an investment to comply with EA – the proactive approach* (adapted from Spurway and Patterson 2005), see also (The Open Group 2006, NIH 2006, Aziz et al. 2006, CIO Council 2001, Paras 2005): this includes particularly direction and guidance of projects and the investment process to ensure that the organization is moving towards the target EA, supporting projects and the investment process by defining how and when EA artifacts are utilized, and encouraging the organization, especially IT projects, to utilize EA descriptions and guidelines.
- *Assuring the compliance between the output of a project or an investment process and EA – the reactive approach* (adapted from Spurway and Patterson 2005), see also (GAO 2003, NIH 2006): this includes EA reviews and assessments within projects and the investment process, and project and investment follow-up with regard to EA descriptions.
- *Assuring the compliance between EA and internal or external standards, reference models and principles* (adapted from The Open Group 2006): this includes evaluation of EA descriptions to be constructed according to defined standards, reference models and principles, by both the organization and external authorities.

Furthermore, based on our experiences in the ongoing research project, we suggest the following additional goal.

- *Ensuring the usability and appropriateness of EA policies, EA frameworks, EA descriptions, business objectives and so forth:* this provides basis for improvement, for example, by evaluating EA through experience-based feedback from projects and the investment process, or by identifying whether the EA descriptions, standards, policies and principles, or even the business requirements themselves require modification.

This notion has also been disclosed in the context of non-compliance, which may be a positive situation: it could provide feedback on the areas of EA to be potentially modified, or areas of project architecture that may be incorporated into EA (The Open Group 2006).

All these goals were considered essential by the interviewees as well. In addition to these high-level goals, a number of various benefits of EA compliance evaluation are defined in literature. Particularly, TOGAF (The Open Group 2006) provides an extensive list of project compliance review benefits, including benefits related to architecture quality management, project management, business, and EA visibility in the organization.

3.2. Evaluation Targets

According to literature, EA compliance evaluation usually deals with the following three high-level objects: 1) the EA itself, 2) a project or an investment process, and 3) the output of a project or an investment process (The Open Group 2006, Spurway and Patterson 2005, GAO 2003, Aziz et al. 2006, CIO Council 2001, NIH 2006). The EA compliance evaluation target can therefore be defined as the relationship between these objects. The high-level objects are displayed in Table 1 together with the potential low-level items to be utilized in evaluating the relationship between the objects in EA compliance evaluation.

Table 1: EA compliance evaluation objects

Evaluation Object	*Items to be evaluated*	*References*
Enterprise Architecture	- Architectural descriptions (target architecture) - Transition plan - Principles and guidelines	(Spurway and Patterson 2005, The Open Group 2006, CIO Council 2001, Aziz et al. 2006, GAO 2003, NIH 2006)
Project / investment process	- Architectural descriptions (project or system architecture) - Business case - Acquisition plan - Project plan	(CIO Council 2001, Aziz et al. 2006, GAO 2003, NIH 2006)
Project / investment process output	- Architectural descriptions (project or system architecture)	(NIH 2006, Spurway and Patterson 2005, GAO 2003)

However, the interviewees considered the above view of three evaluation objects, and therefore also the evaluation targets, to be insufficient in practice. Particularly, they stated that compliance between EA and business (vision, mission, objectives, strategies, and action plans) should not be taken for granted; instead, it should be regarded as a separate evaluation target. Moreover, the group expressed that projects and investments should not be paralleled as one evaluation object; in reality, project is a tool to implement an investment. Finally, they considered external partners, vendors and customers to be important evaluation objects as well in certain situations.

Based on the literature review and the interview, we suggest the following high-level objects between which EA compliance evaluation can potentially be conducted:

- *Business:* particularly business vision, mission, objectives, strategies, and action plans.
- *Investment:* needed to fulfill certain business objectives.
- *Project:* the tool to implement an investment.
- *Enterprise Architecture*: a holistic view to the entire organization.
- *External Directions:* especially regulations, standards, or reference architectures that need to be taken into consideration in business operations or IT development.
- *Partners and Vendors:* may provide their own procedures, guidelines or constraints in out-sourcing engagements or when an organization purchases commercial off-the-shelf (COTS) products.
- *Customers:* in some cases, the organization’s customer’s EA, practices or guidelines need to be evaluated for compliance as well.
- *Actual Impacts of a Project or an Investment:* indicating whether and how long a step or transition has the project or investment taken towards the target EA state.

These evaluation objects, as well as the evaluation targets of both internal and external compliance, are displayed in Figure 1. Compliance between the objects – the evaluation targets – is depicted with arrows. Block arrows depict primary internal or external compliance evaluation targets and small dotted arrows other possible targets to be evaluated. Additionally, examples of lower-level items belonging to each object are included to illustrate the possible documents that can be utilized in compliance evaluation.

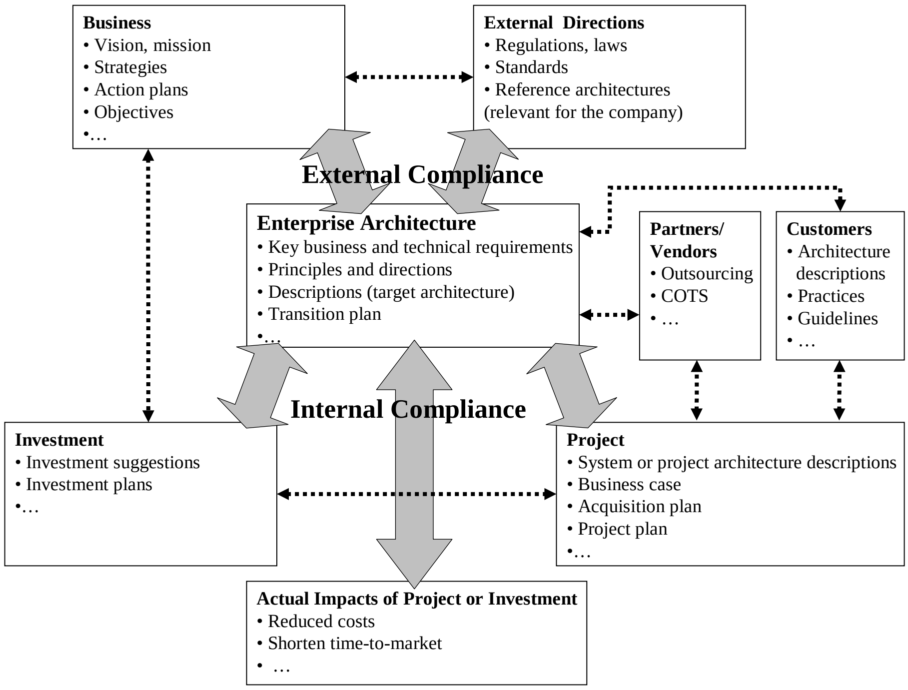

Figure 1: EA compliance objects and evaluation targets (derived from the interview results)

According to the interview, both internal and external compliance should be evaluated. In addition, there is a set of other possible evaluation targets between the evaluation objects that may require consideration in organizations. These aspects are briefly addressed in the following.

External EA compliance evaluation targets. First of all, compliance (on an acceptable level) is required between business and EA. According to the interviewees, it should be evaluated especially in the case of top management or strategy change, helping to assure that EA stays compliant with the altered business strategy, objectives, or other business requirements. Another external compliance evaluation target is the compliance between external directions and EA. Evaluation of this relationship is required especially if a reference architecture, such as TOGAF (The Open Group 2006), is applied.

Internal EA compliance evaluation targets. Similarly, compliance evaluation is required between EA and an investment, a project, and the actual impacts of both investments and projects. The interviewees stressed that it is possible for a project to succeed and fulfill its objectives, but for the investment the project implemented to fail – the impacts of the investment were not as expected. Additionally, compliance between a project and EA may include two levels (adapted from The Open Group 2006): EA design process compliance (are we doing things right) and EA compliance (are we doing the right things).

Other possible EA compliance evaluation targets. First, compliance should be assured between external directions and business to ensure that all necessary regulations, laws, standards, and so forth, are conformed to. Second, it should be assured that there is compliance between business and an investment. Third, compliance is also required between EA and partners and vendors, especially in mergers and outsourcing cases. The merger or outsourcing partner may have their own EA policies and guidelines, and the organization may need to reach compliance with them. If a project utilizes COTS products, the products' characteristics may affect the compliance between EA, the project, and its impacts. In addition, IT vendors and service providers may provide practices, methods and architectural documents to projects, affecting EA compliance. Fourth, in close customerships, compliance (at least to some extent) may be required between an organization's and its customer's EA, practices and guidelines. Finally, it should be assured that a project stays compliant with the investment it is supposed to implement.

3.3. Evaluators

Literature typically does not state precisely which stakeholders should conduct EA compliance evaluation. However, Spurway and Patterson (2005) provide examples on two classes of EA compliance evaluation roles:

- *Project roles*, which provide necessary project documentation needed in EA compliance evaluation, and
- *Architecture roles*, which carry out the actual compliance evaluation and support project roles in the identification and creation of necessary documentation.

Generally, the EA team seems to be considered a self-evident evaluator. Nevertheless, according to National Institutes of Health (NIH 2006), self-evaluation of EA compliance can also be carried out in projects. Hence, we initially proposed two types of stakeholders that carry out EA evaluation (adapted from NIH 2006, Spurway and Patterson 2005):

- *EA team*, which provides direction and guidance to projects and investment processes, and carries out formal EA compliance reviews. Compliance guidance is either 1) provided to projects or the investment process automatically or 2) asked by project or investment process representatives when needed.
- *Project or investment representative*, e.g. the project manager, who provides the EA team with documentation needed in EA compliance evaluation, but can also carry out self-evaluation of EA compliance.

However, the literature-based viewpoint of two major evaluators was considered too limited by the interviewees. Instead, they suggested that potential EA compliance evaluators are the stakeholders (or roles) that have responsibility in the area of each evaluation object. According to this perception, the possible evaluators are displayed in Table 2.

Table 2: Possible evaluators of EA compliance, based on the interview

Evaluator	*Description*	*Responsibility area*
Business Developer, Process Owner, or Business Architect	Has the responsibility of business (process) development or business architecture, and could perform or assist in evaluating the compliance between business and EA. Also, may perform or assist compliance evaluation between business and external directions or an investment.	Business
EA Team or Enterprise Architect	Provides direction and guidance for projects and performs or assists in evaluating both external and internal compliance. Also, may evaluate the compliance between EA and partners' or customers' policies and guidelines. Evaluation is possibly conducted with the help of (formal) compliance reviews.	Enterprise Architecture
Investment Representative, e.g. Controller	Participates in evaluating whether the planned investment is in line with the organization's strategies and goals.	Investment
Project Representative, e.g. Project Manager or Technical Architect	Has the responsibility of project management or project content. May carry out self-evaluation of compliance between the project and EA. In addition, may participate in conducting compliance evaluation between the project and partners, customers or the investment. However, the project manager may not be aware enough about EA to be able to do self-evaluation.	Project
Representative(s) of Out-sourcing or IT/service Provider Partner(s)	Assists in evaluating whether partner's policies and guidelines, or even its EA, are taken into account in organization's EA and projects.	Partners

In addition to the stakeholders mentioned in Table 2, there may be yet another stakeholder who could be regarded as an evaluator of EA compliance: the EA governance board, also referred to as the architecture board (see e.g. The Open Group 2006) or the EA steering committee (see e.g. CIO Council 2001). If an EA governance board exists in an organization (including representatives from various stakeholder groups), it may have – among many other things – the responsibility of evaluating

EA compliance. Thus, possible problems encountered if any single stakeholder (such as a project manager or the EA team) evaluates its own work can be avoided.

4. Conclusions

In this paper, we presented a study which aimed at discussing the various perspectives of EA compliance, and address its evaluation in terms of evaluation goals, targets and evaluators. In this section, the main conclusions of this study are highlighted and themes for further research provided. When judging our study, it should be remembered that it is based on a literature review validated and supplemented by a focus group interview of seven practitioners from five organizations initiating EA work. Our work was planned as a preliminary study: we have attempted to elucidate the vague concept of EA compliance and to start a discussion on the subject.

The concept of EA compliance seems to include more aspects than the compliance with laws and regulations alone. It was suggested that EA compliance can be divided into internal and external aspects. The former refers to ensuring that investments, projects implementing the investments, as well as their actual impacts, are conformant with EA and its policies and guidelines. The latter refers to ensuring that EA is conformant with the business objectives and strategies. It may also refer to the EA's ability to react to the changing environment of the organization, as well as to the conformance with the laws and regulations the organization needs to obey.

Subsequently, EA compliance evaluation was addressed in terms of evaluation goals, evaluation targets and evaluators. The main goal of EA compliance evaluation is to ensure that the organization is moving towards the target architecture. Basically, this can be done in two ways: 1) by directing a project or investment to comply with EA, or 2) by assuring the compliance between the actual impacts of investment or project and EA. Additionally, EA compliance evaluation helps ensure the usability and appropriateness of EA policies, descriptions and so forth and provides valuable feedback to the architecture group: is there a need to change something in the EA, or should even the business requirements be reconsidered?

A set of evaluation objects between which compliance may be evaluated were suggested. These objects include: business, investments, EA, projects, external directions, partners, customers, and the actual impacts of an investment or a project. Therefore, compliance evaluation targets are the relationships between these objects. Several targets were described, divided into external, internal and other possible evaluation targets. Moreover, stakeholders conducting or assisting the EA compliance evaluation were suggested to be those stakeholders who deal with or are in charge of the above mentioned evaluation objects. Usually, the EA compliance evaluation is conducted with the help of documents related to each evaluation object.

Furthermore, the interviewees stressed that also the following two aspects should be kept in mind when planning and conducting EA compliance evaluation:

- *EA compliance has a dynamic nature:* organizations' environment is constantly changing, and so are their EAs. Therefore, compliance can be evaluated to be on an acceptable level at the moment, but it does not guarantee that this is the case in future.
- *EA compliance seems to depend on the EA maturity level:* both the meaning and the content of EA compliance may vary according to the EA maturity level. It was suggested that in the lower levels of maturity (in the beginning of EA development work), EA compliance and its evaluation actually equals quality assurance, and especially the impacts of EA work are a focal issue. After the EA process has become a more established, more profound aspects of EA compliance will become increasingly important. However, the maturity level dependence was not studied further in this research.

The extensive view of EA compliance enables organizations to address the issue more comprehensively. It can be used to make sure that all the important aspects of EA compliance have been considered – judging from the literature reviewed, the concept has not been comprehensively addressed before, even in official compliance processes and practices. In practice, this paper may provide ideas and views on how to deploy EA guidance, descriptions and principles to projects and investment processes, which in turns enables the organization to assure that it is moving towards the desired target architecture. These perceptions, together with the various aspects of EA compliance evaluation presented, may also serve as a stimulus for organization-specific planning of EA compliance evaluation, which is eventually required if the organizations want to endorse EA compliance. However, each organization needs to make its own decisions on the actual steps of the evaluation process, and to implement it as a continuous EA governance activity.

For researchers, the results provide a foundation for which to build further research. Especially, more generic practices, guidelines and reference models for systematic EA compliance evaluation could be developed. Furthermore, the relationship between EA compliance and EA maturity could be studied in more detail to clarify how the organization's EA maturity level affects the meaning and content of EA compliance and its evaluation.

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Enterprise Architecture Evaluation Components

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ABSTRACT

Enterprise Architecture (EA) is a holistic view of an organization, including the viewpoints of business, information, systems and technology. It is stated to provide significant benefits to organizations, and is therefore of interest for both academics and practitioners. However, evaluating EA, or its benefits, is difficult. Moreover, the studies on EA evaluation are mostly inconsistent, and almost omit the planning aspect of evaluation. This study suggests the evaluation components that need to be addressed in EA evaluation planning, charted by a literature review supplemented and validated by a focus group interview. In addition, four evaluation components are further described.

Keywords

Enterprise Architecture, evaluation, evaluation components, evaluation planning

INTRODUCTION

Enterprise Architecture (EA) provides a holistic view of an organization through a set of architectural models, including the viewpoints of business, information, systems and technology [see e.g. 6, 14, 16]. It is an approach for managing and developing an organization, and is stated to provide a multitude of positive business impacts [see e.g. 10, 20]. Therefore, EA is of growing importance for both academics and practitioners. However, a great deal of resources has to be engaged to EA work (that includes EA planning, development and governance), and thus evidence of its positive impacts has to be presented through EA evaluation to rationalize the investments on EA [see e.g. 20]. Moreover, it is widely known that information gained through successful evaluation is crucial in the management and improvement of any initiative. Nevertheless, the research on EA is currently fragmented, focusing mostly on frameworks [see e.g. 12, 28, 31], and development methods and tools [see e.g. 3, 7, 18]. Only recently have EA evaluation issues gained some attention [see e.g. 20, 21, 26]. Still, the studies on EA evaluation are mostly inconsistent, focusing particularly on defining EA metrics and evaluation criteria, especially in the form of maturity models [see e.g. 9, 13, 24], but almost omitting the aspect of elaborate evaluation planning. However, we think that EA evaluation planning requires taking into account a broader set of aspects than metrics alone. Therefore, this study pursues to suggest the evaluation components needed to be addressed already in the EA evaluation planning phase, before organizations move on to the actual evaluation.

The paper is organized as follows. First, the research process is briefly described. Second, the components of EA evaluation are presented. Third, four components – EA objectives, evaluation objectives, evaluation targets, and audience of the evaluation results – are described in more detail. Finally, the last section concludes the paper.

RESEARCH PROCESS

The study was conducted in four stages. First, a literature review was carried out to compose a perception of program evaluation, its components, as well as to chart the possible content of the components in the EA context. Second, a focus group interview [see e.g. 17] of seven practitioners from five Finnish and international ICT user and service provider organizations was organized in August 2006 to validate the literature review results and to supplement additional, experience-based information. The organizations were either 1) independent companies, or 2) divisions, subsidiaries or other parts of domestic or global enterprises. Moreover, they represented different industries and employed from 14 to several thousand people. Three researchers conducted the interview; one moderated the discussion and two took notes. The interview was also audio-recorded for reviewing and completing the notes.

Third, the information from the literature and the focus group interview was analyzed with the help of the recordings and notes, and combined to describe the components of EA evaluation. Fourth, especially four evaluation components – EA objectives, evaluation objectives, evaluation targets, and audience of the evaluation results – were discussed in more detail. These can be regarded as the starting points for EA evaluation planning. After addressing these components, it is possible to go on to defining suitable evaluation criteria (quality attributes), and usable and simple metrics to evaluate each evaluation target.

DEFINING THE EVALUATION COMPONENTS

Even though the evaluation discipline lacks a general theory [19], some definitions can be found. **Evaluation** can be described as “the identification, clarification, and application of defensible criteria to determine and evaluation object’s value, its merit or worth, in regard to those criteria [8]. Briefly, it is “a process of determining merit, worth, or significance” [19]. Basically, evaluation focuses on products or processes. This viewpoint has been adopted particularly in the discipline of quality management aiming at improving the quality of products and processes [5, 15].

Program evaluation refers to “the thoughtful process of focusing on questions and topics of concern, collecting appropriate information, and then analyzing and interpreting the information for a specific use and purpose” [30]. By program we mean a set of ongoing and planned activities aiming at a specific outcome [8, pp. 54]. Thus, EA can be regarded as a program.

A substantial amount of literature exists on evaluation [see e.g. 4, 8, 11, 19, 27, 29, 30]. A literature review gave us a list of building blocks that need to be addressed in evaluation planning. In Table 1, these building blocks or components of evaluation are briefly described. While these components, that are rather generic in nature, are regarded as essential in (program) evaluation, and especially in its planning phase, we suggest that this is also the case in the context of EA evaluation. EA deals with both products (architecture artifacts, models etc.) and processes (development process, management process etc.), which are the focus of evaluation by its definition. Hence, all the components in the table need to be addressed in EA evaluation planning as well.

Table 1. The components of evaluation.

Component	Description	References
Evaluation Purpose	The purpose of evaluation: - Why is the program carried out? - Why should the evaluation be conducted? - What is desired to be accomplished by the evaluation?	[8, 30, 32]
Evaluation Target	The object under evaluation (to delimit the factors to be considered): - What are the evaluation targets (the whole program, a particular area, or a number of areas within the program)?	[8, 19, 30]
Evaluation Audience	Potential users of the evaluation information and results: - Who will use the evaluation results? - How will they use it? - What do they want to know? Which questions will the evaluation seek to answer?	[8, 11, 30]
Quality Attributes and Metrics	The characteristics of the target that are to be evaluated: - What information will help to answer the evaluation questions? - What information is needed to answer the questions?	[8, 19, 30, 32]
Yardstick or Standard	The ideal result against which the real result is to be compared.	[19, 32]
Data Gathering Techniques	The techniques needed to obtain data to analyze each characteristics of an evaluation target: - What sources of information will be used? - What data collection method(s) will be used? - Which instruments (e.g. recording sheet, questionnaire, video or audio tape) will be used? - When will the data be collected (e.g. before and after the program, at one time, at various times, continuously, over time)? - Will a sample be used? - Who will collect the data? - When will the data be gathered? What is the schedule?	[8, 19, 30, 32]

Data Synthesis Techniques	Techniques used to judge each characteristic of an evaluation target and, in general, to judge the target, obtaining the results of evaluation: - How will the data be organized or tabulated? - What, if any, statistical techniques will be used? - How will narrative data be analyzed? - Who will organize and analyze the data? - How will the data be interpreted and by whom? - How will the evaluation findings be communicated and shared? To whom?	[8, 19, 30], see also [11]
Evaluation Process	Series of activities and tasks by means of which an evaluation is actually performed: - What steps are needed? (E.g. evaluation design, examination/data gathering, and decision making including synthesis, analysis, and documentation). - When will the steps be conducted? - How long will it take to conduct each step? - Who conducts the steps? - How will the results be documented, reported, communicated so that they are understood and regarded as credible? - Who will receive the report? Will it answer their questions?	[8, 19, 30, 32]
Evaluation Management	Issues related to responsibilities, resources required (people, budget, timeliness, and so forth) and risks. - What kind of expertise is needed to conduct the evaluation? - Who are available to work on evaluation (either from the organization the evaluation takes place in, or external evaluators)? - How much may the evaluation work cost? - When are the evaluation results needed? Flexibility is important; evaluation should be able to be completed at a point where it will have the maximum impact in the organization. - Are there any threats that may harm the validity or reliability of the results? Are there any other risks to be considered?	[11, 30, 32], see also [8]

According to Table 1, the definition of evaluation purposes needs to start with answering the question “why is the program carried out”. In the context of EA, this requires an understanding of EA objectives; what are the organization’s goals of EA and EA work. EA objectives provide a valuable input to EA evaluation planning affecting both the purposes and the targets of EA evaluation, and can, thus, even be regarded as an additional component to be taken into consideration. Moreover, the evaluation purposes and targets are interrelated with each other. Evaluation audiences, on the other hand, have various evaluation needs and concerns, and thus affect both the evaluation purposes and targets.

Additionally, the interviewees stressed that also the objectivity of evaluation and evaluation information need to be addressed. However, to some extent it must be accepted, that all evaluation information is not necessarily very objective, and different evaluators may come up with different results. To minimize the diversity of the results, both the evaluation process and the analysis techniques should be detailed enough to guide the evaluation work to ensure that the reliability of the evaluation results is acceptable. In Figure 1, a number of other relationships between the evaluation components are, to some extent, depicted as well. These will be addressed by further research in more detail.

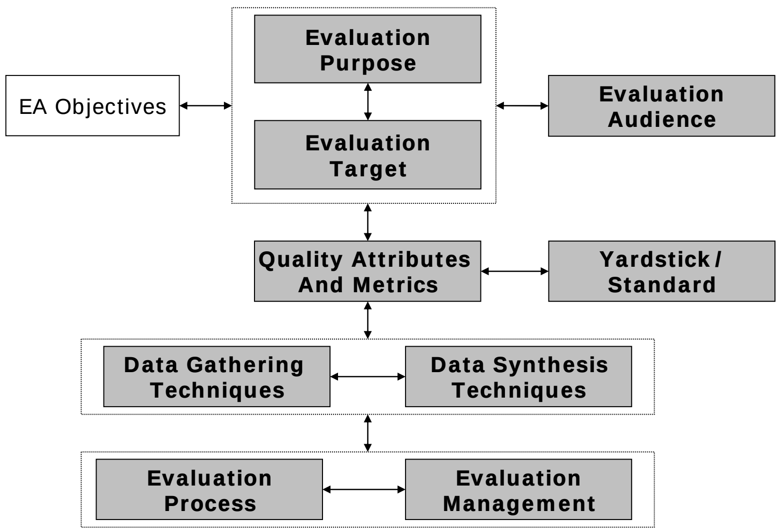

Figure 1. The components of EA evaluation.

FROM ENTERPRISE ARCHITECTURE OBJECTIVES TO EVALUATION TARGETS

This section describes the following EA evaluation components in more detail: 1) EA objectives, 2) evaluation purposes, 3) evaluation audiences, and 4) evaluation targets. These are the first components that have to be taken into account in EA evaluation planning, before any quality attribute or metrics selection and definition can be conducted.

EA Objectives

EA objectives define the goals of the EA approach in the organization; why it wants to apply the EA approach and what it wants to achieve through EA. Even though the EA objectives need to be defined in each organization based on, for instance, the business or IT strategy of the organization, some common features of these goals can be found.

Based on the literature review and the focus group interview, several possible objectives, based on the potential benefits wanted to be realized in the organization, were found to drive EA work. Some examples of these objectives are

- To improve business-IT alignment [see e.g. 6, 20]
- To improve change management [see e.g. 10, 26, 31]

- To improve communication [see e.g. 26, 31]
- To increase interoperability and integration [see e.g. 20, 26, 31]. According to the focus group, these issues could be related to e.g. legacy, migration and new information systems. Moreover, the conformance of new technologies to EA, and the effects of obsolete technologies should be taken into consideration, as stated by the focus group.
- To reduce complexity [see e.g. 20, 26, 31], also emphasized by the focus group.
- To reduce (IT) costs [see e.g. 13, 20, 26, 31], also emphasized by the focus group.
- To shorten cycle times [see e.g. 13, 20, 26, 31].

More detailed discussion on the various potential benefits of EA and EA work is provided by Niemi [22].

Evaluation Purposes

EA evaluation purposes provide justification for doing EA evaluation in the first place. They should answer questions like "why should the evaluation be conducted" and "what is desired to be accomplished by the evaluation". EA evaluation purposes are, to a great extent, dependent on the objectives of EA. Additionally, as it was brought up by the focus group, different audiences (stakeholders) have different needs for evaluation, and thus, different evaluation purposes are required. Especially, business management is mainly interested in financial measurement, while ICT organization may be more interested in technological aspects. Also, the time frame of evaluation affects the evaluation purposes; in the long run, an organization is more likely to be able to evaluate the business value of EA (the business impacts), than in the early phases of EA development cycle.

In literature, various evaluation approaches have been proposed and categorized. For instance, the approaches could be categorized by the areas of knowledge where evaluation is applied, such as education, business, or government [33]. In the beginning, our plan was to organize the EA evaluation purposes according to the categories described in [33]. However, this proved to be a non-trivial task because the categories are overlapping to some extent. Hence, instead, we suggest that most of the EA evaluation purposes seem to fall into the following areas:

- Aiding decision-making about the EA program itself and to steer the program [adapted from 2, 9, 29], or "to ensure that expected benefits from the EA are realized and to share this information with executive decision-makers, who can then take corrective action to address deviations from expectations" [9].
- Describing results of the EA program to the stakeholders by demonstrating, for instance, alignment with business strategy, the (business) value of EA, the benefits of EA, or the value of IT and IT investments [adapted from 1, 2, 9].
- Determining whether the objectives of EA or the EA program are achieved, for instance, by evaluating the effectiveness of EA and the quality of (EA) processes and products, or by performing cost-benefit analysis [adapted from 1, 2, 9, 20, 29].
- Analyzing the status of the EA program by 1) examining the EA objective and benefit achievement trends (short or long term), such as progress towards the goals of the EA program as well as towards the target EA state [adapted from 2, 9, 29], or 2) by identifying and assessing various risks related to EA and business [adapted from 25, 29].

Evaluation Audiences

EA evaluation audience refers to potential users of EA evaluation information and results. While planning EA evaluation, the EA stakeholder groups that may need or require evaluation results need to be defined. Additionally, potential ways these stakeholder groups will use the information should be discussed and determined.

The potential stakeholders of EA are described in [23]. However, each organization has to discuss and determine the relevant stakeholders for its EA approach, as well as for its EA evaluation results. Each audience may have different evaluation needs and concerns because they are interested in different points of view (financial, strategic, efficiency, and so forth). As stated by the focus group, a balance, or priority, between these various needs has to be addressed. In practice, one or two of the audiences are usually dominating, and therefore, according to the focus group, their needs may be given first priority.

In Figure 2, some potential stakeholders – audiences – of EA evaluation results are displayed. Evaluation audiences that were added on the basis of the focus group interview are marked with an asterisk (*). Moreover, in the figure, R&D refers to research and development. An important stakeholder group, that is not actually an audience of the evaluation results, but assists the EA evaluation team (either internal or external evaluators) to format the evaluation information using a language that is comprehensible by each audience, is Internal Communications.

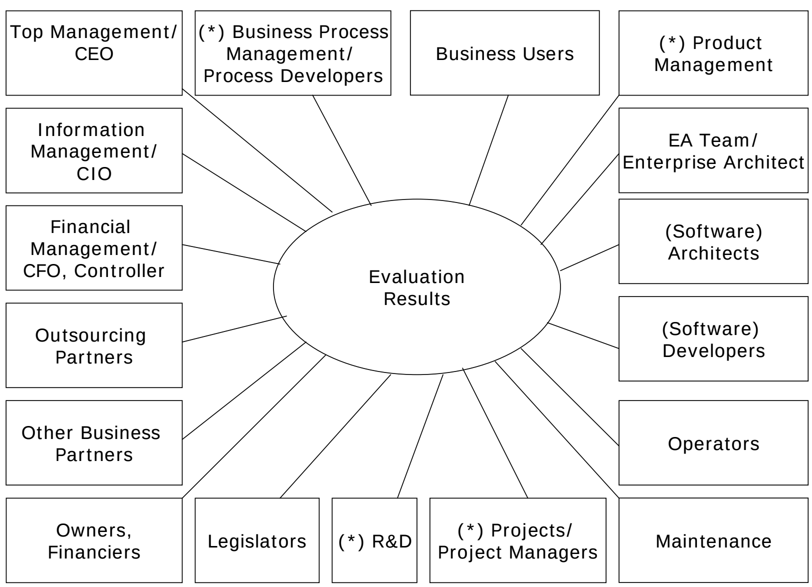

Figure 2. Possible audiences of EA evaluation results.

Evaluation Targets

Previously in our ongoing research project, we have defined a set of potential Critical Success Factors (CSFs) for EA, indicating the issues that have to be done exceedingly well in order to gain high quality EA, which in turn enables the business to reach its business objectives and gain more value [33]. The set of 12 potential CSFs for EA provided a starting point for determining the EA evaluation targets. However, it should be remembered that the evaluation targets are also dependent on the objectives of EA, the purposes of EA evaluation, and the various audiences (stakeholders) that may require the evaluation results; therefore, compatibility between these components should be assured.

In the following, examples of evaluation questions related to each potential target (or a potential CSF for EA), particularly brought up by the focus group, are presented (see [33] for more information about the potential CSFs for EA):

- Scope and Purpose (of EA): Are the EA objectives derived from the business or IT strategies of the organization? How has the scope of EA changed or expanded during the last quarter (or year)? How controllable is the EA scope?
- Business Driven Approach: To what extent are business requirements prioritized and how they are prioritized? To what extent are they conflicting or competing? To what extent is the EA team aware of the changes in business requirements? Has the team all necessary information related to the business?
- Communication and Common Language: To what extent are the architects, the EA team, capable of communicating with different stakeholders using a language these stakeholders can comprehend?
- Commitment: To what extent is the (top) management aware of the EA approach of the organization? Does the management sponsor the EA approach?
- Governance: How is EA work and governance positioned in the organization (e.g. under the information systems management and CIO, or elsewhere in the organizational chart)? How successful has this solution been? Is there any need to relocate or reorganize EA work and governance? Does EA governance have necessary resources (time, money, etc.)? How helpful have the governance processes been considered by e.g. projects?
- IT Investment and Acquisition Strategies: How effective, viable, and practical is the investment decision making process?
- EA Development Methodology and Tool Support: To what extent are methodologies and methodology use evaluated? How effective are the methodologies? What are the costs of tool use? To what extent are verifiable benefits received from tool use? How does the tool use affect other features of system development, such as its production costs, flexibility, adaptability or expandability?
- EA Models and Artifacts: To what extent are EA document templates designed and how useful have the templates been? Are the models consistent enough to provide a holistic view of the organization?
- Assessment and Evaluation (of EA): To what extent are the purposes, targets and audiences of EA evaluation identified and approved? To what extent do these correspond with the maturity of the organization’s EA? To what extent are the EA evaluation criteria and metrics aligned with the other evaluation metrics used in the organization? What is the time-frame of evaluation?
- Skilled Team, Training and Education: Does the EA team have the necessary resources (time, money, etc.)? To what extent does the team have various skills and experience (in business, technology, system development, architecture, etc.)?
- Organizational Culture: How aware are the organization members of the EA approach and its objectives? How has EA affected the organization, its structure and culture, after integrating or consolidating functions, for instance, in finance or personnel management? How long has it taken to make the required changes in the organization? Has it taken longer or shorter time than earlier?
- Project and Program Management: To what extent does the project methodology include EA guidance? To what extent has a project received EA guidance? How useful has the guidance been? How many projects have indicated a need to change or refine EA (e.g. EA plans or objectives)?

While some of the evaluation needs (or evaluation questions) cannot be incorporated into any specific CSF for EA, the entire EA program is considered a separate evaluation target as well. Evaluation questions related to the entire EA program, stressed by the focus group, are particularly: How is the program progressing? What are the benefits of the EA approach to each stakeholder group? What kind of business impacts does EA provide? How have these impacts evolved or changed over time (in a quarter, year, etc.)? How has EA affected IT costs? Have they been decreasing or increasing? How mature is the organization's EA (program)? How has the maturity evolved over time?

CONCLUSIONS

In this study, the evaluation components of EA were defined by a literature review, supplemented and validated by a focus group interview of EA practitioners. Subsequently, four of the evaluation components were described in more detail, namely: 1) EA objectives, 2) evaluation purposes, 3) evaluation audiences, and 4) evaluation targets.

When evaluating our study, it should be remembered that it is mainly based on a literature review, only validated by a focus group interview of seven practitioners from organizations initiating EA work. Therefore, strong generalizations cannot be made. Our work was planned as a preliminary study of revealing issues – also other than metrics definition – to be addressed while planning EA evaluation.

The resulting model of components can be used by practitioners in organizations to structure the planning phase of EA evaluation, and help to assure that all evaluation components are addressed before moving on to the actual evaluation. As a result, organizations could expect better comparability between the results of different evaluations, and greater results validity compared to an ad hoc approach. In addition, we summarize the following practical implications from our study.

One of the most important EA work triggers was underlined by the focus group: the ever more complex and constantly changing environment the organizations have to deal with. There are complexities in the business environment, as well as in the existing information systems environment (legacy systems). It has become ever more challenging to control this multifaceted environment. EA has been suggested to be one possible approach for putting some structure into the chaos as well as to manage the changes needed for improving the business and the organization. To ensure that EA has actually achieved desired results, evaluation is required.

Usually, each organization has its own specific objectives for the EA approach. The purposes of evaluating the organization's EA program can be defined on the basis of these objectives. However, other sources may exist as well, such as the most important audiences and their various requirements for evaluation information – top-management may want information to support decision-making, while EA team would need to know how useful has EA guidance been considered by projects, or how many projects have effected EA. Once these aspects are clarified, the primary evaluation targets, compatible with the requirements set by different audiences, as well as with the evaluation purposes, can be defined.

If the organization has not yet clarified its EA program's objectives, it can stimulate the discussion and definition of the EA objectives with the help of the sample objectives presented in this paper. Similarly, discussion on evaluation purposes, audiences and evaluation targets can be assisted and supported by the given examples. Cross-tabulations can be used to depict dependencies between different evaluation components, such as

- EA objectives and evaluation purposes,
- audiences and evaluation purposes,
- evaluation purposes and targets, and
- audiences and evaluation targets.

In addition, it should be noticed that the maturity of the organization's EA affects the selection of evaluation targets, as well as the definition of evaluation criteria and metrics. Interviewees stressed that the EA maturity level of the organization, the evaluation targets, and the evaluation criteria and metrics need to be compatible. In particular, a 'young architecture organization' should start with defining simple metrics (such as on/off-metrics or quantitative metrics) indicating and demonstrating, for instance, the extent the stakeholders are aware of the EA approach and its objectives, or the support and guidance provided to projects implementing or changing EA. While the organization matures, more detailed business impacts can potentially be measured. However, in this study, evaluation targets and evaluation questions were not mapped to maturity levels.

The interviewees also emphasized that no matter what the EA evaluation targets and metrics are, they must be compatible with the other evaluation and measurement systems used in the organization (such as Balanced Score Cards). Especially, if the business is striving for substantial growth (in the sense of market share, sales volume, and so forth), IT cost metrics are not likely to show lower costs at the same time.

For researchers, the EA evaluation component model constructed provides a basis for further research on EA evaluation. Firstly, more research is needed to validate the evaluation component model. Secondly, the evaluation components and interrelationships not covered by our research, particularly EA quality attributes and metrics, should be further studied. Thirdly, the evaluation components could be mapped to EA maturity levels, highlighting the differences in EA evaluation on different levels of maturity.

Finally, even though the discussion in this paper has focused on EA evaluation, the evaluation components presented are generic in nature and thus applicable to many other evaluation endeavors as well.

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Enterprise Architecture Process of a Telecommunication Company – A Case Study on Initialization

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ABSTRACT

Objectives such as business-IT-alignment, lower costs, higher quality, better time-to-market and greater customer satisfaction are some of the drivers for the development of enterprise architecture (EA) process. Several companies in Europe and the USA, and likely elsewhere, are currently developing their EA processes. The overall question in companies is how EA and architecture processes could give more value to business demands.

Despite the obvious need for research on companies' EA processes, to the date only a few case studies have examined EA processes in companies. The present study, therefore, attempts to address this need for further understanding of EA processes. The study examined and analysed the initial phase of EA process in Elisa, a Finnish telecommunications company. The objective of this study was to gain an understanding of some aims related to the EA process initialization phase.

The case company's EA process choices relating to communication practices, EA requirements management and, relationships and collaboration between the EA process and the company's other processes were described and analysed in terms of the aims in the initial EA phase.

These aims included identification and definition of the role and responsibilities for EA process, the process establishment in the organisation as well as the adaptation of process related work. In addition, it is important to achieve benefits of EA work quickly. It is suggested that these areas could also be relevant for other companies in the initial stages of an EA process. In addition, the waterfall approaches were identified not well suitable for the development of EA processes and EA.

Keywords

Enterprise Architecture, Enterprise Architecture Process, Case Study

INTRODUCTION

Currently, ICT-companies as well as other large companies have pressures to develop their own enterprise architecture (EA) processes. IFEAD has investigated why enterprise architecture is important for companies [11]. Expected benefits of EA approach are that EA delivers insight and overview of business and IT, it is helpful by mergers and acquisitions, it supports (out/in) sourcing and systems development as well as manages IT portfolio and delivers roadmaps for change. In addition, EA is expected to be helpful in decision making, managing complexity, business and IT budget prioritization. Enterprise architecture is seen as one of the solutions for these challenges and development needs.

ICT-companies and organisations' usage and developments of EA processes are examined to a certain extent. The surveys relating to a group of organisations are carried out, for example, by NASCIO, GAO and Institute for Enterprise Architecture Developments (IFEAD) and by Gotze and Christianssen. EA development situation in governmental organisations and departments is investigated by NASCIO and GAO in the United States [5, 20] and by Gotze and Christianssen in several countries [2]. In addition, IFEAD have gathered information about EA usage and implementations in organisations all over the world [11].

A few case studies on companies' EA processes have also been carried out. For example, relating to governmental organisations by Hjort-Madsen [7] and by Martin et. al. [17] , UML-modeling by Armour et.al. [1], SOA practices development by Wong-Bushby et. al. [26] as well as relating to specific companies like Subaru by Merriman et. al, [18]. However, EA processes in European private sector organisations, in teleoperator-domain and especially the initialization phase of an EA process do not yet seem to be examined by case studies.

The study, presented in this paper, examined the EA process of a Finnish teleoperator company, Elisa Oyj. This study was executed in the initialization phase of the EA process. The case company's main choices relating EA process made during the period chosen (February – October 2006) and reasons for and experiences from these choices were identified and analysed. These choices relate especially to communication, enterprise architecture requirements management, and collaboration between the EA process and other organisation's processes. As a result, a group of aims to which the case company focused at the initialization phase of EA process were identified. These aims are suggested also to be central for other companies initiating their EA processes.

This study consists of the following sections. Firstly, existing enterprise architecture practices and the research method used in this study are presented. Secondly, the case company Elisa Oyj, market situation and changes in Finland, and Elisa's reasons for the development of the EA process are introduced. Thirdly, the EA process choices made in the case company, reasons for these choices and the analysis of these choices are presented. A suggestion of a group of aims, to which companies should be concentrated in the initialization of an EA process, is presented. Finally, the study is summarised and future research questions are presented.

ENTERPRISE ARCHITECTURE

Enterprise Architecture Concept

IEEE 1471 Standard [9] defines architecture as the fundamental organization of a system embodied in its components, their relationships to each other and to the environment, and the principles guiding its design and evolution.

The enterprise architecture is defined for example by Kaisler et al. [14] as follows " *the main components of the organization, its information systems, the ways in which these components work together in order to achieve defined business objectives, and the way in which the information systems support the business processes of the organization*". These components include staff, business processes, technology, information, financial and other resources, etc.

Other definition for EA is presented by Lankhorts [15]: "*enterprise architecture is a coherent whole of principles, methods and models that are used in the design and realisation of an enterprise's organisational structure, business processes, information systems, and infrastructure.*"

Methods and Practices for Enterprise Architecture

Enterprise architecture is typically used as an instrument in managing a company's daily operations and future development [15]. Currently, the field of enterprise architecture is evolving rapidly. Academia and ICT-industry actively develop methods and practices for the designing and management of enterprise architectures. Several books have been published on this field (e.g. [13], [15],[25]). Frameworks, methods, practices and maturity models for EA are introduced.

Architecture frameworks identify and sometimes relate different architectural domains and the modelling techniques associated with them [22]. They typically define a number of conceptual domains or aspects to be described [22]. Enterprise architecture frameworks are, for example, Zachman's Framework for Enterprise Architecture [28], The Open Group Architecture Framework (TOGAF) [23], Archimate framework, ISO Reference Model of Open Distributed Processing (RM-ODP) [12], FEAF, OMG's Model Driven Architecture, DoDAF, GERAM and Nolan Norton Framework. Companies use these frameworks or develop their own ones.

A number of languages and tools for modelling organisations, business processes, applications, and technology are also developed. Languages include, for example, IDEF, Business Process Modelling Notation (BPMN), Testbed, ARIS and Unified Modeling Language (UML).

In addition, enterprise architecture maturity models are developed and can be used to support the development of EA process in organizations. Some enterprise architecture evaluation methods are, for example, the following enterprise architecture maturity models: OMB Enterprise Architecture Assessment Framework [24], The Enterprise Architecture Maturity Model [19], The Extended Enterprise Architecture Maturity Model [10], A Framework for Assessing and Improving Enterprise Architecture Management [6] and IT Architecture Capability Maturity Model.

Challenges relating to enterprise architecting (e.g. relating to modeling, managing, and maintaining EA) are also examined, for example, by Kaisler et. al.[14] and Hämäläinen and Ylimäki [8].

RESEARCH METHOD

Research process used in this study is described in the table below.

Table 1. Research method used in the analysis of case company's EA process.

Case company selection criteria	Elisa Oyj was selected for the case company because it is an example of private sector and teleoperator organisation initiating EA process. In addition, the case company, Elisa Oyj, was selected in accordance with its collaboration in the on-going research project.
Unit of analysis in company	Enterprise architecture process in the case company, especially the choices made and the experiences of these choices
Observation period	February – October 2006, the initialization of the EA process was on-going activity in the case company during this period.

Data collection	Participant observer: Participant observer observed the EA process in the case company during the defined period. Observer made especially observations relating EA process choices, reasons for these choices and experiences of these choices. This observer works as an enterprise architecture –architect in the case company and participated in the EA process development and initialization during the observation period.
Research data	A group of qualitative data sources were used to triangulate research finding and confirm outcomes. The data sources used were, for example: ➢ Case company's EA process descriptions ➢ Other material relating to the EA process development o result materials from group meetings between architecture work stakeholders o emails: e.g. news letters for EA interest group ➢ Discussions between architecture work stakeholders and observer
Data documentation	Choices made, reasons for and experiences of these choices were documented partly by the observer and partly together by the researcher and the observer in a few meetings. The choices were categorized in this phase by the researcher and the observer.
Data analysis	The choices were analyzed. Main aims to which the case company focused at the initialization of EA process were identified.

ELISA AS A COMPANY AND ITS REASONS FOR EA PROCESS DEVELOPMENT

Elisa is second largest telecommunication company in Finland. The company's home market area is Finland and Estonia. Global market and international customer demands of Elisa are handled with partners of which main partners are Telenor and Vodafone. Company's amount of personnel was 4,090 in 2006 and revenue EUR 1.52 billion. Elisa's network has in the end of 2006 aprox. 2,2 million mobile subscribers, 852 300 fixed subscribers and over 469 000 broadband subscribers.

Elisa strategy (2003-) is based on three steps (see fig. 1) [4]:

- *Integrating One Elisa*: In this step, radical changes and consolidations in company structures, processes, brands, products and ICT-systems are carried out. For example, in company structure, the holding structure was changed to one company model.
- *Strengthening Market Position:* This means that the organisation should be more effective. Market position is main issue. In overall, this also means new company changes. For example, Elisa bought Saunalahti in 2005.
- *New Markets and New Services:* This step is in initial phase and involves searching and developing new services and markets. 3G- and broadband bundle products are produced as one part of the development of new services to strengthen Elisa's market position.

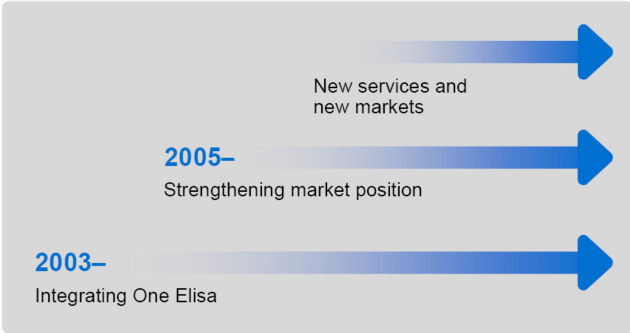

Figure 1. Elisa strategy ([4])

Market Trends in Finland

The following trends existed in the telecom-market in Finland between 2004 and 2007. The fixed-line phone service market has been going down a quite long time. Market changes during this period were approx. -8% per year. Fixed line voice services are replaced by mobile services and data services are replaced by broadband services. This market is based on PSTN-technologies which are near the end of the lifecycle.

At the same time, fixed data services market grew about 4,2% per year. Phone services continued the transforming to the mobile markets, because demands of customers changed. In addition, the broadband penetration grew quite fastly.

During this period, the mobile number portability market also opened. Mobile number portability was launched in 2004. In addition, new virtual operators and service providers came to the market. Number portability was quite high success in Finland (see fig. 1). These factors brought about the pricing competition in the market.

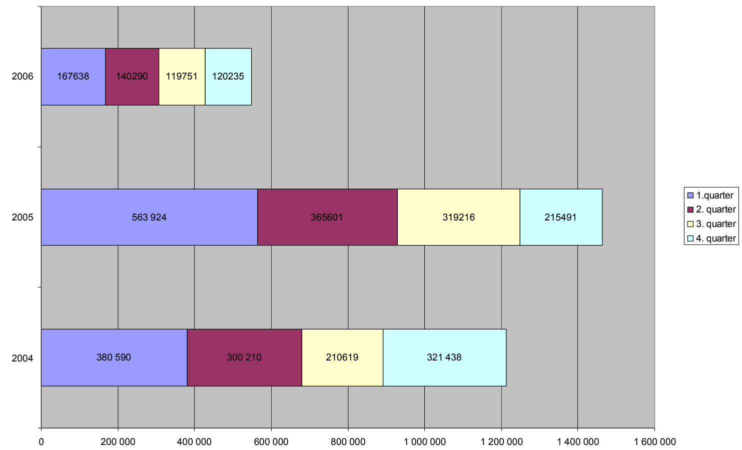

Figure 2. Number portability volumes 2004-2006 ([21]).

Price erosion can be seen from that the average monthly revenue per user (ARPU) dropped from year 2000 to 2005 almost approx 9€ per month. At the same time, number of new content based services and data access was growing very slowly. Number of new services and data accesses started to grow when 3G bundle was allowed in Finland in 2006.

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Reasons for EA process Development in Elisa

Why Elisa started to develop an EA-process? Reasons and drivers for this are based on Elisa's strategy steps as well as on changes in the market, technologies and regulations. These reasons are described in the following.

Strategy Steps: The Development of Elisa

In the first strategy step, many independent companies and their ICT-environment were needed to evaluate and check the overall life-cycle and functionalities of them. Several consolidations were carried out. First phases in consolidations are quite easy. Later it becomes more challenging to understand how different changes in the ICT-environment affect processes and products and vice versa. Thus, later consolidations not only involve shutting down old legacy systems. More and more communication is needed inside the company (e.g. between staff relating the development of processes, product management, decision makers of technology selections). In addition, the technology selections need coordination. In Elisa, these consolidations were also made quite fast and under hard cost effectiveness pressures. In the solving of this problem, it was noticed that this work needs the coordinating and the handling the general view of situation. The need for ICT-architecture work was thus identified.

Affect of the Changes in the Market to the Elisa

Market situation seem to change out from pricing competition to service competition (e.g. Elisa's announcement of the changing its pricing model illustrates this [3]). In this situation, Elisa needs more modular and flexible products, processes and ICT-environments. This also means that partners have increasingly important role in Elisa's ICT-environment, processes and products.

Coming Changes in Business Models and Technologies

In addition, technology aspects become more and more complex. Flexibility demands are also increasing constantly. Convergence between telecommunication and IT-services has started and continues with increasing speed in the future. In addition, business models are based on partner networks, which means more and more distributed ICT-environments. Therefore, processes and products come more and more complex. Telecommunication network and traffics seem to change towards IP-based network in the future. Secondly, technology silo-based network structure transforms to layer based access-core –structures. In addition, network elements are more and more based on IT-based open systems than before. Previously, network elements were dedicated hardware and embedded software. IT-environment changes and moves to service-oriented and event based architectures. In summary, ICT is a critical part of today's basic infrastructure at many ways.

Summary of Elisa's Reasons for the Development of EA process

In summary, Elisa's main reasons for the development of EA and especially ICT-architecture process and practices were the followings:

- Complexity handling:
  How and where some changes have effects?
- Increasing knowledge:
  What and how should a project inform about its work and results to other projects? What are the dependencies between different processes, services, products, systems, networks etc? How are new technologies implemented in

Elisa's ICT-environment?

- Increasing flexibility and effectiveness:
  How are Elisa's services made easier? How services are produced effectively? What parts of system are problematic? For example, what parts of a information system, product or process are problems?
- Customer aspects:
  What are customer demands and wants? When does customer want new services? How to use the existing environment in new innovative ways?

Thus, Elisa decided to start the development of a EA process at the autumn of 2005. Some architecture practices and architecture information had been developed and produced before. An EA team was established at the beginning of 2006. The following chapter describes EA process development work between February and October 2007.

EA PROCESS IN ELISA

The enterprise architecture process related choices made in Elisa are described in the following. Aspects of communication practices, EA requirements management and collaboration between the EA process and other company's processes are discussed.

Communication

Effective communication is essential in sharing knowledge, achieving a common understanding, agreement and a shared view of the EA scope, vision, and objectives, as well as of the developed models and other artefacts. Furthermore, communication is an important means of gaining commitment to the EA effort [27].

Aims of EA communication in Elisa are, firstly, to communicate and inform architecture work related persons and staff about aims of this work and the role of architecture work in Elisa. Secondly, the communication has the meaning of introducing the EA approach, practices and culture, as well as results of EA work (e.g. architecture plans, principles and target architecture). Thirdly, the aim of communication is to get feedback about EA work. In addition, communication increases contacts and familiarity between staff.

The representative from Elisa brought out that ideal situation in architecture communication is when:

"*the needed information is easy to find and to understand and it is opportunity to communicate with others about architecture questions*".

The practices and tools chosen for EA related communication in Elisa are:

- *Intranet:* All Elisa's employees and limited partner employees have access to Elisa's intranet. Firstly, aims of using intranet were to inform and communicate what EA work is, what staff is related to it and what practices are used in it. This material was added to the intranet at the initialization of the EA process. The experience was that this information was sufficient. So, more information was not needed in the intranet at the beginning of the EA process. It was also noticed that it had to be decided what material will be added to the intranet and how often the material will be updated. In addition, it was noticed that static information should be separated from information that will change often. This would have eased the updating of information.
- *News letter:* News letters were sent to the EA interest group (employees that had interests for or responsibility of architecture work). The news letters especially included information about the status of work (e.g. status of

architecture principles), tasks under work and staff responsible for these tasks. The news letter was found useful. However, it was noticed that the news letters must be short. Therefore, links were provided to extra material in the news letters.

- *Document management system*: A network drive was used to store and distribute architecture work documents in Elisa because it was generally used for document sharing in Elisa. There was limited access to this drive: nearly the same group had access rights that were included in the newsletter distribution. Documents were various documents which had to be organised and stored to somewhere. Experience was that the network drive filled the document management requirements in this case.
- *Boards:* Managers do not usually have much time to examine material. Therefore, material was produced for and presentations were given in board meetings to help managers to be aware of the architecture work (status of and its results). These boards convened regularly. It was seen that it is important that decision makers in boards know about what they are deciding and what the possible consequences of the decisions are.
- *Workshop:* Workshops were organised to carry out architecture work related tasks. Persons from the EA interest group participated in these workshops. The amount of participants in the workshops varied. The smallest groups were 8-10 persons and the biggest ones 100 persons. Participants felt that they had the opportunity of participating in architecture work in the workshops. This increased the commitment of staff to EA work.
- *Interpersonal communication:* Interpersonal communication had the meaning of gaining the commitment of staff and managers to EA work. Interpersonal communication and workshops are used actively in Elisa. Thus, these are included in Elisa's organisational culture. So called "management by walking around" is thus also vital part of the architecting.

In summary, EA communication should be adjusted for the dominated organization culture, practices and tools used in a company. In addition, it was noticed that the company has to make choices in which situations to use face-to-face communication and in which situation communication that is supported by technical tools. In addition, the order between communication and content production in the company has to be decided. The company can firstly concentrate on communication and collaboration and then on content production. On the other hand, it can also firstly concentrate on content production and then on communication and collaboration.

EA Requirements Management

Requirements for enterprise architecture were also identified in the initialization of the EA process in Elisa. In Elisa, main sources for enterprise architecture requirements were especially the followings:

- Elisa's strategy information
- Technology road maps, standardization
- Business information:
    - existing and future products and services
    - roadmaps of products and services
    - customer and market researches and studies
- Existing business processes and aims of these processes

In addition, the following sources were also used

- interviews of specialists and
- identification of existing and used principles in the development of architectures / products / services.

It was identified that there exist long-term architecture requirements, that should be taken into account in the long-term planning (taken into account e.g. in business planning), and short-term architecture requirements, that should be taken into account in short-term planning (in the current projects).

The process for the identification of EA requirements was the following. Firstly, data from sources presented previously was gathered and it was produced a list from information that seemed to include relevant information about requirements. From this list, potential EA requirements were identified and based on these potential EA requirements, a list of EA requirements was produced.

The experiences of EA requirements gathering and analysis were the followings. It was difficult to identify or define what the EA requirements are. This seems to be a problem in general. It thus seems that a definition for EA requirements is lacking. In addition, questions were met about how the requirements should be described so that "users of requirements information" understand what the requirements are. In addition, it was not clear how to use and utilize EA requirements and in which processes to use and utilize them.

In summary, the identification and analysis of EA requirements differs from the requirements engineering in system development. EA requirements can be used for example to argue for why a certain EA related choice or principle is made. EA requirements are thus not meant to describe what a system should be able to do.

Collaboration between EA process and Other Company's Processes

Enterprise architecture is typically used as an instrument in managing a company's daily operations and future development [15]. It has to fit in with other established management practices and instruments. According to Lankhorst [15] management areas relevant to EA process are strategic management, strategy execution, quality management, IT governance, IT delivery and support and IT implementation. With these areas EA process may collaborate.

In Elisa, collaboration ways between EA process and strategy management and investment management were planned and defined. In addition, collaboration with project definition and support was planned and defined. Relating to this collaboration it was decided, for example, that the existing decision making practices and methods of other processes are used also in EA work. The EA work and other processes in Elisa were linked in this way.

EA work was organized at the same organizational level as R&D work in Elisa. Elisa has the management of communication networks that also have to be taken into account in EA work. Therefore, EA work was not organized and included in IT governance or business units. Experience was that this organization structure supported the co-operation with different processes and stakeholders. EA work has thus "neutral" position in organization.

Limitations in This Study

In this paper, all aspects of Elisa's EA process were not described. Three aspects were chosen to be analysed and discussed. These aspects were chosen because they were essential in the initialization phase.

CONCLUSION

Currently, the initialization of an EA process is on-going task in many organisations. However, a little of public information exists about experiences of the initialization of EA processes. In this study, we examined the starting of an EA process in a Finnish telecommunication company, Elisa. EA process related choices, reasons for and experiences of these choices were especially examined. Choices relating to communication issues, EA requirements management and collaboration between the EA process and company's other processes were especially analyzed.

Aims in EA process Initialization

During the process of examination of the EA process, the following observations were made. The case company seemed to focus especially on the following aims.

To identify and define the role and responsibilities for the EA process

The case company defined relationships between the EA process and other company's processes. In this definition, it had to be decided what responsibilities the EA process and company's other processes have. It's very important to define and recognize the role of the EA stakeholders and take them for an active role and part in EA work and responsibilities.

To establish the EA process and to adapt EA work in the company

The communication practices were developed especially to support the adaptation of EA process work. Communication practices were especially developed for gathering information from the EA stakeholders and for sharing information to support carrying out architecture work.

To achieve benefits of EA work (to achieve so called "quick wins").

In Elisa, the identification of existing architecture practices and principles was used as a method to quickly achieve benefits of EA work. Especially, principles that are already used in the development of products, services and processes in Elisa were identified and acknowledged.

Observations Made and Questions Met in EA process Initialization

As a whole, the experience of Elisa was that waterfall approaches do not seem to be well suitable for the development of EA and EA processes. We mean as a waterfall approach an approach in which all the phases of the process are cascaded to each other so that the second phase is started as and when a defined set of goals are achieved for first phase and it is signed off. Once a phase thus has been completed, its results are frozen. Backtracking is impossible and nothing can be revised based on changing needs or fresh insights. In addition, until the results of the current phase are complete and approved, any work that properly belongs to the next phase or any later phase many not be started. In the software development area, waterfall approach is criticized especially because the requirements always change and this is not taken into account in this approach.

Some of the approaches that are presented for the development of an EA process seem to have similarities with the waterfall approach. For example, Forrester Research presents the following approach for the initialization of an EA process [16]:

"*… early tasks of a new or newly restarted EA program are creating a mission and an operating model for the EA program, articulating near-term goals, and validating these with the EA sponsor and key stakeholders. Once the EA leader has confirmed that all key stakeholders see the value of the EA program to attaining their own goals, the next tasks are building the team and creating a detailed plan.*"

This approach appears to have similarities with waterfall approach because it does not encourage the iterative development. Firstly, Elisa tried in its EA process initialization an approach that was similar to the waterfall approach. However, Elisa's EA team noticed quite fast that this type approach is too slow, because when the first results are ready, the overall goal and results are already "out of date" and not valid anymore in many aspects as well. In this approach, the planning phase is thus too long. Goals and targets are defined quite well but these are not updated in this approach. In brief, changes in requirements (e.g changes in business) and goals thus can not be thus taken into account in this approach.

One of the challenges met in the development of the EA process was also how to achieve the whole picture of current state of the company. Currently, it seems that the knowledge and practices of the gathering the information and knowledge of the current state of companies' architectures efficiently and reliably are lacking.

In addition, it was noticed that the company has to balance between the achieving quickly benefits of the EA work and the carrying out the long-term EA work. This question was met in the case company. As a whole, communication and collaboration between the EA process and other processes were identified to be the most important tasks in the initialization of the EA process.

Summary

In this study, the following questions arise: Is it possible to use agile and iterative methods to develop EA and EA processes? Can the theories of the agile software development be applied in the EA domain in a way or other? How to choose, execute and combine the tasks in the initialization phase of an EA process? For example in Elisa case the question was how to combine the defining (probably "dirty") EA-level framework and target architecture quite fast, defining and starting the first part of EA work, the making first main implementation of the process and of the target architecture and the collecting feedback for a new planning iteration.

Initialization phase is essential for the future of an EA process. The main responsibilities of this process, its role in a company and practices used in it are defined and developed in this phase. In addition, EA work information is communicated actively.

In this study, we identified aims that one case company had in the initialization of the EA process as well as questions that were met in this phase. We suggest that these aims could also be relevant for other companies in the initial stages of the EA process. In the initialization of the process, we recommend to start doing actual EA work and communicating the purpose and first tasks of it as soon as possible, instead of only focusing on producing detailed plans about the EA process or architectures.

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Defining Enterprise Architecture Risks in Business Environment

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Abstract

Enterprise Architecture (EA) is a modern approach for managing and developing organizations and enabling them to tackle with the challenges induced by constant changes and increased complexity in their environment. However, as an extensive and strategically important program, EA is not without risks. Therefore, this exploratory study aims at providing an overview of generic risks that can potentially be related to EA in organizations, and at suggesting a classification scheme for the risks to facilitate their management. Data is collected by a literature review and a focus group interview of practitioners involved in EA. As a result, a classification scheme for EA risks is suggested and potential risks related to the elements of the scheme presented.

Keywords

Enterprise Architecture, risk, risk classification, risk management

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Introduction

In the modern turbulent business environment, companies are constantly encountering challenges in coping with the changes and complexity in the market. Moreover, the companies have to manage the complexity of their information and communication technology (ICT) environment brought on by the many decades long legacy of ICT, and to assure that ICT supports the business as well as possible. To facilitate companies in responding to these challenges, a recent approach called Enterprise Architecture (EA) has emerged in the last decade (Goethals et al. 2006; Hjort-Madsen 2006; Kluge et al. 2006; Morganwalp & Sage 2004; Veasey 2001). Consequently, the approach has become one of the major concerns of practitioners and academics, and it is being implemented in a multitude of companies and government organizations worldwide.

Basically, EA is a holistic approach for managing and developing an organization, adopting an overall view of its business processes, information systems (IS), information and technological infrastructure (de Boer et al. 2005; Jonkers et al. 2006; Kaisler et al. 2005). EA includes a set of principles, methods and models used to describe the current and future state of an organization, as well as a transition plan to describe the steps needed to transform from the current to the target state (Armour et al. 1999; Lankhorst 2005). The transformation is usually conceptualized as a continuous, iterative process (Armour et al. 1999; Kaisler et al. 2005; Pulkkinen & Hirvonen 2005).

EA can be conceptualized from a number of different viewpoints. These include products (and services), processes (Armour et al. 1999; Jonkers et al. 2006; Rosen et al. 2007), implementations (c.f. Armour et al. 1999; Kaisler et al. 2005) and impacts (Jonkers et al. 2006; Morganwalp & Sage 2004). EA processes include a collection of planning, development and management processes (Armour et al. 1999; Pulkkinen & Hirvonen 2005). EA products, in turn, include for instance EA principles, methods and models (Armour et al. 1999; Lankhorst 2005), which can be complemented with various services, for instance EA guidance (Armour & Kaisler 2001; The Open Group 2006). Since a typical use for EA is its implementation, it can also be considered a separate viewpoint. Implementations include organizational elements (e.g. organizational structures, processes and information systems) implemented according to or in compliance with EA (Armour et al. 1999; Kaisler et al. 2005), and other usage of EA in the organization’s functions, such as strategy management, investment management, project definition and support, ICT governance and IS development (Andersin & Hämäläinen 2007; Bucher et al. 2006; Emery et al. 2007; Lankhorst 2005; Rehkopf & Wybolt 2003). EA impacts, on the other hand, may arise from all of these viewpoints.

Because EA is an extensive program, it requires considerable investments and may thus result in many political, project management and organizational challenges (Kaisler et al. 2005). As with any investment, also EA investments (investments related or driven by EA) involve risks which need to be identified and managed (Saha 2006). Organizations investing in EA may face unexpected materialized risks related to business and ICT alike, threatening the success of the EA program. Moreover, since EA is a critical management tool materialized risks can have serious consequences in the organization utilizing EA.

The extensive, continuous and iterative nature of the approach further complicates EA risk identification and management. For instance, unpredictable effects may arise from EA processes or may be associated with any of the levels of EA products (e.g. business, information, information systems, technology) (Baldwin et al. 2007). Being such a fuzzy target, research on EA is fragmental (see e.g. Niemi 2007), and on the subject in question extremely scarce. However, risks have been extensively discussed in generic risk literature (see e.g. Crouhy et al. 2001; Lam 2003; Reuvid 2005) and even in specific contexts, such as ICT and IS (see e.g. Benaroch 2002; Benaroch et al. 2006; Boehm 1991; Keyes 2005; Sherer & Alter 2004).

In this exploratory study, we aim to provide an overview of generic risks that can potentially be related to EA in organizations. Moreover, we aim to investigate potential classification schemes for the risks to help tackle with the myriad of risks. Consequently, the study contributes to practice and research alike. For practitioners, the results provide a list of risks associated with EA, which can be used as a checklist in risk identification, and to assure that risk management practices have been planned for all relevant risks. For researchers, the results provide a basis for further research, e.g. for developing risk management strategies for the presented risks.

This paper is organized as follows. First, we describe the research process and methods used. Second, we discuss the theoretical background of the study. Third, we present the classification scheme of EA risks selected for this study. Fourth, we give an overview of generic risks related to EA. The paper ends with summary and conclusions.

Research Process and Methods

This study employed the qualitative research paradigm and used literature review and focus group interview as methods for gathering information. The study was structured as follows:

1) *Literature review* was carried out systematically. First, generic literature on risks was charted using high-quality academic databases and generic search engines on the internet to provide an overview of risks encountered in organizations. Subsequently, literature on risks related particularly to EA, business and ICT was similarly charted to supplement the overview. Literature by both academia and practitioners was included in the review for a more diverse perception. The sets of risks identified in literature were compared by the authors to assess their completeness and suitability to the EA context. Furthermore, potential classifications for the risks were charted and one feasible classification scheme was adopted to facilitate comprehension of the review results. The classification also included a set of generic risks to be used as a basis for discussion in the next phase of the study.
2) *Focus group interview* (see e.g. Krueger & Casey 2000) of five practitioners from three Finnish organizations carrying out EA work was organized. The organizations were either independent companies, or parts of larger enterprises. Moreover, they represented different industries and employed from under 20 to several thousand people. The objectives of the interview were 1) to validate the literature review results in a practical context, and 2) to collect additional, experience-based information. Notes were taken from the interview and it was also audio-recorded.
3) *Consolidation and analysis of the results* was done by combining the results from the literature review and the interview.

From General Risks to Enterprise Architecture Risks

This section describes the combined results of both the literature review and the focus group interview.

Definitions and Conceptualizations of Risk

The Collins English Dictionary defines risk as “the possibility of incurring misfortune or loss”. However, in risk literature many authors do not even provide a definition for the term. This may be partly explained by the complex nature of risks. First, they have many characteristics such as *exposure* (maximum amount of damage suffered), *severity* (amount of damage that is likely suffered), *volatility* (variability of potential outcomes), *probability* (how likely a risky event occurs), *time horizon* (the time exposed to the risk), *correlation* (amount of correlation between different risks) and *capital* (how much capital is needed to cover losses) (Lam 2003). Second, all risks are temporal and can thus be materialized in complex chains of risks and mitigations over time (Alter & Sherer 2004). Third, risks are not always negative but may also have positive consequences when they materialize (Alter & Sherer 2004).

As a result, risk seems to have been conceptualized in several ways, each accentuating different risk characteristics. For example, Sherer and Alter (2004) identify various types of conceptualizations of risk from IS literature, such as risks as different types of negative outcomes (risk components), risks as factors leading to a loss (risk factors), risks as probability of negative outcomes, and risks as difficulty in estimating outcome. To broaden the scope of the study and to take into account both causes (risk factors) and effects (risk components), we consider risk both as a factor leading to a negative outcome and as the negative outcome itself (cf. Sherer & Alter 2004). Consequently, in this study, we defined EA risks as

1) any factors that may lead to negative outcomes in the EA program, and
2) any negative outcomes resulting from these factors.

However, the focus group participants commented that in practice the negative outcomes may be considered more important since they represent the actual results. Moreover, it was brought out that the two definitions should be better distinguishable from each other. In practice, it is difficult to disentangle the myriad of risk factors and outcomes as there are more than one level of outcomes.

Risk Classification Schemes

The amount of different risks identified in literature is extensive. Hence, many authors propose classifications for the risks presented in their papers. Typically, the risk categories depict the more or less abstract function, task, object or entity the risk is related to. For example, generic risk management literature divides risks to various classes such as business, market, operations and credit risks (Crouhy et al. 2001; Lam 2003). In the domain of IS and ICT, the risks identified in literature encompass factors related to the development of systems and software, as well as factors arising outside the scope of development (Benaroch 2002; Saha 2006). To classify these kinds of risks, Keyes (2005) proposes categories such as project, technical and business risks. Similarly, Benaroch (2002) divides ICT investment risk components into three categories: firm-specific, competition and market risks, each consisting of more specific risk areas such as financial, political, environmental and project.

Risks can also be classified on other grounds. For instance, Bandyopadhyay (1999) addresses ICT risks on three levels, namely application, organizational and interorganizational levels, depicting the level in the ICT environment the risk is related to. Moreover, risks can be classified on the account of the extent they are known: the risks could be known, predictable or unpredictable (Keyes 2005). However, few authors accommodate the temporal nature of risk to their classification schemes. Yet, Sherer and Alter (2004) present an extensive synthesis of IS risks from literature, classified by generic IS life cycle phases (initiation, development, implementation, and operation and maintenance). Moreover, the authors classify risks by work system (see Alter 2002; Alter 2003) components, namely customers, work practices, participants, information, technologies, environment, infrastructure and strategies, creating a generic model of risks potentially adaptable to any work system. The risks presented are conceptualized as both risk factors and risk components.

Views of Enterprise Architecture Risk

The reviewed literature included few papers exclusive on EA risks. Drawing from the discussion of ICT investment risks by Benaroch (2002), Saha (2006) discusses EA investment risks and options, presenting EA investment risk factors divided into the categories of organization specific, competitive, market and technical risks. Baldwin (2007), on the other hand, states that EA risks can exist on and between the various levels of EA products (e.g. business, information, information systems and technology).

Some authors also present results that can be applied to the EA risk context. Especially EA challenges (see e.g. Kaisler et al. 2005; Rehkopf & Wybolt 2003) and EA critical success factors (see e.g. Ylimäki 2006) could indicate potential areas where risks may arise. ICT risk literature, again, refers to architectural risks (see e.g. Avritzer & Weyuker 1998), typically uncovered by architecture reviews or audits, including a great number of technological and project management related factors. However, they seem clearly limited in the EA context, because EA adopts much more extensive view of an organization than traditional software development.

Enterprise Architecture Risk Classification Scheme

The work system framework of risks (see Sherer & Alter 2004) was adapted to this study because of its genericity and extensive literature base. The authors also acknowledge that generic work system risks apply to the IS context (Sherer & Alter 2004), suggesting that they may apply to the EA context as well. Furthermore, because a risk classification scheme should consider the conceptualization of risk in question, it is an advantage that the work system framework of risks shares the same conceptualization with this study. The model also provides a meaningful context to classify risks, understandable by not only technically-oriented persons but business personnel as well (Sherer & Alter 2004). Many other classification models utilize insufficiently defined, abstract categories, which may be difficult to comprehend by practitioners. Finally, the model already includes a set of generic risks based on an extensive literature basis, also including factors mentioned in EA risk literature (Saha 2006). However, it should be noted that even though the model takes the temporal nature of risk into account by classifying the risks by IS life cycle phases, this viewpoint was not covered in our study because of time limitations in the focus group interview.

Alter (2003) defines work system as “a system in which human participants and/or machines perform work using information, technology, and other resources to produce products and/or services to internal or external customers”. Originally, the author argues that the work system construct should replace the “IT artifact” as the central concept of the IS domain, because the contemporary IS domain is work system-centric rather than ICT-centric (Alter 2003).

However, as EA can be considered from at least the four viewpoints presented in the first section (process, product, implementation and impact), the adaptation of the framework to the EA context may not be straightforward. Therefore, we had to define how the viewpoints are represented by the framework. In our adapted framework, EA processes are represented with the *Work Practices* element, supported by *Participants*, *Information* and *Technologies*. EA products and services are naturally covered by the *Products and Services* viewpoint. EA implementations and impacts, on the other hand, are represented by the *Customer* element since customers implement the EA products and services, and expect the implementations to result in planned impacts. Moreover, implementations (e.g. a new information system developed according to EA) themselves can also be considered to be part of *Environment* and *Infrastructure* elements, and even *Information, Technologies* and *Work Practices*, if these elements include EA implementations.

The revised work system framework is depicted in Figure 1. The framework includes nine elements which all contribute to the operation of the system. Conforming to the original definitions (see Alter 2002), we define the elements for our adapted framework as follows.

- *Customers* are the internal and external users of EA products (e.g. principles, methods and models) and services (e.g. EA guidance) (adapted from Alter 2002). A typical use for EA products is their implementation, meaning both the implementation of organizational elements according to or in compliance with EA (see e.g. Armour et al. 1999; Kaisler et al. 2005), and other use cases (see e.g. Andersin & Hämäläinen 2007; Bucher et al. 2006; Emery et al. 2007; Lankhorst 2005; Rehkopf & Wybolt 2003). Customers might include, for example, organization’s management, project managers, ICT developers and partners (see e.g. Niemi 2007).
- *Products and Services* include all EA products and services produced by the work system (adapted from Alter 2002).
- *Work Practices* consist of EA processes (e.g. planning, development and management) and the practices and methods utilized in their operation (adapted from Alter 2002).
- *Participants* include persons who perform any work in the EA work system (adapted from Alter 2002). These include a broad range of roles carrying out work in any of the EA processes, such as enterprise and domain architects, ICT developers and project managers (see e.g. Niemi 2007).
- *Information* consists of any information used or created by the EA work system participants as they produce the EA products and services (adapted from Alter 2002). To produce EA products, information on the entities to be depicted by the products (e.g. organizational structures, processes, systems, applications and services) is required.
- *Technologies* include all kinds of tools and techniques used by the EA work system participants to carry out their work (adapted from Alter 2002). Several tools, such as Rational Rose and UML, are available for modeling EA (see e.g. Kaisler et al. 2005).
- *Environment* encompasses the organizational, cultural, competitive, technical and regulatory factors that have an impact on the operation of the EA work system although it is not directly dependent on them (adapted from Alter 2002). For example, management support and organizational culture have an effect on the architectural performance of an organization (see e.g. Ylimäki 2006).
- *Infrastructure* consists of human, informational and technical resources that are required in the operation of the EA work system although they are situated and managed externally (adapted from Alter 2002). In addition to organizational information systems and training and support staff (see Alter 2002), these resources include sources of information necessary for the production of EA products and services. These sources of information, in turn, may include subject matter experts with knowledge and experience in a specific domain (e.g. business, information,

information systems or technology) and various organizational descriptions and plans (see e.g. Babers 2006).

- *Strategies* include both the strategy of the EA work system and the strategy of the organization where the system operates (adapted from Alter 2002).

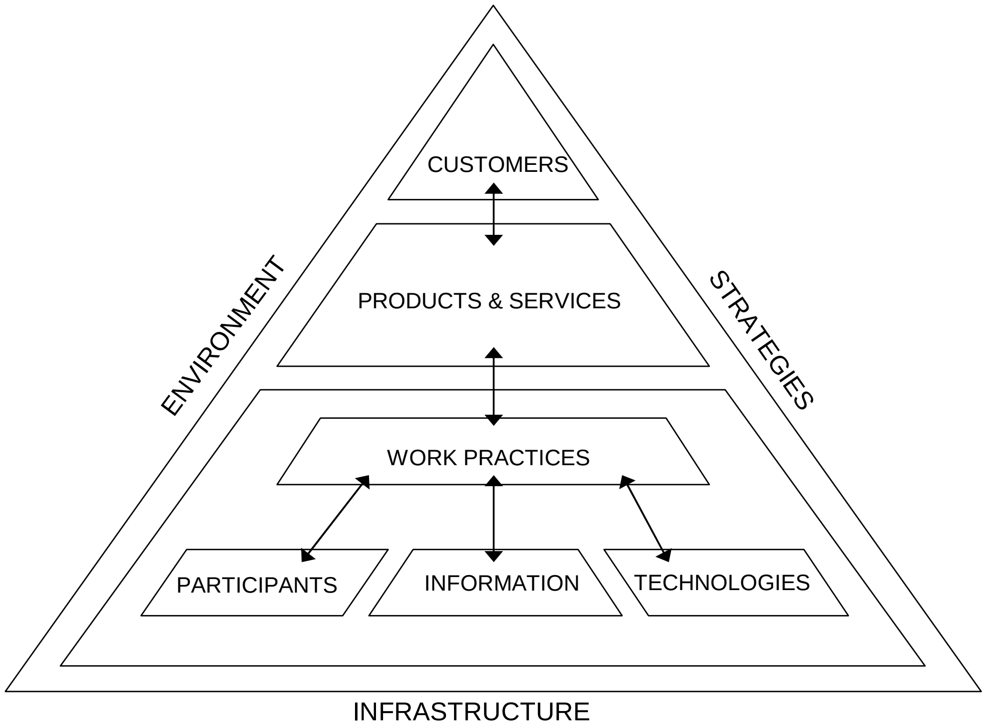

Figure 1. The revised work system framework (Sherer & Alter 2004)

The focus group participants also agreed that the framework is generic enough to be used to depict an EA work system. Nevertheless, several additional points regarding the framework were brought out. First, it was emphasized that the temporal nature of EA should be taken into account. Specifically, the focus group agreed that each of the elements has its own life cycle (i.e. each element changes in a different rate), and even inside the elements different objects (e.g. technologies and work practices) may have particular life cycles. Therefore, we suggest that the work system elements should be connected to the life cycle phases of EA (c.f. Sherer & Alter 2004).

Second, EA products and implemented EA can also be conceptualized from the temporal perspective. Individual EA products, such as architectural models depicting different viewpoints of the organization, have particular life cycles, as well as their implementations such as information systems and processes. The focus group stressed that it is always necessary to consider planned and implemented, as well as outgoing EA implementations. This presents the challenge of depicting the implemented EA in the framework, since it also is a source of risks not to be disregarded. In our adapted framework, the implementation viewpoint is included to the customer element. However, in the future it might be necessary to add an extra element for implementation to signify its importance.

Third, the focus group brought out that as well as all of the elements should implicitly include the temporal dimension, should they similarly include the aspects of security and competence. The focus group stated that competence is at least related to technology, work practices, participants, products and services, and customers. However, we consider that competence should be related to all elements that include stakeholder effort. Therefore, risks relating to the lack of competence may arise in at least the elements of participants, customers, infrastructure and environment; they are not merely related to participants as suggested in the original framework (c.f. Sherer & Alter 2004). Nevertheless, the focus group stated that lack of competence in this context refers more to the lack of common understanding about EA than to the lack of skills. Regarding organizational security, it was suggested that it should be similar, implicit aspect that crosses every element in the framework. Lack of security in the elements of EA work system was considered a risk by the focus group, and should not be included merely to the information element (c.f. Sherer & Alter 2004). According to the group, security influences EA and vice versa.

Fourth, the role of partners in carrying out work on EA was accentuated. However, it was commented that partners cannot be associated with one particular element due to their different roles in the operation of the system. According to the focus group, partners can directly carry out operative tasks in the EA work system, act as suppliers of necessary EA or ICT products and services, or even offer whole outsourced service interfaces for the operation of the EA work system. Moreover, the group accentuated that partners might as well be a source of risks, a point missing in the original framework (c.f. Sherer & Alter 2004). Consequently, we suggest that partners should be considered as participants if they have a role which involves performing operational tasks in the EA work system. If partners act as product or service providers or outsourcing partners, they can be considered as infrastructure. Internally managed ICT products, on the other hand, could be included into technologies.

Fifth, it was stated that the different roles of the management of the organization similarly make it difficult to classify management to any single element. According to the focus group, management is an important stakeholder of EA, providing necessary resources, steering EA by making architecturally significant decisions, observing and measuring the work system, and utilizing EA in organizational decision-making. Management does not directly carry out work in the system, but is a significant facilitator, user and also a developer of EA since its decisions set the general direction for the work in the system. Therefore, we consider management to be part of not only the environment (c.f. Sherer & Alter 2004) but also the participants, customers and infrastructure elements, depending on its role in the organization in question.

Potential Enterprise Architecture Risks

The generic work system risks presented by Sherer & Alter (2004) were adapted to be utilized as a basis for discussion in the focus group interview. The focus group participants generally agreed with the generic risks presented, but provided a number of additional risks and examples of risks’ realization in practice.

The EA work system risks are displayed in Table 1, including both 1) factors that may lead to negative outcomes in the EA program, and 2) potential negative outcomes resulting from these factors. The table includes both the original risks (see Sherer & Alter 2004) and the additional risks mentioned in the focus group interview. Moreover, examples of risks’ realization in practice, brought out in the interview, are displayed. The information from the interview is displayed in *italics*.

Table 1. Generic EA work system risks and examples of their realization (adapted from Sherer & Alter 2004; complemented by the focus group)

EA work system element	**Factors leading to negative outcomes**	**Negative outcomes**
Customers	▪ Disagreement regarding the requirements for EA products and services *- Insufficient source information on EA for producing products and services* *- Inconsistent requirements because of different competencies in comprehending products and services* ▪ Difficulty in using EA products or services *- Insufficient competence for using EA products and services correctly* *- Inadequate instructions and training* ▪ *Inadequate implementation of EA products and services* *- Inadequately high or low compliance between EA and its implementations* *- Inadequate temporal planning of implementation* *- Inadequate EA guidance to the implementation project (e.g. incorrect content or timing)* *- Inadequately narrow or wide scope of the implementation project* ▪ *Insufficient organizational security*	▪ Lack of use of EA products and services ▪ Dissatisfaction of customers ▪ *Misuse or misinterpretation of EA products* ▪ *Insufficient realization of EA objectives*
Work Practices	▪ Poorly designed EA processes *- Burden of obsolete work practices* ▪ Incompatibility between work practices and other EA work system elements *- Lack of approval, authorization or need for work practices* ▪ Insufficient resources ▪ Inadequate planning and control mechanisms *- Insufficient comprehension of objectives* *- Insufficient observation of work practice feasibility* *- Insufficient feedback mechanisms from the customers and participants* ▪ *Insufficient organizational security*	▪ Inadequate EA process performance ▪ *Insufficient predictability of outcomes* ▪ *Insufficient documentation*

EA work system element	**Factors leading to negative outcomes**	**Negative outcomes**
Products and Services	▪ Inadequate quality or cost of EA products or services to customer - *Inadequately high EA quality (positive risk)* - *Inadequately high initial costs* ▪ Incompatibility between customer requirements and EA products or services - *Inadequately simple or complex EA* - *Insufficient flexibility of EA* ▪ *Insufficient organizational security*	▪ Lack of use of EA products and services ▪ Dissatisfaction of customers
Participants	▪ Inadequate management of EA processes - *Lack of measurement of participants' work* - *Unclear organization and responsibilities* ▪ Lack of competence - *Incompatibility between participants and technology* - *Inadequate instructions and training* ▪ Lack of motivation and interest - *Lack of measurement of participants' work* - *Inadequate instructions and training* ▪ Poor conflict management ▪ Incompatibility between characteristics of participants and processes ▪ *Insufficient organizational security*	▪ Inadequate EA process performance ▪ Personnel problems
Information	▪ Insufficient information quality - *Insufficient reliability of information (e.g. documented information vs. tacit knowledge)* - *Insufficient or vast amount of information* -*Insufficient information integrity* ▪ Insufficient information accessibility - *Unobtainable information even when access rights are correct* ▪ Insufficient information presentation ▪ Insufficient information security	▪ Inadequate EA process performance ▪ Participant frustration ▪ Information loss or theft
Technologies	▪ Inadequate usability of technology ▪ Inadequate technology performance for EA processes ▪ Technology errors ▪ Incompatibility between technologies Which all may result from e.g. - *Inappropriate technology (e.g. too old or new technology)* - *Unorthodoxly applied technology* ▪ *Dependence on technology providers* ▪ *Insufficient organizational security*	▪ Inadequate EA process performance ▪ Participant frustration

EA work system element	Factors leading to negative outcomes	Negative outcomes
Environment	▪ Insufficient management support *- Insufficient resources (time, personnel, money) directed to the EA work system* ▪ Inconsistencies with organizational culture ▪ *Inconsistencies with partners or legislation* ▪ Incompatibility between environment and the EA work system *- Incompatibilities between EA and reality* *- Insufficient flexibility of EA* *- Insufficient competence for understanding EA* ▪ High level of turmoil and distractions ▪ *Insufficient organizational security*	▪ Diminished EA work system performance
Infrastructure	▪ Inadequate human infrastructure *- Unclear who to ask for input information for EA* *- Insufficient competence for participating in work on EA* *- Infrastructure consists of separate silos* ▪ Inadequate information system infrastructure *- Infrastructure consists of separate silos* ▪ Inadequate technical infrastructure ▪ *Insufficient organizational security*	▪ Diminished EA work system performance
Strategies	▪ Poor alignment between organizational strategy and the EA work system *- Unclear or missing “big picture” of EA* *- Inadequate control of the effects of organizational strategy change on EA* ▪ Inadequate EA work system strategy for accomplishing work system goals *- Incorrect comprehension of strategy* ▪ *Insufficient organizational security*	▪ Ineffective EA work system performance

Summary and Conclusions

This study aimed at providing an overview of generic risks that can potentially be related to EA in organizations, by carrying out a literature review and a focus group interview of practitioners. Furthermore, potential classification schemes for the risks were charted from literature, and one of the schemes – the work system framework – was selected and discussed in the focus group interview. The framework also included a set of generic work system risks, which were also discussed in the interview. In this study, EA risks were conceptualized both as 1) factors that may lead to negative outcomes in the EA program, and 2) negative outcomes resulting from these factors. The latter was considered more important aspect in practice by the focus group interviewees.

Although the focus group participants agreed that the work system framework is generic enough to be used to depict an EA work system, they brought out several comments regarding to the framework:

- The life-cycle aspect of all of the EA work system elements should be more explicit in the framework. Particularly, both EA products and implementations have distinct life cycles, which should be considered.
- Implemented EA is an important source of risk in the EA work system so it should potentially be highlighted in the framework.
- All of the EA work system elements are affected by the level of organizational security.
- Every EA work system element that involves stakeholder effort is prone to risks related to lack of competence. However, lack of competence in this context should be more conceptualized as the lack of common understanding about EA than the lack of skills.
- Both partners and management may have diverse roles in the operation of the EA work system so they cannot be associated with only one specific element.

Judging from the comments, it may be that the work system framework, as is, is not an unambiguous classification scheme for risks related to EA. The framework should be further adapted to consider the comments above. Nevertheless, the focus group generally agreed with the generic EA work system risks presented, but provided a number of additional risks and examples of risks' realization in practice, which were added to the initial list of EA work system risks.

We suggest that EA risk management supports the attainment of EA objectives (c.f. Lam 2003). Successful EA, in turn, supports the attainment of organizational objectives, such as organizational flexibility and agility (see e.g. Hoogervorst 2004). Likewise, unsuccessful EA can have serious consequences in the organization. On the other hand, EA can even be exploited to facilitate organizational risk management (see e.g. Morganwalp & Sage 2004). This viewpoint was also shared by the focus group interviewees.

Practitioners can use these results to identify typical risks related to each element in the EA work system, and to assure that risk management practices have been planned for all relevant risks. Moreover, the EA work system framework may be used to structure the EA approach in organizations, regarding other aspects than risks as well. However, further work on the framework is needed; for example, it should be investigated if different EA life cycle phases (e.g. planning, development and use) or viewpoints (process, product, implementation and impact) need separate work systems that are connected with each other. A similar idea has also been presented by Alter and Sherer (2004) in the IS context.

As the validation of the results was rather limited in the course of this study, more empirical research is still needed. Especially, the EA risks presented should be further analyzed for their significance in practice and more concrete examples of their realization uncovered. Moreover, as the temporal nature of EA risks was not thoroughly investigated in this study, the risks should be studied with regard to time; for example, which risks are especially related to which steps in the EA program, levels of EA maturity, or phases of the EA life cycle. Uncovering the actual causal chains of risks is also an important area of further research, as well as the different levels of risks; in this study, only two levels (risk factors and resulting negative outcomes) were included. Following lines of research could also focus on scrutinizing EA risk management approaches and methods and quantifying the effects of the realization of EA risks on the organizational level. Also, implementing EA risk management as an organized, continuous activity that is linked to the organization’s generic risk management is a challenge which requires further investigation.

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a|EA JOURNAL **Article**

Towards a Generic Evaluation Model for Enterprise Architecture

By Tanja Ylimäki

Abstract
During the past few years, enterprise architectures (EAs) have become one of the major interests of both business and information technology (IT) practitioners and academics. It has been suggested that EA is an approach for controlling the complexity and constant changes in the organization's business environment. Research has mainly focused on the development and modeling of EAs, while the quality aspects of EA have only recently gained attention, especially in the form of EA maturity models. These models have been developed to provide a means to evaluate the stage – and the quality – of the organization's EA. While most existing maturity models seem to be domain-specific, this study aims at developing a more generic evaluation model for EA usable in private sector organizations, regardless of their lines of businesses. The generic evaluation model is based on the combination of the potential critical success factors for EA, defined in the previous steps of the project, and the maturity stages. The initial generic evaluation model for EA was trialed in three organizations. The experiences and needs for improving the evaluation model derived from these cases are also represented.

Keywords
enterprise architecture, critical success factors, quality, maturity, evaluation, assessment, evaluation model, maturity model

INTRODUCTION

During the past few years, enterprise architectures (EAs) have become one of the major interests of both business and information technology (IT) practitioners and academics. It has been suggested that EA is an approach for controlling the complexity and constant changes in the business environment of an organization, enabling a real alignment between the business vision, business requirements and information systems (Armour et al., 1999a; 1999b; Kaisler et al., 2005). In brief, EA can be seen as a collection of all models needed in managing and developing an organization. It takes a holistic, enterprise-wide and consistent view of the organization instead of a looking at it from the point of view of a single application or system (Kaisler et al., 2005; Lankhorst, 2005).

Typically, EA studies have focused on the development and modeling of EA (see e.g. Armour et al., 1999a; Halttunen et al., 2005; Lankhorst 2005; Pulkkinen & Hirvonen, 2005; The Open Group, 2002; Ylimäki & Halttunen, 2006; Zachman, 1987), but recently, the quality and assessment aspects have also gained some attention. Specifically, maturity models, which have their origins in the field of quality management (Chrissis et al., 2003; Fraser et al., 2002;), have been developed to assess the stage of an organization's EA and to enhance its quality (U.S. Department of Commerce, 2003; Chief Information Officers Council, 1999; U.S. Government Accountability Office, 2003; Industry Advisory Council, 2005; National Association of State Chief Information Officers, 2003; Office of Management and Budget, 2005).

The maturity of EA refers to an organization's capability of managing the development, implementation and maintenance of its architecture (van der Raadt, et al., 2004), which usually consists of four viewpoints: business, information, systems, and technical architecture (e.g., The Open Group, 2002). Furthermore, the idea of these maturity models is that maturity evolves over time from one level to a more advanced level, without skipping any level in between, eventually moving towards the ideal ultimate state (Klimko, 2001).

I regard these maturity models as one means of advancing the quality of EA by providing at least an initial EA quality management system (see also Cullen, 2006). Something that I consider to be a downside with these maturity models is the fact that they seem to be more or less domain specific; especially developed for the various areas of the public administration (see e.g. U.S. Department of Commerce, 2003; Industry Advisory Council, 2005; National Association of State Chief Information Officers 2003; Office of Management and Budget, 2005; U.S Government Accountability Office, 2003; Vail, 2005). Publicly available maturity models, specifically suitable for evaluating the EA of heterogeneous private sector companies, are still hard to find. Hence, I decided to take another approach to the problem: we applied the concept of a Critical Success Factor (CSF) to the field of EA and defined the potential CSFs for EA. These CSFs represent the factors that have to be carried out exceedingly well in order to attain successful EA (i.e. a high-quality EA) which in turn enables the business to reach its objectives and gain more value (Ylimäki, 2006).

In this article, I present a study that aims at developing a generic evaluation model for Enterprise Architecture (later the model is referred to as gemEA), a model that is suitable for evaluating the stages of EA in private sector organizations, regardless of their line of business. The potential CSFs for EA that were defined during the previous steps of the ongoing research project (see Ylimäki, 2006) provide the basis for the generic evaluation model. These factors combined with the appropriate maturity levels form the initial gemEA.

The article proceeds as follows. In the next section, I present the construction of the generic evaluation model for EA, gemEA. Following this, the trial use of the initial gemEA in three case organizations is presented, and the usability of the model in practice is discussed. Finally, the last section summarizes the article and presents suggestions for further research.

CONSTRUCTION OF THE EVALUATION MODEL

The previously defined set of potential CSFs for EA awoke our interest to study whether this set of factors can be utilized in evaluating the current state of any private sector organization's EA, and furthermore, how holistic and extensive a view of the state of the organization's EA do the factors provide? Consequently, we needed to construct an evaluation model that is based on the set of potential CSFs for EA. In this section, the construction of the generic evaluation model is briefly described.

The set of potential CSFs for EA (Figure 1) were defined in the previous steps of the research project (see Ylimäki, 2006). They provided the baseline for the initial gemEA. In Table 1, brief descriptions of each potential CSF are presented. More detailed descriptions of the CSFs are presented in (Ylimäki, 2006) in the form of key questions assigned to each factor.

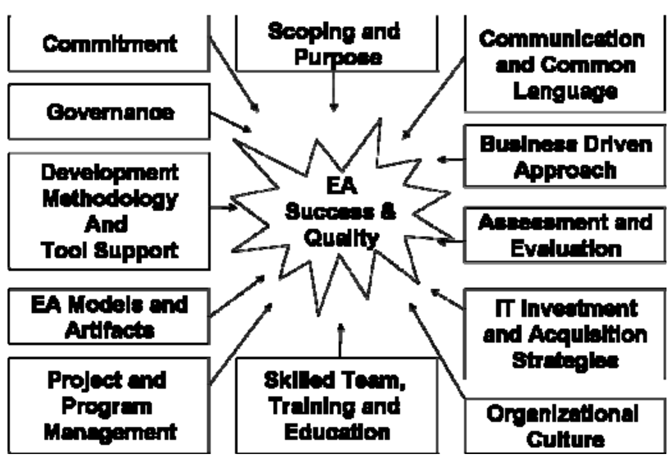

Figure 1. The Set of Potential Critical Success Factors for Enterprise Architecture

CSF for EA	Description
Assessment and Evaluation	The extent to which the architecture and architecture processes are evaluated and improved, and how established the evaluation processes are. Deals with issues such as definition of EA evaluation targets, evaluation purposes and audience, evaluation process and criteria (metrics), as well as data gathering and analysis techniques.
Business Driven Approach	The extent to which the business strategies, business objectives and requirements are taken into account in the architecture development.
Commitment	The extent to which both the top-management and the employees of the organization are committed to and involved in the EA effort.
Communication and Common Language	The extent to which the organization has established architecture related terminology (the common vocabulary) and effective means to conduct architecture related communication.
Development Methodology and Tool Support	The extent to which the organization has an established architecture framework and development process, and the extent to which different tools are exploited in architecture development and management.
EA Models and Artifacts	Deals with issues such as developing a documentation plan, collecting and analyzing the requirements, ensuring that all necessary views are modeled in order to provide a coherent and concise picture of the enterprise (current and future models), and developing a transition plan.
Governance	Relates to issues such as governance (architecture guidance) structures, roles, responsibilities, processes and activities, change management processes (both organizational and architectural changes) and risk management processes.
IT Investment and Acquisition Strategies	Deals with the relationship (and dependency) between architecture development and governance processes and the IT investment and acquisition processes and decisions.
Organizational Culture	Deals with issues such as the organization's readiness to develop and utilize EA, attitudes towards the architecture approach, attitudes towards changes in general, and the organizational changes the architecture development may lead to.
Project and Program Management	Deals with issues such as the coordination between various (architecture) projects, utilization of project milestones and checkpoints for architectural evaluation or guidance, taking advantage of lessons learned and best practices, as well as being on budget and schedule.
Scoping and Purpose	Deals with issues such as the definition of EA in the organization, the key stakeholder groups, the mission, goals and direction of EA, the purpose of EA, and how wide organizationally, how deep and detailed and how fast the EA should be developed in the organization.
Skilled Team, Training and Education	The extent to which the architecture team is organized and established as well as the extent to which required skills are available or acquired.

Table 1. Potential Critical Success Factors for Enterprise Architecture (In Alphabetic Order)

The maturity levels, shown in Table 2, were derived from the existing maturity models (Chrissis et al., 2003; U.S. Department of Commerce, 2003; U.S. Government Accountability Office, 2003; National Association of Chief Information Officers, 2003; Office of Management and Budget, 2005). The aim was to define the maturity levels in such a way that they can be used for evaluating the stage of all the diverse areas, i.e. the CSFs in the gemEA.

Level		Description
0	Undefined / None	No evidence of any kind of the particular area being taken into account.
1	Initial	The need for taking the particular area into account has been recognized. Artifacts and practices may exist, but they may be incomplete or inconsistent. Processes are mainly informal and ad-hoc.
2	Under Development	Artifacts and documented practices or processes exist. Some may be even complete. Implementation or deployment is not yet carried out. Practices or processes are not yet utilized.
3	Defined	Practices or processes and artifacts have been completed, accepted and communicated to the stakeholders. Implementation, deployment, and utilization have started.
4	Managed and Measured	Implemented or deployed. Practices or processes and artifacts are being utilized and considered as part of normal operations in the organization. Practices or processes and artifacts etc. are measured against a set of predefined and established metrics or criteria.
5	Optimizing (continuous improvement)	Practices or processes related to the particular area are continuously improved. More specifically, clear proofs of architecture benefits, e.g. demonstrable improvements in efficiency, cost savings and service quality, can be seen.

Table 2. The Maturity Levels Defined for the gemEA

As a conclusion, the initial gemEA consists of three main parts:

1) the set of 12 CSFs for EA representing the areas to be evaluated;
2) the key questions assigned to each CSF (see Ylimäki, 2006 for more details); and
3) the maturity levels to evaluate the stage of each CSF.

In the following section, the usability of the initial gemEA is described on the basis of the model's trial use in three case organizations.

TRIAL USE OF THE INITIAL EVALUATION MODEL IN THREE CASES

The initial gemEA was tested in the three organizations participating in the research project, as is shown in Table 3. Each organization operates in a different line of business and represents an enterprise of different size. In organization 2 and organization 3, the current stage of their EA was evaluated. In organization 1, the evaluation was two-fold: on one hand, the organization's ability to deliver architecture development and management services, as well as practices in customer projects was evaluated; and on the other hand, the average state of its customers' EA was evaluated from the consultants' viewpoint. Suggestions for modifying and improving the evaluation model were collected during the following steps:

1. Data Gathering: For each company, one semi-structured focus group interview (Krueger and Casey 2000) was carried out. The option of a complementary interview existed and was applied as a phone interview in the case of Organization 1. The evaluation model – specifically, the CSFs together with the key questions – formed the basis for the interviews, which were carried out by three researchers. The interview was moderated by one researcher while the other two took notes. The interviews were also digitally audio-recorded for the purposes of reviewing and completing the notes. Moreover, the companies provided some documentation to support the interviews.

2. Data Analysis: The interview notes were checked against the recordings and necessary corrections and additions were made. Descriptive text was written according to the notes. Documentation, such as organization charts, was used to add information. In addition, a ballpark estimate for the maturity level was made for each of the areas (CSFs) in the gemEA.

3. Reporting the Results: A separate report was compiled for each company. Before completing the reports they were reviewed by the researchers, who focused especially on the maturity measures of each CSF as well as on the conclusions drawn from the study in order to verify the consistency of the researchers' views. In addition to the company specific reports, an analysis of the current status of architectural work, underlining the challenges and developmental potential in organizations, is described by Niemi (2006).

Industry	Number of Personnel[1]	Number Interviewed
Business & IT Consulting and Development	1,400	3
Finance and Insurance	12, 000	3
Telecommunications	4,700	1

[1] approximate number (Year: 2005)

Table 3. The Case Study Companies

USABILITY OF THE EVALUATION MODEL

In this section, I describe the usability of the evaluation model in practice, as well as provide ideas and suggestions to improve the gemEA, that were perceived during the trial use of the model in three heterogeneous case organizations.

Based on the trial use of the gemEA, it seems that the model – the set of 12 CSFs for EA together with the maturity levels – is suitable for evaluating the current stage of EA in various types of private sector organizations (representing IT user organizations). Furthermore, the gemEA provides a tool to evaluate an IT service-provider organization's ability to deliver EA development and management services and practices for its customers.

The CSFs in the gemEA take various viewpoints into account and provide a more holistic and extensive view to an organization's EA than most of the existing models. In addition, the gemEA is also generic enough to enable the evaluation of the state of EA in various organizations representing different lines of businesses; whereas, most existing maturity models that have been used in the EA evaluation are defined in terms of public sector organizations (administration) only. Furthermore, even if the EA maturity models for private sector organizations exist, they are seldom publicly available. It should be noted, however, that organizations may have different means and paths to move from a maturity level to a more advanced level, particularly depending on the industry and the size of the organization. For instance, in an organization consisting of five consultants in total, EA issues can possibly be communicated alongside with every day business actions without hundreds of pages of EA documentation; whereas, in large organizations employing hundreds or thousands of people, successful communication on EA issues needs more careful planning and established channels.

The gemEA is, however, an initial evaluation model, and during its trial use, the following improvement needs were detected:

- Categorization of the questions attached to each CSF: Two or three levels of questions for each CSF could be determined; general-level questions supported by more detailed questions (see also Taylor-Powell et al. 1996). This categorization would enable evaluators to use the gemEA either on a high-level (only the general-level questions are answered) or on a more detailed level (detailed questions are also answered) depending on the objectives of the evaluation as well as the resources available for conducting it.
- Prioritization or weighting either 1) the CSFs, 2) the different parts of the CSFs, or 3) both: During the analysis of the interview data, it was noted that difficulties may appear in assessing the maturity of a CSF if it consists of several different aspects; which part of a CSF should be emphasized and why? One solution to this problem would be the prioritization of the CSFs, or perhaps the weighting of them, as well as the different aspects within a CSF. Prioritization could be done, for instance, on the basis of the phase of the organization's EA development, or the available resources (time, money, or workload). Specifically, if the organization has just started its EA journey, it is likely that gaining a common understanding and commitment through effective communication and common language, utilizing the EA models and other artifacts in this effort, is important or even vital. When the EA development advances, issues such as establishing the governance structures or the evaluation metrics will gain more attention. As a conclusion, there seems to be a need to develop a more sophisticated mapping between the CSFs and the maturity levels of the gemEA: at the lower maturity levels, the emphasis may be on different factors than on the more advanced levels. However, the initial version of the gemEA already provides a workable tool for revealing the areas important to the EA that the organization may have ignored or neglected.
- Combining or dividing the CSFs: Depending on the organization's needs (or the phase of the EA development), there may be a need to divide some CSFs into several separate parts (such as framework, development methodology and tool support), especially if there seems to be a lot of variation in the maturity or development activity among these parts.
- Organization of the CSFs: During the analysis of the interview data, some questions arose; should the CSFs be organized or categorized further? How should they be categorized? One possible grouping for the CSFs was found, namely:

  1) Architectural starting points (including Scoping and Purpose; Organizational Culture; Commitment; Communication and Common Language);

  2) Methods and tools for architecture work (including Development Methodology and Tool Support; EA Models and Artifacts; Assessment and Evaluation);

  3) Support for architecture work (including Governance; Skilled Team, Training and Education; Project and Program Management); and finally

  4) Integration with the organization's other processes (including Business Driven Approach; IT Investment and Acquisition Strategies).

  This categorization provides one possible way of interpreting the results. For example, it may help in depicting the extent to which the organization has addressed the architectural starting points, which are crucial in facilitating the further EA development.

CONCLUSIONS

In this study, the first version of a generic evaluation model for EA, gemEA, was presented. The model consisted of:

- the CSFs for EA;
- the key questions assigned to each CSF; and
- the maturity levels to assess the stage of each CSF.

The model was tested in three organizations in which either the current state of the organization's EA or the organization's ability to provide EA development and management services was evaluated. All of the cases demonstrated that the model is comprehensible and usable and that it provides an extensive view on the state of the organization's EA or its ability to support EA development and management in its customer projects. When evaluating our study it should, however, be remembered that the usability of the model is based on only three cases and the subjective views of the interviewees may have been emphasized. More tests are needed in order to develop the model into something truly generic.

Finally, in addition to the improvement needs of the gemEA described in the previous section, some further research questions raised by this study are:

- How stable are the CSFs in the gemEA? Are there any other areas or objects that should be taken into account when evaluating the state of an organization's EA?
- In addition to the determination of the maturity of EA in terms of the CSFs in the gemEA, which sophisticated, yet simple and practical, evaluation criteria and metrics are suitable for assessing each CSF, especially in order to demonstrate the benefits of the EA program to the top management?
- How many evaluation criteria and metrics should be used for evaluating the state of an organization's EA? How many evaluation criteria and metrics are needed to assess each CSF?
- How can an organization choose the most suitable evaluation criteria and metrics for the EA assessment from the array of different criteria and metrics? One primary driver for metrics selection is that they need to be compatible with the other measures and measurement systems used in the organization (such as Balanced Score Card).
- How do the metrics and the phase of the EA development, or the EA maturity level, interrelate with each other? Which metrics are suitable for specific phases of the EA development or specific EA maturity levels?

The next steps of the research project will focus on determining:

- the requirements and targets for more detailed evaluation of EA; and
- suitable and simple metrics for assessing these evaluation targets.

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a|EA JOURNAL **Article**

A GOAL-ORIENTED WAY TO DEFINE METRICS FOR AN ENTERPRISE ARCHITECTURE PROGRAM

By Niina Hämäläinen and Tommi Kärkkäinen

ABSTRACT

Metrics are becoming more and more important in the development of enterprise architecture (EA) programs. Therefore, guidelines and support to define metrics for EA programs are needed. A goal-oriented approach for defining metrics for EA program and the measurement aspects for EA program are presented in this article. This approach was developed and tested during the development of proposals of EA program metrics for two companies.

KEYWORDS

enterprise architecture program, metric, measurement, GQM, measurement program, iterative

INTRODUCTION

Measurement and metrics are more and more concerns of EA groups in the development of EA programs. Metrics are seen to be crucial to both managing the development of Enterprise Architecture and to justifying its existence. Value and significance of measurement and metrics for enterprise architecture work is commonly recognized: *"Being able to measure, in the meaning of having skills and capability to measure, is essential at all stages of the EA adaptation."* (Christiansen and Gotze 2007) In addition, consultation companies have stated, for example, "*We will begin to see metrics become an integral part of EA and SOA programs*" (Cutter Consortium 2007).

However, currently there is very little guidance on metrics that can be captured to help the assessment of EA (Kaisler, et al. 2005). One consequence of this may be that metrics for EA programs are not defined at all. "*A recent Forrester survey of more than 50 European enterprise architects revealed that while many enterprise architects were working to achieve specific goals, metrics related to those efforts often did not exist or were not clearly defined*" (Wollmer 2007).

Goal-oriented way has been suggested as an approach to define metrics for EA programs (Cullen 2005; Weiss 2006). However, unclearly defined goals for EA programs are recognized to be an obstacle in the actual definition of metrics (Hoppermann 2007). There seem to be no public guidelines or processes how to carry out the goal-oriented definition of metrics for EA program or these guidelines are very roughly described. Public guidelines or solutions how to handle the problem of unclearly defined goals for EA program in the measurement planning seem not exist.

This article supports the planning of metrics for EA programs by presenting measurement aspects and phases of iterative and goal-oriented metrics development process. In addition, experiences of metrics definition are presented. These were developed and tested during the development of proposals of EA program metrics for two companies.

The remainder of this article is structured as follows. Firstly, measurement program success factors, goal-oriented approach of defining metrics and use of measurement aspects are discussed. Secondly, the research phases are presented. Thirdly, the measurement aspects and metric planning process is presented.

Finally, some experiences of developing metrics for EA program are described and the summary of paper is presented.

GOAL-ORIENTATION IN MEASUREMENT PROGRAMS

Factors affecting the success of measurement programs have been studied previously, especially in the software engineering domain by (Gopal, et al. 2002), (Jeffery and Berry 1993), (Hall and Fenton 1997), (Rifkin and Cox 1991). Factors affecting the success include goal-oriented approach and incremental development of metric program, transparency of metric program (practitioners know and understand what data is collected, why it is being collected, and how it is being used), usefulness of metrics data, metric data gatherers' and users' participation in designing metrics program, and metrics integrity (the collected data sensible to collect, accurately collected, and not being "fiddled"). In addition, it is important that practitioners' get feedback on data that is collected and practitioners are trained to carry out measurement and to collect data. Automated data collection, using gurus and champions as examples and dedicated metric team that has responsibility of metric program are also important (Hall and Fenton 1997).

One well known approach to measurement plan definition is the Goal Question Metrics (GQM) (Basili, et al. 1994). The main idea behind GQM is that the measurement should be goal-oriented and based on context characterization (Ardimento, et al. 2004). The approach is based on the assumption that for an organization to measure in a purposeful way it must first specify the goals for itself and for its projects, then it must trace those goals to the data that are intended to define goals operationally, and finally provide a framework for interpreting data with respect to the stated goals (Basili, et al. 1994). Thus, it is important to make clear, at least in general terms, what information needs the organization has, so that these needs can be quantified whenever possible, and the quantified information can be analyzed to whether or not the goals are achieved (Basili, et al. 1994). GQM-approach uses a top-down approach to define metrics and a bottom-up approach for analysis and interpretation of measurement data (Ardimento, et al. 2004). GQM is highly iterative process (e.g. goals are identified during working with questions (Berander and Jönsson 2006).

Metrics often represent different dimensions and are collected for different purposes (Berander and Jönsson 2006). Measurement aspects (categories) can be used to support the definition of metrics (Berander and Jönsson 2006). These measurement aspects allow one to consciously take into account several dimensions and they provide guidance and context. In addition, they minimize the risk for ending up with questions and metrics covering a few dimensions and make sure that some dimensions are not missed when eliciting measurement goals and metrics.

The aspects used in the categorization can, roughly speaking, come from two sources. Either they have been defined before the GQM-work, or they are defined during the work based on the elicited questions (Berander and Jönsson 2006). In this study, pre-defined measurement aspects are suggested to be used for the basis of planning the metrics for EA program.

RESEARCH METHOD

This study consist of two parts: 1) identifying measurement aspects for EA program and 2) construction of metric definition process for EA program and testing while developing proposals of EA program metrics for two companies.

Measurement aspects for the EA program include:

1. *Needs for EA evaluation and measurement*. Before this study, studies were conducted where needs for architecture evaluation and measurement were identified (Hämäläinen, et al. 2007;Ylimäki and Niemi 2006). These studies included, for example, a focus group interview on EA evaluation and measurement needs of practitioners from collaborating companies.

2. *Literature review*. Literature on evaluation and measurement was charted to identify why, how and where measurement and evaluation is carried out in organizations in general. In addition, the existing knowledge and views on EA related measurement work were gathered.

3. *Definition of measurement aspects*. The findings of literature review and studies on evaluation needs were used as a basis to define

measurement aspects. A description of the aspects was produced.

4. *Focus group interview of practitioners*. Measurement aspects were evaluated in a focus group interview. Interviewees are presented in Table 1.

5. *Updating the description of the measurement aspects*. The findings from the focus group interview were analyzed and the description of the measurement aspects was modified and updated according to the experiences disclosed by the focus group.

Companies	Number of interviewees	Viewpoints of Interviewees
Architecture consultation company Number of personnel 10 (year 2005)	1	enterprise and software architecture consultation
Banking, finance and insurance company Number of personnel 11 974 (year 2005)	1	enterprise architecture
Telecommunication company Number of personnel 4989 (year 2005)	1	enterprise architecture
Business & IT consulting and development organization A part of a large international company having 329 373 employees (year 2005) in total	2	software architecture, enterprise architecture, marketing, business

Table 1. Focus Group Interviewees

CONSTRUCTION OF MEASUREMENT PLANNING PROCESS

At the next stage, proposals of metrics for two companies' EA programs were produced. These companies were the telecommunication company and banking, finance and insurance company mentioned in Table 1. During this activity a process for the metric definition for EA program was developed because no public process for this was available. In this development, the measurement aspects developed during part one and GQM-approach was utilized. Measurement aspects were updated on based experiences during this development. The development of metric proposals for companies included two iterations.

MEASUREMENT ASPECTS FOR THE ENTERPRISE ARCHITECTURE PROGRAM

Based on literature review and identified measurement and evaluation needs, the following measurement aspects for enterprise architecture program were identified:

- *Benefits of EA program for organization*
- *Impacts and use of EA program and its results*
- *Progress and Operations of EA program*: EA team's and architects' accomplishments, particularly progress toward pre-established goals
- *Quality / Maturity*
    - o Maturity of EA program capabilities
    - o Quality of results produced by EA program
- *Architecture structures in organization:* evaluation of architecture alternatives and solutions

These aspects can be used to support the identification of company's measurement needs and derivation of related metrics.

METRICS DEVELOPMENT PROCESS FOR EA PROGRAM

The research process allowed use to identify that the basis for the EA program's metric definition is the understanding of 1) company's business and IT goals, 2) company's rationale and goals for EA program, 3) information needs related to EA program and 4) measurement context and possibilities in company. This information is used as basis for the definition of metrics and in the evaluation of metrics' suitability for the company. Figure 1 below and Table 2 on the next page describe the goal-oriented definition approach of metrics for EA program.

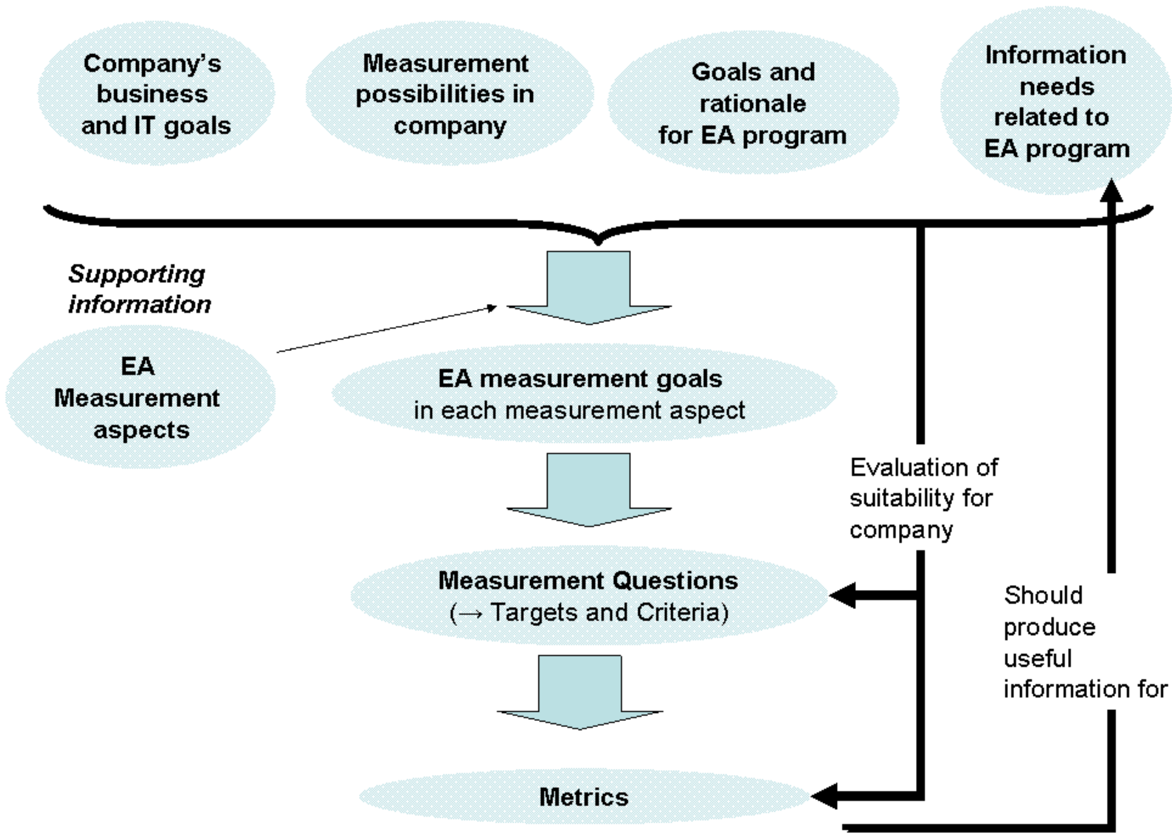

Figure 1. Information Gathered, Used and Produced in the Definition of Metrics for EA program

In the development of metrics, the tables produced with Microsoft Office Word were utilized in the gathering and planning metrics and in discussion with companies concerning Phases 3-6. The colums of tables were from left to right: *Measurement aspect*, *Measurement goal* (What is the goal of measurement?), *Targets* (What is the focus?), *Metrics/Criteria* and *Comments*. Target-column was used in the same meaning as the question-aspect in GQM-approach.

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Phase	**Tasks and results**
Phase 1. Company's Goals, EA Goals, and Information Needs	• Identifying and documenting information and EA program's stakeholders' conceptions about goals and rationale for company's EA program and team • Identifying company's business and IT goals from EA program point of view • Identifying information needs related to EA program (what information should metrics produce?).
Phase 2. Measurement Possibilities	• Identifying company's and EA group's resources and capabilities for the measurement (e.g. existing practices and metrics, resources for measurement).
Phase 3. EA Measurement Goals	• Defining EA goals that are decided to be measured.
Phase 4. Measurement Questions	• On based measurement goals, identifying measurement questions including measurement targets and criteria which will be measured.
Phase 5. Metrics	• Choosing metrics suitable for measurement questions (for target & criteria) • Choosing only few critical metrics • Choosing useful metrics that: o Produce information that is useful in current situation, and o Suitable for the goals of organization and for the goals of architecture work (in the short and long term).
Phase 6. Feedback	The feedback gathering from stakeholders about: • Used measurement goals: Are metrics suitable for goals? • Defined measurement questions, targets, criteria and metrics: Are metrics possible to be used in company? • Utilization feedback in the next development iteration of metrics.
Phase 7. Use Metrics	• Defining responsibilities in measurement (Who will collect the metrics? Who will analyze the metrics? Who will use the information gathered? To whom will the results be reported?). • Timetable (When and how the metrics should be collected and analyzed?) • Change needs (What needs to be done before it is possible to collect and analyze metrics (e.g. changes in processes and tools)?) • Do the measurement. Collect metrics and analyze them and report results. • Update measurement goals, questions and metrics when needed. Start thus a new development iteration of metrics.
Phase 8. Utilization of Results	• Making decisions or planning actions based on measurement results. • Achieving benefits of measurement by utilizing information produced by it.

Table 2. The Phases of One Iteration of Metrics Defining Process for an EA Program

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EXPERIENCE OF DEVELOPING METRICS

Proposals of metrics and evaluation criteria developed for two case companies included the following types of metrics. Examples related to these are based on suggestions are given by Aziz et. al. (Aziz, et al. 2006) and Leganza (Leganza 2002):

- *Activity-oriented metrics* which track the performance of the EA group (e.g. number of architects certified, number of designs reviewed, consulting hours booked).
- *Acceptance-oriented metrics* which describe the perception of EA with the company (e.g. percentage of compliant projects, feedback surveys (qualitative), number of software development team members in business units who look for EA for mentoring).
- *Quality-oriented metrics* and criteria which support the identification of development needs of architecture processes and products.
- *Value-oriented metrics* which guide the EA work towards producing value to the company and show EA work's value to the company:
  - Metrics that aim *to guide the activities towards* producing business or IT value.
  - Metrics that aim *to prove* the amount of achieved business and IT benefits (e.g. cost savings through re-use of software components, time to market improvements).

EXPERIENCES OF DEVELOPING A METRICS PROGRAM

Following observations were made during the development of this approach and developing EA metrics for two companies.

Iterative approach and feedback session was found essential in the development of metrics. Understanding goals for EA program and information needs about EA program become deeper during the process. Therefore, it is essential to go through several development iterations to fully utilize this knowledge. The problem of unclearly defined EA goals was treated in case studies by using the predetermined measurement aspects and iterative approach.

To some areas useful metrics were difficult to develop (e.g. quality of architecture processes). In this case, evaluation criteria and practices for these areas were defined instead of metrics.

CONCLUSIONS

This paper presented an iterative and goal-oriented approach to define metrics for EA programs. Measurement aspects were utilized to handle the problem of unclearly defined goals for EA programs and to support the definition of metrics. The approach was developed and tested during the development proposals of metrics for EA programs for two companies.

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QUALITY MANAGEMENT ACTIVITIES FOR SOFTWARE ARCHITECTURE AND SOFTWARE ARCHITECTURE PROCESS

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ABSTRACT
Architecture processes are considerably new parts of organisations' processes. These processes have the responsibility to aim at high quality and financially successful architectures. However, the activities which promote this aim are not clearly defined yet. This study reviews literature and practitioners' experiences on quality management activities that could be suggested to promote the achievement of high quality software architectures and a good quality software architecture process. These activities are proposed to be taken into account in the software architecture process design, development and capability assessment.

KEY WORDS
Software architectures, software architecture process, software engineering, quality assurance, and quality

1. Introduction

Product and process quality management practices as well as process maturity and capability assessment practices are widely adopted and introduced in ICT industry. These practices include, among others, quality standards (e.g. ISO 9000 standards), frameworks for assessment the process maturity of an organization or a project (e.g. CMMI, Software Productivity Research (SPR)) and quality award programs (e.g. Malcolm Baldrige, European Quality Award).

Enterprise and software architecture management processes and their quality management are relatively new parts of organisations' processes. Software architecture management (SAM) consists of the activities of capturing the architectural requirements of software-intensive systems and understanding them. Moreover, the process also includes design, analysis/evaluation, implementation, maintenance, improvement, and certification of the architecture as well as its documentation [1, 2].

It is quite generally known that software architecture and its management process have an impact on the quality of the system. Academia and practitioners have come to realize that a critical success factor for system design and development is finding a high quality and financial successful architecture. Although the idea of a successful architecture is not clearly defined, practitioners and academia have become increasingly interested in how successful software architecture can be achieved. The aim of this study is to identify and describe such quality management activities relating to software architecture management (SAM) which could be suggested to promote the achievement of a high-quality successful software architecture. In the following, these activities are called SAM-related quality management (QM) activities. By identifying these QM activities, this study aims to help an organisation's processes developers, quality managers and architects to design and develop architecture management processes that aim at high-quality architectures.

Development work and research on SAM related QM practices have already been conducted in the recent years. A variety of methods and best practices, which could be utilized in the quality management of software architectures, are being developed and studied. Process models and approaches for the architectural design have been developed (e.g. by de Bruin and van Vliet [3] and Chung et al [4]). Architecture evaluation methods (e.g. ATAM [5], ARID [6], ALMA [7]) and principles (e.g. by Barbacci [8]) are being developed and studied for the assessment of architectures. Architecture review practices are also discussed, for example, by Maranzano et al. [9] and Kazman and Bass [10] and quality assessment criteria and metrics have been investigated, for example, by Hilliard et al. [11], Losavio et al. [12, 13] and Dias et al [14]. However, architecture management processes and process activities which promote the achievement of high-quality software architectures have only been briefly discussed or completely ignored in previous research.

This research involved reviewing the quality management literature on QM activities that are relevant for architectural design and development. These activities, presented in sections 3 and 4, were distilled from ISO quality standard, CMMI and Juran's Quality handbook [15]. Moreover, in order to collect empirical data for the present study, a group interview was organised for a focus group of practitioners from four ICT service providers and user organizations. As a result, this study presents a number of quality management activities relating to SAM. This study consists of the following sections. Firstly, section 2 presents the research method used in this study. Secondly, sections 3 and 4 present the results of this study: the quality management activities relating to software architecture management. Section 5 compares the results with the current state of architecture management in ICT service provider and user organisations. Finally, section 6 summarizes the study and presents areas for further examination.

2. Research Method

In order to identify and analyse the quality management activities relating to software architecture management, a series of the following research phases was used in this study.

Phase 1. The study of quality management literature, standards and maturity models: Firstly, a list of general product and process quality management activities, mentioned in CMMI, ISO standards and Juran's Quality handbook ([15]) was produced. The list of activities was analysed and the objectives and activities were organised into groups.

Phase 2. Applying the QM activities to SAM: The phases of software architecture management were analysed against the identified QM activities. A proposal was produced in which it was described which QM activities could be executed in a certain phase of software architecture management.

Phase 3. Empirical research: A focus group interview [16] **of practitioners:** A semi-structured group interview for a focus group of practitioners from four ICT user and service provider organisations was organised. The goal of the interview was to collect activities from the practitioners. Practitioners were specialists of the management of software and enterprise architectures. The companies and interviewees are described in the table 1.

The participants from these companies were interviewed as one group in order for group members to influence each other by responding to ideas and comments of others [16]. This group influence came up and new aspects were brought out. However, some aspects may not have been brought out by interviewees due to confidentiality reasons. We presented a proposal of SAM-related QM activities in the interview and in turn structured the interview according to them. The practitioners reviewed the proposal based on their own practical experiences. Moreover, they were also asked to add new activities to the results on the basis of their practical experiences.

Table 1. Interviewees in the focus group interview.

Companies	*Number of interviewees*	*Viewpoints of interviewees*
Architecture consultation company Number of personnel 10 (year 2005)	2	system and software architecture consultation
Banking, finance and insurance company Number of personnel 11 974 (year 2005)	2	enterprise architecture, management
Telecommunication company Number of personnel 4989 (year 2005)	2	enterprise architecture, management
Business & IT consulting and development organization A part of a large international company having 329 373 employees (year 2005) in total	1	software architecture, management, marketing

Data collection: The interview was tape-recorded and notes were written during the interview session. Based on this data a list of QM activities for software architecture management was produced.

Phase 4. Consolidation and analysis of results: The results from the empirical study and previous research were combined. These results are presented in chapters 3 and 4. In the results, the factors identified in the literature review are marked with the literature reference. The factors identified purely from the interview data are marked with the marking [FGI] and these factors are without literature reference. The factors recognized both from the interview data and from literature are marked both the literature reference and [FGI].

3. Quality Management of SAM Process

In this study attention was paid to both process and product quality aspects. The quality management activities of software architecture management can be divided as follows:

1) *Activities that relate to the quality management of SAM process*. These activities concentrate on the quality of SAM-process (process quality aspect).

2) *Activities that relate to the quality management of SA*. These activities concentrate on the achievement of software architecture of good quality (product quality aspect).

In this chapter the QM activities that relate to the quality management of the SAM- process are presented. The QM activities included in the SAM-process are presented in chapter 4.

The quality of architecture is influenced by the process used to acquire, develop, and maintain it. The process capability and quality management activities presented in table 2 were identified as being related to the QM of SAM process.

Table 2. Quality management activities of the software architecture management process.

Activity	**Adapted from**
Organisational Policy	
Establishing and maintaining an organisational policy for planning and performing the software architecture management (SAM) process.	[17], [FGI] = according to focus group interview
Development of SAM Process	
Planning and developing a process which is able to produce and manage the software architecture in the operating conditions.	[17], [15], [FGI]
Proving then that the process can produce, develop and manage software architectures under operating conditions.	[15], [FGI]
Optimizing the process features and goals.	[15], [FGI]
Maintaining the plan for performing the SAM process.	[17]
Establishing and maintaining the description of the SAM-process.	[17]
Transferring the SAM-process to operations.	[15]
Process management	
Providing resources (e.g. staff, time, funding) and assigning responsibility and authority for performing the SAM-process, developing the architecture related work products, and providing the services of the SAM-process.	[17]
Identifying and involving the relevant stakeholders of the SAM-process as planned.	[17]
Training and advising the people performing or supporting the SAM-process as needed.	[17], [FGI]
Quality Objectives / Goals	
Establishing and maintaining quantitative quality objectives for the SAM-process that address quality and process performance based on customer and stakeholder needs and business objectives.	[17], [FGI]
Establishing general (no project-specific) optimal quality goals for the SAs that are produced by SAM-process.	[15], [FGI]
Quality Measurement and Metrics	
Planning process measurements.	[15], [FGI]
Planning software architecture evaluation.	[15], [FGI]
Evaluation of Process Performance	
Evaluating the actual performance of the SAM-process, comparing the actual performance of the process with quality goals and acting on deviations.	[17], [15]
Monitoring and controlling the SAM process against the plan for performing the process and taking appropriate corrective action.	[17]
Objectively evaluating adherence of the SAM-process against its process description, standards, and procedures, and addressing non-compliance.	[17]
Reviewing the activities, status, and results of the SAM-process with higher level management and resolving issues.	[17]
Process Improvement	
Ensuring continuous improvement of the SAM process in fulfilling the relevant business objectives of the organisation.	[17]
Collecting work products, measures, measurement results and improvement information derived from planning and performing the SAM process and from architectures produced by the SAM process.	[17], [FGI]
Identifying and correcting the root causes of defects and other problems in the SAM process.	[17]

4. Quality Management of Software Architecture

In this study we identified the following list of quality activities that can be executed and included in the software architecture management process.

QM activities related to **architectural requirements capturing and understanding** are as follows.

Requirements Collection

- Planning the collection of requirements. Planning to collect customer and stakeholder needs (“af = adapted from [15]).
- Identifying customers and stakeholders. Identifying both internal and external customers and stakeholders (af [15]).
- Identifying what requirements and boundaries organisation’s strategy and ICT strategies set for the system [FGI].
- Identifying all relevant standards, regulations, and policies (af [15]).
- Describing the existing environment and identifying boundaries that the existing environment sets for the system [FGI].
- Identifying the possible change situations. Identifying how the company’s environment and the system operation environment may change. [FGI]
- Identifying also the long term requirements for architecture [FGI].
- Finally, collecting the requirements. Collecting a list of customers’ and stakeholders’ needs, expectations, constraints, and interfaces in their language (af [15, 17]).

Analysis of Requirement*s*

- Analyzing, validating and prioritizing customers’ and stakeholders’ requirements and needs (af [15]). Grouping together related requirements and needs (af [15]).
- Developing a definition of required functionality and quality attributes for the system (af [17]).
- Identifying architecturally significant needs/requirements by identifying architecturally significant functionality and architecturally significant quality attributes of the requirements definition [FGI].

- Executing language transfer. Translating architecturally significant needs and requirements into the language of a software architecture development team (af [15]).

QM activities related to the **architectural design** are as follows.

Preparation for architectural design

- Identifying what is needed so that the architectural designs can be delivered without deficiencies (af [15]). Defining design process and other practices.
- Determining methods for identifying architectural features (af [15]).

Architectural design

Designing and developing a software architecture that can respond to the needs and suit the environment (af [15]).

- Firstly, determining which architectural features and goals will provide the optimal benefit for the customer/stakeholders (af [15]).
- Selecting main structures of architecture by selecting high-level architectural features and goals (af [15], [FGI]).
- Selecting and designing detailed structures of architecture. Developing detailed architectural features and goals (af [15], [FGI]).
- Addressing all relevant standards, regulations, and policies (af [15]) in the design process.
- Optimising architectural features and goals. Optimising the software architecture features so as to meet stakeholder needs as well as customer needs (af [15]).
- Finally, setting and publishing the final architectural design.

QM activities related to **architecture evaluation/analysis** are as follows.

- Establishing project-specific optimal quality objectives for software architecture (af [15], [FGI]).
- Deciding the evaluation criteria and metrics by creating project-specific measurements of quality for software architecture (af [15], [FGI]) and identifying the unit of measurement for each customer need [15].
- Deciding the explicit criteria to be used in evaluating alternative architectural designs and design features.
- Executing the evaluations. Evaluating and measuring architectural features in the suitable phases of the system life cycle (af [15], [FGI]).
- Executing the certification of architecture. Architecture certification can be seen as an act of attesting that the system will meet a certain standard or, generally, as an act of verifying conformance with certain requirements.

QM activities related to **architecture realization / implementation** are as follows.

- Before the implementation, proofing and testing the architectural concept by implementing the main structures of the architecture [FGI].
- Producing an implementation plan.
- During the implementation, organising the architecture advisor who gives advices on how to conduct the implementation of the architecture [FGI].
- Collecting feedback from the architecture implementation (e.g. problems occurring in the architecture implementation) [FGI].

QM activities related to **architecture maintenance and improvement** are the following update and evolution activities.

- During the system maintenance, identifying and correcting the causes of defects and other problems in the architecture (af [17]).
- Making other minor changes for the architecture (e.g. construction of a new interface to the system in the integration situation) [FGI].
- Identifying the development needs of the architecture.
- Proving the development or improvement needs of the architecture (af [15]).
- Establishing the infrastructure for improvement (af [15]). Identifying the improvement project(s) and establishing project team(s) (af [15]). Providing the teams with resources, training, and motivation to 1) diagnose the causes and 2) stimulate remedies (af [15]).
- Conducting a diagnostic journey from symptom to cause. This includes analyzing the symptoms, theorizing as to the causes, testing the theories and establishing the causes (af [15]).
- Conducting a remedial journey from cause to remedy. This includes developing the remedies, testing and proving the remedies under the operating conditions, dealing with resistance to change, and establishing controls to hold the gains (af [15]).
- Finally, implementing remedies and controls (af [15]).

QM activities related to **architecture documentation** are the following.

- Documenting at least the following aspects: 1) input information for architectural design and development, 2) architectural plans including architectural decisions, 3) reviewing results by management, and 4) results from architectural evaluations/assessments and the measures taken because of the results (af [18]). Taking the users of the documentation into account in documentation process.
- Updating and maintaining architectural documentation [FGI].
- Controlling architectural documents to ascertain that they correspond to the organisation's standards.

5. Discussion

Quality management activities relating to software architecture management were identified and analysed. The identified activities were categorised to activities that concentrated on the quality of the SAM-process and to activities that concentrated on the quality of software architecture. These identified quality management activities are suggested to promote the achievement of high-quality software architectures and a good quality software architecture process. During the process of defining these activities, the following observations were made. These observations focus on the current state of architecture management and how the results of this study could be applied in organisations.

Architecture management is spread out to many processes in organisations. As mentioned at the beginning of this paper, software architecture management (SAM) consists of the activities of capturing and understanding the architectural requirements of software-intensive systems. Moreover, it includes designing, analyzing/evaluating, realizing, maintaining, improving, and certifying the architecture as well as documenting it [1, 2]. In this study the more detailed activities were also identified. In the focus group interview the idea was raised that these activities, which aim to drive and control the architecture and architectural quality, may be included in several separate processes in organisations. Parts of these activities may be included in, for example, in investment planning, project management, the organisation's processes management and system development process. Currently, architecture management processes are not so clearly separate processes in organisations. This situation makes the capability assessment of architecture management difficult. In addition, this situation means that the organisations' different processes and the related tasks currently affect on the organisations' architectures and architectural quality.

A need to move from architectures driven by investment planning and system development towards architectures driven by architecture management. Practitioners in the focus group interview described how investment decisions made in the investment planning process and system development choices affected on the organisation's architectures. It seems that single investments on software or a system (e.g. ERP investments) and single system development projects in organisations may drive the organisations' architectures and architectural quality more than organisations' architectural designs and visions (e.g. enterprise architecture). This means that other processes than architecture management processes drive the architectures. This may affect on the quality of an organisation's architectures. A challenge is to change this situation so that architecture management processes start to drive architectures.

A need of architecture management practices and process models that aim at high-quality architectures. Currently, it is not clear what activities architecture management process should include, in which order these activities should be executed, and what results should be produced relating to the activities. In addition, it is not entirely clear how the system development and architecture management processes should co-operate. For example, it is not clear in which phases of the system development process architecture evaluations should be executed. This study gives answers to the question what activities should or could be executed in architecture management that would focus on the architectural quality. The development work of process models and of the best practices for architecture management which include these identified activities and describe the execution order should be continued.

A need to advance the maturity of architecture management processes. As mentioned previously, the architecture management activities may be spread out to be parts of many processes in organisations, and other processes may drive architectures more than an architecture management processes. This means that there is a need, firstly, to establish the status of architecture management processes in organisations, and secondly, to increase their maturity. This work is already on-going in many organisations. The results of this study aim to help this work by defining such architecture management activities that promote the achievement of high-quality architectures. The results of this study can be used to support this work of establishing of a SAM-process.

A need for agility in architecture management and development. It came up in the focus group interview that it is hard to execute all these QM activities identified in this study in a very quick-moving industrial environment. Restricted time and quick changes in organisations' structures and operations (e.g. companies' mergers) often change organisations' architectures and architecture management processes. In addition, architecture management processes cannot be too heavy (e.g. require a lot of time and resources) although those processes could produce ideal architectures. However, it was also suggested that the maturity of an organisation's architecture management could be higher when more of these QM activities (identified, for example, in this study) are executed in the organisation's architecture management processes. In summary, agile architecture management should be considered in further research.

A need for metrics and metric programs for architectural maturity and quality. In the focus group interview, it was also mentioned that metrics and metric programs for architectural quality should also be developed. Metric programs have traditionally been primarily developed for the measurement of software and software development quality (e.g. Motorola's, IBM Rochester, and Hewlett-Packard's metrics programs [19]). As mentioned at the beginning of this paper, the metrics for the assessment of architectures and their management processes have been developed for example, by Hilliard et al. [11] and Losavio et. al. [12, 13]. Research and development work must be continued in order to detail and establish evaluation criteria and metrics for architectural quality. Metric programs for architectural quality can then be developed in organisations.

Restrictions and limitations in this study. There are some limitations in this study. Corresponding quality management activities were combined from different sources. In addition limited number of sources was studied. Limited number of quality management activities of software architecture management was considered in this study. However, the results give an image of the QM activities in SAM.

6. Conclusion

Architectural quality is one aim of the architecture management process. Evaluation practices for architectural quality have been developed and extensively discussed in the previous research. However, the architecture management process activities aiming at architectural quality have only briefly been discussed so far.

This study identified activities that are suggested to promote the achievement of high-quality architectures and a good quality software architecture process. The criticality and execution of these architecture management related quality management activities in system development need to be assessed based on surveys directed to ICT service providers and user organisations.

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Quality Evaluation Question Framework for Assessing the Quality of Architecture Documentation

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Abstract

The present day demanding business environment and increasing complexity of ICT development have raised the significance architecture work. The architecture processes, practices and documents have become increasingly important for the companies. As the utilisation of the architectures are highly dependent on the quality of the documentation, there is an evident need for practical means for architecture documentation evaluation. This paper presents a study addressing the architecture documentation quality assessment. The research was carried out in co-operation with industry practitioners from a group of companies. The result of the study was a validated proposal of architecture documentation quality evaluation question framework. This framework can be used by organisations as a practical tool for developing the quality of the produced architecture documentation.

1.0 Introduction

The software and enterprise architecture documents are used in the companies for ICT development work. However, they have gained also more central role in communication between development, management and business. Architecture descriptions and models are essentially a communication media. The quality of the documentation has a significant effect on their understanding and usage, and consecutively to the understanding and following of the architecture itself. A warning example is presented by Rosen [1]: "... *"shelfware"- the architecture documents look spiffy on the shelf, and having them there demonstrates how smart you are to be able to understand the architecture. Unfortunately, in many cases* *they are never opened again, and certainly not by the development organisation*". The quality determines the value of the documents, and following from this, partially the value of the architecture work. The quality of documents improves communication and collaboration in architecture work. For assuring that the architectural documents can be well understood and correctly used, the companies should have practices for their quality evaluation.

Number of definitions and studies on the quality evaluation of documents and architectural descriptions have been presented in the literature. Concepts and use situations for architecture descriptions are described, for example, by the IEEE 1471 standard [2]. Literature and guidelines have been published relating to software architecture description [3,4,5,6,7] and enterprise architecture description [8,9,10,11,12]. Some studies have also tackled the quality evaluation of conceptual models [13,14,15] and technical documentation [16,17]. However, there seems not to exist proper guidelines how to carry out the quality evaluation of architecture documentation. Quality evaluation criteria for architecture documentation are not yet well identified and analysed.

This paper presents a study of quality assessment of architecture documentation. It was carried out in AISA (see acknowledgements) research project, in co-operation with a group of companies. The objective of the research was to develop practical means for assessing the quality of the architecture documentation in the companies. The study was started with a literature review. An evaluation question framework was chosen as the form of the practical quality assessment tool. Based on the analysis of the related documentation quality evaluation factors presented in literature, the main quality aspects were identified and architecture description criteria and questions specified. Those results were used to form an initial architecture documentation evaluation question framework. After that, the initial framework was validated by industry practitioners using focus group interview and questionnaire and the final framework was constructed.

The result of the study is a validated architecture documentation quality evaluation question framework. This evaluation question framework can be applied by the industry for assessing the enterprise and software architecture documentation within the companies. The proposed evaluation question framework was intended to be practical and flexible means for architecture documentation assessment, which can be applied in the companies for increasing the quality of architecture documentation produced by the software and enterprise architects.

The structure of the paper is the following. The next chapter 2 introduces the context of architecture documentation and presents the literature sources for the background of architecture documentation evaluation. In the following chapter 3, the used research method is explained. The chapter 4 presents the result of the study, the architecture documentation evaluation question framework. In the concluding chapter 5, the results are discussed.

2.0 Architecture documentation

Enterprise architecture are usually produced and used at the organisation level, as an instrument in managing the company's daily operations and future development [9]. The enterprise architecture is defined for example by Kaisler et al. [18] that enterprise architecture is "*the main components of the organization, its information systems, the ways in which these components work together in order to achieve defined business objectives, and the way in which the information systems support the business processes of the organization*". These components include staff, business processes, technology, information, financial and other resources, etc.

Software architecture descriptions are mostly produced in the projects in their system or software development work. A definition of software architecture is provided by Bass et al. [19]: "*The software architecture of a program or computing system is the structure or structures of the system, which comprise software elements, the externally visible properties of those elements, and the relationships among them*."

The concept of an architectural description / documentation is formalized and standardized in IEEE 1471 Standard: Recommended Practice for Architectural Description [2]. In addition standards for architecture descriptions are also developed and defined by companies. For example, IBM has presented architecture description standards [20, 16].

Main architecture documentation concepts defined by IEEE 1471 Standard [2] are especially the following:

- Stakeholder: An individual, group or organization that has at least one concern relating system.
- Architectural description: A set of views (which consist of architectural models) and additional architectural information.
- View: A set of model representing enterprise or system from the perspective of a related set of concerns.
- Model: A particular diagram and description constructed following the method defined in a viewpoint.
- Viewpoint: The conventions for creating, depicting and analyzing a view.

Relationships between these concepts are presented in Figure 1.

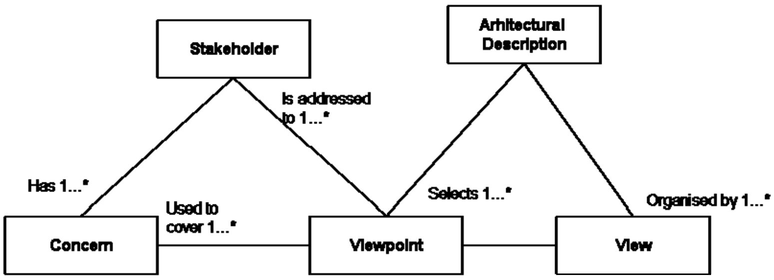

Figure 1: Architectural description related concepts (IEEE 1471 [2])

Various documents may be related to architecture documentation. Different document types are needed because of the varying purposes and users of the documents. The enterprise architecture models can be categorised in the following way [8]:

- Ad hoc models: models that serve basic goals of communication and documentation and that are usually developed using simple drawing or presentation tools.
- Standardized models: models adopting a standard or framework-based approach and using case tools.
- Formal models: models that are based on reference architectures.
- Federated models: models that aggregate across diverse sources and using EA tools interoperating with diverse repositories of information.
- Executable models: active knowledge models that can be consulted by applications as well as humans.

Rozanski and Woods [3] classify software architecture models to formal qualitative, quantitative models and informal qualitative models (sketches). These are defined as follows:

- Qualitative models illustrate the key structural or behavioral elements, features, or attributes of the architecture being modelled.
- Quantitative models make statements about the measurable properties of an architecture, such as performance, resilience, and capacity.
- A sketch is a deliberately informal graphical model, created in order to communicate the most important aspects of an architecture to non-technical audience. It may combine elements of a number of modelling notations as well as pictures and icons.

2.1 Architecture frameworks

Architectural frameworks have a central role in architecture documentation. These frameworks provide structure to the architecture descriptions by identifying and sometimes relating different architectural domains and the modelling techniques associated with them [21]. They typically define a number of conceptual domains or aspects to be described [21].

Enterprise architecture frameworks are for example Zachman's Framework for Enterprise Architecture [22], The Open Group Architecture Framework (TOGAF) [23], Archimate framework, ISO Reference Model of Open Distributed Processing (RM-ODP) [24]. Software architecture frameworks are for example Kruchten "4+1" View Model [25], Software Engineering Institute (SEI) set of views [4], Siemens Four View Model [26] and Rational Architecture Description Specification (ADS).

As discovered by May [27], viewpoints defined for example by different SA frameworks do not completely correspond to each other. The similar situation seems to be relating to EA frameworks. Currently, there seems not to exisit any commonly accepted set of architectural viewpoints [27, 28]. As Smolander [28] brought out, architectural viewpoints chosen by companies are rather agreements between people depending on the organizational and project environment. In the practice, the selection of architectural viewpoints is thus based on the prevalent situation and characteristics in a company and in the project at hand.

2.2 Architecture documentation practices and realities

For organisational level practice assessment, a maturity model for enterprise architecture representations and capabilities is introduced by Polikoff and Coyne [8]. This maturity model consists of the following levels:

- Level 1 Ad hoc: No common reference framework, possible use of case tools, little commonality between descriptions produced by different people or groups.
- Level 2 Standardized: Established methodology for describing architectures, use of industry standard/custom framework, methodology not fully supported and enforced by tools.
- Level 3 Formal: Methodology enforced by tools; Reference architectures; Multiple tools in use but from different vendors with low level of interoperability; Reference framework and architectural models cannot be readily queried.
- Level 4 Federated: Connections between different systems and tools established.
- Level 5 Executable: Models are consultable by applications at run time. Knowledge about enterprise activities, systems and capabilities becomes a real time resource.

In companies, the architecture documentation practices are affected by architects' own practices as well as by company level practices. Architect's decisions and choices affect on architecture documentation. Architect decides what to describe in architecture documentation. Given a specific goal and focus, an architect decides which aspects of an enterprise or a system are relevant and should be represented in the model [9].

Company's situation affects the possibilities for architecture documentation work. It is needed to know [4]: what people you will have and which skills are available, what budget is on hand, and what the schedule is. In addition, some other realities relate to architecture documentation work, such as: resources and time limits; stakeholder's requirements and; needs for architecture documents, notations and tools. Architects often do not have much time to architecture design and analysis [3]. The reality is that all projects and work make cost/benefit trade-offs to pack all the work to be done into the time and the resources allocated for that work. Architecture documentation is no different [4]. A rough-and-ready model that is produced early and becomes established and familiar to the team over time may be more useful than something considered more fully that appears too late [3].

Simple models are more useful in presentations to non-technical stakeholders, as well as in the early stages of the architectural analysis for bring out some key features. Sophisticated models are more useful as analysis, communication, and comprehension tools for technical stakeholders, such as software developers [3]. The range of phenomena addressed by enterprise and system modelling stretches multiple disciplines. Several modelling languages and practices are used, and one cannot always find a single person/profession that can guarantee the consistency of all models involved.

There are several factors affecting architecture work and documentation practices. However, the development in business environment and ICT field is leading to more and more complex systems and environments. In order to deal with this, well planned and documented, high quality, architecture and architecture documentation have become more and more vital for organisations. In order to promote high quality architecture work and efficient usage of the architectures, the companies need practical means for evaluating the quality of the architecture documentation.

3.0 Research method

The objective of the research was to develop practical means for assessing the quality of the architecture documentation in companies. In order to find a solution to this problem, the following phases were carried out in the research process.

In the beginning of the study, the form of the resulting quality evaluation means was selected to be an evaluation question framework. As specific quality dimensions of documents can be measured by asking probing questions [29], the questions give the direction and foundation for the evaluation.

In the first phase, a literature review and analysis was carried out for identifying and constructing the initial evaluation question framework. In identification and construction of criteria, evaluation questions and metrics, several different sources can be used [30]. The used sources were: models, findings and salient issues raised in the literature of the enterprise and software architecture field; questions, concerns and values of practitioners; general evaluation and quality models for documentation (e.g. technical documentation); views and knowledge of expert consultants (comments and recommendations in articles published in internet).

In the second phase, a semi-structured focus group interview was organised for the validation of the initial evaluation question framework. The initial evaluation question framework was also complemented based on the interview. The focus group consisted of 7 practitioners from five ICT user and service provider organisations. The practitioners were specialists of the management of enterprise and software architectures in their organisations. The organisations were: architecture consultation company (10 employees); banking, finance and insurance company (11.974 employees); Telecommunication company (4.989 employees); business & IT consulting and development organisation (part of large international company with total 329,373 employees); retail and service company (28,092 employees). The viewpoints presented by the interviewees were: business consultation, software architecture consultation, enterprise architecture, software architecture, marketing, business and IT governance.

The participants from the companies were interviewed as one group, in order to allow the group members to influence on each other by responding to the ideas and comments of the others [31]. The group influence was discovered to be fruitful and discussion brought up new aspects on the topic . The initial evaluation question framework was presented to the group of practitioners. They were asked to evaluate the value and the usefulness it, based on their own practical experiences. The interview was recorded and notes were written down during the session. In addition, the questionnaire for assessing the usefulness of the evaluation question framework was organised for the workshop participants, and four of them answered to it. In the questionnaire, the practitioners assessed the importance of each criterion with four point scale (1 = important to evaluate, 2 = useful to evaluate, 3 = not necessary to evaluate, 4 = useless to evaluate).

The results of the focus group interview and questionnaire was then used for developing the final architecture documentation quality evaluation question framework.

4.0 Architecture documentation quality evaluation question framework

The result of the study was a validated architecture documentation quality evaluation question framework, which is presented in this section.

Three main aspects of the quality of documents, on which the evaluation of architectural descriptions can be based, can be identified from the literature. These main quality aspects are presented in the Figure 2 below.

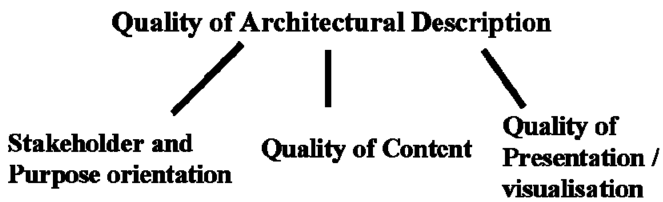

Figure 2: Main aspects of quality of architectural description

The first aspect, stakeholder and purpose orientation, is used for evaluating how well documents are focused on their purpose and on the stakeholders using them. The second aspect, content quality, is used for the evaluation of the quality of the information included in the documents. The third aspect, presentation/visualisation quality, is used for evaluating how well information is presented in the documents. In addition to these three aspects, related directly to the quality of architectural descriptions, the management of documentation was identified to be the fourth main aspect of the architecture documentation quality.

The final architecture documentation quality evaluation question framework was organised according the identified four main aspects. The framework is presented below, following this organisation, in four tables. Table 1 presents the stakeholder and purpose orientation aspect criteria and questions, Table 2 quality of content, Table 3 quality of presentation/visualisation and Table 4 architecture document management. The last column in the tables reports the results of the importance questionnaire, as a mean importance. The scale of the importance varies from 1 (high) importance to 4 (low). In some of the criteria, more detailed (question/metrics level) importance evaluation is given.

Table 1: Evaluation question framework for the stakeholder and purpose orientation

Criteria	**Questions/metrics**	**Importance**
Stakeholders	Are the stakeholders of the description defined and who are them?	1.25
Purpose	Is it the purpose of the description in relation to these stakeholders defined and what it is?	1
Suitability for the stakeholders	Does the description provide the stakeholder with the desired knowledge? Does the description answer/correspond to the objective of stakeholder? Does the description relate to problem? Is a practical reason for the information evident? Is the information presented from the stakeholders' point of view?	1.25
Usage	Frequency of use: How frequently the description is used or referenced. Number of users: The approximate number of personnel who will likely want or need to use the description. Variety of users: The variety of different functional areas or skill levels of personnel who will likely use the description. Impact of non-use: The level of adverse	2

	impact that is likely to occur if the description is not used properly.	

As the stakeholder and purpose orientation aspect Table 1 above shows, the most essential for the practitioners is, that the purpose of description is well defined with respect to the users of description.

Table 2: Evaluation question framework for the content

Criteria	**Questions/metrics**	**Importance**
Scope and focus	Scope: Is it defined what part of reality will be described in the description (e.g. only primary processes)? Aspects: Is it defined what aspects will be described? The level of detail: Is it defined what level of detail will be described?	1 1.25 1.5
Currency of EA description	Does information reflect the current enterprise? Is there made changes in EA after EA description has been produced? Number and scope of architectural effects having projects carried out after EA description have been produced Number and scope of architecture changes made after EA description has been produced Degree with which the current version of the description is up to date (Percents, subjective evaluation) How much time is from the previous updating of description?	2
Currency of SA description	Does information reflect a system? Has there been made changes in system after architecture description has been produced? How much time is from the previous updating?	1.5
Correctness of Information	Verification of information: Is the information included in the description verified? Is there any incorrect arguments, or in-accurate or untrue reasoning?	2
Correctness of EA	“Substantive” errors / deficiencies after the EA description has been released: Is there found “substantive” errors/	2.25

	deficiencies? The number of "substantive" errors / deficiencies found (e.g. the number and type of change request applied to EA principles)?	
Correctness of SA	Correctness for stakeholders: Does the description present correctly needs and concerns of stakeholders? Correctness of solution: Does the description define correctly architecture that will meet stakeholder's needs?	1.75
EA completeness	EA's coverage of business areas: The degree to which EA description addresses needs of each business area (e.g. subjective evaluation score 1-10)	1.75
Sufficiency / completeness	Description's coverage of required viewpoints: The degree to which description addresses each required architectural viewpoint (e.g. subjective evaluation score 1-10). Sufficient amount of information: Is the all required information included in the description? Are all topics relating stakeholder's objectives and concerns covered, and only those topics? Is information repeated only when needed? Does the description contain irrelevant or superfluous elements? Sufficient level of detail: Has each topic has just the detail that stakeholder needs?	2 1.5 2
Consistency	Are views presenting different viewpoints in description consistent with each other?	1.75

With respect to the quality of content (Table 2) the practitioners considered to be most important that the scope and the focus of the description is well defined and suitable for need as well as that the description includes sufficient amount of information. In addition, the currency of software architecture descriptions is also highly important, with respect to their usage in system development.

Table 3: Evaluation question framework for the presentation/visualisation

Criteria	Questions/metrics	Importance
Conformance to corporate standards	Does the presentation of the description conform to the corporate standards (if any) for such documents?	2.25
Intuitiveness of the presentation	Does the description have intuitive structure for the stakeholder? What is the intuitive structure of stakeholder? Does the description correspond to it? Are used structures to which the receiver is used to?	2
Definition of the notation and structures	Does the description use a defined notation? Is the notation/structure of the description explained? Is stakeholder familiar with notation?	1.75
Clarity of the vocabulary and concepts	Is the vocabulary and concepts stakeholders' concepts? Are the terms and concepts used known by stakeholder? Are the terms used defined? Are the (new) concepts defined and explained? Are the names of elements descriptive? Are the all of description's elements defined so that their meanings, roles, and mapping to the real world are all clear and not open to different interpretations?	1.5
Information complexity	Is there too much information included in the model? The number of elements in the model. (Humans are only good at working with models that do not include more than 30 elements.) The number of types of elements in the model. The number of relations depicted in the model. The number and types of concepts. The number of architectural viewpoints. (Viewpoints reduce complexity).	2
Visual complexity	Proximity: Are the related objects placed near to each other in a model? Continuity: Is there any right angles positioned next to each other? (Right angles should not be positioned next to each other in a model.) Closure: Are objects symmetry and regular?	2

	(This increases readability of models and reduces the perceived complexity.) Similarity: Are similar objects presented in the similar way? Common fate: Are similar object presented to move or function a similar manner? (People have a tendency to perceive different objects that move or function in a similar manner as a unit.)	

As the Table 3 shows, the practitioners did not see any of the presentation/visualisation criteria of highest importance. However, the suitability of the used vocabulary and concepts for the users was the most essential presentation quality criterion.

Table 4: Evaluation question framework for the architecture documentation management

Criteria	Questions / metrics	Importance
Maintenance of documentation	Ownership: Is staff responsible for the documentation clearly identified and supported?	1
	Maintenance practice: Is it known how the documentation will be maintained once it has been accepted? Is defined how often and when documentation is updated? Frequency of updates (number of updates / year or project). Needs for updates (number of architecture changes made in a year, in projects that require documentation update).	2
	Maintainability of documentation: The relative ease or difficulty with which the documentation can be updated, including revision dates and distribution of new versions and the relative ease or difficulty with which the consistency between descriptions can be checked.	2.5
Cost effectiveness	Costs: Time and resources needed to produce or update architecture documentation (required man-days).	2.25
	Amount of documentation: Number of documents/models.	3
	Frequency of documentation updates:	2.5

	Updates/project or updates/year. Needs for updates (number of architecture changes made in (a year, in projects) that require documentation update	
Architectural framework and views	Architecture framework (for EA and for SA): Is there existing architectural framework? Is the framework accepted in organisation? Is the framework used in the EA documentation work? Architectural views: Are the suitable architectural views chosen for the company or for the project? Are there viewpoints well defined? A Viewpoint name? The stakeholders the viewpoint is aimed at? The concerns the viewpoint addresses? The language, modelling techniques, or analytical methods to be used in constructing a view based upon the viewpoint?	1.75 1.5
Tools support	Support for organisation's framework and viewpoints: Does design tools support the framework and viewpoints that organisation has chosen to use? Does design tools support production of the deliverables required? Suitability for Stakeholders: Is there ability to represent architecture descriptions (e.g. models and views) in a way meaningful to stakeholders (e.g. to non-technical stakeholders)? Repository for architecture documentation: Is there a repository for storage and dissemination of the captured information?	1.5 1.5 1.75

The results in the Table 4 show that clearly defined responsibilities in maintaining the architecture documentation is of highest importance. In addition, it is essential that the practices related to architecture documentation are defined, especially the used architecture views and design tools.

In summary, all the four main aspects of quality of architecture documentation include certain criteria that are seen important to assess when the quality of the

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documentation is evaluated. The most important quality criteria of the stakeholder and purpose orientation are definition of the stakeholders and the purpose, and also suitability for the stakeholder. With respect to the quality of content, highest importance is given to the scope and defined aspects of documents, as well as to the level of detail and sufficiency of information. In addition, the currency of SA descriptions in relation to the system is seen vital. In the quality of presentation, the vocabulary and the concepts, and their adequate definition and explanation, is the main concern. When considering the documentation management, the most important quality criteria are clear ownership identification, defined architecture views and appropriate architecture design tool support.

5.0 Conclusion

In the present day complex and demanding business, information system development and software engineering context, the significance of well designed architectures and high quality documentation has been continually increasing. Current architecture documentation related questions and challenges in the industry appears to be related especially to the following issues: multiple stakeholders of architecture work; definition of the architecture framework and views used in organisation; decision concerning what documents to produced; multiple existing notations and tools and; the lack of architecture documents, in some cases.

Architecture descriptions are used as communication tool. Architecture documents of bad quality may funnel the communication to irrelevant aspects. High quality documents support more efficient communication about architecture issues and high quality documents enhance thus the understanding of the architecture. The understanding of architecture can be seen as a prerequisite for the following and applying of architecture. It can thus be seen as a prerequisite for the realization of architecture. We believe that the quality of architecture documents may thus even have an effect on the realization of architectures.

As one solution to this architecture documentation quality question, we presented architecture documentation quality evaluation question framework. It was planned to be a practical and flexible solution that can be applied in aspiration of increasing the quality of the architecture documentation. The presented framework was developed in co-operation with industry practitioners in a research project.

The framework consists of the four evaluation aspects (stakeholder and purpose orientation, quality of content, quality of presentation/visualization and architecture documentation management) and criteria and questions relating to these aspects. In the focus group interview in which this framework was validated, the practitioners mostly brought out that evaluation aspects and criteria included in framework seem to be useful and those help in evaluation of quality of architecture documents. In addition, they accepted the four specified main evaluation aspects In the focus group interview, there arose also the issue that the significance and meaning of architecture documentation is different for specialist representing different domains. Therefore, the specialists of different domains can vary in seeing the relevance of architecture documentation quality evaluation.

The industry practitioners involved in the study were mainly EA and SA design and development specialists. Their perspectives might reveal much more than the companies' other business and ICT stakeholders' perspectives. The points of views of the documentation users were thus not gathered. Including directly also the users' experiences would be a reasonable extension to this research in the future. The questionnaire supplemented the focus group interview and gave more exact measures of the importance of each evaluation criteria. The limited number of replies to it by the focus group member may have a little effect to the reliability of the results. However, the evaluations were mainly quite consistent.

Our recommendations on based the results of this study are following. The quality of architecture documentation should be a concern of the architects, as well as of the whole company. We suggest that enterprise and software architects should ensure the quality of architecture documents during the producing of them. The producing of document is thus the first situation when quality can be ensured. We suggest also including the checking the quality of architecture documents in architecture reviews. We suggest that quality evaluation checklists should be developed in companies. The results of this study can be used in the producing these checklists. These checklists are suggested to be used in architecture design by architects and in architecture reviews by reviewers.

The future research work would include validation of the presented framework in practice in different companies. An interesting direction to continue the research would also be to study the documentation from different stakeholders' perspective: how architecture documents can be produced and managed efficiently when reality is that different stakeholders need different levels of information presented in different ways.

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The Role of Architecture Evaluations in ICT-companies

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ABSTRACT

Architecture evaluation is a way to get answers to organisation's information needs and problems relating to its business and ICT. Companies' needs to move towards business value driven ICT-development and pressures to improve the cost-effectiveness of ICT are some of the reasons for the increasing interest in the evaluations and measurements of architectures. However, the role and the meaning which architecture evaluation may have in companies is not clearly identified or defined. For example, needs and triggers for architectural evaluations do not seem to be identified in previous studies. The aim of this study is to gain understanding of roles and meanings, which architecture evaluation and measurement may have in companies. Triggers for evaluations and measurements were identified and analyzed. Practitioners from five ICT user and service provider organisations were interviewed in this study. This study reveals that the role of architecture evaluation may be to enhance the understanding of company's business and ICT-environments from financial and structural viewpoints. In addition, it can be used as a tool in change management, quality assurance, process planning, IT cost management and architectural choice making.

Keywords

Architecture evaluation, enterprise architecture, software architecture

INTRODUCTION

Companies' needs to move towards business value driven ICT-development and to improve the cost-effectiveness of ICT are illustrative of contemporary development pressures. These, among others, pressures drive companies to improve the understanding of their business- and ICT-environments. Architectures and architectural descriptions (enterprise and software architectures) are used to enhance understanding of the company's environments. However, architectural descriptions and documents do not directly answer all business and ICT related questions and information needs.

Stakeholders in a company have various information needs, questions and topics of concern relating to the company's business and ICT. One way to seek answers to these questions and information needs is the execution of architecture evaluations. Lately, interest in carrying out such evaluations of architectures has increased in companies. In addition, experts also highlight the importance of evaluations of architectures and architecture processes (e.g. [25, 26]). The methods and practices for architecture evaluations and measurement are studied and developed by many organisations as well. However, the role of architecture evaluation in companies and its meaning for them is not yet clearly defined or identified, suggesting that real evaluation needs or triggers for evaluations are not identified and gathered from practitioners and specialist in ICT companies.

The aim of this study is to gain understanding of the meanings and roles, which architecture evaluation and measurement may have in companies. This study identifies and analyses companies' triggers for architecture evaluations. Our research involved reviewing five ICT-companies' practitioners' experiences on and conceptions of triggers for enterprise and software architecture evaluations. Triggers for architecture evaluations are problems, questions, topics of concerns and information needs which initiate the evaluation work.

This study consists of the following sections. Firstly, general evaluation concepts and architecture evaluation related concepts and architectural viewpoints are considered. Secondly, the research method used in this study is presented. Thirdly, the triggers for architecture evaluations identified and categorised in this study are presented. Finally, these triggers are analysed and suggestions for roles and meanings of architecture evaluations are given. The areas for further examination are also presented.

ARCHITECTURE EVALUATION CONCEPTS

It seems that there is no commonly accepted evaluation and measurement theory. Nevertheless, many sources and research areas in several domains define evaluation and measurement concepts as well as present methods and practices for it. For example, evaluation and measurement concepts are defined in the domains of program evaluation (e.g. [6, 29, 34, 37, 38]), quality management (e.g. [15], [16]) and software engineering (e.g. [19], [11], [4]). Research and development work on evaluation methods and practices is ongoing in the context of enterprise and software architecture management (e.g. relating EA [9, 27]). However, evaluation theory (e.g. concepts and practices) does not yet seem to be established in this context.

Enterprise and Software Architecture Definitions

IEEE 1471 Standard [12] defines architecture as the fundamental organization of a system embodied in its components, their relationships to each other and to the environment, and the principles guiding its design and evolution. In one instance enterprise architecture is defined by Kaisler et al. [18] as " *the main components of the organization, its information systems, the ways in which these components work together in order to achieve defined business objectives, and the way in which the information systems support the business processes of the organization*". These components include staff, business processes, technology, information, financial and other resources, etc. A definition of software architecture is provided by Bass et. al [5]: "*The software architecture of a program or computing system is the structure or* *structures of the system, which comprise software elements, the externally visible properties of those elements, and the relationships among them."*

Stakeholders

Architecture work has a group of stakeholders. These stakeholders have varying topics of concern, information needs and questions relating to company's business and ICT. These stakeholders have thus different perspectives on architectures. Therefore, they have different questions and concerns relating to architectures. On one hand, enterprise architecture related stakeholders may include the ICT and the business organisations, management, the architecture group, the investment board, ICT maintenance and security groups (e.g. [1, 33]). On the other hand, software architecture related stakeholders may include acquirers, developers, architects, users, maintainers, suppliers, testers, assessors, communicators, system administrators and support staff [28].

Evaluation Perspectives

Due to this variety of stakeholders and their information needs, different evaluation approaches are needed. A classification of evaluation approaches is proposed by Worthen et. al [38] in the context of program evaluation. The adaptation of this classification to the architecture context is presented in the next table.

Table 1. Evaluation approaches (adapted to the architecture evaluation context from Worthen et al.* [38]*).

Evaluation approach	General purpose of evaluation
objective-oriented evaluation	determining the extent to which goals are achieved
management-oriented evaluation	providing useful information to aid in making decisions
consumer-oriented evaluation	providing information about products to aid in making decisions about purchases or adoptions
expertise-oriented evaluation	providing professional judgments of quality
adversary-oriented evaluation	providing a balanced examination of all sides of controversial issues, highlighting both strengths and weaknesses
participant-oriented evaluation	understanding and portraying the complexities of a architecture, responding to an audience's requirements for information

Architecture Evaluation Concepts

Fundamental evaluation concepts are described, for example, by Marta Lopez in the examination of one architecture evaluation method (ATAM) [23]. These concepts are:

- *target*: the object under evaluation
- *criteria*: the characteristics of the target that are to be evaluated
- *yardstick or standard*: the ideal target against with the real target is to be compared

- *data-gathering techniques*: the techniques needed to obtain data to analyze each criterion
- *synthesis techniques*: techniques used to judge each criterion and, in general, to judge the target, obtaining the results of the evaluation
- *evaluation process*: series of activities and tasks by means of which an evaluation is performed.

Data gathering and synthesis techniques and evaluation process for architectures are largely not defined separately. Rather, these are defined by and included in the architecture evaluation methods. In addition, evaluation methods support different evaluation approaches. An array of methods is also being developed for evaluation of enterprise and software architectures. These methods are evaluated and compared in some studies (e.g. [3], [8], [13]).

ARCHITECTURAL VIEWPOINTS

This study focuses on examining architecture evaluations which are based on information included partly or totally in architecture descriptions and documents. Architectural descriptions related concepts are considered in this chapter.

Architectural Descriptions

Both enterprise and software architectures are described by architectural descriptions. The architectural descriptions may be baseline and/or target architecture descriptions. IEEE 1471 defines a couple of concepts relating to architecture descriptions. IEEE 1471 concepts seem to be accepted both in the SA and in the EA domain (EA domain adaptations for example relating to Togaf Framework [10] and by Steen et. al. [32]). Concepts defined by IEEE 1471 [12] are especially the following:

- *Architectural description*: A set of views (which consist of architectural models) and additional architectural information.
- *View*: A set of model representing enterprise or system from the perspective of a related set of concerns.
- *Model*: A particular diagram and description constructed following the method defined in a viewpoint.
- *Viewpoint*: The conventions for creating, depicting and analyzing a view.

Relationships between these concepts are presented in figure 1.

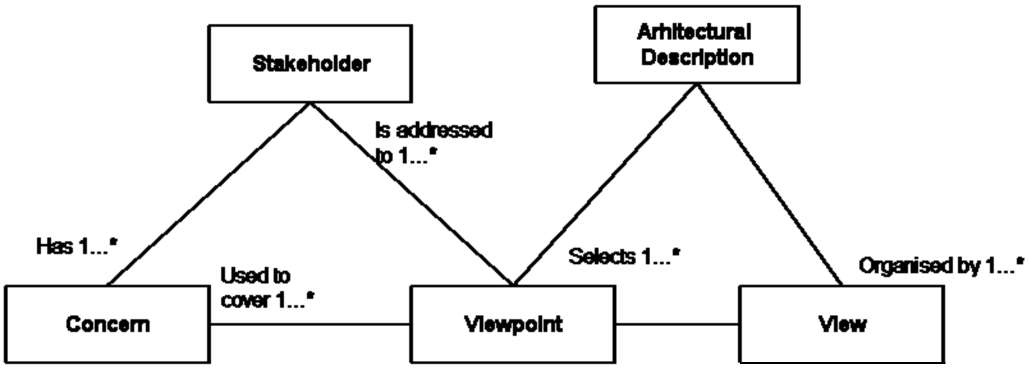

Figure 1. Architectural description related concepts (IEEE 1471 [12]).

Viewpoints

Viewpoints delineate the architectural information that is presented to the stakeholders [20]. Viewpoints, on the one hand, prescribe the content and "models" to be used, and, on the other hand, indicate their intended "stakeholders" and their concerns [20].

Architecture frameworks both in enterprise architecture and in software architecture domain define a couple of viewpoints. For example, EA viewpoints are defined by Zachman's Framework for Enterprise Architecture [39], The Open Group Architecture Framework (TOGAF) [35], Archimate framework, ISO Reference Model of Open Distributed Processing (RM-ODP) [14]. SA viewpoints are defined, for example, by viewpoint models such as Kruchten "4+1" View Model [21], Software Engineering Institute (SEI) set of views [7], Siemens Four View Model [31] and Rational Architecture Description Specification (ADS).

As discovered by May [24], viewpoints defined such as defined by different Viewpoint models do not completely correspond to each other. Enterprise architecture viewpoint models seem to be similar situation. A commonly accepted set of architectural viewpoints does not thus currently exist [24, 30]. As Smolander [30] reveals the architectural viewpoints chosen by companies are rather agreements between people depending on the organizational and project environment. In practice, the selection of architectural viewpoints is, thus, based on the prevalent situation and characteristics in the company and in the project at hand.

However, different viewpoint models have similarities in the viewpoints defined by them. In the following, viewpoints that seem to be accepted on some level in the EA domain are presented firstly; secondly, viewpoints that seem to be on some level accepted in the SA domain are introduced.

Enterprise Architecture Viewpoints

Enterprise architecture viewpoints define abstractions on the set of models representing the enterprise architecture, each aimed at a particular type of stakeholder and addressing particular concerns [32]. Enterprise architecture viewpoints which are generally mentioned include: *business architecture, information and data architecture*, a*pplication (systems) architecture* and *technical (technology, infrastructure) architecture* (e.g. [17, 35, 36]). Roles these viewpoints have and examples of targets suggested to be described relating to each viewpoint are described in the table 2.

Table 2. Enterprise architecture viewpoints.

Business architecture	
Role	Defines what the enterprise must produce to satisfy its customers, compete in a market, deal with its suppliers, sustain operations, and care for its employees [36]. An enterprise view of what the business must do today as well as in the future to accomplish particular business requirements [36].
Content examples	Key business operations and value streams for the organization [17, 18, 36], Business processes [18], Organisational structure: Organisations, units and functions and responsibilities of them, Roles/Skills [18, 36], Enterprise operating environment [36]

Information / Data architecture	
Role	*Information architecture* The informational needs of the enterprise in the context of core business processes and strategic goals of the enterprise [36]. Major information entities needed to operate the business, their relationships, and how they map to business processes, units, and locations [2]. *Data architecture* Identifies how data are maintained, accessed and utilized [17].
Content examples	*Information architecture* The information and data management framework and precepts [36]. Operational and decision support systems needed to support the core processes and strategic goals, where the information for those systems is located, and how this information will be management [36]. *Data architecture* Data, at the element level, its associated relationships, in what processes they are used and in what form, and how they flow between processes [36].
Application / Systems architecture	
Role	To provide a logical portfolio of applications for supporting the various business processes of an enterprise [36].
Content examples	The application software portfolio and integration relationships; Interface specifications, tools, utilities, and in some cases approved products for applications; Application inputs and outputs; Application geographical deployment requirements; Guiding principles, standards, and design characteristics for the acquisition and the development [36].
Technical / Technology / Infrastructure architecture	
Role	To describe the technology needed to meet the business requirements, helps ground the other architecture views by making it clear that the technology exists to implement them [2].
Content examples	Supporting services, computing platforms, and internal and external interfaces the information systems need to run [2].

Software Architecture Viewpoints

May [24] has analyzed five different software architecture viewpoint models: the Kruchten "4+1" View Model, the Software Engineering Institute (SEI) set of views, the ISO Reference Model of Open Distributed Processing (RM-ODP), the Siemens Four View Model and the Rational Architecture Description Specification). The result was that the commonly accepted SA viewpoints (that these viewpoint models seem to define one way or another) are *functional*, *behavioural*, *external* and *deployment viewpoint*. In addition to these, Rozanski and Woods [28] define *information* and *operational viewpoints*. Roles of these viewpoints and examples of their content are described in the table 3.

Table 3. Software architecture viewpoints.

Functional viewpoint	
Role	Business aspects of the system. Description of the system's functional/structural elements and their responsibilities, interfaces and primary interactions [24, 28]
Content	Functional capabilities, decomposition, uses, layered, abstraction, external interfaces, internal structure, design philosophy [24, 28]
Information viewpoint	
Role	Description of the way the system stores, manipulates, manages, and distributes information [28]
Content	Information structure and content, information flow, data ownership, transaction management and recovery, timeliness, latency, and age, references and mappings, data volumes, archives and data retention, regulation [28]
Behavioral / Concurrency	
Role	Description of the system's dynamic aspects [24] Description of the concurrency structure of the system, mapping functional elements to concurrency units to clearly identify the parts of the system that can execute concurrently, and showing how this is coordinated and controlled [28]
Content	Process, concurrency (task structure, mapping of functional elements to tasks, interprocess communication, state management, etc.) etc.
Development / External viewpoint	
Role	Description of system's implementation structures
Content	Code structure and dependencies, system-wide design constraints, system-wide standards to ensure technical integrity, work assignment [24, 28]
Deployment viewpoint	
Role	Description of the physical environment into which the system will be deployed, including the dependencies the system has on its runtime [28]
Content	Hardware, third-party software, network, physical constraints etc.
Operational viewpoint	
Role	Describes how the system will be operated, administrated, and supported when it is running in its production environment [28]
Content	Installation and upgrade, functional migration, data migration, operational monitoring and control, configuration management, performance monitoring, support, backup and restore [28]

RESEARCH METHOD

In order to gain understanding of meanings and roles that architecture evaluation and measurement have in companies, a series of research phases was used in this study. A semi-structured group interview with a focus group of practitioners from five ICT user and service provider organisations was organised.

Interviewees

Practitioners were managers and specialists of the management of enterprise and software architectures in their organisations. The companies and interviewees are described in the next table.

Table 4. Interviewees in the focus group interview

Companies	*Number of personnel (year 2005)*	*Number of interviewees*	*Viewpoints of interviewees*
Architecture consultation company	10	2	enterprise and software architecture consultation
Banking, finance and insurance company	11 974	1	enterprise architecture
Telecommunication company	4989	1	enterprise architecture
Business & IT consulting and development organization	a part of a large international company with 329 373 employees in total	2	enterprise architecture, software architecture, marketing, business
Retail and service company	28 092	1	IT governance, enterprise architecture

The arrangements for the interview

The participants from these companies were interviewed as one group in order for group members to influence each other by responding to ideas and comments of others [22]. This use of group did have an impact, bringing out new aspects. However, some aspects may not have been brought out by the interviewees due to confidentiality reasons.

Interview

Architectural viewpoints and their definitions discussed at the beginning of this paper were presented to the participants. In addition, the main evaluation concepts and perspectives were presented. Based on practitioners' own practical experiences, practitioners were asked to name evaluation or measurement needs that relate to each architectural viewpoint. In addition, they were asked to name evaluation needs that exist relating to relationships between these viewpoints.

Data collection and analysis

The interview was tape-recorded. Notes were written during the interview session. Based on this data, a list of questions, information needs and topics of concern which may be triggers for architectural evaluations was produced. This list was reviewed by practitioners and the list was completed with comments. This list is presented in the next chapter.

TRIGGERS FOR ARCHITECTURE EVALUATIONS

In the focus group interview, it came up that from the practitioner's point of view it was difficult to directly specify evaluation needs that relate to each architectural view. Practitioners suggested that company's business and ICT related problems, questions, topics of concern and information needs may be triggers for architecture evaluations. A group of triggers which came up in the focus group interview are presented in the table below. In addition, evaluation needs which arise due to these triggers are presented.

Table 4. Triggers for architecture evaluations.

Triggers for architecture evaluations	**Evaluation needs**	**Evaluation Targets**
A need for the documentation of good quality		
A need to produce architectural models and documentations that • can be quickly communicated and • are understandable by many different stakeholders • are cost-effectively kept up to date.	The evaluation the quality of architectural documentation. A need to evaluate: - Policy: do policies (e.g architectural framework) exist for documentation and are they followed? - Intelligibility and usability: are documents easy to understand and use? - Accuracy: are documents truthful and factual? - Cost effectiveness of maintenance: how much effort is needed to keep models and documentation up to date? - Traceability between architectural documents: is there traceability between architectural documents?	Architec-ture documen-tation (EA / SA)
A need to have organisation's business environment descriptions of good quality	The evaluation existence and quality of business descriptions (goals, strategy, company's operations) : • existence of business descriptions (e.g. goals, strategy, company's operations) • Accuracy: are the descriptions up to date?	Business architec-ture documen-tation
A need to have information / data models of good quality	The evaluation of the quality the information / data models	Information / Data architec-ture
Change pressures in organisation		
A change need in the business or ICT (e.g. a need to move from one solution to another)	The evaluation and identification of the places affected by a change and effects in each architectural viewpoint.	EA viewpoints
An observation that ICT-architecture do not correspond to company's business's requirements	The evaluation how the enterprise architecture should be changed by identifying what chances should be carried out in each architectural viewpoint.	EA viewpoints
The understanding of business and ICT environments		
A need to enhance the understanding of company's business/ICT	The evaluation of enterprise architecture from different aspects or against different factors e.g. the identification of overlaps.	EA viewpoints
A goal that ICT supports business	The evaluation of how business architecture is supported by other viewpoints (information, applications, infrastructure).	EA viewpoints

A need to enhance the understanding of responsibilities in the company	Identification and evaluation of responsibilities in company (for example who is responsible for customer informations).	Business architecture
A need to understand the state of the company's product portfolio and processes	The description and evaluation of business architecture related aspects.	Business architecture
A need to understand information managed in company	The description of major information entities and responsibilities in information management.	Information / Data architecture
A need to understand the state of the company's application portfolio	The description and evaluation of structures and components of application architecture.	Application architecture
A need to understand quality aspects relating to the company's application portfolio	The evaluation the application architecture against quality aspects and attributes e.g. the identification of overlaps.	Application architecture
A need to understand the current state of technical infrastructure	The description and evaluation of structures and components of technical infrastructure.	Technology architecture
Company management and process planning		
A need to make sure that organisational choices are suitable	The evaluation of organisational structures and operations: are those suitable or should those be changed.	Business architecture
The distribution of work	The evaluation of processes: identification of which tasks will be carried out by the company and which are dealt out to partners.	Business architecture
Business process planning	The evaluation of functionality of business processes: e.g. do processes correspond to company's strategy?	Business architec-ture
Management of architectures		
An observation that ICT-architecture does not correspond to ICT-development projects' needs	The evaluation of how architectural principles or architecture descriptions should be changed.	EA viewpoints
An effort to drive investments to follow up architectural principles	The evaluation of if the investment corresponds and is suitable to the existing architecture and architectural principles.	EA viewpoints
A need to drive technical infrastructure investments to follow the architectural principles	The evaluation of if investments correspond to the principles.	Technology architecture principles

IT cost management		
A need to understand and manage costs relating to the company's application portfolio	The evaluation of financial aspects and factors relating to application architecture	Application architec-ture
A need to understand and manage costs relating to technical infrastructure	The evaluation of financial aspects and factors relating to technical infrastructure	Technology architec-ture
Architectural choices		
A need to find the best possible system solution and a need to understand the aspects relating the solution	The evaluation of the architectural solution: e.g. evaluation of • quality aspects (evaluation against quality attributes), • flexibility of solution, • the life cycle of solution, • suitability for the situation in question (e.g is solution possible within available time, money and resources).	SA viewpoints (EA viewpoints)
An effort towards long-term technical solutions and need to argue for the long-term technical solutions	The comparison of a long-term and short-term solution.	EA / SA viewpoints

DISCUSSION

Architecture evaluation triggers and needs were identified and analysed in this study. During this study, the following observations were made.

Architecture evaluation is more trigger-based than stabilized work in companies.

This study revealed that architecture evaluations do not at least yet have a stabilized role in companies unlike, for example, requirements engineering and architecture design have. Evaluations seem not to have a fixed status in the architecture processes or in other processes in companies. Therefore, evaluations are not executed regularly.

In this study, it came up that some kind of trigger must exist before the evaluation is executed. This trigger may be, for example, a problem, a question or a need for information relating to company's business or ICT-environment. In the figure below, the first steps before the architecture evaluation, identified in this study, are summarized.

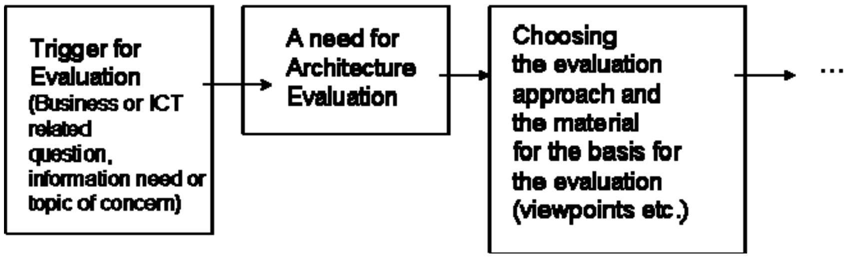

Figure 2. Starting steps for the architecture evaluation.

Architecture evaluation has several meanings and roles in companies and evaluations can thus be used for different purposes.

This study revealed a couple of triggers for architecture evaluations. These triggers can be categorised to the following categories:

- Company and business management: Support needs for organisation's structural design (e.g. business process design) and for the distribution of the work (e.g for out-sourcing).
- Holistic view: Needs to understand the current status of organisation's business and ICT-environment.
- IT cost management: Financial information needs relating to company's ICT (applications and technical infrastructure).
- Change management: Change pressures relating to architectures and architectural principles – identification of probability and nature of changes that should be made and decision making about changes.
- Quality management: Quality questions relating architectural documentation, the company's information/data structures, application and technical infrastructure, as well as systems solutions.
- Architecture management: Confirming that architecture related work meets expectations e.g. investments correspond to the architectural principles.
- Architectural choices: evaluation of architectural alternatives against quality, cost and other aspects.

We suggest that these evaluation triggers describe role and meaning that architecture evaluation may have in companies. Architecture evaluations can hence be one of the tools of quality assurance, change management, architectural planning and IT cost management. In addition, evaluations may support the organisational planning and decision making. Different evaluation approaches are needed because architecture evaluation's role varies remarkably.

A motivation for the evaluation defines the material and architectural viewpoints to be viewed.

The nature of a trigger for the evaluation drives the choosing of architectural documentation and viewpoints to be viewed in the evaluation. Sometimes it can be concentrate only on one viewpoint, but sometimes many viewpoints and their relationships can be analyzed.

The nature of evaluation and its challenges differ between viewpoints.

In the interview, practitioners brought out that business architecture seems to be the most difficult area to evaluate. The challenge relating to evaluation of information / data architectures is the lack of information and data models in companies. Currently, companies are not accustomed to actively producing information and data models.

Practitioners felt that application and technical architecture are the most understandable areas and these areas are typically evaluated in companies. The evaluation of these areas is numerical (e.g. amounts of components, cost).

One challenge in architectural evaluations is the architectural documentation.

Evaluations are based on the architectural documentation and descriptions that the company has. In the interview, practitioners brought out some challenges that relate to architectural documentation. It is not clear and easy to decide what descriptions and documentation should be produced relating to architectures. In addition, the amount of documentation produced should be limited. The quality and amount of architectural documentation may have an effect on the possibilities to execute evaluations for a company's architectures. However, the descriptions are needed for analysing and understanding architectures.

The relationship between architecture evaluations and organisation's other measurement activities

Companies already have measurement practices and metric programs (e.g. enterprise performance measurement, balanced scorecard). In the interview, it came up that a link between an organisation's existing measurement practices and architectural evaluations and measurements should be specified.

Restrictions

In this study, the EA and SA design and development specialists were interviewed. Their perspectives might reveal much more than the companies' other business and ICT stakeholders' perspectives. In addition, all the possible triggers for evaluations may not have been identified in this study. However, the results give an image of the role and meaning of architecture evaluations in companies.

CONCLUSION

This study revealed that currently architectural evaluations seem not to have a stabilized role and meaning in companies. This situation is reflected, for instance, in architecture evaluations not having stabilized place in organisations' architecture process models. It came up that a trigger for evaluation must exist. However, the reason for this may be that architecture evaluation practices are still immature in general and, therefore, we might expect to see changes in the future.

In this study, triggers for architecture evaluations in companies were identified and analysed. This study aims to enhance the definition of the role for architectural evaluation in organisations.

The future research questions, raised in this study, include the questions of what kind of stabilized role architecture evaluation could have in organisations and how architecture evaluations and measurements could be linked to an organisation's other measurement and evaluation programs and practices.

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Success and Failure Factors for Software Architecture

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Abstract

This paper provides a view of the software architecture development and management process. It reviews the literature and practitioners' experiences relating to the factors that cause success and failure for software architecture and classifies these factors into subgroups. This study demonstrates that the success of software architecture depends on multiple factors. Project management, organisational culture and communication, the skills of architects and architectural know-how, architecture methods and practices, the quality of system requirements and, finally, architecture solutions seem to affect the achievement of successful architecture.

1. Introduction

Currently, a concern of many ICT-service providers and user organisations in their system development work is software architecture. Another central issue in this development work is the quality of the system. Software architecture is a critical factor in the design and construction of any complex software-intensive systems. Software architecture has an impact on the quality of the system. On one hand, a good architecture can help ensure that a system will satisfy key requirements in such areas as performance, reliability, portability, scalability, and interoperability [10]. On the other hand, a bad architecture can be disastrous. It may prevent the achievement of goals that are set for the system.

Architecture evaluation is a way to increase the understanding of the quality of architecture. A variety of methods is being developed for the evaluation of software architectures. Evaluation methods developed during the last decade are, for example, SAAM [15], ATAM [16], ARID [8] and ALMA [4]. Evaluation objectives, criteria, as well as evaluation targets, examined by the software architecture evaluation methods, differ markedly. Evaluation objectives and use cases are discussed in some method comparisons (e.g. [2, 9]) and other studies (e.g. [13]). In spite of this discussion in various papers, evaluation criteria and metrics are presently neither established nor detailed yet. Nevertheless several evaluation criteria and metrics descriptions exist. Software architecture evaluation criteria are discussed for example by Hilliard et al. [11, 12] and Losavio et al. [18, 19]. One reason for the non-establishment of architecture evaluation criteria and metrics may be that common views on what is successful software architecture and what factors have an effect on achieving it do not exist. It is not clear what targets and factors should be evaluated and measured. However, successful architecture is a widely used concept.

Academia and practitioners have come to realize that a critical success factor for system design and development is finding a successful architecture. Although the idea of a successful architecture is not clearly defined, practitioners and academia have become increasingly interested in what makes software architectures succeed or fail. The identified success and failure factors help system development managers and architects make a number of critical decisions. These decisions relate, for example, to the selection of evaluation criteria and metrics for the quality assessment of architectures and architecture management processes.

It is generally known that the success of software architecture is typically influenced by factors at various levels. However, these factors are mainly discussed only in a few studies and reports organised and produced by some research institutes and the ICT industry (e.g. [21], [1], [5]). Thus, these factors are, as yet, far from having been fully investigated in detail.

Our study contributes to this field with an identification and analysis of success and failure factors of software architecture. Our research involved reviewing the relevant literature and practitioners' experiences on factors that cause the success or failure of software architecture efforts. The factors listed in the following section were distilled from various articles and empirical research on software architecture implementation. Moreover, in order to collect empirical data for the present study, we organised an interview for a focus group of practitioners from three ICT service provider and user organisations. Success and failure factors were then categorised into a number of subgroups representing various dimensions of change related to the development and management of software architecture. As a result, this study presents a number of factors related to software architecture success and failure.

This study consists of the following sections. Firstly, section 2 presents the research method used in this study. Secondly, sections 3 and 4 present the results of this study: success and failure factors for software architecture. Finally, section 5 summarizes the findings and presents areas for further examination.

2. Research method

In order to identify and analyse the success and failure factors for software architecture a series of the following research phases was used in this study.

Phase 1. The study of previous research and reports.
Firstly, a list of success and failure factors mentioned in previous research and ICT-industry reports was produced. Secondly, the list of factors was analysed and the similar factors were organised into groups. Finally, the preliminary system development areas to which similar factors were related were identified.

Phase 2. Empirical research: A focus group interview [17] of practitioners.
A semi-structured group interview with a focus group of practitioners from three ICT user and service provider organisations was organised. The goal of the interview was to collect success and failure factors from the practitioners.

Interviewees
Practitioners were specialists of the management of software and enterprise architectures. The companies and interviewees are described in the table below.

Table1: Interviewees in the focus group interview

Companies	*Interviewees*
Architecture consultation company Number of personnel 10 (year 2005)	3 system and sofware architecure consultants
Banking, finance and insurance company Number of personnel 11 974 (year 2005)	enterprise architecture architect
Telecommunication company Number of personnel 4989 (year 2005)	enterprise architecture architect

The arrangements for the interview
The participants from these companies were interviewed as one group in order for group members to influence each other by responding to ideas and comments of others [17]. This group influence came up and new aspects were brought out. However, some aspects may not have been brought out by interviewees due to confidentiality reasons.

We presented previous research results in the interview and in turn structured the interview according to them. The practitioners reviewed the previous study results based on their own practical experiences. In addition they were asked to add new factors to the results on the basis of their practical experiences.

Data collection
The interview was tape-recorded and videotaped. Notes were written during the interview session. Based on this data a list of system development areas affecting the success of software architecture and success and failure factors relating to these areas was produced.

Phase 3. Consolidation and analysis of results.
The results from the empirical study and previous research were combined. These results are presented in chapters 3 and 4. In the results, the factors identified in the literature review are marked with the literature reference (proportion of these factors 49 %). The factors identified purely from the interview data are marked with the marking [FGI] and these factors are without literature reference (proportion of these factors 27 %). The factors recognized both from the interview data and from literature are marked with both the literature reference and [FGI] (proportion of these factors 24 %).

3. Software Architecture Success Factors

In this study, we identified six system development areas that seem to affect the success/failure of software architecture. These areas are presented in figure 1. The success and failure factors, identified in this study, relate to these areas. In the following sections, we describe the success factors included in these areas. The failure factors related to these areas are presented in chapter 4.

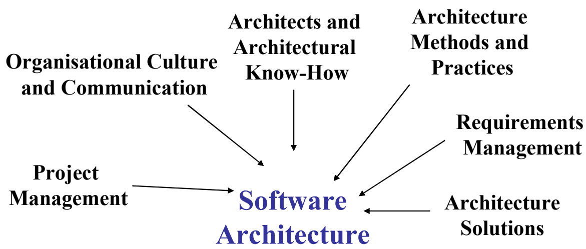

Fig. 1. System development areas affecting the success and failure of software architecture.

Success Factors within Project Management
Project management offers time, staff and resources for architectural work. Software architecture success factors relating to the project management can be divided into factors relating to staffing, scheduling, planning and funding. In this study, we identified the following project management factors that promote the success of software architecture:

- *Clear aim of project*: The aim of the project is clear and reasonable [FGI = based on Focus Group Interview].

- *Strong management sponsorship*: The project and architecture work have strong management sponsorship [6]. Management offers time and funding for the project [FGI].
- *Clear milestones in the project*: Predetermined milestones are set in the planning stage to track the direction of the project [FGI].
- *Strong leadership:* Strong leadership specifically for the project [6].
- *Clearly defined teams and roles:* Project management teams are clearly defined. A good lead architect with a well-defined role and style [6].
- *Available knowledge / staff:* Market / business understanding is available [6].
- *Teamwork* [6].

Success Factors Related to the Organisational Culture and Communication

Organisational culture refers to the values, beliefs and customs of an organisation. Whereas organisational structure is relatively easy to draw and describe, organisational culture is less tangible. Organisational culture has an impact, for example, on how well the architecture will be adopted and followed. The success factors related to organisational culture are:

- *Status and role of architecture*: Architecture is woven into the organisational culture [6]. The role of the architecture and of the architectural descriptions is more instructive than supervisory [FGI].
- *Ownership:* Willingness to take ownership of architecture [6] [FGI].
- *Approving attitude towards architecture*: The project organisation is willing to follow architecture [6].
- *Training, teambuilding* [5]: The training of staff to design and manage architectures [FGI].

Successful communication between different groups can be seen as an effective exchange of information.

- *An effective and constructive communication culture relating to architectural issues:* Interpersonal and team communication [6]. The communication culture in an organisation is based on an open exchange of well-argued, even critical, opinions [FGI].

Success Factors Related to the Architects and Architectural Know-How

The personal skills of architects have an effect on the fluency of the architectural design process in collaboration with the stakeholders. Personal skills may also have an impact on architectural decision making. We identified the following skills of architects affecting the success of software architecture:

- *Practical experience:* Architects have practical experience on system development [21] or architects have the humility to discuss architectural solutions with the development team [FGI].
- *Domain knowledge*: Architects have at least a minimal knowledge on the problem domain [6, 21] [FGI].
- *System development knowledge:* Architects have knowledge on the system development method used and on how the architectural work is related to the method [FGI].
- *Capability to create architectural vision*: Architects have a capability to create a clear and compelling vision [6] that suits the organisation [FGI].
- *Conceptual thinking*: Architects are able to think conceptually and analytically [FGI].
- *Capability to argue rationally*: Architects are able to reason rationally, be critical of their own ideas, and put this rationality to use [FGI].
- *The ability to outline large entities* [FGI].
- *Communicative and social skills:* Architects can understand and combine views of the stakeholders [FGI]. Architects have communicative and social skills [21]. They are good communicators and listeners as well as good persuaders [6]. Moreover, they provides constructive feedback when it is needed [6]. They are also effective in selling and marketing architectural ideas [FGI]. These skills are important in spreading architectural knowledge, and explaining the urgency of architecture within an organization and a project team [21].
- *Project management skills*: Architects have good project management skills [6]. However, the project management skills needed depend on the scope of the project [FGI].
- *Humility:* The progress of architectural work is more important for the architect than personal merits [FGI].

Success Factors Related to the Architecture Methods and Practices

The software architecture management process contributes to the activities of capturing architectural requirements and understanding them, designing, analyzing/evaluating, realizing, maintaining, improving, and certifying the architecture as well as documenting it [3, 14]. The process model together with the methods and tools chosen to carry out architectural work, in turn have influence on this work. In addition, the standardization of the architectural concepts and of the descriptions in an organisation has an effect on the architectural practices. We identified the following factors relating to the architecture management process model, architectural methods and tools that affect the success of software architecture.

Architecture Management Process model:

- *Incremental and iterative development*: Deployed in phases / incrementally [6] [FGI].
- *Validation of requirements:* Validation of requirements during each step of the process [6].

- *The evaluation of architecture:* The evaluation of the architecture before it is implemented [FGI].
- *Life-cycle thinking in the architectural design*. The needs for change are taken into account in the architectural design [FGI].

Methods, tools and practices:

- *Suitable and effective methods and tools:* Architects should have effective tools at hand: methods that fit the specific requirements and situation of a company [21]. The methods should not constrain the architect in his work nor his creativity.
- *Well-defined limits for architects:* A well-defined field in which the architect is allowed to use his creativity in the architectural design and work [FGI].
- *Clear rules in the architectural decision making:* Clear rules on which architectural decisions can be made in the project and which decisions are made outside the project. Furthermore, clear definitions on which architectural decisions are made by architect and which are only prepared by him and which have to be decided by the project management. [FGI]
- *Change management* [FGI].

Standardization of architectural practices:

- *Standardization of architectural practices:* Standardisation architecture methods, descriptions, and terminology within the organisation [FGI].

Architectural specifications:

- *Clear and understandable architectural specifications*: Clear specifications including dependencies [6]. Architecture is understandable by all. That is, the architectural models and descriptions an architect produces, should be understandable and unambiguously interpretable by all stakeholders [6, 14]. Architectural models and descriptions are practical, easily translatable to the practice of software development and implementation. Otherwise the architecture will exclusively be used by the architects [21].

Enterprise architecture:

- *Defined and described enterprise architecture* [FGI]. Enterprise architecture is important in improving the adjustment of different projects to each other, and making sure information systems fit together, and into the entire architecture [21].

Success Factors Related to the Requirements Management

Architectural design and decision making is founded on identified requirements. Previous studies do not clearly highlight which factors in the requirements management advance the success of software architecture. However, the problems in requirements quality cause failure for software architecture like as described in the next chapter. Therefore, it is evident that the quality of the requirements and of the requirements management process advances the success of software architecture.

Three basic quality characteristics for the requirements of good quality are [20]:

- *Complete*
- *Agreed*: The requirements are correct, consistent, feasible, prioritized [FGI] and necessary.
- *Well-represented*. The requirements specifications are unambiguous, concise, traceable, non-redundant, organised [FGI], conformant to standards and verifiable.

Success Factors Related to the Architecture Solutions

Architectural choices and decisions are made in architectural design. Based on these decisions, the architectural specifications are produced. The following high-level success factors relating to architecture solutions are mentioned:

- *Simple architecture* [6]
- *Architecture solve the problem*: Solve at least the current [6] and impending [FGI] problems as well as change needs.

4. Software Architecture Failure Factors

The software architecture failure factors identified in this study are presented in this chapter.

Failure Factors related to the Project Management

Problems in staffing, scheduling, project planning and project funding complicate the architectural work. These kinds of problems are presented in the following section. In the interview of practitioners, we also noticed that some of these problems are more relevant for the service provider organisations than for the user organisations. For example, the lack of clear statement of the problem is more critical problem for the service providers than for the user organisations.

Problems and deficiencies in the project planning:

- *Not a clear statement of the problem*: The project lacks a clear problem statement or the project team has not provided a clear statement of the problem [1]. The organisation does not have time or willingness to define clearly the aim of the project [FGI = based on Focus Group Interview].
- *The project scope too broad*: The project scope is too broad [1]. The capability to divide the project into smaller entities/units may also be lacking [FGI].
- *No project, system or testing planning*: A project plan has not been put in place [1]. The project team has not written an overall architecture plan [1] and has not developed a system test plan [1].

No contingency plan has been provided [1]. No plan for moving to OO technology has been established. [1]

- *The lack of clear milestones in the project*: The direction of the project is not checked during the project. The only milestone is the end of the project [FGI].
- *No measures of success*: Measures of success have not been identified [1].

Problems in the scheduling:

- *No scheduling or unrealistic scheduling*: No project schedule is in place.[1] The deployment date is unrealistic [1] [FGI]. The focus is too much on getting positive results in the short term [21]. The project team has not put a hardware and installation schedule in place [1]. The project team has not allocated sufficient time for testing [1].

Problems in the project funding:

- *Funding not formalized*: Project funding has not been formalized [1].
- *Insufficient resources:* Insufficient resources have been allocated for building tasks. [1]

Problems and deficiencies in staffing:

- *Poor leadership*: No project manager/leader has been identified [1]. Poor leadership [6] Lack of control/authority [6].
- *Stakeholders unclear*: The stakeholders are not clearly identified [1] or they are difficult identify [7].
- *Lack of resources/talent:* The needed resource does not exist or project management is not able to offer it [FGI].
    - *Lack of domain expertise*: No domain experts have been committed to the project team [1].
    - *Lack of architect*: No architect exists [7] or failure to select software architects. Each layer has an architect assigned; however, a chief architect with responsibility for the overall architecture has not been selected [1].
    - *Lack of other resources*: For example the lack of points of view of end users or of administrator [FGI].
- *Lack of a quality assurance organisation*: A quality assurance organization has not been selected [1].
- *Lack of requirement team*: An independent requirement team has not been selected [1].

Failure Factors related to the Organisational Culture and Communication

The following aspects and factors relating to organisational culture and communication complicate architectural work:

- *Profit-centre and project culture:* Consideration of architectural issues only from the point of view of one's own profit centre or project [FGI]. Thinking too narrowly or short-sightedly [FGI].
- *Quarterly thinking:* Far-sighted architectural decisions are difficult to justify in the quarterly thinking [FGI].
- *"Turf" thinking:* Architectural decisions are formulated so that the decisions complicate the work of the decision maker as little as possible [FGI].
- *Organisational Politics:* Organisational politics drive the architectural decision making [6].
- *Negative Attitude towards Architecture and Architects:* The product team believes "we can solve it better ourselves" [6]. The designed architecture is not implemented. The product team implements its own ad hoc solutions [FGI].
- *Poor communication*: Poor communication inside/outside the architecture team [6]. The architecture team loses touch with the product team's problems [6].
- *Disparity in the perception of the architecture:* There are, for example differences in the perceptions between developers and architects [7].

4.3 Failure Factors related to the Architects and Architectural Know-How

Failure factors relating to the architects and architectural know-how are identified only briefly in previous research. However, the following factors are mentioned by previous studies and practitioners:

- *Unconvincing leadership by architects*: Architect or architecture team does not "sell" (lead) architecture enough [6].
- *Incapability to create an architectural vision* [6] [FGI].

Failure Factors related to the Architecture Methods and Practices

The following factors related to the architecture management complicate the architectural design.

Architecture management process, methods, tools and practices:

- *Attention focus on methods and tools, not on architecture*: Much time is spent on finding the best methods and modelling languages, which takes the attention away from the real purpose of architecture [21].
- *No architecture selection decision criteria*: The project lacks decision criteria to choose the software architecture [1].
- *No change management*: No modification (MR) tracking system in place [1] [FGI].
- *No iterative design*: The first version of the architectural design is implemented. The time is not used on architectural evaluations or on assessments of architectural alternatives [FGI].
- *The cutting down of the architectural design*: The time is focused on the coding rather than on the architectural design and evaluations [FGI].

- *Outputs not identified*: The expected outputs of the architectural work have not been identified [1] [FGI].
- *Outdated architectural documentation* [7].

Architectural specifications:
- *Essential architectural views / aspects not documented* [FGI].
- *Architectural descriptions are at too low a level or are not detailed enough* [6] [FGI]. Architectural specifications are class diagrams [7].
- *Architectural descriptions are at too high a level.* The architecture can not be carried out based on descriptions [FGI].

Enterprise architecture:
- *Enterprise architecture is not defined or described* [FGI].
- *Enterprise architecture is very heterogeneous* [FGI].

Failure Factors related to the Requirements Management

The following factors related to requirements quality complicate the architectural design and decision making:
- *Incomplete requirements:* Requirements are missing for a feature [1]. The existing environment (e.g. legacy systems) of system is not considered or described. An assessment of the size of the expected user community has not been done [1] Project lacks a clear statement of its data storage requirements. [1] Anticipated usage of the system was not clearly characterized. [1]
- *Unbalanced set of requirements* [7].
- *Requirements not prioritized:* The project team has not prioritized the requirements [1].
- *Requirements not documented*: No requirements documentation exists [1].
- *Requirements unclear:* Requirements not well-defined, not signed off, changing [6]. The team has not clarified some requirements. Requirements need to be clarified.[1]
- *Insufficient resources to support a new requirement have been allocated* [1].

Failure Factors related to the Architecture Solutions

The following factors relating to the architectural solutions are mentioned to be failure factors for the software architecture:
- *Architecture does not correspond to the requirements*: Does not solve the project teams problems [6]
- *Architectural decisions are based on the wrong interpretation of requirements:* The wrong interpretations of the regulations may lead, for example, to unnecessary complex architectural solutions [FGI].
- *Bad design / idea* [6].
- *Standards and standard components neglected* [7].
- *External structures drive the architecture*: Architecture follows customer's organizational structure [7]. Architecture depends on specifics of an operating system [7]. Architecture follows hardware design [7].
- *Exceptions drive architecture* [7].
- *Complex*: Too many components on every hierarchical level [7].

5. Conclusion

In this study, we identified and analysed success and failure factors for software architecture in system development work. This study demonstrates that the success of software architecture depends on multiple factors. Project management, organisational culture and communication, the skills of architects and architectural know-how, architecture methods and practices, the quality of system requirements and, finally, architecture solutions seem to affect the achievement of successful architecture.

Based on the analysis of the identified factors presented above, the main success factors and their relationship are presented in the figure 2.

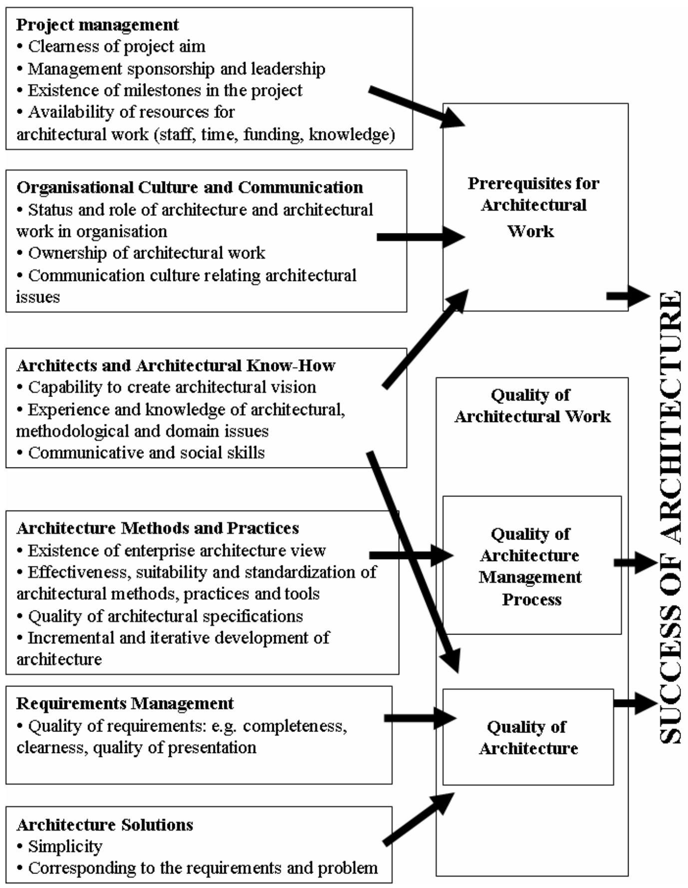

Fig 2. Main factors affecting the success of software architecture.

The results of this study can be used as a checklist by which practitioners in ICT service providers and user organisations undertaking, or planning to undertake, software architecture efforts can ensure that their software architecture–related efforts are comprehensive and well-implemented. These results can also help to decrease the chance of failure in architecture development.

A further outcome of this study is the development of software architecture quality management methods and process models, such as software architecture evaluation practices. This study shows for which targets architecture management evaluation criteria, metrics and methods could be developed and utilized.

Further research questions, raised in this study, include the question of which evaluation criteria and metrics are suitable for each success factor. In addition, the criticality of these software architecture success and failure factors in system development need to be assessed based on surveys directed to ICT service providers and user organisations. We are addressing this last question in our on-going research.

6. Acknowledgements

This paper is based on the work carried out in the AISA project (Quality Management of Enterprise and Software Architectures) financed by the the Finnish Funding Agency for Technology and Innovation (TEKES) and participating companies: Elisa Oyj, IBM Finland, OP Bank Group, SOK, and A-Ware Oy. We wish to thank the participating companies for their co-operation.

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AISA Project : Presentations

Title	Author(s)	Date
AISA Research Project. Quality Management of Enterprise and Software Architectures.	Niemi Eetu & Ylimäki Tanja	20.2.2008
Architecture Evaluation Methods.	Hoffmann Martin	18.4.2007
Architecture Planning and Decision Making in Companies.	Niemi Eetu and Hämäläinen Niina	6.3.2008
Architectural Work Status - A Case study of Three Finnish Business Enterprises.	Niemi Eetu	-
Assessing Architectural Work - Criteria and Metrics for Evaluating Communication, Common Language & Commitment.	Ylimäki Tanja	7.2.2007
Enterprise Architecture Compliance Evaluation.	Ylimäki Tanja, Niemi Eetu and Hämäläinen Niina	18.4.2007
Enterprise Architecture Risks - an Overview.	Niemi Eetu and Ylimäki Tanja	20.2.2008
Evaluation Needs for Enterprise Architecture.	Ylimäki Tanja	1.11.2006
Evaluating the Benefits of Architectural Work.	Niemi Eetu	7.2.2007
Evaluating Business-IT Alignment in the EA Context.	Niemi Eetu and Ylimäki Tanja	18.4.2007
Long-Term and Short -Term Architecture Decisions.	Hämäläinen Niina	-
Measurement in Enterprise Architecture Work.	Hämäläinen Niina, Niemi Eetu and Ylimäki Tanja	-
Quality Management Activities for Enterprise Architecture.	Ylimäki Tanja	3.5.2006
Quality Management Activities in Software Architecture Process.	Hämäläinen Niina	-
Role of Architecture Evaluations in ICT-Companies.	Hämäläinen Niina	-
Towards Critical Success Factors for Enterprise Architecture.	Ylimäki Tanja	11.1.2006

AISA Research Project

Quality Management
of Enterprise and Software Architectures

2005-2008

Eetu Niemi & Tanja Ylimäki

INFORMATION TECHNOLOGY RESEARCH INSTITUTE
UNIVERSITY OF JYVÄSKYLÄ

Contents

Introduction

- A three-year research project studying the quality management and evaluation aspects of both **enterprise architecture (EA)** and **software architecture (SA)**
- 1.3.2005 – 31.3.2008
- Participating organizations: A-ware, Elisa, IBM, Osuuspankkikeskus, SOK, Tieturi
- Funded by the Finnish Funding Agency for Technology and Innovation (Tekes) and the participating organizations

Project Themes and Objectives 1/2

Major research questions:

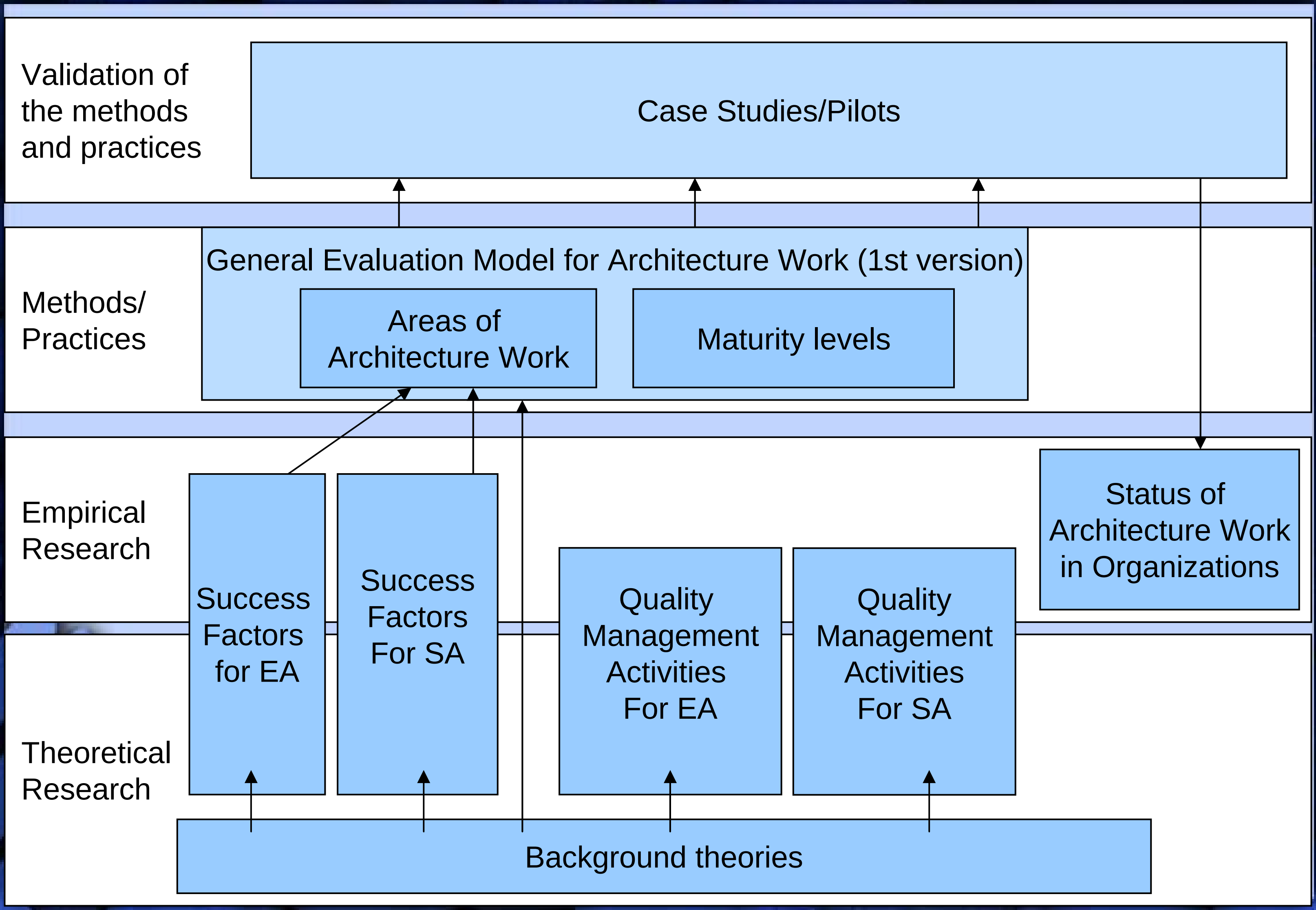
- What are the characteristics of architecture planning and development processes of high quality and maturity (= process view)?
- What are the characteristics of enterprise and software architectures of high quality and maturity (= product view)?

Project Themes and Objectives 2/2

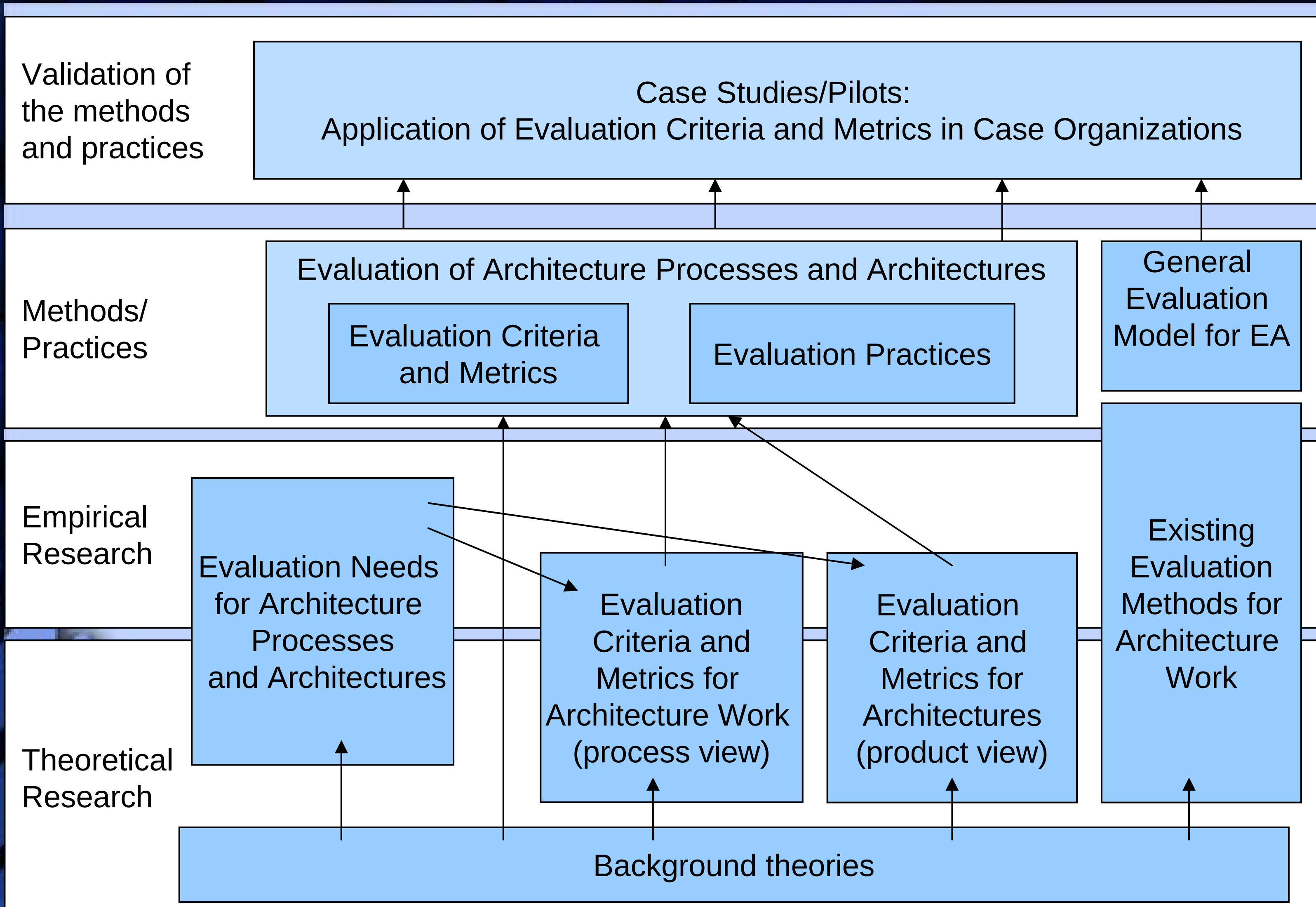
To tackle the research questions the following sub-themes were scrutinized:

- Architecture success from the viewpoint of architecture maturity and quality
- Architecture quality management processes
- Architecture work status and development needs in ICT-provider and user organizations
- Architecture quality evaluation criteria and metrics
- Architecture quality management/evaluation methods and practices
- Architectural decision-making
- Architectural risks

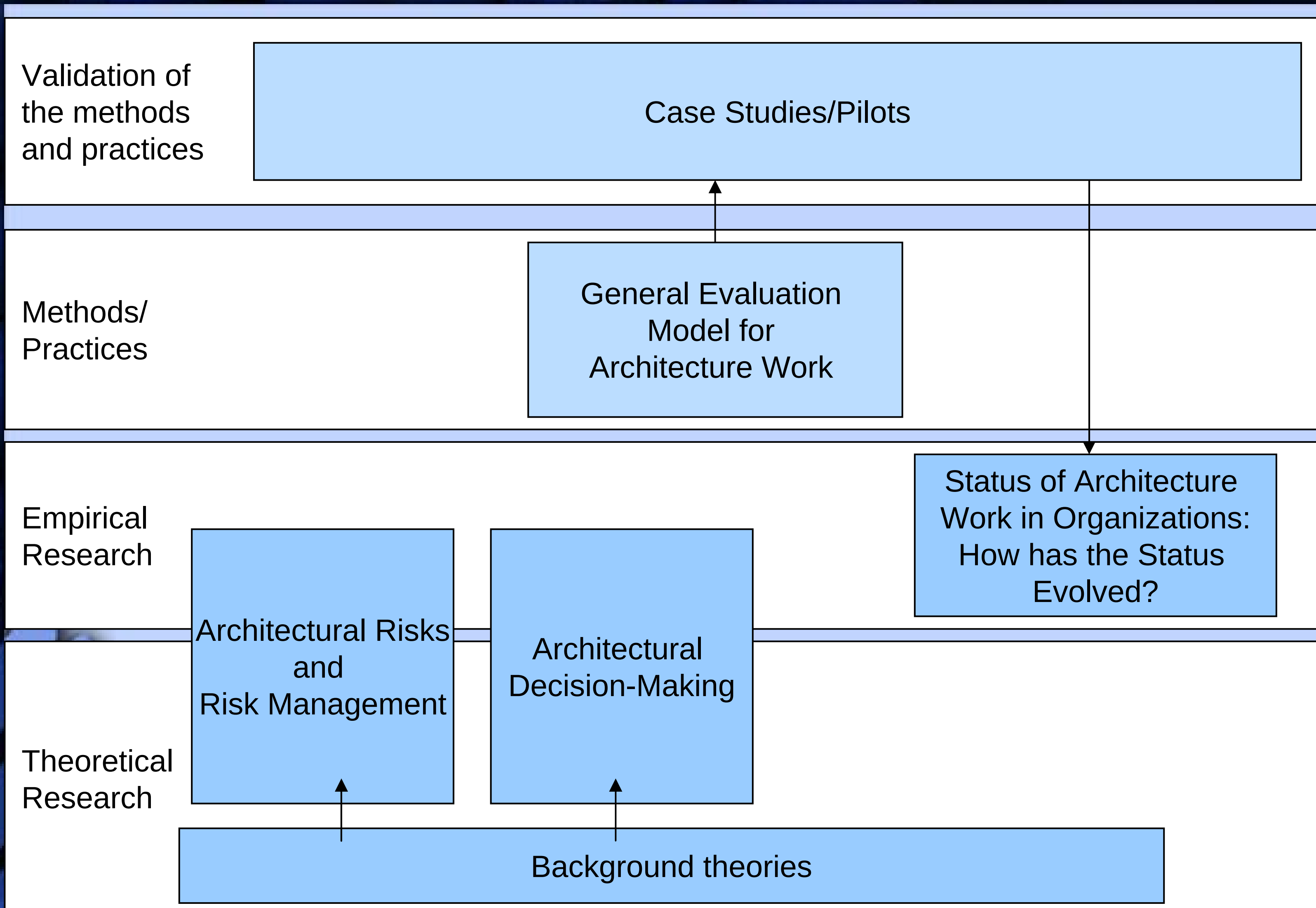
First Year Results



Second Year Results



Third Year Results



Publications

- 17 Scientific Articles
  - 4 Journal Articles
  - 13 Conference Articles
- 16 Project Reports and Related Presentations
- Theses
  - 1 Dissertation
  - 1 Master's Thesis
- Results are also wrapped up in a CD-Rom publication titled "Evaluation of Enterprise and Software Architectures – Critical Issues, Metrics and Practices". Publications of the Information Technology Research Institute, 18, 2008.

Main Conclusions 1/2

- Architectural work is a vast area, and the success and quality of both EA and SA work seem to be influenced by multiple - and to some extent interrelated – factors
  - factors can be used as checklists or to support the definition of company-specific success factors
- Architecture work is currently under development or in initial state
  - Organizations may have defined e.g. architectural frameworks and principles, but architectural models are still generally under construction as well as the transition plan

Main Conclusions 2/2

- Architecture evaluation is a multifaceted instrument in architecture work; the wide selection of evaluation questions, criteria and metrics charted for various evaluation targets can be used to define the few specific metrics for the organization-specific needs
- In practice, architectural work seems to be very different from theoretical frameworks and process models. There seems to be **a need for a light and agile EA methodology**, or at least a usable and simple enough EA process, in organizations initiating architectural work.

Further Research

Suggestions for further research relate e.g. to the

- improvement of the generic evaluation model for EA
- construction of the evaluation methods and metrics for architecture benefits
- creation of a systematic, consistent architecture evaluation methodology
- clarification of the initialization phase of architecture work
- implementation and utilization of architectures

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Architectural Work Status – A Case Study of Three Finnish Business Enterprises

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Project AISA (http://www.titu.jyu.fi/aisa/)

INFORMATION TECHNOLOGY RESEARCH INSTITUTE

UNIVERSITY OF JYVÄSKYLÄ

Outline

- Enterprise Architecture (EA)
- Study Background
- Research Process
- Generic Evaluation Model for Enterprise Architecture
- Enterprise Architecture Work Status
- Enterprise Architecture Work Challenges
- Summary and Development Suggestions
- Further Research

Enterprise Architecture (EA)

Enterprise Architecture

- Business Architecture
- Information Architecture
- Systems / Applications Architecture
- Technology Architecture / Infrastructure

Study Background

- Academic and industry interest
- Potential for significant benefits
- Fragmented research domain
- Few studies on EA work status

→ What is the status of EA work in companies?

Research Process

- Generic Evaluation Model for EA
- Case companies
- Semi-structured focus group interviews
- Data analysis: EA work status, challenges & maturity
- Conclusions & suggestions for development

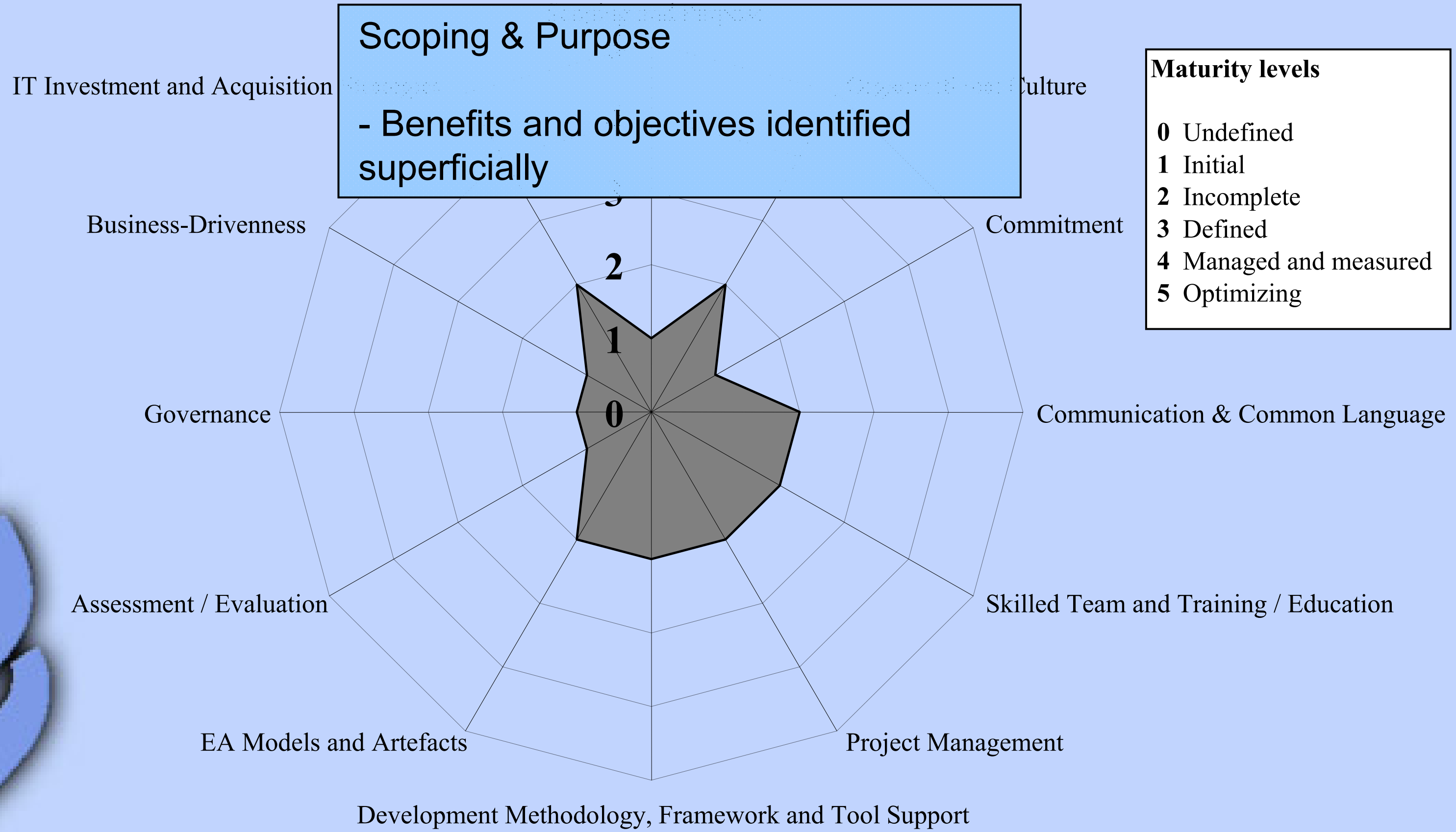
Generic Evaluation Model for EA

- The model consists of
  - areas of EA work (adapted from EA critical success factors)
  - key questions related to these areas
  - six maturity levels
- Introduced in detail by Ylimäki (2006)

Enterprise Architecture Work Status

- Company 1 – IT service provider
  - EA work methods, models and tools
  - EA evaluation methods, metrics and criteria
  - Knowledge and skills
  - Project management practices
- Company 2 – IT user organization
  - EA frameworks and work methods
  - EA policies
  - EA planning linked to IT investments
- Company 3 – IT user organization
  - Objectives and benefits
  - Business-driven
  - Development plan
  - Independent EA team

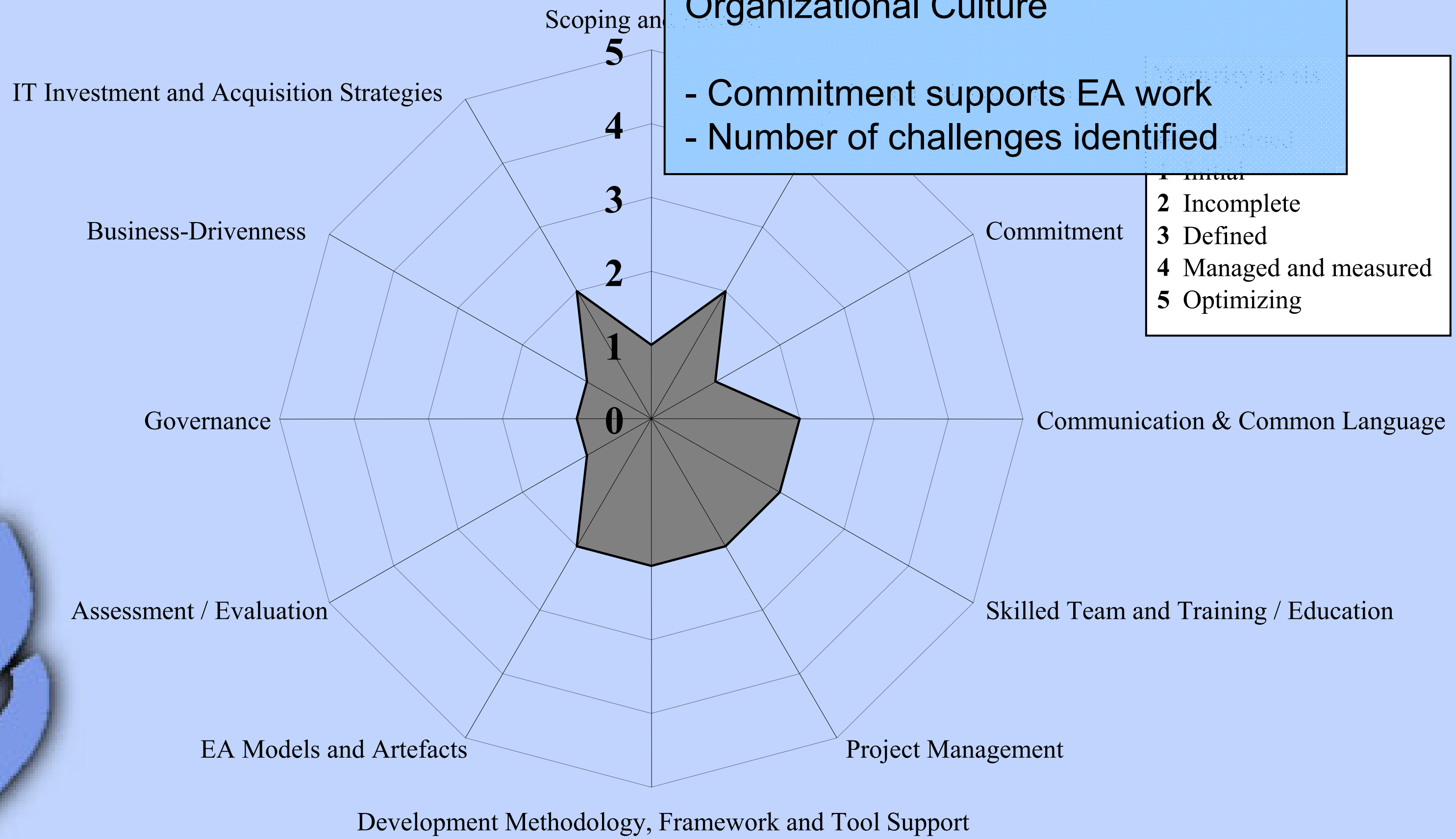
Enterprise Architecture Work Challenges



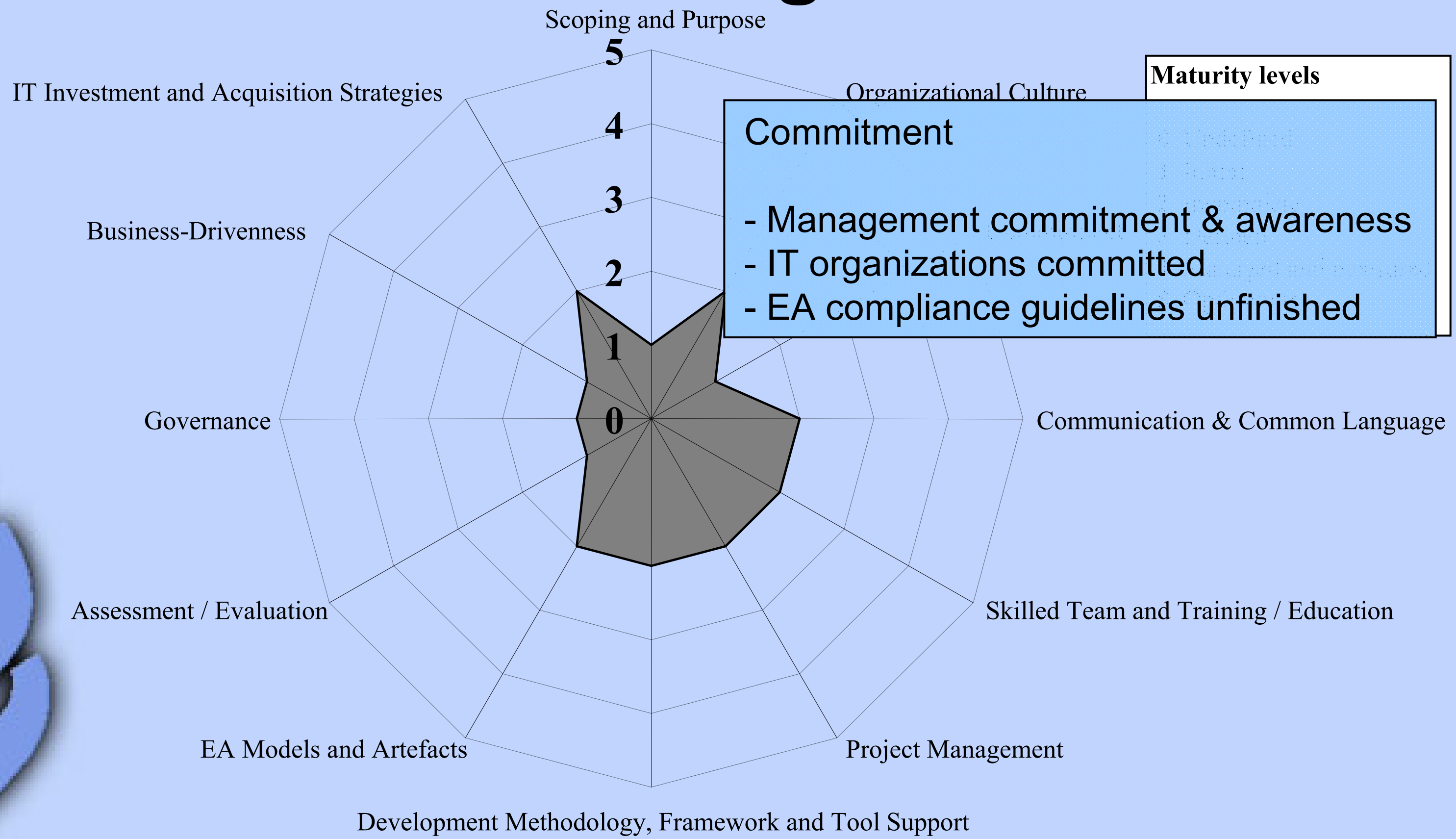
Enterprise Architecture Work Challenges

Organizational Culture

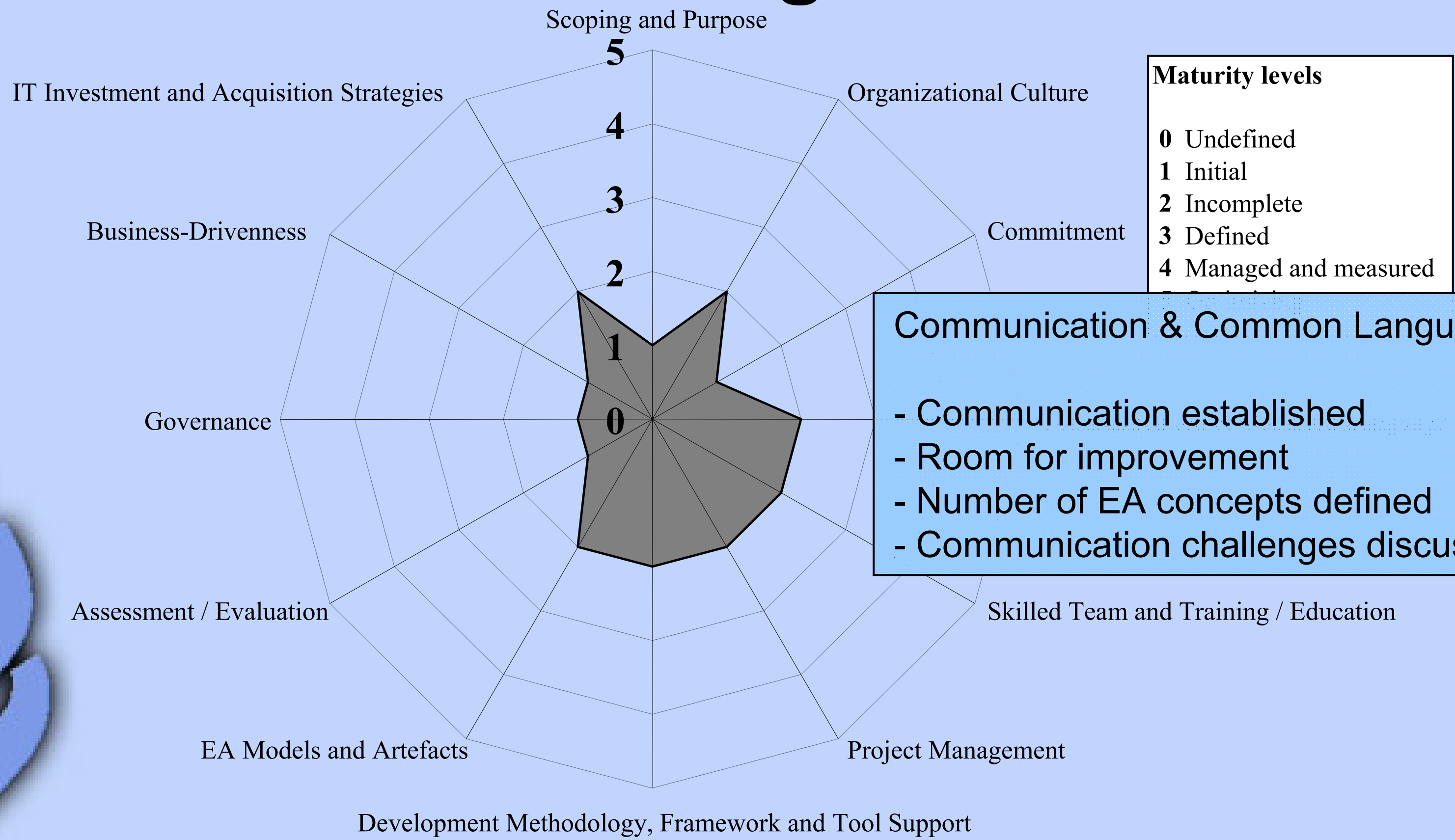
- Commitment supports EA work
- Number of challenges identified



Enterprise Architecture Work Challenges



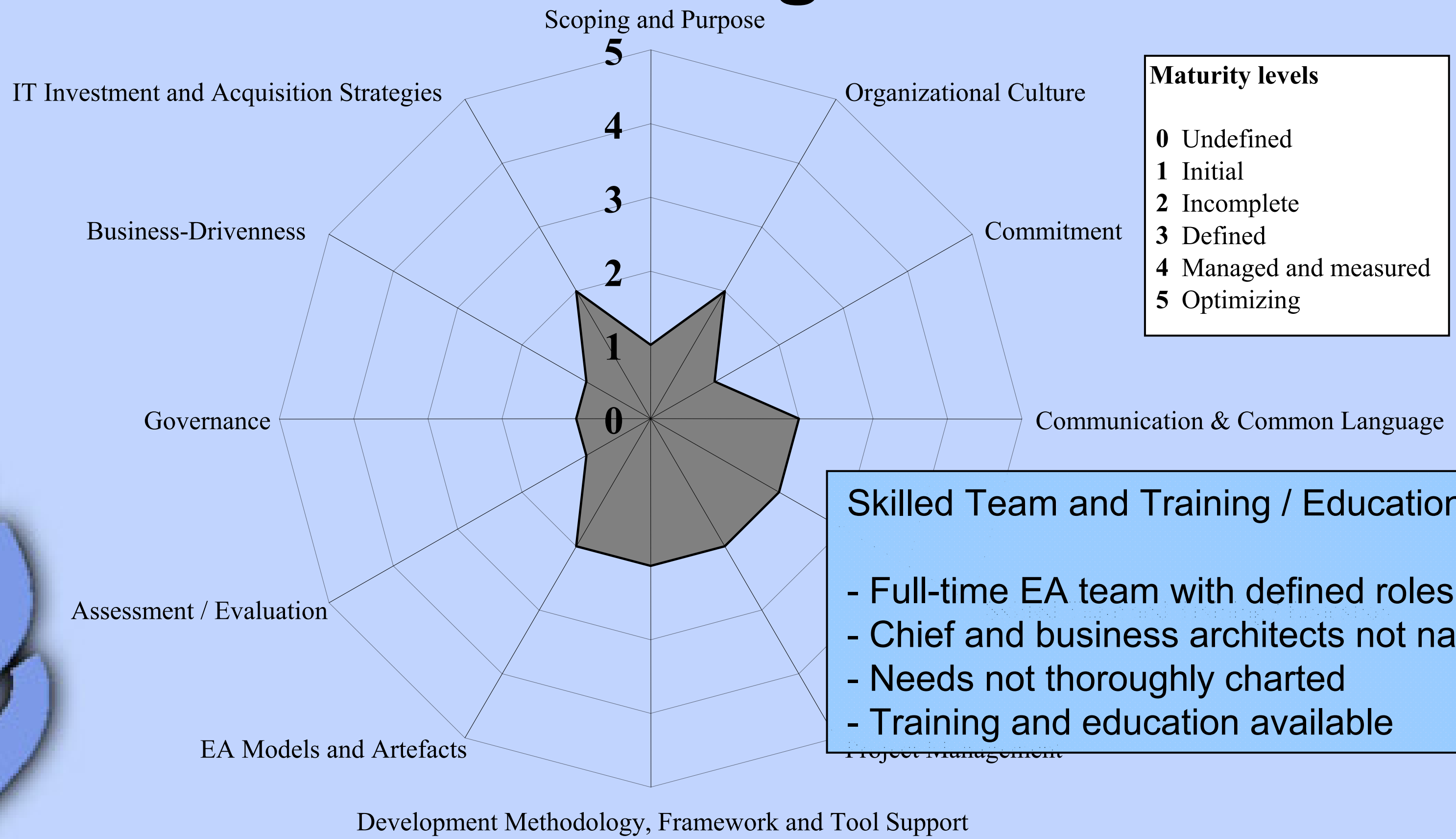
Enterprise Architecture Work Challenges



Communication & Common Language

- Communication established
- Room for improvement
- Number of EA concepts defined
- Communication challenges discussed

Enterprise Architecture Work Challenges



Skilled Team and Training / Education

- Full-time EA team with defined roles
- Chief and business architects not named
- Needs not thoroughly charted
- Training and education available

Enterprise Architecture Work Challenges

Maturity levels

0 Undefined
1 Initial
2 Incomplete
3 Defined
4 Managed and measured
5 Optimizing

Project Management

- Established practices
- Coordination works well
- Best practices collected

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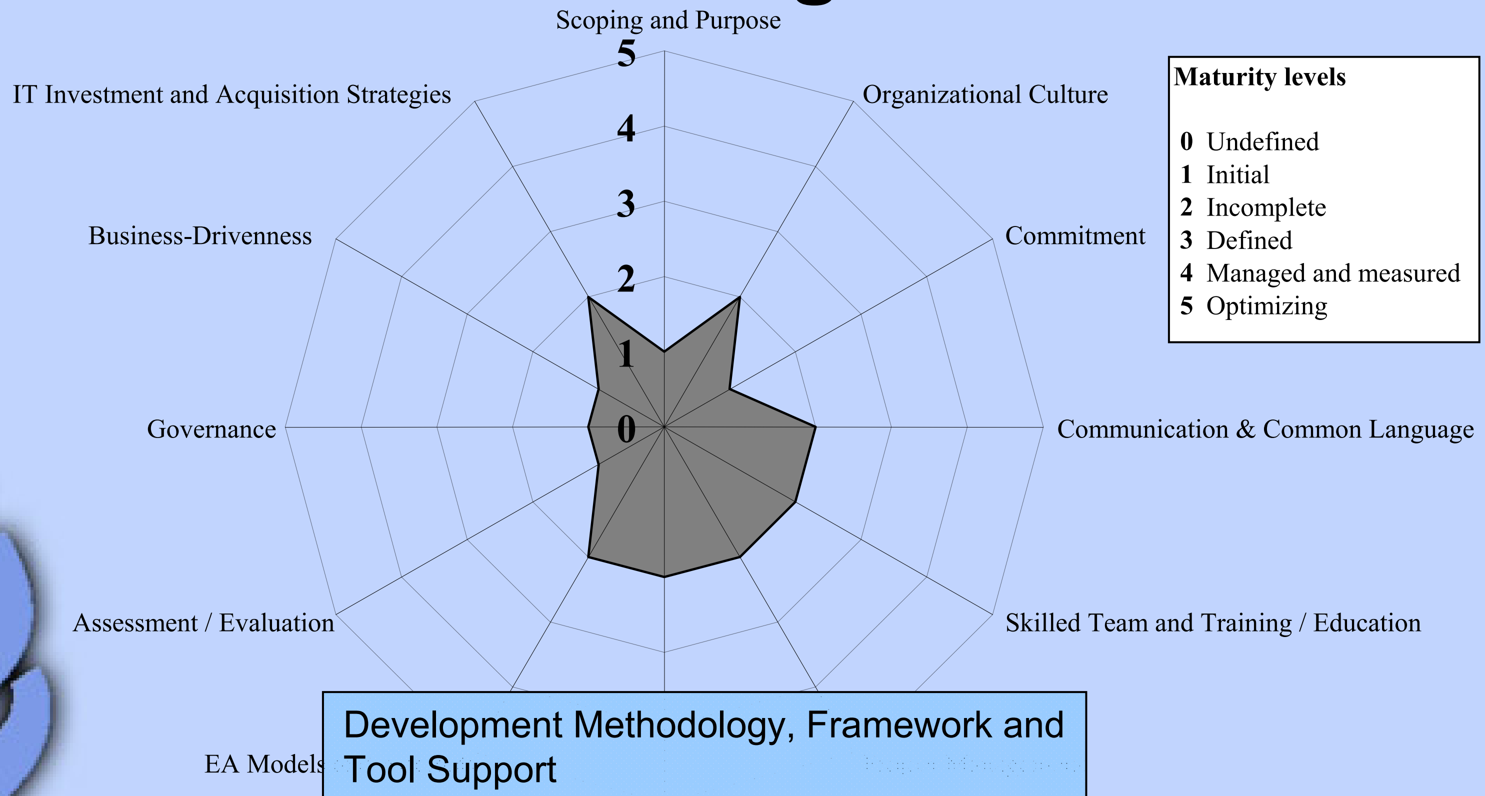
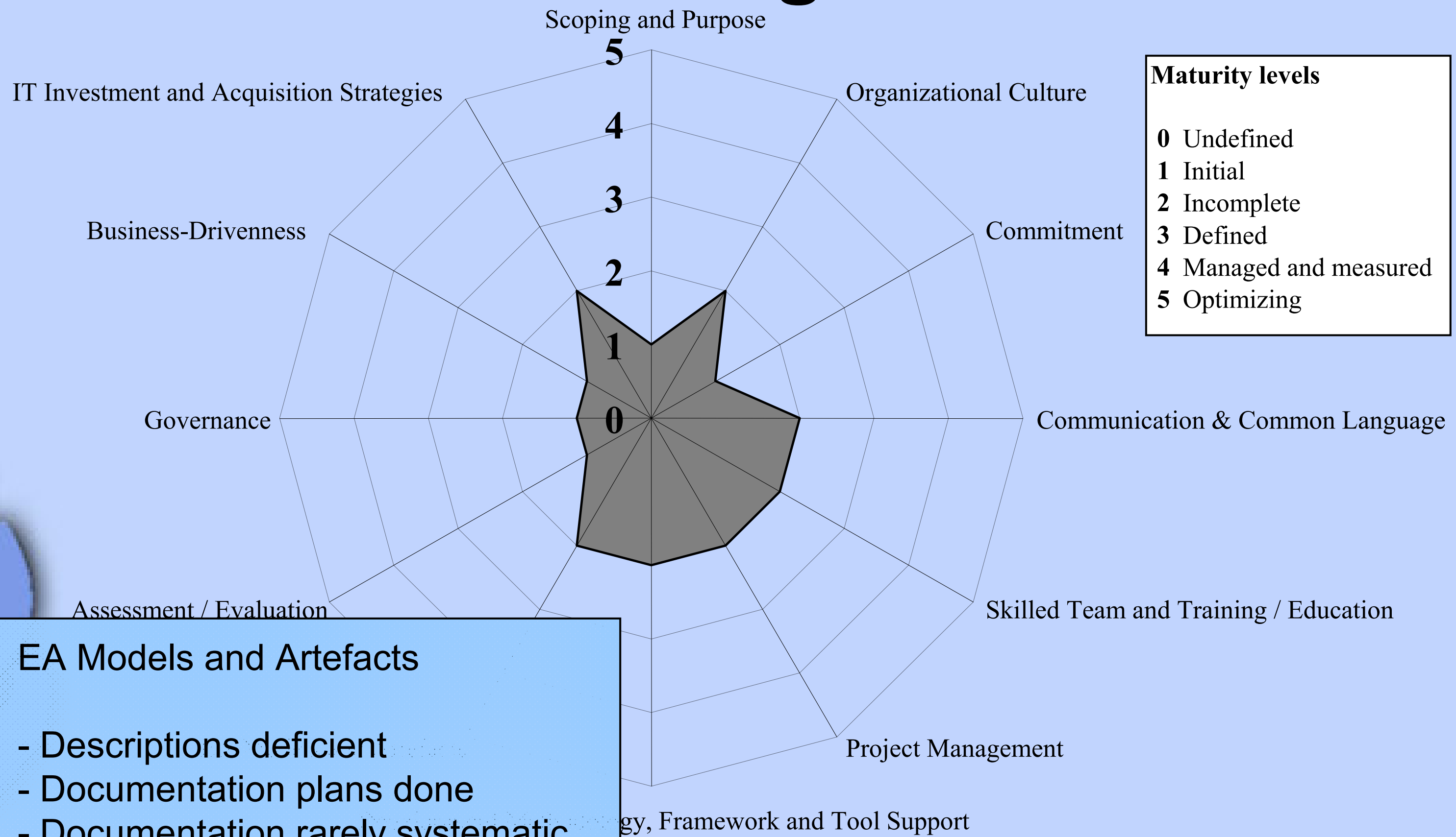
Enterprise Architecture Work Challenges



Development Methodology, Framework and Tool Support

- Framework defined and documented
- No defined EA development methodology
- Multiple tools used

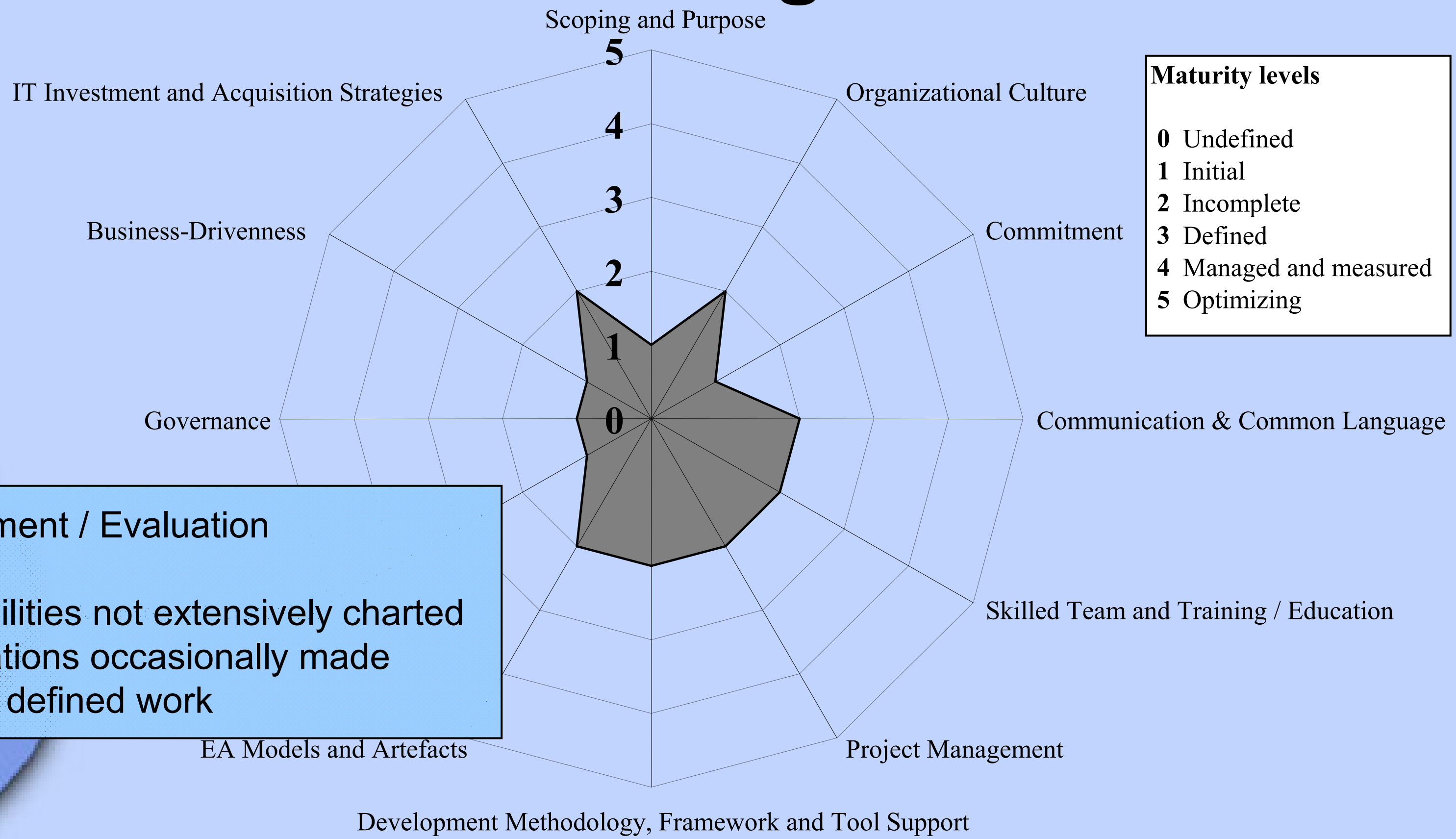
Enterprise Architecture Work Challenges



EA Models and Artefacts

- Descriptions deficient
- Documentation plans done
- Documentation rarely systematic

Enterprise Architecture Work Challenges



Assessment / Evaluation

- Possibilities not extensively charted
- Evaluations occasionally made
- Rarely defined work

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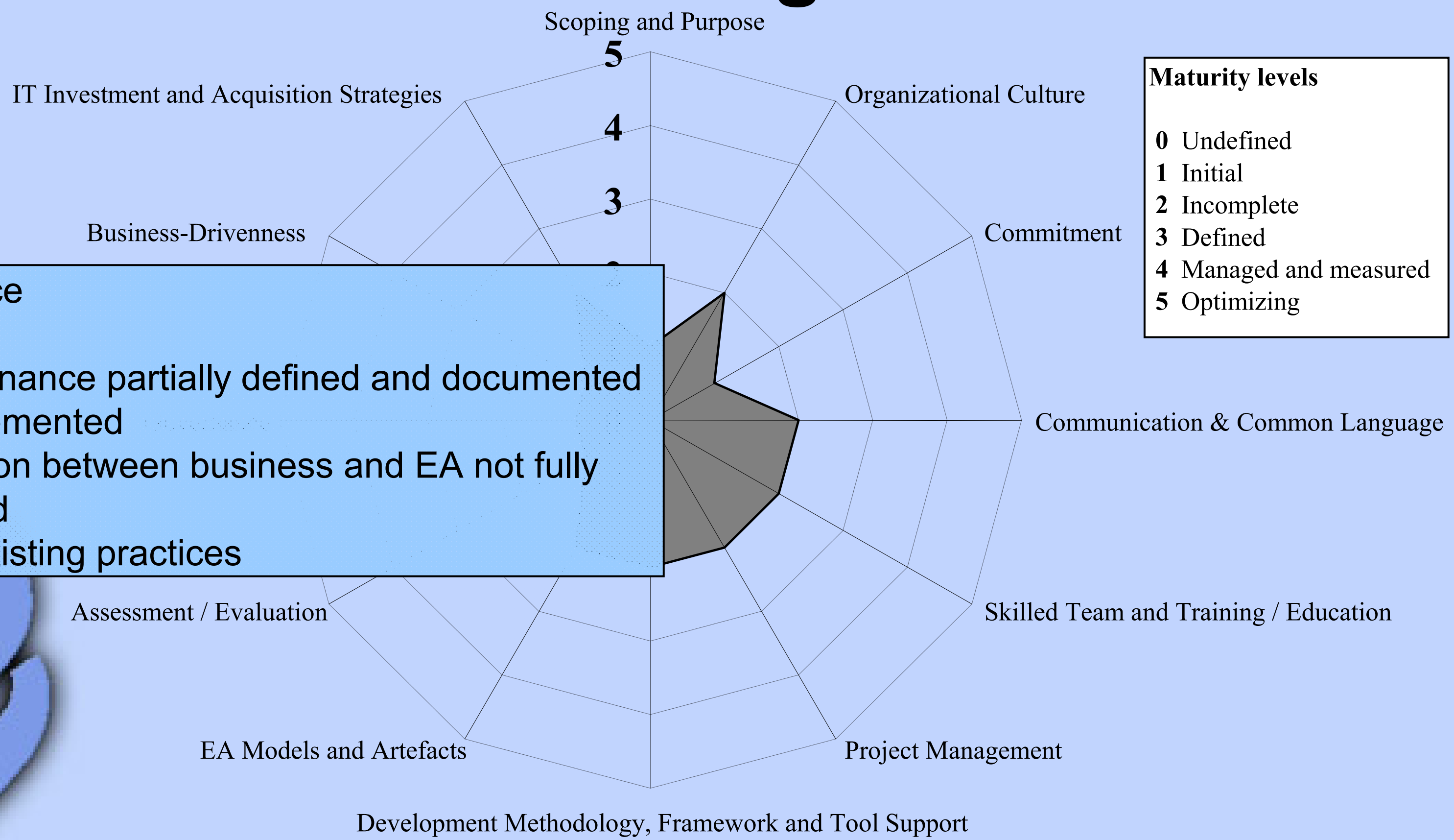
Enterprise Architecture Work Challenges



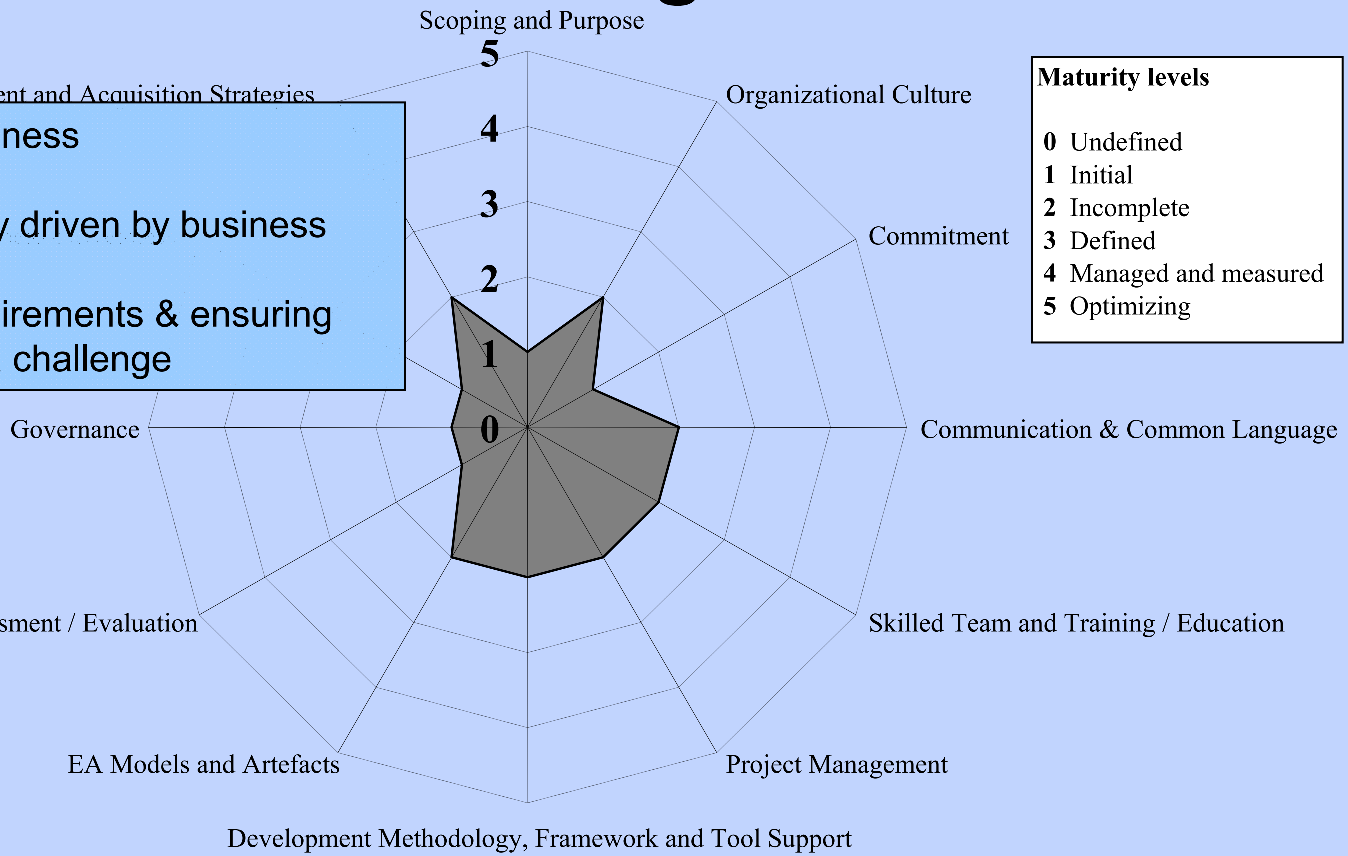
Governance

- EA governance partially defined and documented
- Not implemented
- Connection between business and EA not fully established
- Use of existing practices

Enterprise Architecture Work Challenges

Business-Drivenness

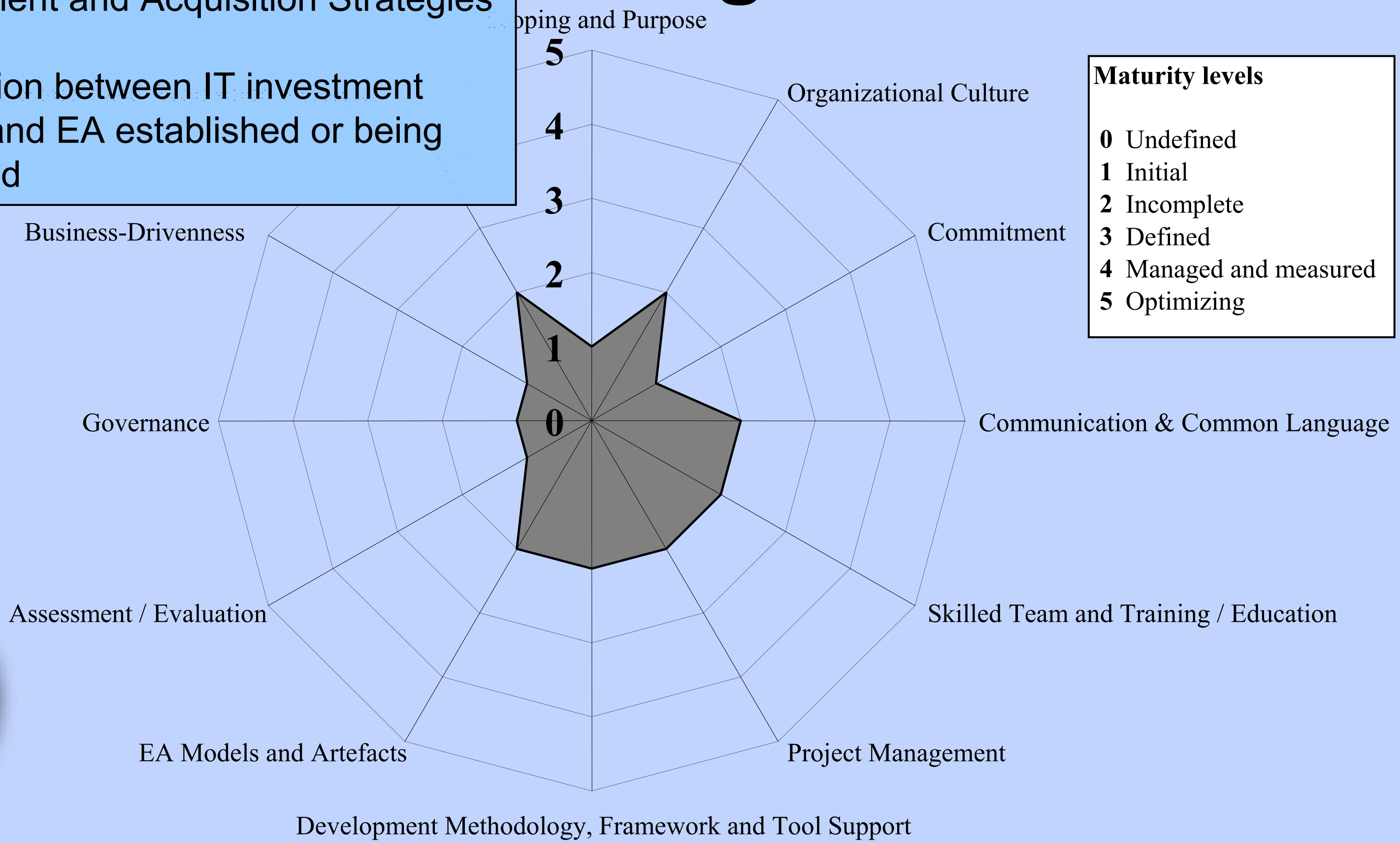
- EA work mostly driven by business requirements
- Collecting requirements & ensuring traceability are a challenge



Enterprise Architecture Work Challenges

IT Investment and Acquisition Strategies

- Connection between IT investment planning and EA established or being established



Summary and Development Suggestions

- EA work incomplete or at the initial state
- Challenges identified -> basis for improvement
- Development suggestions
  - Defining the benefits and objectives of EA and EA work
  - Charting & tracing business requirements
  - Carrying out business-driven EA projects
  - Displaying EA benefits to management & business
  - Charting evaluation needs and possibilities
  - Increasing interaction between business and IT

Further Research

- Prioritizing EA work areas
- Charting connections between areas
- Producing more generalizable results
- Longitudinal research

Architecture Evaluation Methods

AISA Project

Martin Hoffmann

18.4.2007

INFORMATION TECHNOLOGY RESEARCH INSTITUTE
UNIVERSITY OF JYVÄSKYLÄ

Content

Research Questions

- What are the evaluation needs for architecture evaluation?
- What kind of architecture evaluation methods exist?
- Which needs do these evaluation techniques satisfy?
- What do the existing methods not accomplish?

Research Objectives

- Focus on enterprise architecture (EA) and software architecture (SA) as part of EA
- Identification of evaluation needs
- Identification of architecture evaluation methods for evaluation of EA and SA artefacts
- Mapping methods to needs

Architecture Evaluation Needs

- Essential stakeholders' concerns to the architecture
- Needs have been identified from interviews with practitioners
- Usually certain concerns and needs for information trigger an evaluation
- Evaluation needs are derived from those triggers

Trigger and Need Categories

- Need for the documentation of good quality
- Change pressures in organisation
- Understanding of business and ICT environments
- Company management and process planning
- Management of Architectures
- IT cost management
- Architectural decision making

Enterprise Architecture Frameworks

- Adoption of EA frameworks to cope with the changing environment and to improve performance and competitiveness
- Combination of different views of the enterprise: business, information, application, technology architecture
- Views:
  - Knowledge transfer about the organization towards involved stakeholder roles
  - Guideline for the necessary architectural documentation

Enterprise Architecture Evaluation

Areas of EA Evaluation

- There are at least two main areas which can be evaluated regarding EA:
- enterprise architecture management and the management process
- architectural artefacts which describe the structure and behaviour of the EA

Main Problem in EA evaluation

- Many different concepts, modelling techniques, tool support, and visualisation techniques for every view
- No coherent view on EA -> complicates the evaluation
- There is no method for assessing the whole EA

Evaluation Approach

- Top-Down Approach
- Evaluation of every EA view
- Business Architecture, Information Architecture, Software Architecture, and Technology Architecture

Business Architecture Evaluation

Aspects of the Business Architecture

- Business goals and objectives
- Business functions
- Business processes
- Business roles

Business Governance Modelling

- Vision, goals, objectives are made explicit
- Transparency of transformation drivers
- Tracing of decisions and responsibilities
- Basis for analysis and evaluation (conflicts, improvement, level of fulfilment)
- Basis for planning and changing strategies and processes (linking *why*-knowledge to *how*)

Business Motivation Model (BMM)

- Set of concepts for modelling the business governance
- Object Management Group (OMG)
- Scheme to develop, communicate and organize corporate governance
- Central element groups are: Means, Ends, Influencer, Potential Impact and Assessments

Business Process Modelling

- Visualization of processes
  - Processes' relationships, dependencies, and effects
  - Process activities and resources
- Enhancement of understanding about processes for many stakeholders
- Aim is clarifying the organization's processes
- 80% of process advancements are achieved

Business Process Modelling

- Examining and modelling the organizational structure
- Examining and modelling the existing business processes (*as-is state*)
- Creating a base of the company’s business processes
- Verifying business processes
- Analysing weak points
- Modelling advanced business processes (*to-be state*)

Business Process Modelling Approaches

- Event-Driven Process Chain (EPC)
- Business Process Modeling Notation (BPMN)
- Unified Modeling Language (UML)
- Activities and events are main elements
- EPC and BPMN models can be executed
  - Enables simulation and implementation

Business Process Simulation

- Evaluation of current processes (*as-is* state) regarding costs, performance
- Analysis of *what-if* scenarios, obtain cost and performance predictions
- Predictions support the decision making regarding organizational change and future investments
- Tools: ARIS, BPEL

Assessing the business value of IT investments

- Measuring the value of IT-enabled business change
- Intangible benefits, such as customer satisfaction are taken into account
- Benefits are related to risks
- Future benefits or opportunities are considered

Intel's Business Value Index

- Priority-based assessment of future investments
- Supports the prioritization of investment options
- Tangible and intangible value can be measured

Total Economic Impact (TEI)

- Developed by Forrester
- Risk-adjusted Return on Invest calculation
- Measures cost, benefits, flexibility, and risk impact on business

ValIT

- From IT Governance Institute (ITGI)
- Value governance
- Portfolio management
- Investment management

Applied Information Economics (AIE)

- IT investment assessment through mathematical and scientific methods
- Developing financially-based quality assurance measures
- Developing a strategic plan for information

Information Architecture Evaluation

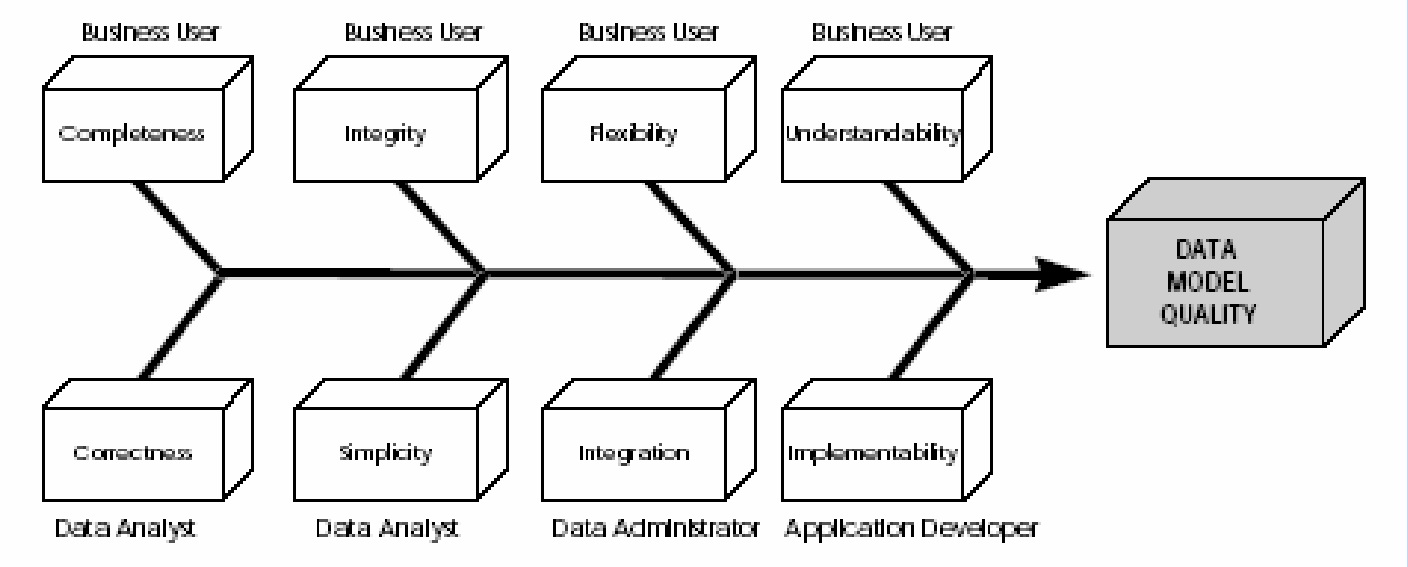
Information Architecture

- High-level model of information which an organization needs
- Information is necessary to perform the enterprise's processes
- Information is described in entities and relation between them
- Corporate data model = conceptual data model

Moody's Framework for Evaluating and Improving the Quality of Data Models

- Framework for conceptual data model evaluation
- Defines necessary quality factors
- Assigns stakeholder roles to quality factors
- Assessment based on metrics and stakeholder reviews

Data Model Quality Factors and Stakeholder Roles



Systems/Application Architecture Evaluation

Systems/Application Architecture

- Definition of the software systems necessary to process the data and support the business
- A software system is described by the software architecture
- Software architecture describes the software system's components
  - Structure and behaviour

Software Architecture Evaluation

- Early evaluation
  - Fragments of the architectural description exist
- Questionnaires, checklists, and scenario-based methods
- Late evaluation
  - Detailed design available
- Architectural metrics, simulation/prototyping and mathematical modelling

Scenario-based Methods

- Evaluate the software architecture by considering it from a higher abstraction level
- Architectural description must neither be complete nor very detailed
- Scenarios describe the desired system's behaviour during performing certain tasks
- Fulfilment of certain scenario

Architecture Trade-Off Analysis

- Scenario-based review regarding system's quality characteristics including scenario validation
- Identifies risks and points of trade-off
- Enables evaluation of structural and behavioural system characteristics
- Improves architectural knowledge sharing

Cost-Benefit Analysis Method

- Scenario-based review with focus on cost and benefits
- Measurement of design decisions with cost and benefit metric
- Makes uncertainty explicit

Technology Architecture

- Description of hardware and communication technology used within the organization
- Hardware and platforms
- Local and wide area networks
- Operating System
- Infrastructure software
  - Application servers, database management system, and middleware

Technology Architecture Evaluation

Technology Architecture Evaluation

- Software architecture models include a description of the execution environment
- Technology can be evaluated as part of the software system within SA evaluation
- Benchmarking for performance, scalability, and reliability evaluation of the used infrastructure

Conclusion

- Architecture evaluation depends strongly on conceptual models (CM's)
- CM's share and communicate the architectural knowledge among different stakeholders from different domains
- CM standards are part of the evaluation methods
- CM's are evaluation input and basis for analysis and discussion about architectural decisions

Conclusion

- Complexity of EA and variety of concerns complicates establishment of overall evaluation approach
- Only possible to apply different techniques on single architectural views of EA
- Mapping of evaluation needs and methods difficult
- Degree of needs fulfilment is uncertain
- Difficulty of methods implementation and integration

Towards Critical Success Factors for Enterprise Architecture

AISA Project
Tanja Ylimäki
11.1.2006

Objectives of the Study

- To determine what quality means in the context of enterprise architecture (EA)
- To identify the potential/candidate critical success factors (CSFs) for EA
- To prioritize the potential CSFs for EA: an example of prioritization is given

Enterprise Architecture (EA)

- Identifies the main components[1] of the organization, the ways in which these components work together in order to achieve defined business objectives, and the way in which the information systems support the business processes of the organization

- It takes a holistic view of the enterprise's IT resources rather than an application-by-application view

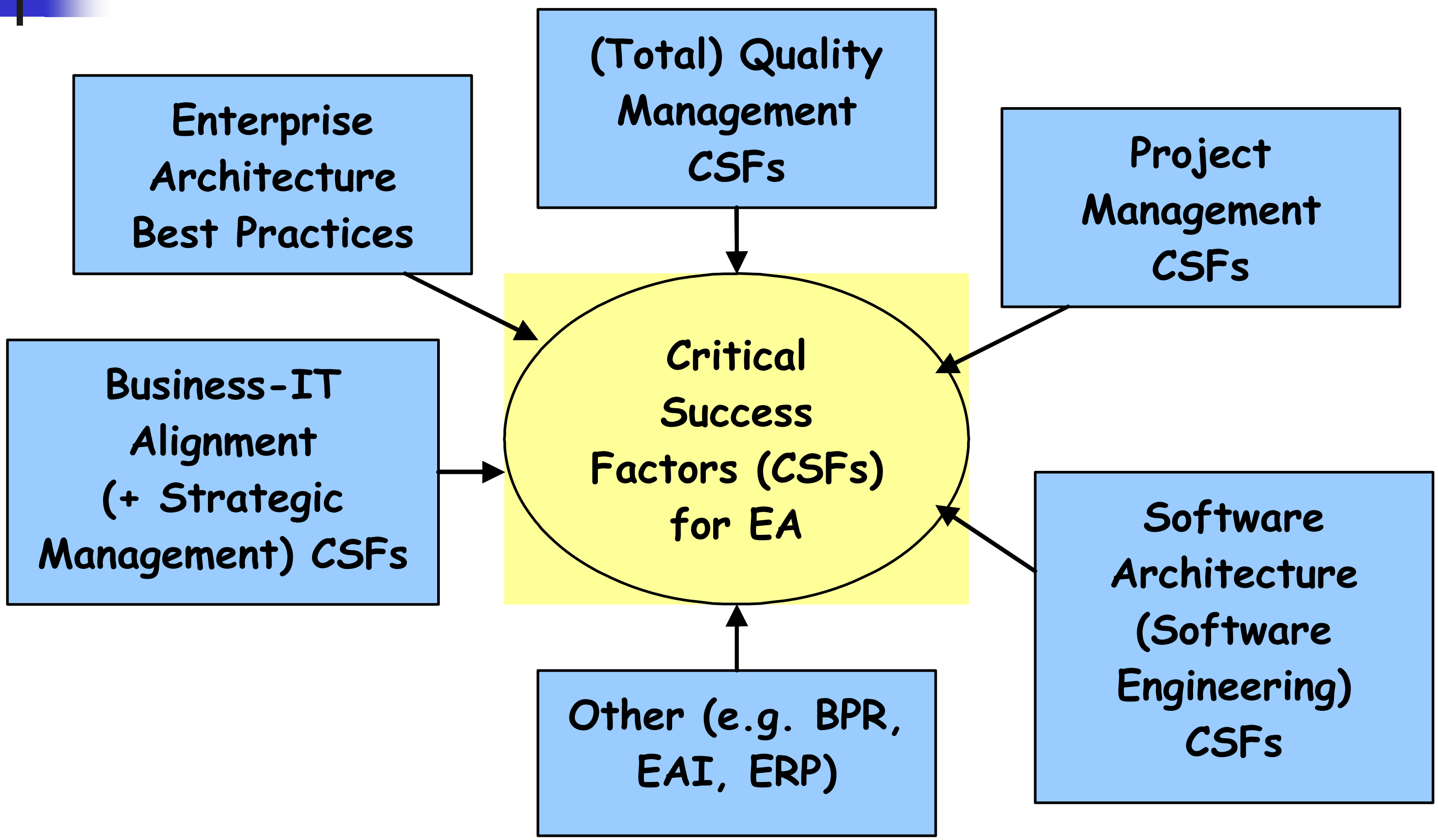
[1] E.g. Staff, business processes, technology, information, financial and other resources, information systems

(Kaisler et al., 2005)

Some Characteristics of an EA of High Quality

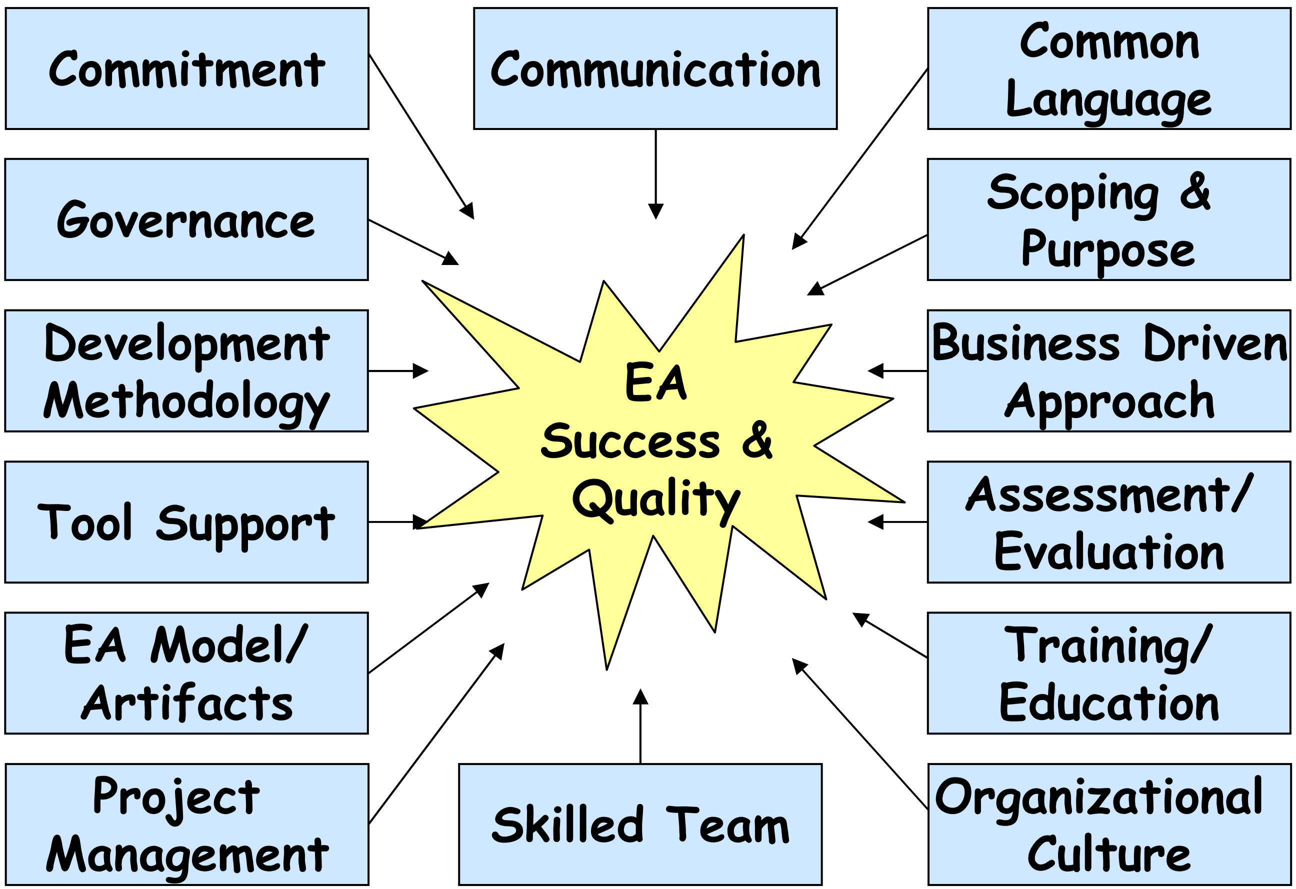
- Conforms to the agreed and fully understood business requirements and business strategies
- Fits for the purpose (e.g. more efficient ICT decision making)
- Satisfies the various stakeholder groups' (e.g. the top management, IT management, architects, developers) expectations in a cost-effective way
- Understands both the current needs and the future requirements
- Is understood, accepted and used in every day business functions
- Brings value to the organization

CSFs[1] for EA were derived from…



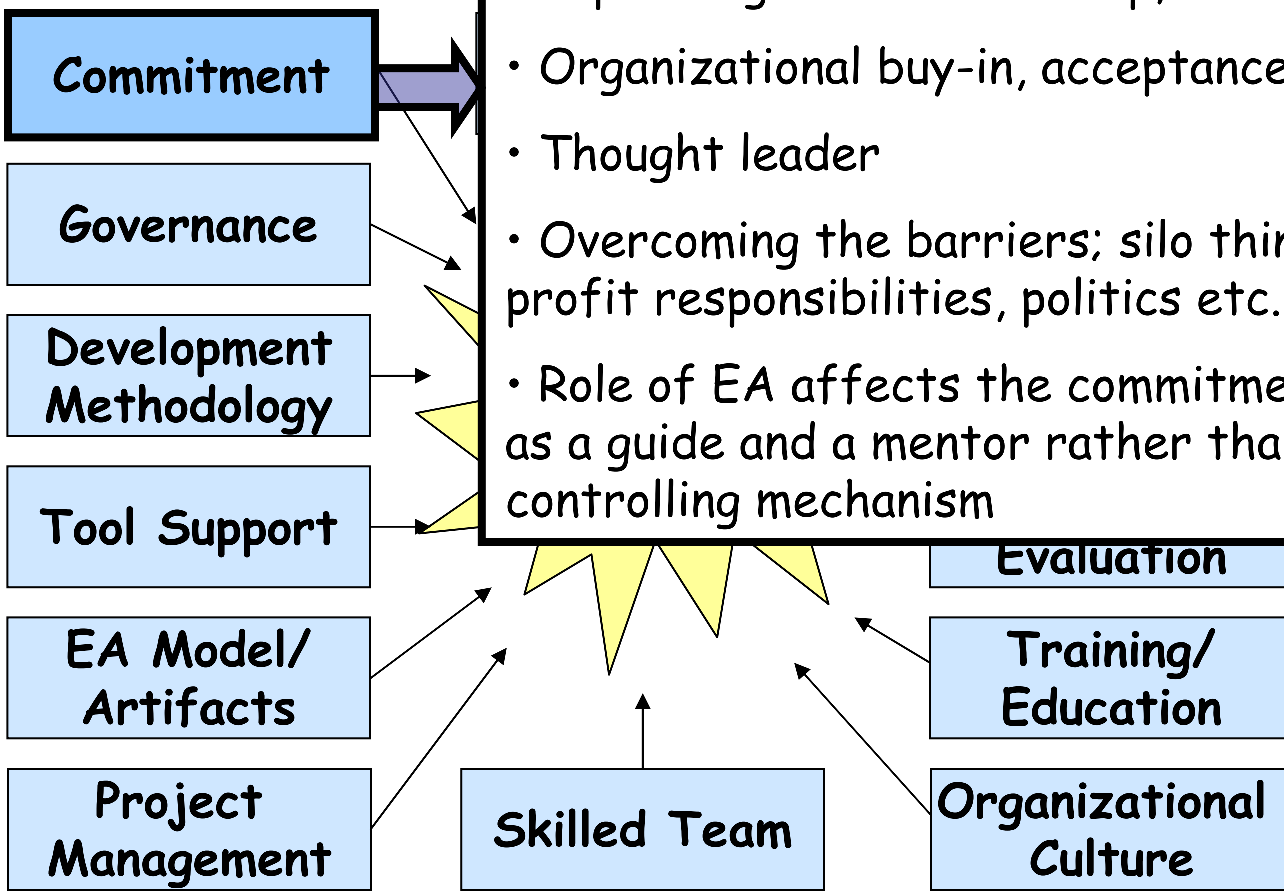
[1] Things that must be done exceedingly well in order to gain a successful EA

Potential CSFs for EA

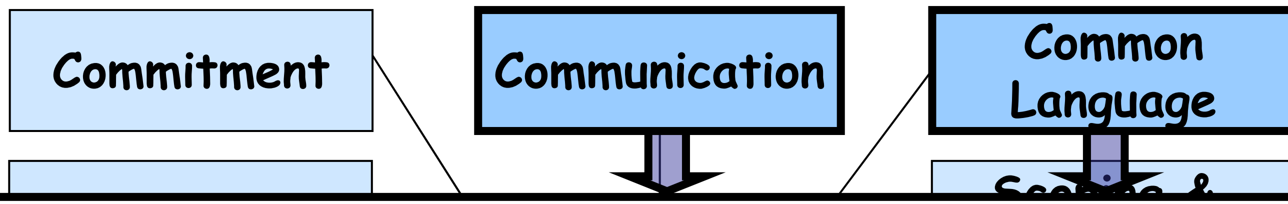


Potential CSFs for EA

- Top management leadership, involvement
- Organizational buy-in, acceptance
- Thought leader
- Overcoming the barriers; silo thinking, profit responsibilities, politics etc.
- Role of EA affects the commitment; EA as a guide and a mentor rather than a controlling mechanism

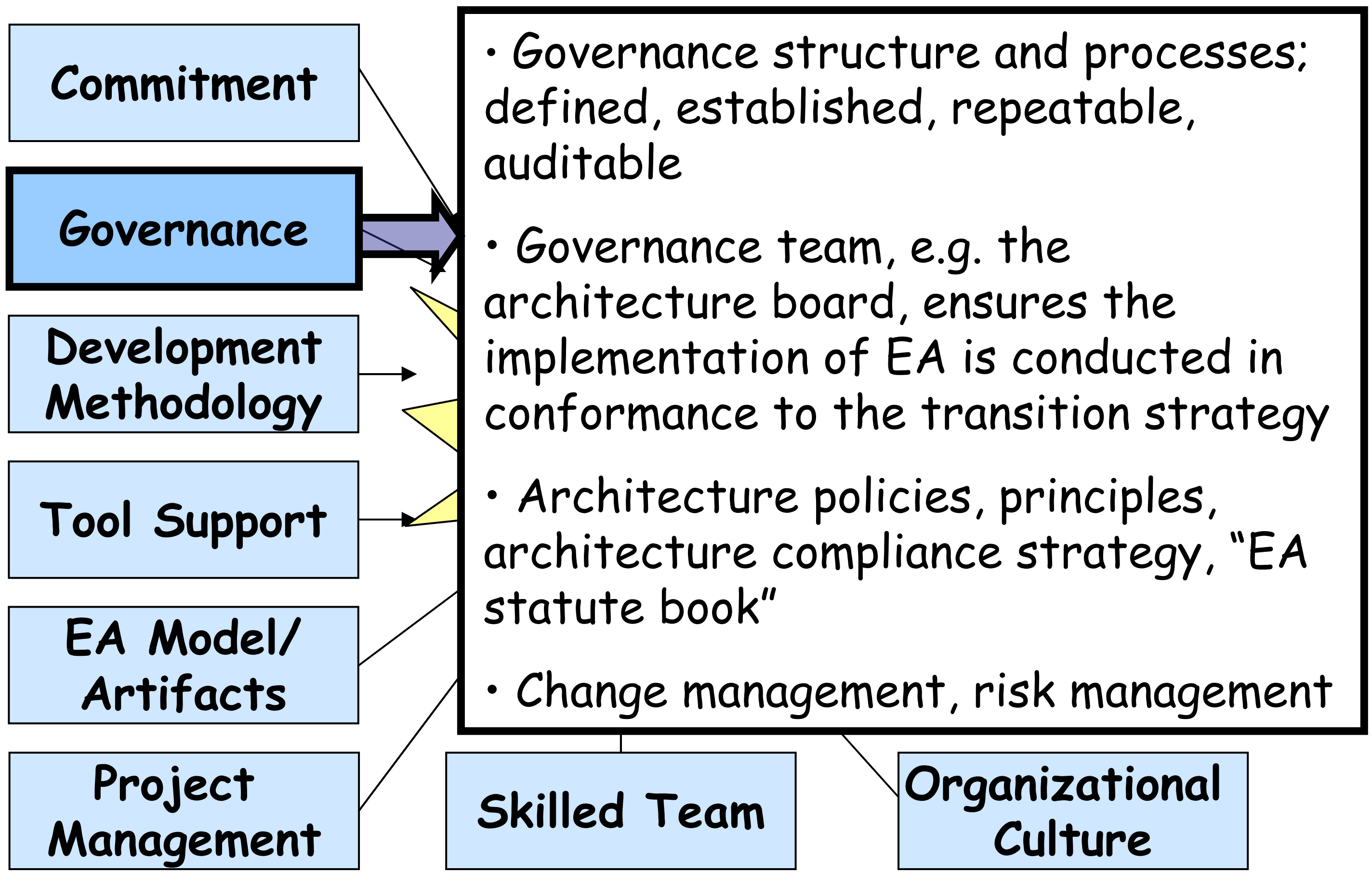


Potential CSFs for EA



- Communication essential in gaining a common understanding, agreement and a shared view → commitment
- Communication is needed between all the diversified stakeholder groups, and projects implementing EA conformant information systems
- Proactive, various channels used, regular, frequent, feedback channels available, ongoing process, documented (communications plan/strategy)
- A common, well-defined vocabulary of architecture terms and concepts to help communication
- Enterprise architect as an interpreter between the various stakeholder groups, also able to speak “business language”

Potential CSFs for EA



- Mission, goals and direction, objectives of the organization, why it wants to apply the EA approach, what is the existing or future problem it wants to solve/be prepared for

→"declaration of will", mission statement

- To get everyone to share the same architectural vision

- EA scope clearly defined; how wide, how deep, how detailed, how fast an EA should be developed
    - continuous improvement approach
    - prioritization of sub-projects
    - holistic in scope
    - specific to the enterprise

Common Language

Scoping & Purpose

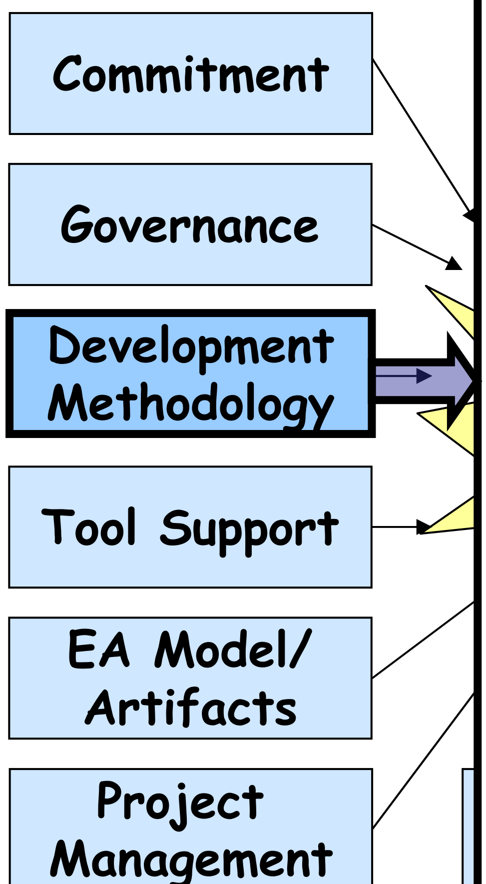
Business Driven Approach

Assessment/ Evaluation

Training/ Education

Organizational Culture

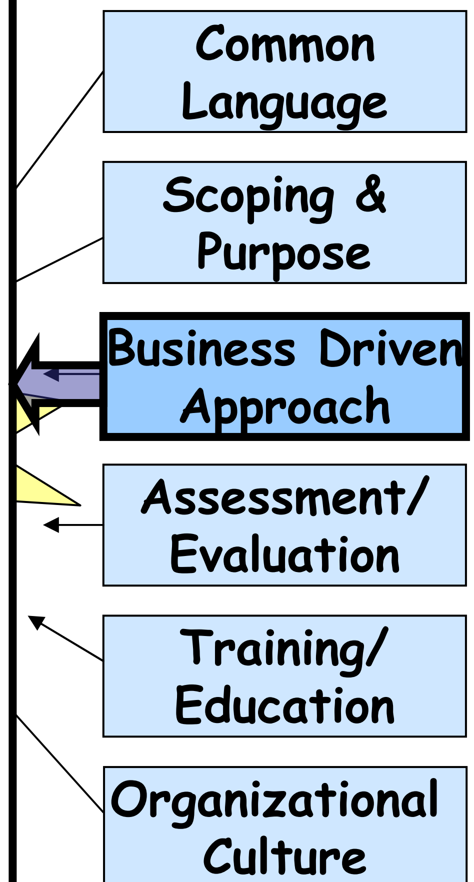
Potential CSFs for EA



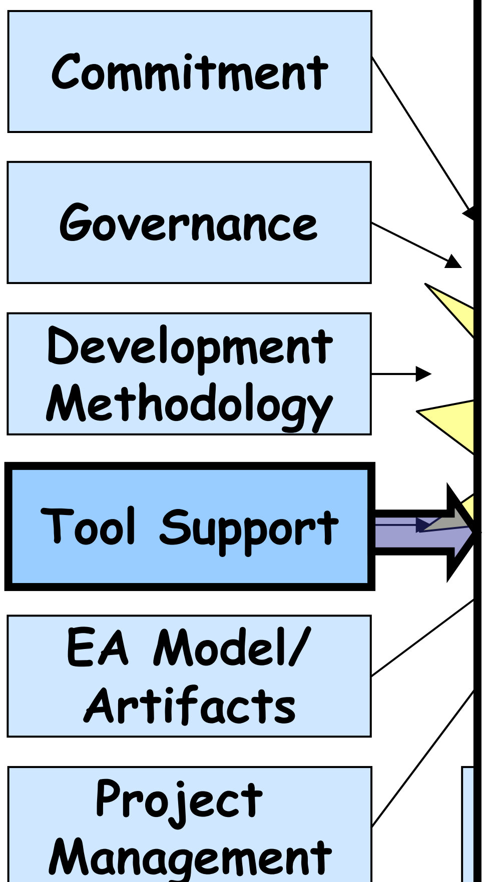
- Structured, well-defined and documented incl. e.g. processes, guidelines, best practices, drawing standards
- Business-strategic-driven, customer-focused, practice-oriented, situational, model-based, repeatable, future-oriented, widely usable with reasonable costs
- Architecture principles; simple, direct statements of how an organization wants to use IT, establishing a context for architecture decisions
- Guiding principles provide consistent, shared vision for developing architecture, ensuring the development initiatives to be in line with the organization's strategic goals

EA

- Defining the business requirements and ensuring they are met → clear alignment between business and IT
- EA initiatives traceable to business strategies
- Requirements set by external stakeholders (legislation, standards, business owners, partners) should also be considered and defined
- Architecture visions are needed
  - They should be compatible with the business vision and objectives
  - When the limited resources (time, money, skills) are considered, realistic and realizable objectives are reached



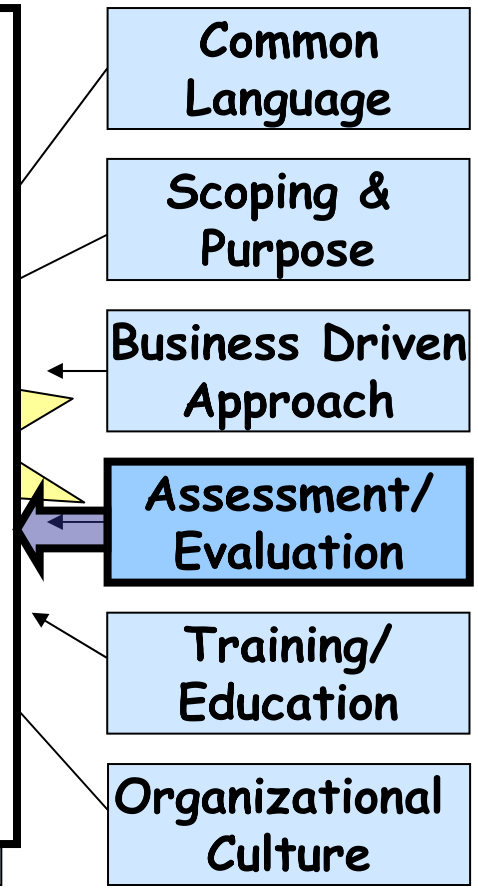
Potential CSFs for EA



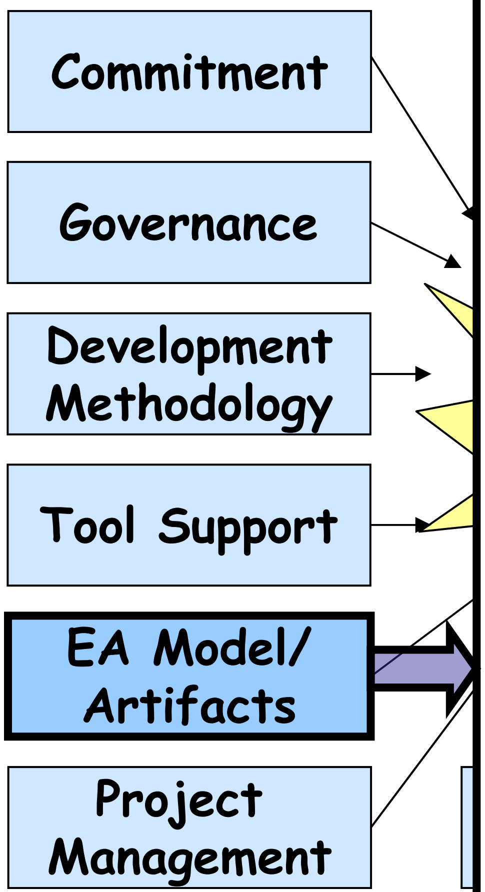
- Set of tools that work together, compatible with e.g. business process modeling tools, software development tools
- Some features needed in EA tools:
  - Framework support/generation
  - Repository
  - Unrestricted ability to link information
  - Web publishing/access
  - Graphical and textual data
  - Graphical navigation paradigm

Potential CSFs for EA

- Questions to be asked
  - Why measurement is needed?
  - What is measured?
  - How? Which metrics are used?
  - Who does the work?
- Continuous process, proactive
- Metrics should be developed as early as possible in the development process
- Post-mortem analysis, lessons learned
- No established metrics available



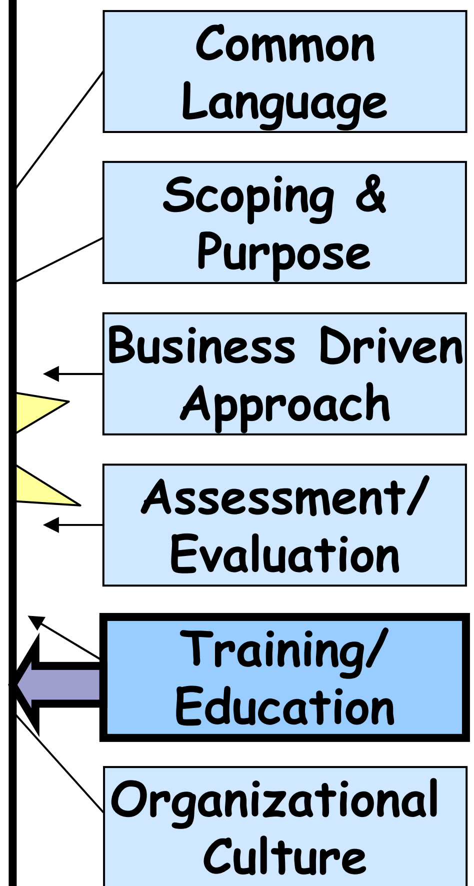
Potential C



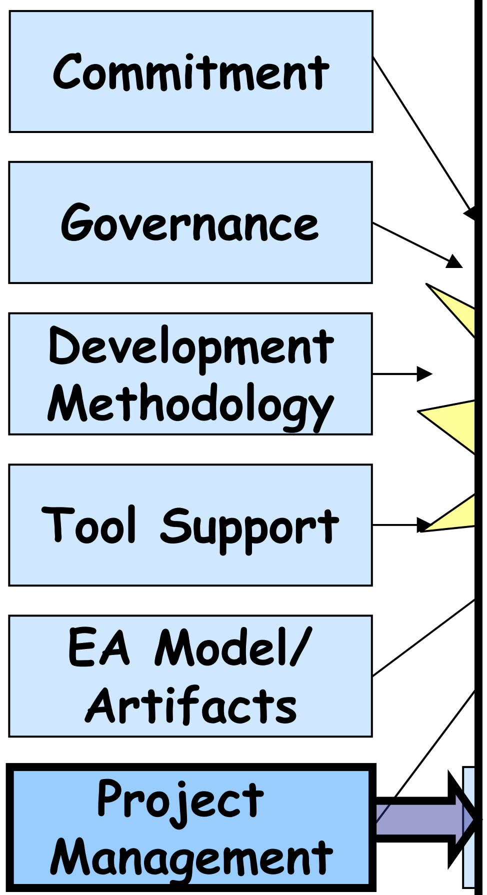
- All the necessary levels or views of the architecture are modeled
- Coherent, concise picture of the enterprise
- Current and future architecture, transition plan, architecture decisions
- Other requirements for EA models, e.g.
    - must meet the business requirements
    - traceability between the models and business requirements
    - conformance to standards and business strategies
    - well documented, current and available
    - efficient and complete enough, clear, readable, verified and validated

EA

- Training is an important part of enhancing quality, also a continuous process
- One way of gaining EA awareness and acceptance
- Training is needed e.g. in the following levels:
    - General EA education; frameworks etc.
    - Best-practices, methods, tools for architects
    - Business training for IT people, IT training for business people
    - Education on the possibilities new technologies may offer
- Things architects teach to other stakeholders
- Avoid using the term education when communicating with the top management



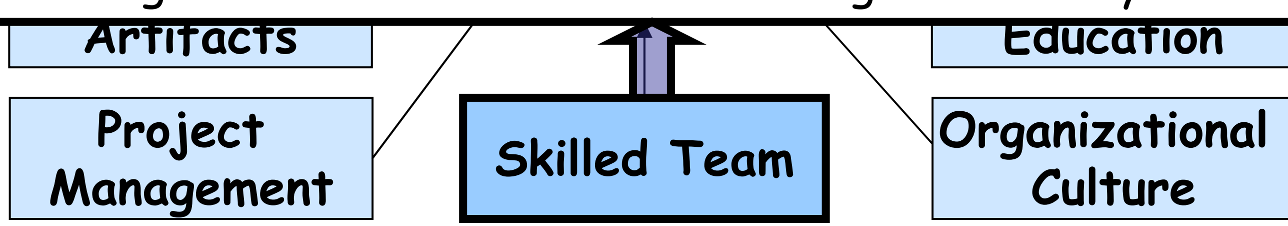
Potential C



- EA development is conducted through projects → project management skills are needed
  - Realistic scope, size, plans, scheduling
  - Requisite financial and human resources
  - Risk management
  - Organizational structure
  - Continuous measurement of project success
  - Leadership, commitment
  - Clear milestones
  - Lessons learned gathered
- <u>Program management</u>; managing, coordinating and supporting several various development projects

Potential CSFs for EA

- Teamwork is essential in EA development
- Representatives from all key stakeholder groups, e.g. business experts, business management, system development experts, data, infrastructure and security system architects, partners
- Chief architect assigned, should be able to work in various roles, e.g. visionary, translator, system designer, auditor, consultant, interpreter
- Various skills needed, e.g. criticism, abstract thinking, courage to question things, able to sell ideas/thoughts, capable of expressing himself/herself both in writing and visually



Potential CSFs for EA

- Organization's readiness to develop and use EAs is an essential issue
- Cultural readiness; integration of EA and the company culture
- Attitudes towards change, managing the organizational change
- Organization's structure affects the success of EA; e.g. silo thinking is too narrow a perspective
- Communication environment; should encourage to challenge each others view, especially regarding the architecture, allow everyone to participate and to discuss, debate

Common Language

Scoping & Purpose

Business Driven Approach

Assessment/ Evaluation

Training/ Education

Organizational Culture

An Example of Prioritization – "Top 10 CSFs for EA"

1. Communication
2. EA Model/Artifacts
3. Commitment
4. Common Language
5. Business Driven Approach
6. Organizational Culture
7. Training/Education
8. Scoping and Purpose
9. Governance
10. Assessment

Vital issues in the initial steps of EA development

↕

Taken into consideration as the EA development advances

Conclusions

- Quality of EA is still an open issue
  - Maturity is a more familiar term in this context
- The success of EA is influenced and enabled by several various and to some extent interrelated factors
  - Dependencies or interactions between the CSFs were not studied
- Prioritization of the factors dependable on the organization's EA maturity?
  - Prioritization example implies that in the beginning of the EA journey it is vital to gain understanding and commitment through effective communication and a common language, utilizing the EA models and other artifacts in this effort

Enterprise Architecture Compliance Evaluation

AISA Project

Ylimäki, Niemi, Hämäläinen

18.4.2007

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Research Questions

- What are the aspects of EA compliance?
- What are the meaning and goals of EA compliance evaluation?
- What are benefits of EA compliance evaluation?
- How can EA compliance evaluation be carried out?

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Research Process

- A literature review and analysis
  - Scientific articles
  - Organizations' public EA compliance method descriptions (mostly US Government sources)
  - Standards (such as TOGAF)
- Focus group interview of seven practitioners from five companies to validate and discuss the literature review results

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Concept of Compliance

- Various definitions exist
- Compliance seems to be a multifaceted concept: it may indicate conformance of an object's (e.g. a product, process, service etc.) characteristics' (e.g. documentation and models) with at least one or more of the following:
  - business requirements
  - organization's internal plans, policies, and standards
  - organization's internal practices (e.g. project procedures and guidelines)
  - standards
  - regulations and laws, and
  - partners' practices and policies

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EA Compliance – an Initial Definition

- An affirmative indication or judgment that individual projects and investments will meet or have met the Enterprise Architecture related requirements, i.e. comply with the relevant specifications, such as established or approved enterprise architecture descriptions, policies, compliance criteria, and business objectives

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Goals of EA Compliance Evaluation

1. Directing a project or investment to comply with EA – the proactive approach
2. Assuring the compliance between the impacts of investment or project and EA – the reactive approach
3. Ensuring the usability and appropriateness of EA policies, EA frameworks, EA descriptions, business objectives etc.

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EA Compliance Evaluation

- EA compliance evaluation was discussed in terms of
  - More precise evaluation targets of compliance: what is evaluated, which objects are compared with each other?
  - Evaluators: who does the evaluation?
  - Levels of compliance: what is the “amount” of compliance?
  - Timing of evaluation: when the evaluation is done? and
  - Evaluation practices: how the evaluation can be carried out?
- Especially, evaluation targets and evaluators suggested by literature were considered to give too narrow a view

→ A broader view was outlined

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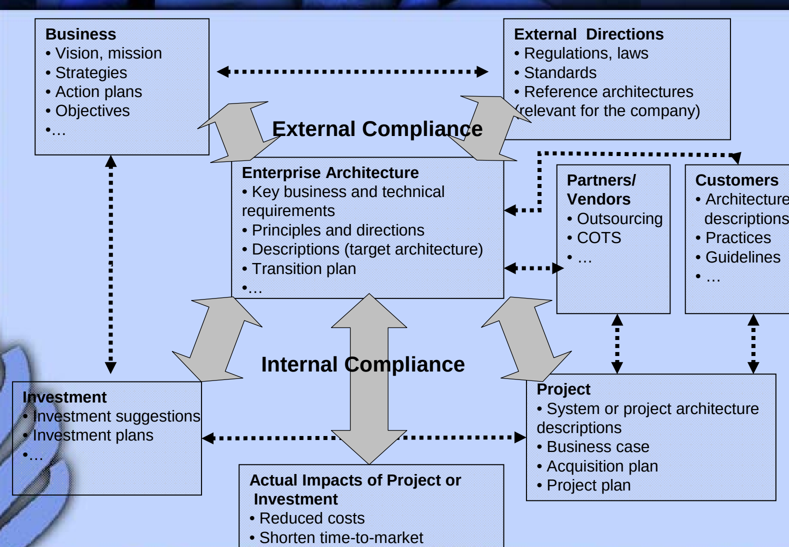

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Internal and External EA Compliance

- **Internal compliance**
  - compliance between investments – as well as the projects that implement the investments – and EA and its policies and guidelines
  - compliance between the impacts of the investments and projects and EA in order to ensure that expected results and affects have actually been achieved
- **External compliance**
  - compliance between the EA and the business objectives or strategies of the organization
    - are the EA guidelines, framework, target state, and so forth, in line with the business requirements
  - conformance with the laws and regulations the organization needs to obey
  - organization's ability, with the help of its EA, to react to the changing environment of the organization

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Possible EA Compliance Evaluation Targets

- **Business**; including e.g. vision, mission, strategies, and plans of actions.
- **Investment** that is needed to fulfill the business vision and mission.
- **Project**; the tool to implement the investment.
- **Enterprise Architecture**; a holistic view to the entire enterprise or organization aiming at better business-IT alignment.
- **External Directions**; including e.g. regulations, standards, or reference architectures that need to be taken into consideration in the business operations or IT development.
- **Partners**; they may provide their own procedures, guidelines or constraints in out-sourcing engagements or when an organization purchases COTS products.
- **Customers**; in some cases the organization's customer's EA, practices or guidelines need also to be taken into consideration when evaluating EA compliance.
- **Actual Impacts of the Project or Investment** indicating whether and how long a step, a transition, has been taken towards the target architecture state.

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Possible Evaluators of EA Compliance

- ➢ The possible EA compliance evaluators are those stakeholders (or roles) that have the responsibility in the area of the evaluation targets:
  - Business Developer/Process Owner, Business Architect
  - EA Team/Enterprise Architect
  - Investment representative (e.g. a controller)
  - Project representative (e.g. a project manager)
  - Representative(s) of Out-sourcing or IT/Service Provider Partner(s)
- ➢ How about the EA governance board?
  - architecture board (e.g. The Open Group 2006) or an EA steering committee (e.g. CIO Council 2001)

Conclusions I

- ➢ The initial EA compliance definition was regarded as too limited → EA compliance was suggested to consist of external and internal compliance
- ➢ EA compliance has also a dynamic nature
  - The environment of the organization is constantly changing, and so is its architecture
  - Compliance – internal or external – can be evaluated to be on an appropriate and acceptable level at the moment, but it does not guarantee that this is the case next week, or next month
- ➢ Literature gave too limited a view of EA compliance evaluation targets and evaluators → a broader view was suggested

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Conclusions II

- Examples for EA compliance evaluation practices were presented, but each organization needs to make its own decisions on various issues, such as
  - Audience/stakeholders: Who is interested in the EA compliance evaluation results? Whom the results are presented to?
  - Responsibilities: Who conducts the evaluation?
  - Timing: When the evaluation is conducted (milestones)?
  - Process and practices:
    - How the evaluation is conducted (processes and tasks)?
    - Which project or investment related artifacts are compared to which EA related artifacts?
    - Compliance levels: How many levels of compliance need to be defined? Is there a need to define specific levels of compliance?

Conclusions III

- EA compliance depends on the EA maturity level
  - Both the meaning and content of EA compliance may vary according to the EA maturity level
  - In the lower levels of maturity EA compliance and its evaluation actually equals quality assurance, and especially the impacts of architecture development and architecture work are a focal issue
  - After the architecture work has become a more established process in the organization, the various aspects of EA compliance (internal and external compliance) will become more current

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Enterprise Architecture Risks – An Overview

Eetu Niemi & Tanja Ylimäki

AISA Project

20.2.2008

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Contents

Introduction

- Enterprise Architecture (EA) is an approach for controlling complexities and constant changes in the business environment
- EA has become an important management tool by providing the ”big picture” of an organization
- EA requires considerable investments
- EA is extensive, continuous and iterative approach which further complicates EA risk identification and management
- All of EA’s components (e.g. processes and products) and domains (e.g. business and technology) may involve risks
- EA is an important strategic management approach -> realization of risks can cause serious effects
- Research on EA risks is scarce

Research Questions

1) What EA risks exist?
2) How can EA risks be classified?
3) How can EA risks be managed?
4) How is EA risks management connected with organizational risk management?

Research Process

1) **Literature review**
   - Identification of sets of risks
   - Charting for potential risk classifications
   - Scrutinizing the nature of EA risk management
   - Adopting one feasible classification scheme and a set of generic risks and adapting them to the EA context
2) **Focus group interview**
   - Five practitioners from three organizations
   - Validation
   - Collection of experience-based information
3) **Consolidation and analysis**

Definitions and Conceptualizations of Risk

- Many meanings in risk literature
- “The possibility of incurring misfortune or loss” (the Collins English Dictionary)
- Many characteristics (e.g. severity, volatility, propability, time horizon)
- Many conceptualizations (in IS domain, see e.g. Sherer & Alter 2004)
  - Risks as different types of negative outcomes (risk components)
  - Risk as probability of negative outcomes
  - Risk as difficulty in estimating outcome
  - Risks as factors leading to a loss
- Risks can also be positive (see e.g. Alter & Sherer 2004)
- Enterprise Architecture Risks:
  1. any factors that may lead to negative outcomes in the EA program
  2. any negative outcomes resulting from these factors (may be more important in practice)

Risk Classifications

- Typically, the proposed risk categories depict the function, task, object or entity the risk is related to
- Generic risks
  - Business, market, operations and credit risks (Crouhy et al. 2001; Lam 2003)
  - Known, predictable or unpredictable risks (Keyes 2005)
- IS and ICT risks
  - Project, technical and business risks (Keyes 2005)
  - Firm-specific, competition and market risks (Benaroch 2002)
  - Application, organizational and interorganizational level risks (Bandyopadhyay 1999)
  - Risks classified by IS life cycle phases (Sherer & Alter 2004)
  - Risks classified by work system components (Sherer & Alter 2004)

Views on Enterprise Architecture Risks

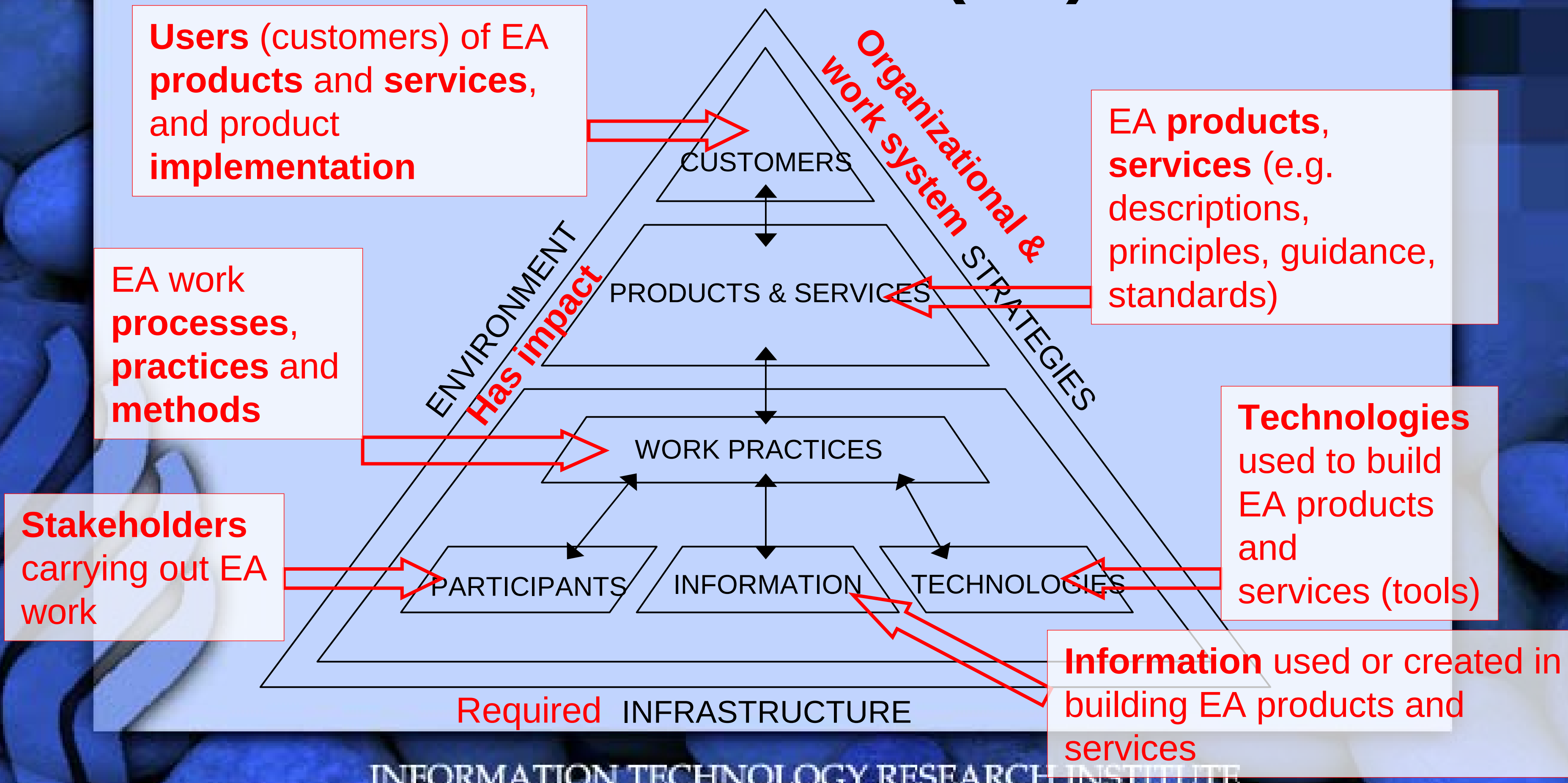
- **Architectural risks (Avritzer & Weyuker 1998)**
  - Project management, requirements and performance-related risks
- **EA investment risk factors (Saha 2006)**
  - Organization specific, competitive, market, and technical risks
  - Derived from ICT risk literature
- **EA risks on and between the levels of EA (Baldwin 2007)**
  - E.g. business, information, information systems, technology
- **Architecture pitfalls (Rehkopf & Wybolt 2003)**
  - E.g. declaring the architecture effort “done”, assuming that technical people make good architects, failing to communicate early and often, and forgetting to assess people and process impacts
- **EA critical problems (Kaisler et al. 2005)**
  - EA modeling, management and maintenance-related problems
- **EA critical success factors (Ylimäki 2006)**
  - E.g. scoping and purpose, architecture models and artifacts, business-drivenness, assessment, commitment, communication
  - Potential risk areas

Enterprise Architecture Risk Classification (1/3)

The work system framework of risks (see Sherer & Alter 2004) was adapted to this study because

- It is generic
- It has an extensive literature base
- Generic work system risks apply to the IS context (Sherer & Alter 2004), suggesting that they may apply to the EA context as well
- The framework shares the same conceptualization of risk with this study
- The model provides a meaningful context to classify risks, understandable by not only technically-oriented persons but business personnel as well (Sherer & Alter 2004)

Enterprise Architecture Risk Classification (2/3)



Source: Sherer & Alter 2004 (adapted)

Enterprise Architecture Risk Classification (3/3)

- Each of the elements in the frameworks has its own life cycle and even inside the elements different objects may have particular life cycles
- It is important to consider implemented EA as a source of risks
- All of the elements include the aspects of security and competence
- Partners can be a source of risks but they cannot be associated with one particular element due to their different roles
- Management has a significant impact on EA work but it is difficult to classify management to any single element due to its many roles

Source: Focus group interview

Examples of Potential Enterprise Architecture Risks

	Factors leading to negative outcomes	Negative outcomes
Work practices	▪Poorly designed processes ▪Insufficient resources ▪*Insufficient organizational security*	▪Inadequate performance ▪*Insufficient predictability of outcomes* ▪*Insufficient documentation*
Products and services	▪Incompatibility between customer requirements and products or services	▪Lack of use ▪Dissatisfaction
Customers	▪Disagreement regarding the requirements for products and services ▪Difficulty in using products or services ▪*Inadequate implementation of EA products and services*	▪Lack of use of products and services ▪Dissatisfaction ▪*Misuse or misinterpretation of EA products* ▪*Insufficient realization of EA objectives*
Technologies	▪*Dependence on technology providers* ▪Inadequate usability of technology ▪Incompatibility between technologies	▪*Inadequate EA process performance* ▪*Participant frustration*

Sources: Sherer & Alter 2004; *Focus group interview*

Enterprise Architecture Risk Management (1/4)

- Risk management aims at helping the organization in achieving its objectives (Lam 2003)
- Risk management involves balancing 1) risk and reward, and 2) processes and people (Lam 2003)
- Risk management process involves
  - Risk awareness and identification
  - Risk measurement and analysis
  - Risk control
- EA success vs. organizational success
  - EA risk management supports the attainment of EA objectives (c.f. Lam 2003)
  - Successful EA supports the attainment of organizational objectives (Hoogervorst 2004)
  - EA is a tool for facilitating organizational risk management (Morganwalp & Sage 2004; Focus group interview)

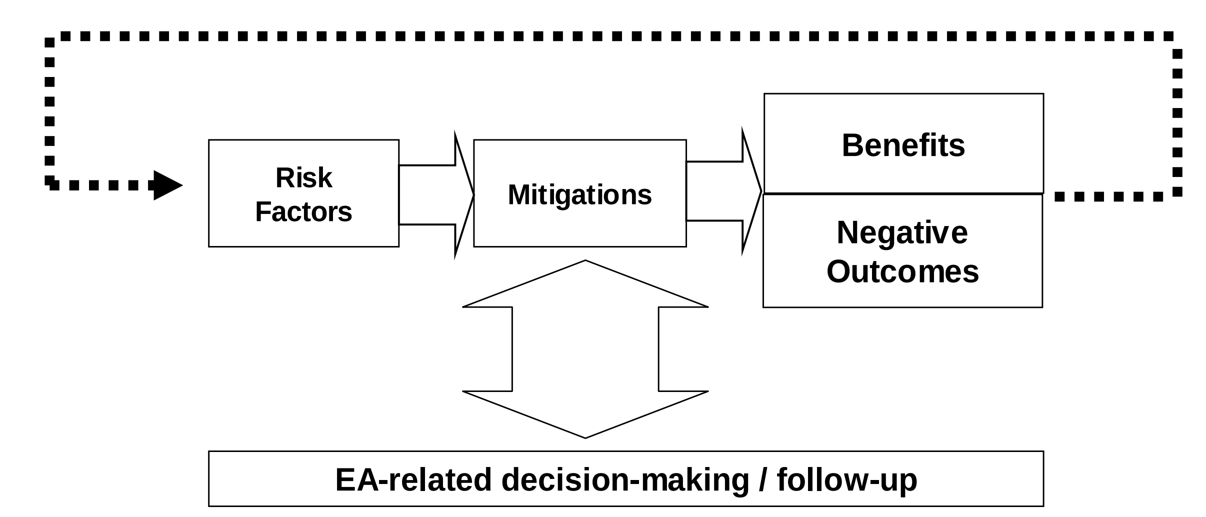
Enterprise Architecture Risk Management (2/4)

- EA risk management responsibilities
  - EA risk management is one of the tasks of EA management (governance)
  - Risk identification: responsiblity of the EA management team, assisted by everyone carrying out EA work
  - Risk measurement: responsibility of the EA management team
  - Risk control: responsibility of the EA management team
- EA risk management is linked to EA maturity
- EA risk management vs. organizational risk management
  - EA risk management should not be separate from organizational risk management
  - EA risks can be considered as one category or type of risks the organization's risk management needs to deal with
  - General risk management practices should be applied in the EA domain
  - EA-related risks are not currently considered in detail in organizations but there seems to be the need of identifying, measuring and controlling them

Source: Focus group interview

Enterprise Architecture Risk Management (3/4)

EA risk management vs. EA-related decision-making



EA risks are one criterion for EA-related decision-making which aims at optimizing the risk-benefit ratio

Sources: Benaroch, et al. 2006 (adapted); Focus group interview

Enterprise Architecture Risk Management (4/4)

- EA risk management can be supported by
  - Efficient and adequate communication on EA issues using a common language that is understandable by each stakeholder
  - Proper documentation of EA products and services
  - Clear, sufficiently extensive risk management responsibilities: who is the ”owner” of risk?
  - Defining EA risk limits: the EA does not need to be perfect

Source: Focus group interview

Summary and Conclusions (1/2)

- EA risks:
  1. any factors that may lead to negative outcomes in the EA program
  2. any negative outcomes resulting from these factors (may be more important in practice)
- The work system framework was considered generic enough by the focus group to be used in the EA context but several comments regarding it were brought out
- The focus group generally agreed with the generic EA work system risks presented and provided a number of additional risks and examples of their realization in practice

Summary and Conclusions (2/2)

- Contributions
  - Practitioners can use the results to identify typical risks related to each element in the EA work system, and to assure that risk management practices have been planned for all relevant risks
  - The EA work system framework may be used to structure the EA approach in organizations or in research
- Further research
  - Studying the significance of the identified EA risks and uncovering concrete examples of their realization in practice
  - Investigating the temporal nature of EA risks
  - Uncovering the actual causal chains of EA risks and effects
  - Quantifying the effects of EA risks
  - Scrutinizing how to implement EA risk management as an organized, continuous activity that is linked to the organization's generic risk management

Evaluating Business-IT Alignment in the EA Context

AISA Project

Niemi & Ylimäki

18.4.2007

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Research Questions

- Why should we care about business-IT alignment?
- What does business-IT alignment mean?
- How are business-IT alignment and EA related?
- How can business-IT alignment be evaluated?

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Introduction

- The idea of Business-IT Alignment (BIA) grew together with the rise of IS in organizations in the 70's (Silvius 2007, Luftman & Brier 1999)
  - Methods for IS development (e.g. Business Systems Planning)
- The term has however remained rather vague and unclear, and it is also unclear how to practice BIA
  - Many definitions exist
  - What should be aligned with what?
    - Usually, deals with strategic alignment between business and IT strategies

The Importance of Business-IT Alignment (BIA)

- High degree of alignment has been associated with improved business performance by empirical evidence (Chan, Huff et al. 1997; Papp 1999)
  - More efficient IT investments
  - Greater profitability
  - Increased competitive advantage
- Majority of organizations produce tangible products and services (Symons 2005a)
  - IT has an important role in supporting or enabling the business, but it is not the business itself
  - Many of these organizations consist of multiple business units

→ Alignment remains a challenge

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Definitions of BIA

- "The extent to which the IS strategy supports, and is supported by, the business strategy (Luftman, Lewis et al. 1993)
- "The degree to which the IT mission, objectives, and plans support and are supported by the business mission, objectives and plans" (Reich & Bensabat 1996)

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More Definitions of BIA

- BIA "refers to applying IT in an appropriate and timely way, in harmony with business strategies, goals and needs" (Luftman 2000)
- BIA is "the continuous process, involving management and design subprocesses, of consciously and coherently interrelating all components of the business-IT relationship in order to contribute to the organization's performance over time". (Maes et al. 2000)

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Consensus on BIA?

- Despite many definitions, there seems to be a kind of consensus what alignment is:
  - "the fit between business strategy, IT strategy, organizational structures and processes, and IT structures and processes"

→ Goal of alignment: IT activities that support the activities of the entire business

(van der Raadt et al. 2005)

BIA Models

- Strategic Alignment Model (SAM) by Henderson and Venkatraman (1993)
  - Defines four alignment domains: business strategy, IT strategy, organizational infrastructure and processes, and IT infrastructure and processes
- Luftman's model (Luftman et al. 1999; Luftman 2000)
  - Builds on SAM
  - Defines 12 components
  - The relationships that exists between the components define the business-IT alignment
- Unified Framework for Alignment (Maes et al. 2000)
  - Builds also on SAM
  - Alignment as a dynamic process
  - Takes all components of BIA into account
  - Levels: Strategy, Structure, Operations

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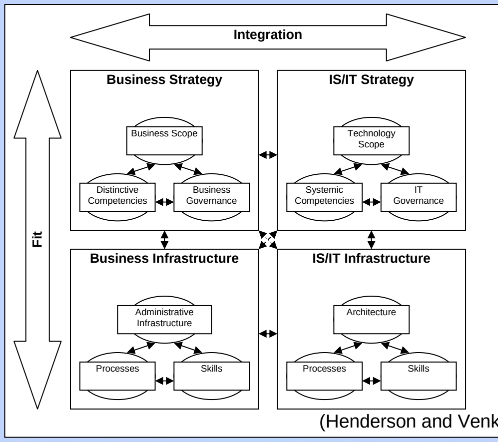
Strategic Alignment Model



(Henderson and Venkatraman 1993)

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Luftman's Model – Twelve Components of Alignment

1. Business Strategy
   1. Business scope
   2. Distinctive Competencies
   3. Business Governance
2. Organizational Infrastructure & Processes
   1. Administrative structure
   2. Processes
   3. Skills
3. IT Strategy
   1. Technology Scope
   2. Systemic Competencies
   3. IT Governance
4. IT Infrastructure and Processes
   1. Architecture
   2. Processes
   3. Skills

(Luftman et al. 1999)

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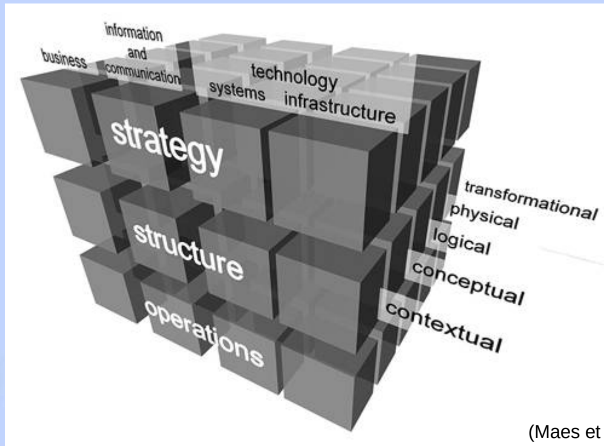
Unified Framework for BIA



(Maes et al. 2000)

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Yet Another View to Alignment…

- Alignment is about business management and IT personnel communicating with each other and understanding each other → two "types" of alignment:

1. IT-to-business alignment:
   - IT personnel has business knowledge and is able to understand the business goals, as well as to create technological solutions to reach those goals
2. Business-to-IT alignment:
   - Business management knows what IT might offer them and is able to express their needs to IT personnel

(van der Raadt et al. 2005)

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Challenges in Achieving BIA

- Business-IT alignment is considered a fuzzy target; it is not clear (Luftman 2000; Silvius 2007)
  - How to achieve and sustain the harmony between business and IT (what should be aligned with what)?
  - How to assess the maturity of alignment?
  - What are the impacts of misalignment?
- "One of the major obstacles to achieving strategy alignment is that many organizations do a poor job of communicating their strategy." (Symons 2005b)
- "The mere act of aligning something (IT strategy) to something else (business strategy) implies that they both already exist and must be forced into some alignment." (Symons 2002) → alignment comes too late!

BIA & EA – How Do These Concepts Relate?

- EA can be seen as an enabler of achieving business-IT alignment
  - One of the goals for EA work is to improve business-IT alignment
  - EA provides the big picture, procedures and tools to achieve information systems that enable the business to reach its objectives
- Or, can BIA be even regarded as EA work having slightly narrower scope?
  - e.g. Luftman's way to address alignment is close to EA

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EA as a Bridge between Business and IT

Business Development

EA Development

System Development

Business
-vision, objectives
-strategy
-processes

BUSINESS IT ALIGNMENT THROUGH EA

Information Technology
-IT strategy
-Systems and Applications
-Technology

EA development is suggested as a bridge to make the efforts of business development and systems development a seamless continuum.

(adapted from Hirvonen & Pulkkinen 2003)

Relationship between BIA and EA Compliance?

- Objects (business, EA, investment, project etc.) between which EA compliance may be evaluated – could these the objects between which alignment is needed in the EA context?
- Compliance between these objects does not automatically guarantee that there is alignment between these objects?
  - e.g. business and EA may be compliant, but not aligned if the business strategies have been interpreted into EA incorrectly

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Characteristics of an Unaligned IT Organization

- Reporting structure: IT reports to the CFO or an operational executive with significant non-IT responsibilities instead of reporting to an executive who understands the strategic potential of IT
- Cultural attitude: IT is treated as utility
- Perception of IT service: IT has a history of poor service and high costs
- IT access to business goals and strategy: IT leadership is not aware of business goals or the strategy, at least not detailed enough
- IT planning and project prioritization: there is no process for prioritizing projects or tasks within IT based on business priorities
- Business project prioritization: There is no enterprise-wide prioritization process for business initiatives
- Communication regarding IT's role: the business is not aware of IT's role in any strategic endeavors
- Communication style: IT communicates more effectively with technical staff than business people.

(Leganza 2003)

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A Solution: IT and Business Strategy Are the Same Thing?

- CIO as an integral part of the senior management team, having an understanding of the business and how IT can play a role in creating new, innovative products and services consistent with the overall goals of the organization
- CIO working with CEO to make IT strategy and business strategy one and the same

(Symons 2002)

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How to Evaluate Business-IT Alignment?

- Luftman's Alignment Maturity Assessment Method (Luftman 2000)
- Reich & Benbasat (2000): Social Dimension of Alignment
- Symons's (2005a) practical suggestions for alignment measures
- Chan et al. (1997): Four measurement instruments
- …

Luftman's Strategic Alignment Maturity Model

- Five maturity levels:
  - Initial/ad hoc process
  - Committed process
  - Established focused process
  - Improved/managed process
  - Optimized process
- Six criteria:
  - Communication maturity
  - Competence/value measurement maturity
  - Governance maturity
  - Partnership maturity
  - Scope & architecture maturity
  - Skills maturity

(Luftman 2000)

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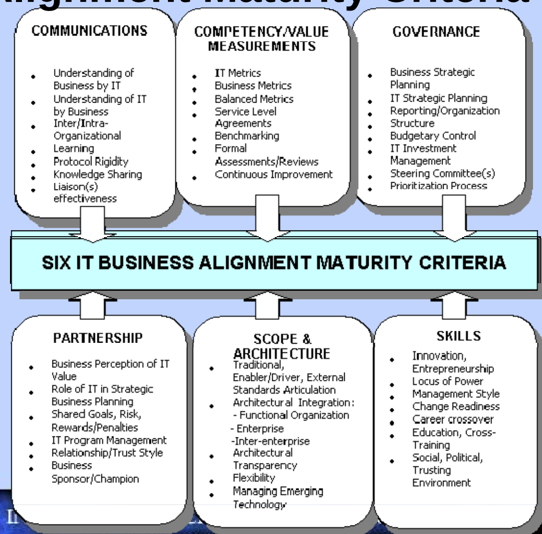
Alignment Maturity Criteria



(Luftman 2000)

Social Dimension of Alignment

- Social dimension of alignment is "the state in which business and IT executives within an organizational unit understand and are committed to the business and IT mission, objectives and plans"
- Constructs that affect the social dimension of business-IT alignment:
  1) Communication between business and IT executives
  2) Connection between business and IT planning
  3) Shared domain knowledge between business and IT executives
  4) IT implementation success
- By measuring these constructs, both the short-term and long-term business-IT alignment can be evaluated

(Reich & Benbasat 2000)

Practical Examples of Alignment Measures

- Meetings
  - Number of IT steering committee meetings
  - Number of joint IT and business planning meetings
  - Percentage of IT budget allocated to new initiatives versus sustaining the business
- Projects
  - Number or percentage of current projects that are directly linked to a strategic business goal
  - Number or percentage of projects in which the business unit provided the ROI or the business case as opposed to IT
  - Number or percentage of projects with post-implementation audits to determine if the business case or ROI targets were met
- Budget:
  - Percentage of IT budget for new initiatives

(Symons 2005a)

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IS Strategic Alignment Assessment – Some Examples of Measures

- Dimension: Current Realized Business Unit Strategy
  - Aggressiveness: increasing market share even if it means reduced prices
  - Proactiveness: first to introduce new products and services
  - Innovativeness: creativity and experimentation are strengths
- Dimension: Business Performance
  - Market share gains, sales growth, revenue growth
  - ROI, cash flow, profitability
  - Satisfaction with new product or service development
- Dimension: IS Effectiveness
  - Satisfaction with IS staff and services, e.g. satisfaction with the time required for new systems development
  - Satisfaction with users' participation in systems projects
  - IS increase the efficiency of business operations
  - IS improve decision-making
- Dimension: Realized IS Strategy
  - Systems used in the BU help introducing products and services
  - Systems used in the BU help monitoring changes in the market share

(Chan et al. 1997)

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Conclusions

- Definition of BIA is still vague
  - Briefly, BIA is the fit between business and IT
- EA can be seen as the enabler of BIA, as a bridge between business and IT
  - Improved BIA is one of the goals of EA work
- BIA evaluation can be seen as a part of evaluating the EA and its benefits
  - Examples of measures to evaluate BIA were presented

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Assessing Architectural Work – Criteria and Metrics for Evaluating Communication, Common Language & Commitment

Tanja Ylimäki

7.2.2007

Why to Evaluate Communication & Common Language and Commitment?

- "Communicating what an EA is and how it will benefit the organization is paramount to its success." (META Group Inc. 2000)
- Communication is vitally important in order to share knowledge, to achieve a common understanding, agreement and a shared view of the EA scope, vision, objectives, developed models and other artifacts, and to gain commitment to the EA effort (e.g. Luftman 2000; Rehkopf and Wybolt 2003;Lankhorst 2005)
- "Without a shared sense of purpose and mission, effective governance structure, and executive leadership and commitment, enterprise architecture will only have a minimal impact" (Nelson 2004)

Research Process

- Literature review
  - Especially, communication audit studies (evaluation of organizational communication) and commitment studies were charted, e.g.
    - Downs & Hazen's Communication Satisfaction Questionnaire (presented e.g. in Downs, 1988)
    - Hargie & Tourish's (2000) Communication Audit Questionnaire
    - SEI's degrees of commitment
    - Abrahamsson & Jokela (2000): management commitment
- Workshop 12.10.2006
  - Review, discussion and validation of the literature review results
- Consolidation of the results

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Evaluating Communication and Common Language

- Evaluation of communication is suggested to be conducted with the help of
  - 6 sub-targets in addition to communication in its entirety
  - 13 evaluation criteria in total
- Examples of evaluation questions (metrics) for each sub-target were presented to stimulate the definition of the organization specific questions (metrics)
- Evaluation metrics of communication mainly include
  - On-off measures
  - Identifying the level of satisfaction of a stakeholder

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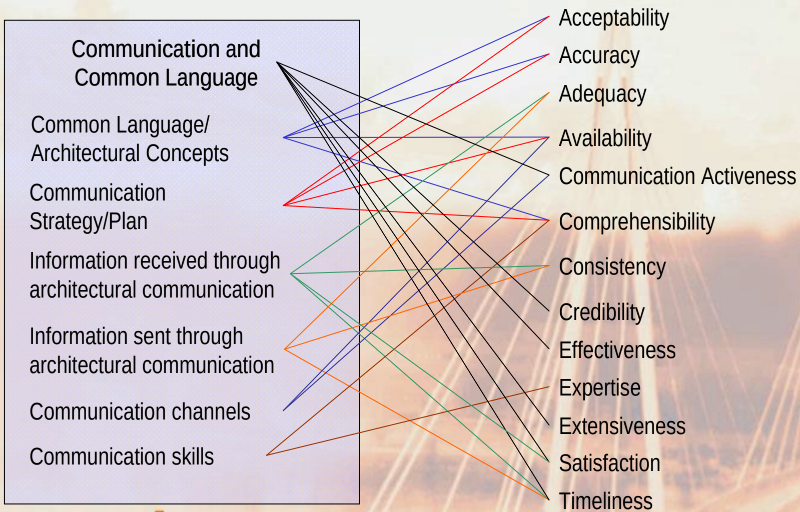
Sub-Targets of Communication vs. Evaluation Criteria



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Examples of Evaluation Questions for Communication 1/3

Sub-target	Evaluation Questions / Metrics	Metric Type / Possible Values
Communication strategy/plan	Does a strategy/plan exist? Is it approved? Is the communication strategy/plan up-to-date?	On-off: yes/no
Common Language	Are the architectural concepts defined, documented, approved and available to key stakeholders?	On-off: yes/no
Common language	How satisfied you are with the concepts? Are the concepts and terms simple enough, clear and understandable?	Likert scale (ranging from very dissatisfied to very satisfied)
Information received through architecture communication	How satisfied are you with the amount and/or quality of architecture related information you have received? - The types of information may be specified - The sources of information may also be specified	Likert scale

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Examples of Evaluation Questions for Communication 2/3

Sub-target	Evaluation Question / Metrics	Metric Type / Possible Values
Information sent through architecture communication	How satisfied are you with the amount and/or quality of architecture related information you have sent to others? - The types of information may be specified - The receivers of information may also be specified	Likert scale (ranging from very dissatisfied to very satisfied)
Communication channels	Which channels you use in architecture communication? Additional questions: - Are these channels easily available? - Is the information easily available through these channels? - Which other channels would you like to use?	"Checkbox"; e.g. Face-to-face contact, telephone calls, written communication, notice boards, internal audio-visual material, e-mail, intranet, meetings, briefings, grapevine
Communication skills	How understandable and clear is the communication/information provided by the architecture team?	Likert scale

Examples of Evaluation Questions for Communication 3/3

Sub-target	Evaluation Question / Metrics	Metric Type / Possible Values
Communication and Common language in its entirety	How actively do you provide feedback to -The architecture team - the management - your co-workers, etc.?	Likert scale, e.g. daily, weekly, a couple of times a month, a couple of times a year, never
Communication and Common language in its entirety	How satisfied are you with the architecture communication in general? Additional question: How would you change the communication to make you more satisfied?	Likert scale

Evaluating Commitment

- Evaluation of commitment is suggested to be conducted with the help of five evaluation criteria
  - Awareness, acceptability, satisfaction, involvement and participation activeness, resources (adequacy of resources)
- Examples of evaluation questions (metrics) that demonstrate each evaluation criteria were presented to stimulate the definition of the organization specific evaluation questions (metrics)
- Evaluation metrics of commitment mainly include
  - On-off measures
  - Identifying the level of satisfaction of a stakeholder

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Examples of Evaluation Questions for Commitment 1/2

Criteria	Evaluation Question / Metrics	Metric Type / Possible Values
Awareness	Have you heard/been informed about the EA/architecture approach adopted in the organization?	On-off: yes/no
Acceptability	To what extent do you consider the EA/ architecture approach to be important/ useful/essential to the success of e.g. - the entire organization - your department/your team - your personal work tasks	Likert scale 1-5 (e.g. not at all important - very important)
Satisfaction	To what extent you utilize architecture guidelines/architecture documentation/ architecture guidance given by architects as a normal part of you work tasks?	Likert scale 1-5 (e.g. daily, weekly, a couple of times a month, a couple of times a year, never)

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Examples of Evaluation Questions for Commitment 2/2

Criteria	Evaluation Question / Metrics	Metric Type / Possible Values
Involvement and participation activeness	Does the EA governance team include executive-level representatives from each line of business? Do they have the authority to commit resources and enforce decisions within their respective organizational units?	On-off: yes/no
Involvement and participation activeness	How actively do you provide architecture related feedback to - the architecture team - the management - your co-workers?	Likert scale 1-5 (e.g. daily, weekly, a couple of times a month, a couple of times a year, never)
Resources	Does a budget for EA exist?	On-off: yes/no
Resources	Has an architecture team (architects) been assigned? Have their responsibilities and authorities been defined? Does a chief architect exist?	On-off: yes/no

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Conclusions

- Communication and commitment are important factors to the success of EA work and, therefore, evaluation in these areas should be carried out
  - Communication can be evaluated independently (i.e. not only as part of organizational communication studies)
  - The level of commitment may be derivable from the evaluation of architecture benefits, as well as from the communication assessments
    - If benefits can be demonstrated and value has been gained through EA, commitment has likely been reached
- Selection of metrics is required, as well as translation of the metrics into the organization's own terminology
  - Metrics selection is dependent on the phase of the EA development, or the maturity level
  - Simple metrics (e.g. on-off metrics) may be more useful in the beginning, more detailed metrics (quantitative or qualitative) in later phases

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Evaluating the Benefits of Architectural Work

Eetu Niemi
Aisa Project
7.2.2007

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Introduction

- Architectural work has to be justified by demonstrating positive impacts
- Challenges
  - Undefined and unconfirmed benefits of architectural work
  - Lack of estrablished metrics and evaluation criteria
- This study aims to
  - Define the benefits of architectural work
  - Present evaluation criteria and metrics for quantifying the realization of benefits

Research Process

- Literature review on architectural work benefits
  - Charting literature for references of benefits.
  - Product: preliminary list of 27 benefits
- Workshop III 8.8.06
- Composing a categorization of architectural work benefits
  - Analyzing and combining results
  - Product: categorization of EA benefits
- Literature review on architectural work benefit evaluation
  - Charting for evaluation criteria and metrics
  - Assigning the criteria and metrics found to the architectural benefits
  - Products:
    - list of evaluation criteria and metrics assigned to 23 architectural work benefits
    - list of seven emphasized benefits and their related metrics and evaluation criteria
- Workshop IV 12.10.06
- Reporting
  - Analyzing and presenting the results of the workshop with the architectural work benefits, benefit evaluation criteria and metrics
  - Product: report

Architectural Work Benefits

1	Evolutionary EA development & governance
2	Provides a holistic view of the enterprise
3	Improved alignment to business strategy
4	Improved alignment with partners
5	Improved asset management
6	Improved business processes
7	Improved business-IT alignment
8	Improved change management
9	Improved communication
10	Improved customer orientation
11	Improved decision making
12	Improved innovation
13	Improved management of IT investments

14	Improved risk management
15	Improved staff management
16	Improved strategic agility
17	Increased economies of scale
18	Increased efficiency
19	Increased interoperability and integration
20	Increased market value
21	Increased quality
22	Increased reusability
23	Increased stability
24	Increased standardization
25	Reduced complexity
26	Reduced costs
27	Shortened cycle times

Example of Metrics: Increased Efficiency

Evaluation target	Metrics	Type	Sources
Organization	Organizational costs: Costs of transactions, Overhead costs and Infrastructure costs	Objective Financial	(Drury 1992; Morgan 2005)
	Accordance to budget (organization-level/business-unit level/department-level group level)	Objective Number	(Drury 1992)
	Organizational Financial Metrics: Revenue growth, Profitability, Cash flow, Return on Investment, Return on Equity, Economic Value Added, Market share	Objective Financial	(Drury 1992; Morgan 2005; Papalexandris, Ioannou et al. 2005)
	Costs avoided through elimination of redundant/duplicative/overlapping functions/departments/groups/teams/positions	Objective Financial	(GAO 2003; SETLabs 2004)
IT Assets	Number of assets - Systems - Software products - Licenses - Servers - Etc.	Objective Number	(Rosser 2006)
	- All IT costs - Maintenance costs - Operations cost	Objective Financial	(SETLabs 2004; Rosser 2006)

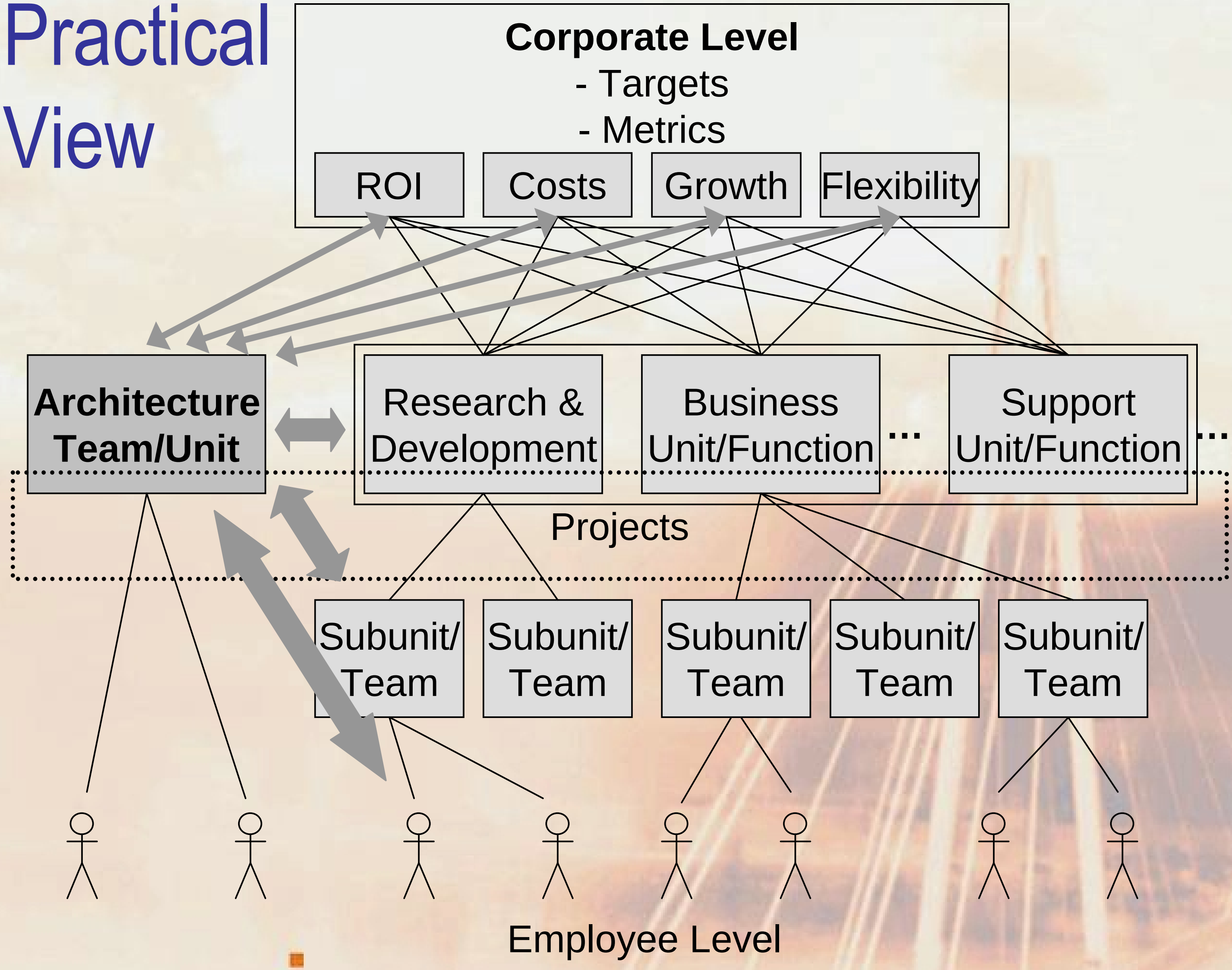
Challenges

- Proposed metrics too great in number
- Would not suit practice without a guiding reference model

→ Practical view of architectural work benefits and their evaluation (developed by the company representatives in workshop IV)

  – Based on three categories of benefits (costs, growth, and flexibility)
    - Basic targets and needs of a business enterprise and its owners

Practical View



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(developed by the company representatives in workshop IV)

Conclusion (1/3)

- Report presents
  - benefits of architectural work
  - evaluation criteria and metrics for the benefits
  - classification of benefits (basic need of an enterprise, suggested by the company representatives in workshop IV)
  - practical view of architectural work benefits and their evaluation (developed by the company representatives in workshop IV)

Conclusion (2/3)

- Contribution to practice
  - architectural work benefits as a basis for defining the objectives of architectural work
  - rationalizing architectural work in the initial stages by presenting potential benefits
  - benefits and their related metrics and evaluation criteria as a basis for developing a measurement system
  - the practical view as a reference model for a generic corporate measurement system

Conclusion 3/3

- Challenges
  - a great number of factors affect the realization of benefits
  - defining a generic set of benefits with respective metrics
    - the prioritization of benefits is company-specific
  - balancing between presenting short-term and long-term benefits
  - architectural work benefits cannot be directly measured (?)
  - communication as a prequisite to benefits

→ How to attribute realized benefits to architectural work?

Evaluation Needs for Enterprise Architecture

Tanja Ylimäki
AISA Project
1.11.2006

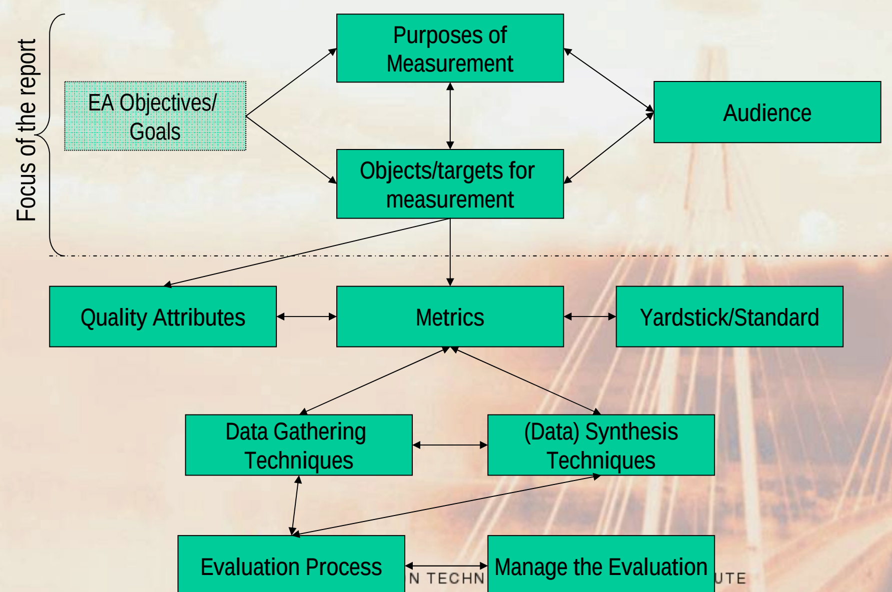
Objectives of the Study

- What does (program) evaluation mean?
- How to plan an EA evaluation? Which issues need to be addressed?
  - → Components of evaluation planning
- What are the needs for EA evaluation in terms of the evaluation components?
  - EA objectives: why to develop EA?
  - Evaluation purposes: why to evaluate EA?
  - Audiences: who needs the evaluation results?
  - Evaluation targets: which aspects of EA to evaluate?
  - (Attributes: what characterizes the evaluation targets?)

What Does Evaluation Mean?

- Evaluation is “a process of determining merit, worth, or significance” (Lopez 2000)
- “The thoughtful process of focusing on questions and topics of concern, collecting appropriate information for a specific use and purpose” (Taylor-Powell, Steele et al. 1996)
- No general theory exists, various approaches can be used (see e.g. Fitzpatrick et al. 2004)
- Typically, evaluation focuses on either <u>products</u> or <u>processes</u>

EA Evaluation Components



Examples of EA Objectives

EA Objectives/ Goals

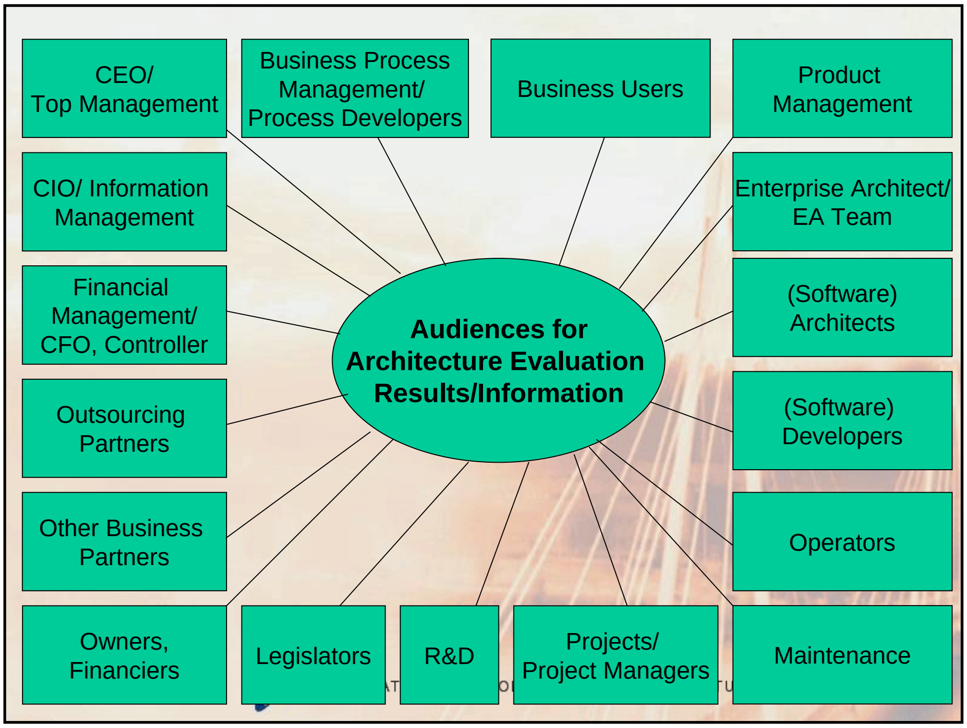
Quality Attributes

- Reduced (IT) costs (cost-effectiveness)
- Standardization, consolidation (of systems, information, processes)
- Increased interoperability and integration
- Enabling business change, business and strategic agility and flexibility
- Improved decision-making
- Improved process effectiveness
- Improved innovation, time-to-market etc.
- Improved communication between business and IT; better business-IT alignment
- Improved risk management

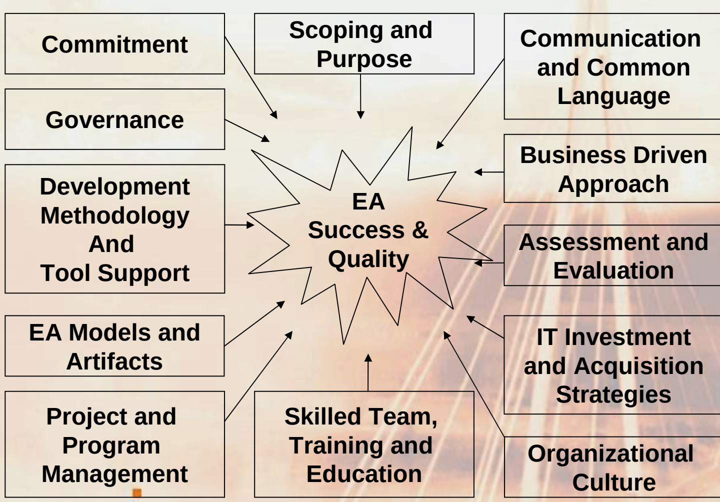
Examples of EA Evaluation Purposes

Purposes of Measurement

- To determine if the EA objectives are achieved
- To aid decision-making related to e.g.
  - the EA program itself
  - the selection among different architecture solutions
  - the business, ICT investments etc.
- To provide stakeholders with accurate accounting of the results of the architectural work, e.g.
  - to assess benefits and gains of EA or EA program
  - to assure that the results of EA or EA program are positive
- To provide balanced information on strengths and weaknesses of
  - EA, EA program (EA maturity)
  - organization's EA readiness/EA capability etc.



Critical Success Factors for EA – EA Evaluation Targets



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Evaluation Needs – Scoping and Purpose

Commitment | **Scoping and Purpose** | **Communication and Common**

- To what extent are the objectives and benefits of the architecture approach identified, documented and approved in the organization? How clear or understandable are the objectives and benefits?
- Are the objectives derived from the business or IT strategies of the organization (FGI 2006)?
- To what extent are the stakeholders of EA and their concerns identified?
- To what extent does the architectural work cover the organization?
- What is the scope of the EA? How has it changed/expanded during the last quarter/year etc.? How controllable is the EA scope? (FGI 2006)
- To what extent are the objectives and benefits of the architecture approach evaluated in order to ensure that they are met?

Evaluation Needs – Business Driven Approach

E.g.

- To what extent are the business requirements taken into account in architectural planning?
- To what extent are the business requirements identified and documented?
- To what extent are the business requirements prioritized and how they are prioritized? To what extent are they conflicting or competing? To what extent is the architecture team aware of the changes in business requirements? Has the architecture team all necessary information related to the business? (FGI 2006)
- To what extent do the requirements cover the concerns of stakeholders? To what extent are the requirements of different stakeholders in balance (FGI 2006)?

Communication and Common Language

Business Driven Approach

Assessment and Evaluation

IT Investment and Acquisition Strategies

Organizational Culture

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Evaluation Needs – Communication and Common Language

E.g.
- To what extent are the architectural concepts defined, documented, approved and used in communication?
- To what extent is the communication on architectures and architectural work established between different stakeholders?
- To what extent are the architects/the architecture team capable of communicating with different stakeholders using the language these stakeholders can comprehend (FGI 2006)?
- Has the communication been on such a level (granularity) that it satisfies the needs of the stakeholders (FGI 2006)?
- To what extent has the architects/architecture team been capable of communicating the top management whether the business requirements can be implemented in the schedule set by the business (FGI 2006)?

Communication and Common Language

Business Driven Approach

Assessment and Evaluation

IT Investment and Acquisition Strategies

Organizational Culture

Evaluation Needs – Commitment

Commitment

Scoping and Purpose

Communication and Common

- To what extent is the (top) management aware of the architecture approach of the organization (FGI 2006)?
- To what extent is the (top) management aware of the objects and benefits of EA?
- To what extent is the (top) management committed to and involved in the architecture approach? Does the management sponsor the EA approach (FGI 2006)?
- To what extent are the other stakeholders aware of the architecture approach of the organization (FGI 2006)?
- To what extent are the other stakeholders committed to and involved in the architecture approach?
- To what extent do the various stakeholder groups participate in the architecture development?

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Evaluation Needs – Governance

- Commitment
- Governance
- Development Methodology And Tool Support
- EA Models and Artifacts
- Project and Program Management

E.g.

- Does the governance have the necessary resources (time, money, etc.) (FGI 2006)?
- How is the architecture work/governance positioned in the organization (e.g. in the information system management/CIO or elsewhere in the organization chart)? How successful has this solution been? Is there any need to reposition the architecture work/governance? (FGI 2006)
- How effective are the EA governance processes, structures and practices? How helpful are they considered e.g. by the projects (FGI 2006)?
- To what extent do the governance processes provide feedback to the strategic or business planning processes (FGI 2006)?
- To what extent is the EA governance process integrated into other business management processes (FGI 2006)?

INFO

Evaluation Needs – IT Investment and Acquisition Strategies

- To what extent does architectural work influence the IT investments and acquisition strategies of the organization?
- How many investments comply with EA? How many do not comply with EA and why not?
- How effective are the investment and acquisition strategies?
- How effective/viable/practical is the investment decision making (process) (FGI 2006)

- Communication and Common Language
- Business Driven Approach
- Assessment and Evaluation
- IT Investment and Acquisition Strategies
- Organizational Culture

Management

Education

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Evaluation Needs – Development Methodology and Tool Support

- Commitment
- Governance
- Development Methodology And Tool Support
- EA Models and Artifacts
- Project and Program Management

E.g.

- To what extent are methodologies and methodology use evaluated? How effective are the methodologies (FGI 2006)? Do they provide sufficient guidance? Do they support reuse of models, patterns etc.?
- To what extent are tools and tool use evaluated? How helpful are the tools, can the work be done faster with them (FGI 2006)? How well do they support the architecture development and management? How effectively are the tools used?
- What are the costs of tool use? To what extent are verifiable benefits received from tool use? How does the tool use affect other features of system development, such as, its production costs, flexibility, adaptability or expandability (FGI 2006)?

INFO

Evaluation Needs – EA Models and Artifacts

- Commitment
- Governance
- Development Methodology And Tool Support
- EA Models and Artifacts
- Project and Program Management

E.g.

- To what extent are the document templates designed and how useful have those templates been (FGI 2006)?
- How many decisions were made to develop e.g. the target architecture? How long did it take make these decisions? (FGI 2006)
- Are the models understandable and clear? Are they up-to-date? Are they complete enough? Are the concepts used in the models consistent? Are the models consistent enough providing a holistic view of the organization? (FGI 2006)
- To what extent are the different views of EA aligned? Do they provide a coherent view of the organization? (FGI 2006)
- How flexible is the architecture? To what extent does it consider the future (business) requirements that can be seen at present time (FGI 2006)?

IN

Evaluation Needs – Assessment and Evaluation

E.g.

- To what extent are the needs for architecture evaluation identified and approved? To what extent do these needs correspond to the maturity of the organization's EA as well as to the organization's policies (ways of working)? (FGI 2006)
- To what extent are the evaluation criteria and metrics aligned with the other evaluation metrics used in the organization (FGI 2006)?
- To what extent are the evaluation points identified? What is the time-frame of evaluation (FGI 2006)?
- What are the costs of evaluation? To what extent are verifiable benefits received from evaluation? (Cost-benefit analysis)
- Are evaluation techniques aligned with architecture maturity?

Communication and Common Language

Business Driven Approach

Assessment and Evaluation

IT Investment and Acquisition Strategies

Organizational Culture

Evaluation Needs – Skilled Team, Training and Education

E.g.

- To what extent are the roles and responsibilities of the architecture team (architects) defined?
- Does the team have the necessary resources (time, money, etc.) (FGI 2006)?
- To what extent does the team has the necessary skills and knowledge needed in architectural work? How skillful and knowledgeable is the team? To what extent does the team possess various skills and experience (in business, technology, system development, architecture, etc.) (FGI 2006)?
- How have the necessary skills been acquired; through training, hiring, partners, consultants etc. (FGI 2006)?
- To what extent is training and education available for the architects, for the other stakeholders? Is the training provided internally/externally?

Project and Program Management

Skilled Team Training and Education

Organizational Culture

Evaluation Needs – Organization Culture

E.g.
- To what extent is the architecture approach approved by the organization? How aware are the organization members of the architecture approach and its objectives (FGI 2006)? How is the EA perceived by the organization (members)?
- To what extent are the cultural challenges or constraints for architectural work been identified?
- To what extent are the challenges or constraints responded to?
- How has EA affected the organization, its structure and culture, after integrating or consolidating e.g. some of the financial and personnel management functions (FGI 2006)?
- How long time has is taken to make the required changes in the organization? Has it taken longer or shorter time than earlier? (FGI 2006)

Project and Program Management
Skilled Team, Training and Education
Organizational Culture

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Evaluation Needs – Project and Program Management

E.g.
- To what extent is the coordination between architecture development or implementation projects organized?
- To what extent does the project methodology emphasize the importance of architecture? To what extent does the project methodology include architecture guidance (FGI 2006)?
- To what extent has a project gained architecture guidance? How useful has the guidance been? (FGI 2006)
- How many projects have had difficulties in following the guiding principles or architectural constraints? How many projects have indicated a need to change or refine the architecture (plans, objectives etc.)? (FGI 2006)

Project and Program Management
Skilled Team, Training and Education
Strategies
Organizational Culture

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Evaluation Needs – Entire EA Program

E.g.

- To what extent does EA meet the key stakeholders' concerns (i.e. captures the right information)?
- What are the benefits of the EA approach to each stakeholder group (FGI 2006)?
- To what extent are the EA and business objectives and benefits met? If objectives are not met, why not, and how to assure that the same mistakes are not done again (FGI 2006)?
- What kind of business impacts does EA provide? How have these impacts evolved/changed over time (quarter, year, 2-3 years, etc.)? (FGI 2006)
- To what extent does EA provide the 'big picture" of the organization and assist business operations effectively in a situation where e.g. the market share is increasing, and the profitability is high (i.e. in a situation, where no radical changes are not necessary) (FGI 2006)?
- How effective/viable/practical is the decision making (process) (FGI 2006)
- How has EA affected the IT costs? Have they been decreasing or increasing? (FGI 2006)
- What kind of support does EA provide for the business processes development and management (FGI 2006)?
- What is the business value of EA?
- What is the ROI/ROA of EA?
- How mature is the organization's EA (program)? How has the maturity evolved over time (quarter, year, 2-3 years etc.)? (FGI 2006)

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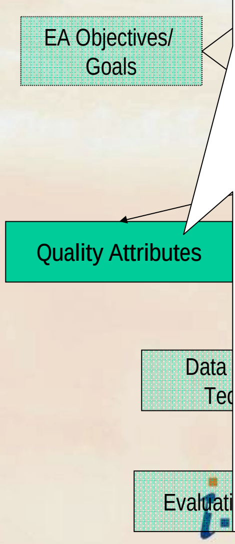
Quality Attributes for EA?



- Which characteristics of the targets are to be evaluated? How to describe the targets to be evaluated?
  → Evaluation criteria / quality attributes
- Attributes/criteria were not scrutinized yet, but a list of possible attributes was generated (see the Appendix 3 in the report)
- Examples:
  - Functionality
  - Usability
  - Security
  - Compliance
  - Interoperability
  - Efficiency
  - Visibility
  - Maintainability
  - Flexibility

Conclusions

- Evaluation planning starts with the definition of e.g. evaluation purposes, audiences, evaluation targets, and quality attributes
  - Examples of these were presented to stimulate intra-organizational discussion
  - These components are interconnected; architecture evaluation targets depend at least on the objectives of the architectural work, evaluation purposes and the audience
  - Also the organization's EA maturity affects the selection of evaluation targets

  → compatibility is required between the components and the maturity level
  - CSFs for EA provide a starting point for defining architecture evaluation targets
- Evaluation targets and metrics need to be compatible with the other measurement systems used in the organization (e.g. BSC)

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Long-Term and Sort-Term Architecture Decisions

AISA - Quality Management of Enterprise and Software Architectures

Niina Hämäläinen
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Content

- Research Description and Motivation for Study
- Concepts: e.g. short-term, long-term
- Architecture Planning Levels
  – Architecture Decision Making Levels
- Short and Long-Term Architecture Decisions in Architecture Planning and Decision Making Levels
- Arguments for Short-term and Long-term Architecture Decisions

Motivation For Study

- Challenge in Architecture Decision Making
  - Far-sighted architectural decisions are difficult to justify in the quarterly thinking.
- Open Questions:
  - What are short-term and long-term architecture decisions?
  - Why should it be done long-term architecture decisions?
  - How could it be argued for long-term architecture decisions?
- Exist a need
  - To understand what distinguish long-term and short-term decisions
  - To find ways to argue for long-term solutions
  - To identify metrics that can be used in arguing for long-term architecture solutions

Research Description

- A prestudy for research of architecture decision making (AISA-project's 3rd year).
- Aims:
  - To define concepts: short-term and long-term architecture decision
  - To define features relating short-term and long-term architecture decisions
- Research phases and sources:
  - Literature review, concept definition
  - Some discussions with practitioners
- Results:
  - Aspects on long-term and sort-term architecture decisions and decision making

Decision, Solution -Concepts

- **Decision**
  judgment, arbitration, conclusion, finding, outcome, resolution, result, ruling, sentence, settlement, verdict

- **Solution**
  answer, clarification, elucidation, explanation, key, resolution, result, solving, unfolding, unravelling

•MOT Collins Compact Thesaurus 1.0

Short-term vs. Long-term -Concepts

- **Short-term:**
  1 of, for, or extending over a limited period.
  2 *Finance.* extending over, maturing within, or required within a short period of time, usually twelve months: *short-term credit; short-term capital.*

- **Long-term:**
  1 lasting, staying, or extending over a long time: *long-term prospects*
  2 *Finance.* maturing after a long period of time: *a long-term bond*

MOT Collins English Dictionary 1.0a

Architecture Planning and Decision Making Levels in Organisations

- EA Planning: Architecture visioning, road map development, principles development
  - Are we building right capabilities? Are we preparing for business changes?
  - Long-term planning
- Portfolio planning:
  decision of projects to be carried out and how projects link to each other
  - Are we leveraging synergies and avoiding redundant business solutions?
  - Near-term planning
- Project: solution design – design of architecture solutions
  - What is the best practical solution for in-scope business needs?
  - Current

Source: FORRESTER August 2006, Best Practices **"Requirements For Long-Term Architecture"**

Decisions in Architecture Planning / Decision Making Levels

Architecture Planning / Decision Making Level	**Decisions**
EA Planning	• Decisions made in enterprise scope • Architectural guidelines and principles, Roadmap, Architecture Visio, Target architecture, etc. • EA development tasks to be carried out
Portfolio planning - Choosing of the projects	• Decisions made in enterprise / unit scope • Projects to be carried out, prioritization of projects
Project – Solution Design	• Decisions made in project / system scope • System's key structural elements, relationships between elements, used patterns, fitting to the context etc.

Short-Term vs. Long-Term Architecture Decision

- Commonly used concepts in industry: Clear definitions for these lacks.

- Suggestion on based previous concepts and definitions for these definitions:

Sort-term decision / solution

- Decision /solution is expected to have limited life span.
- It is known already in decision making that decision has to be changed in future or in solution planning that solution has to be replaced in future.
- Financial benefits are expected to be achieved quickly.

Long-term solutions

- Decision/solution is expected to have long life span.
- Decision is not expected to be changed or solution is not to be expected to be replaced.
- Financial benefits are expected to be achieved over a long time.

Short and Long-Term Architecture Decisions in Architecture Planning Levels

	Short-term architecture decision	Long-term architecture decision
EA planning: Architecture visioning, road map development, development of principles	• Suitable for near-term strategy, near-term business environment change and near-term business trends and forecasts	• Suitable for long-term strategy, business environment change and business trends and forecasts
Portfolio planning - Choosing of the projects	• Suitable for current business plans, drivers and needs BUT • Do not support long-term architecture visio and roadmap	•Suitable for current business plans, drivers and needs AND • Support long-term architecture visio and roadmap
Project – solution design	• Suitable for the defined business requirements for project BUT • Do not support the long-term plans	• Suitable for defined business requirements for project AND • Supports long-term architecture plans

Argumentation: Short-Term Architecture Decisions (examples)

Arguments For

- Requires less resources (e.g. money, time and manpower) initially
  - Only acquisition/project resources required
  - Fasten time-to-market
- Yields benefits quickly
- Fulfills project/investment requirements

Arguments Against

- Greater costs in long-term (e.g. maintenance, standardization and integration)
- Do not typically support long-term requirements

Argumentation: Long-Term Architecture Decisions (examples)

Arguments For e.g.

- Less life cycle costs (e.g. maintenance, integration and standardization)
- Greater quality of solutions in long-term (e.g. maintainability, less complexity, agility in changes)
- Less IT costs at company level (e.g. maintenance, integration and standardization)
- Greater level of standardization and integration at company level

Arguments Against e.g.

- Requires more resources (e.g. money, time and manpower) initially
- Yields benefits in long-term
- More difficult to justify

Good Architecture Decision?

- Short-term or long-term architecture decision can be a good decision.
- Good Architecture Decision:
  - Suitable for situation
  - Arguments for decision exist
  - Consequences of decisions are identified

Summary

- This study define concepts:
  long-term and short-term architecture decision
- This study will be continued in the project's 3rd year
- Future research :
  - What architecture decisions are and what kind of architecture decisions may exist?
  - In which levels architecture decisions can be done?
  - How can decisions be done and managed?
  - How architecture decisions relate to other decision making processes?

Measurement in Enterprise Architecture Work - the Enterprise Architecture Team Viewpoint

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UNIVERSITY OF JYVÄSKYLÄ

Motivation for Study

- In the development of a new process in a company, the company has to decide and define, what kind of measurement work will be performed relating to the process or included in it:
  - what the purposes of measurement are,
  - what measurement activities will be carried out, and
  - who has the responsibility of measurement.
- Enterprise architecture processes are currently developed in many organizations
  → measurement aspects in this EA work is thus also needed to be defined.
- A lack of a holistic view of measurement work that could or should be carried out relating to EA work

Study Description

- The goal: To define
  - EA work related measurement aspects and activities
  - responsibilities of EA team in measurement
- Study aims especially to assist practitioners in their EA measurement planning.

Research Approach, Phases and Data

- Constructive approach
- Pre Study –phases
  - Identification of needs for EA evaluation and measurement (literature review and focus group interview)
  - Literature review: identification why, how and where measurement and evaluation is carried out in organizations and identification
- Construction phases
  - Definition of EA work measurement aspects and activities -> Description of aspects and activities
  - Focus group interview of practitioners
  - Updating the description of the EA work aspects and activities

Measurement Process Acts

Understand framework

↓

Plan Measurement

↓

Collect and store data

↓

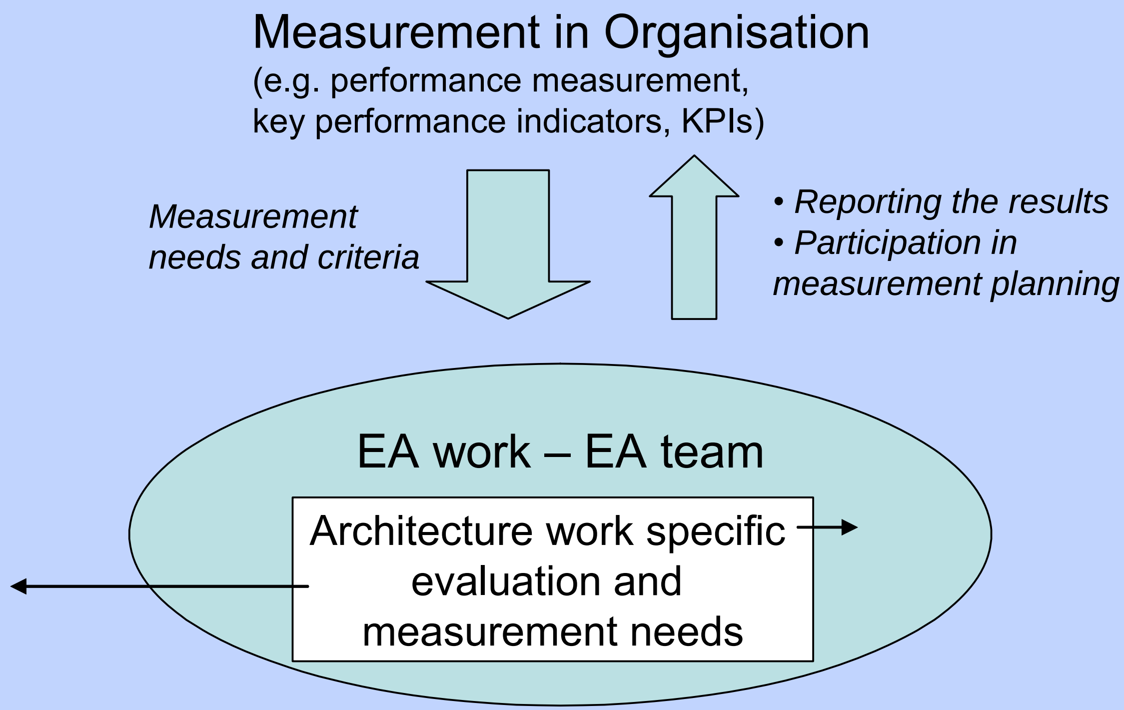
Analyze, Synthesize, Formulate Recommendations, Present Results and Recommendations

↓

Make Decision, Take action

Juran, J. M.; Godfrey, A. B., 2000, Juran's Quality Handbook, McGraw-Hill Companies.

Results: Measurement Needs Affecting EA work



Organisation's General Measurement Work

- In organizations, there are general measurement needs which need to be taken into account also in EA work

  e.g. quality management, performance measurement etc.

- Especially, performance measurement related key performance indicators (KPIs) are used in EA work (Christianssen and Gotze, 2007)

- Measurement aspects and activities
  - Performance measurement reporting
  - Company performance measurement planning / consulting

EA Work Specific Measurement Work

Evaluating EA Work Impacts	▪ To evaluate the impacts caused by EA work ▪ To demonstrate the impacts and possible benefits to company level ▪ To aid decision making about e.g. the future and resources of EA work ▪ To improve EA work practices
Evaluating EA Approach Use	▪ To evaluate the extent of EA approach use/adoption in the company
Evaluating EA Team Operations	▪ To support the management of the EA team ▪ To monitor and report the EA team's and architects' accomplishments, particularly progress toward pre-established goals

EA Work Specific Measurement Work

Evaluating EA Work	▪ To evaluate and monitor the quality of EA work and the artifacts produced ▪ To identify improvement needs of EA work ▪ To measure EA work against other companies (e.g. toughest competitors or industry leaders)
Evaluating of Architectures and Architectural Solutions	▪ To evaluate architecture alternatives, architectures and architectural solutions produced in projects

EA Team's Responsibilities in Measurement

- To plan what measurement or evaluation work is carried out in EA work
- May carry out part of measurement work, and the rest part of this work can be carried out by other staff or partners
- Suggestion:
  EA team should have the complete the whole, holistic picture of the measurement work carried out relating to EA work and its aims of it.

EA team's Measurement Activities

- gathering information for pre-planned measurements and reporting the results (e.g. company's performance measurement),
- carrying out the whole measurement process from the planning of the measurement work to the analysis of the results (e.g. quality evaluation of architecture work results)
- supporting and consulting the measurement planning (e.g. supporting the planning of company's general measurement activities),

Factors Affecting EA Measurement

- how clear are the roles and responsibilities of EA work and EA team,
- does it exist also long-term goals for EA work exist and,
- what is the status and maturity of EA process and practices

Conclusions

- means of EA measurement are
  1) the supporting the management of EA work,
  2) the improvement of EA work practices and products, and
  3) evaluation of impacts and benefits of EA work,
  4) to produce information for architecture planning and decision making
  5) responding to common measurement needs and requirements in organisation

Conclusions

- A limited effort is currently done to measure, for example EA progress and value in organizations (Christianssen, Gotze, 2007).
- As soon as the maturity of EA processes is increased and the role of EA work in companies is be stabilized, more and more EA measurement efforts can be expected to be carried out.
- Future of measurement in EA work
  - The significance of measurement will increase.
  - Measurement will be an actual part of daily enterprise EA work.

Quality Management Activities for Enterprise Architecture

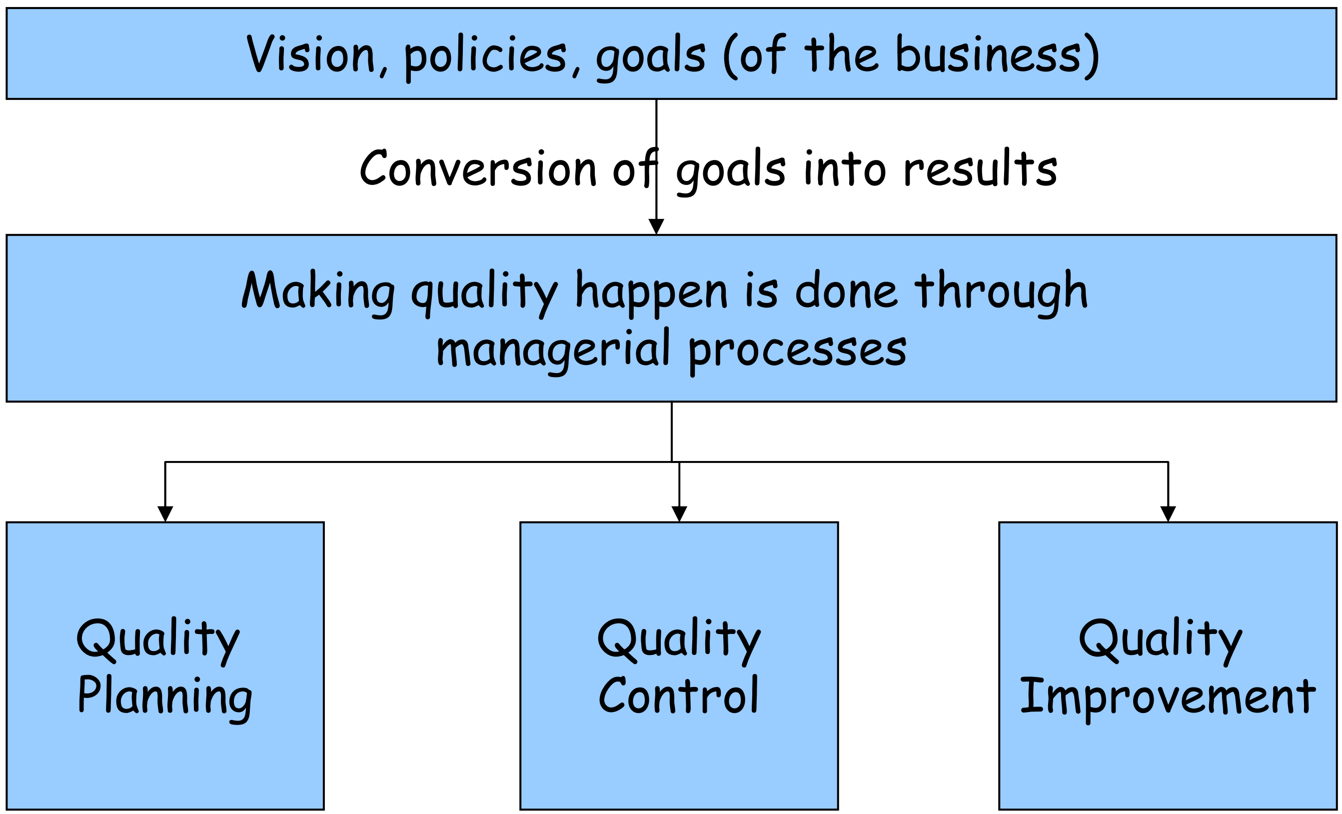
AISA Project
Tanja Ylimäki
3.5.2006

Research Settings

- Objectives:
  - To shed light on the quality management (QM) of Enterprise Architecture (EA)
  - To identify QM activities for EA
- Research process:
  - Literature review
  - Empirical research; focus group interview
  - Consolidation of the results

→ <u>Theoretical</u> perspective to QM activities for EA

Quality Thinking 1: the Juran Trilogy



(based on Juran & Godfrey, 2000)

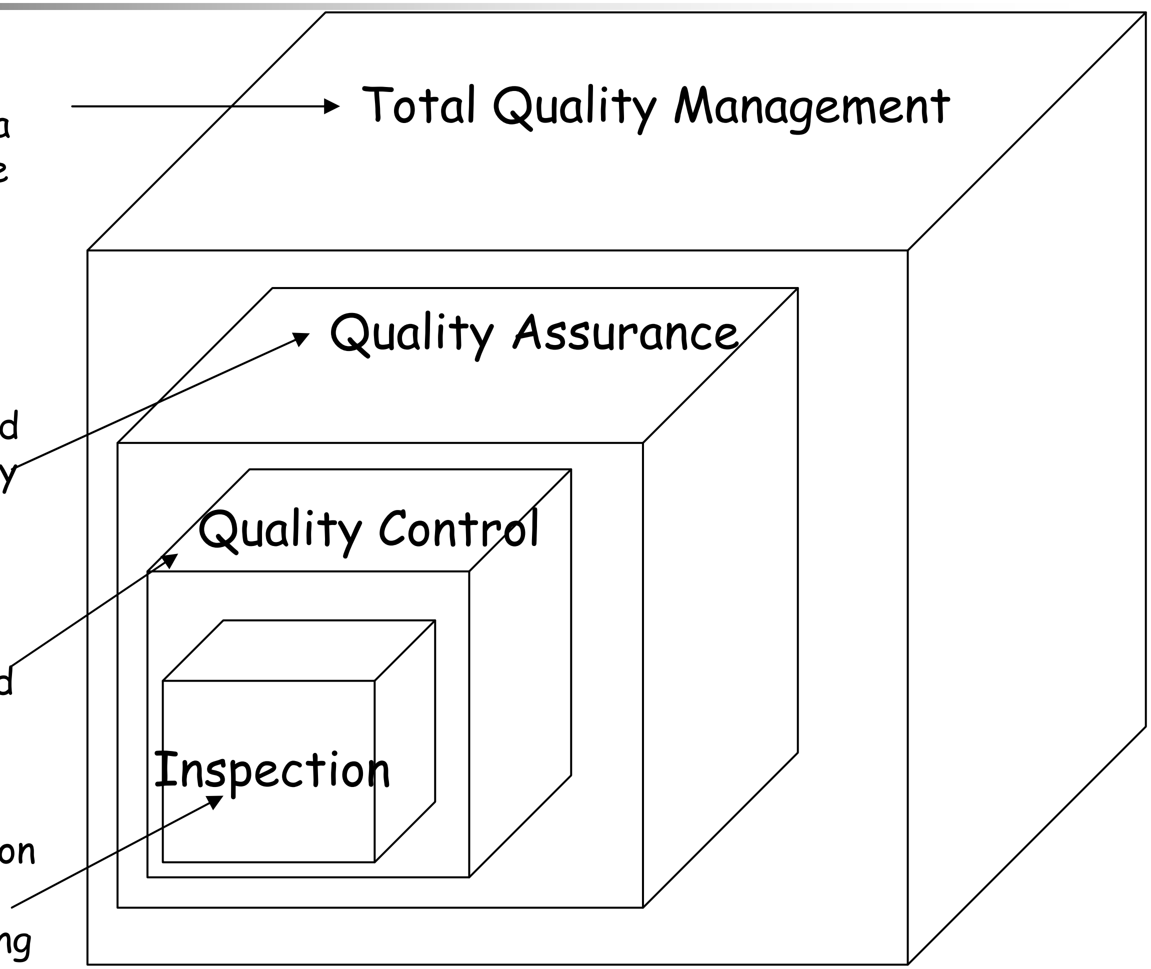
Quality Thinking 2: Levels of the Evolution of TQM

Company-wide approach to quality, with improvements undertaken on a continuous basis by everyone in the organization; is both a philosophy and a set of guiding principles for managing an organization to the benefit of all stakeholders.

Part of quality management focused on providing confidence that quality requirements will be fulfilled (ISO9000:2000); a prevention-based system.

Part of quality management focused on fulfilling quality requirements (ISO9000:2000).

Conformity evaluation by observation and judgement accompanied as appropriate by measurement, testing or gauging (as defined in ISO 9000:2000).



(Dale, 2003, pp. 21)

Enterprise Architecture (EA)

- Identifies the main components[1] of the organization, its information systems, the ways in which these components work together in order to achieve defined business objectives, and the way in which the information systems support the business processes of the organization

- It takes a holistic view of the enterprise's IT resources rather than an application-by-application view

[1] E.g. Staff, business processes, technology, information, financial and other resources

(Kaisler et al., 2005)

Some Characteristics of an EA of High Quality

- Conforms to the agreed and fully understood business requirements + business strategies
- Fits for the purpose (e.g. to gain business value through EA)
- Satisfies the various stakeholder groups' (e.g. the top management, IT management, architects, developers) expectations in a cost-effective way
- Understands both the current needs and the future requirements
- Is understood, accepted and used in every day business functions
- Brings value to the organization

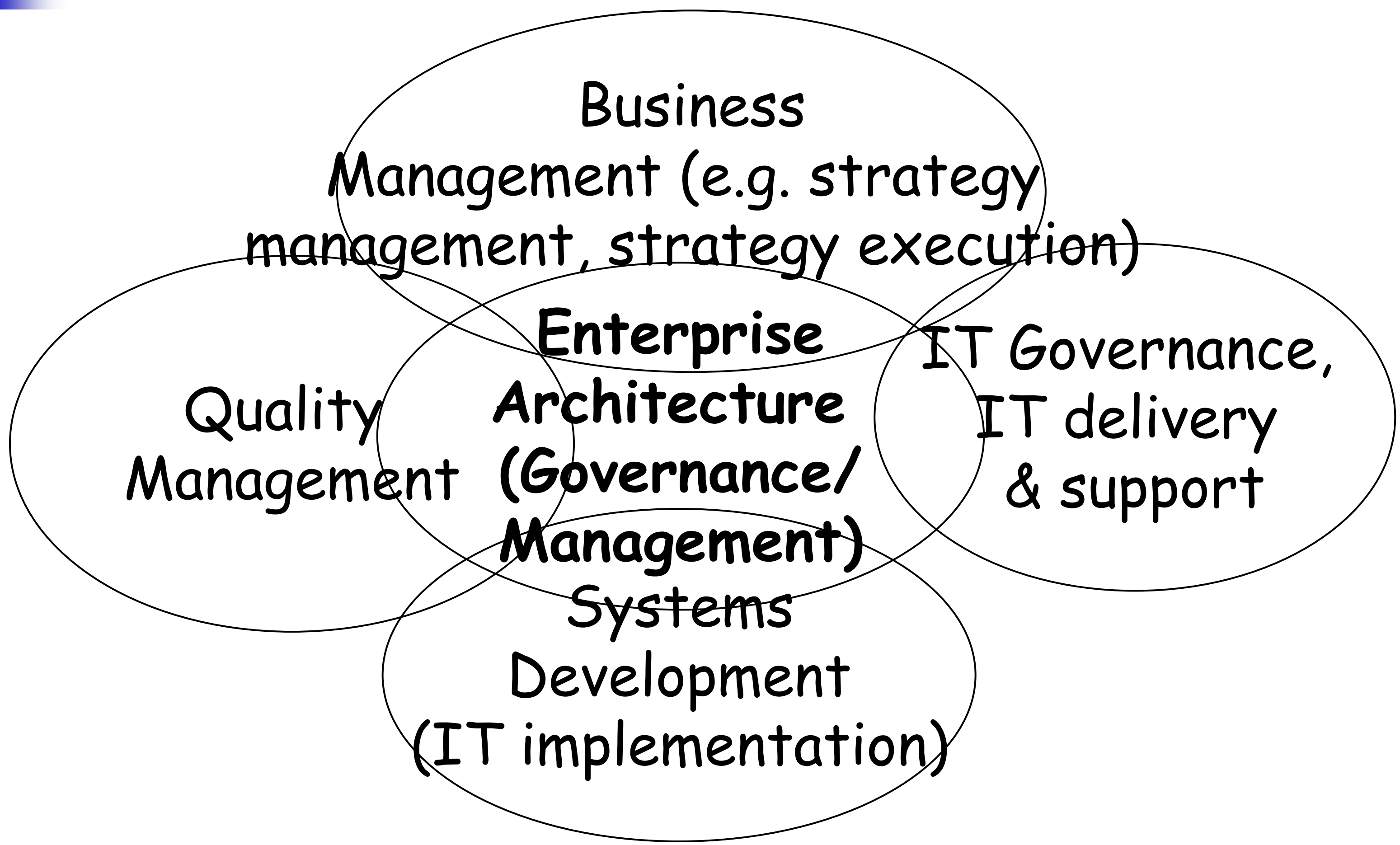
EA Maturity vs. EA Quality

- Most maturity models have their roots in the field of TQM
- Maturity as a word means “ripeness” and it conveys the notion of development from some initial state to some more advanced state (Fraser, Moultrie et al. 2002)
- Also quality improvement evolves step by step
- Maturity models are one means or approach of advancing the quality of EA

Quality Management of EA

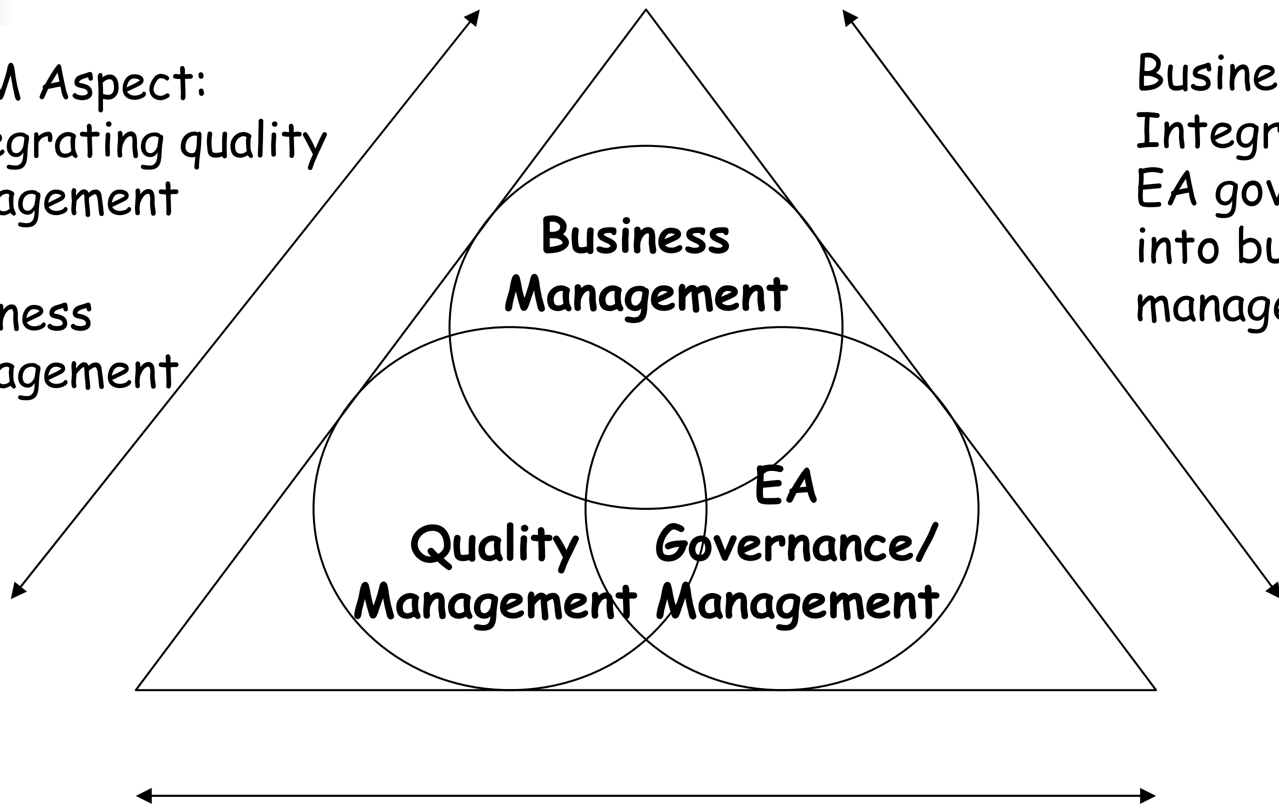
- It is about defining and conducting all those activities needed to reach an EA of high quality
- Relates to the same perspectives than the quality of an EA
  - Quality of EA governance process
  - Quality of EA development process
  - Quality of EA artifacts/specifications
  - Quality of implemented EA – the EA conformant systems and software
  - Quality of use?

Some Management Activities in an Organization



"The Management Triangle"

TQM Aspect:
Integrating quality management into business management

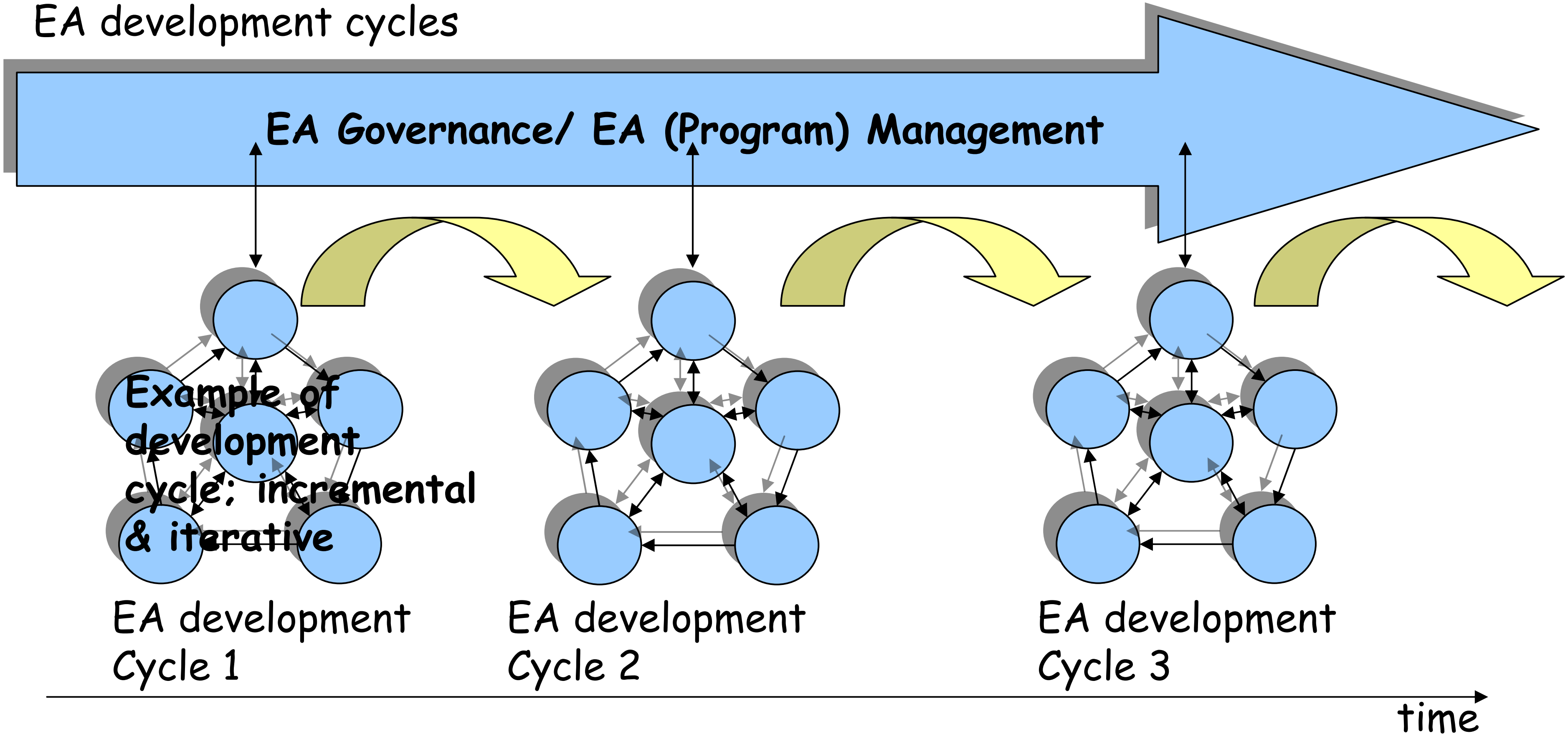


Business-Driven EA:
Integrating EA governance into business management

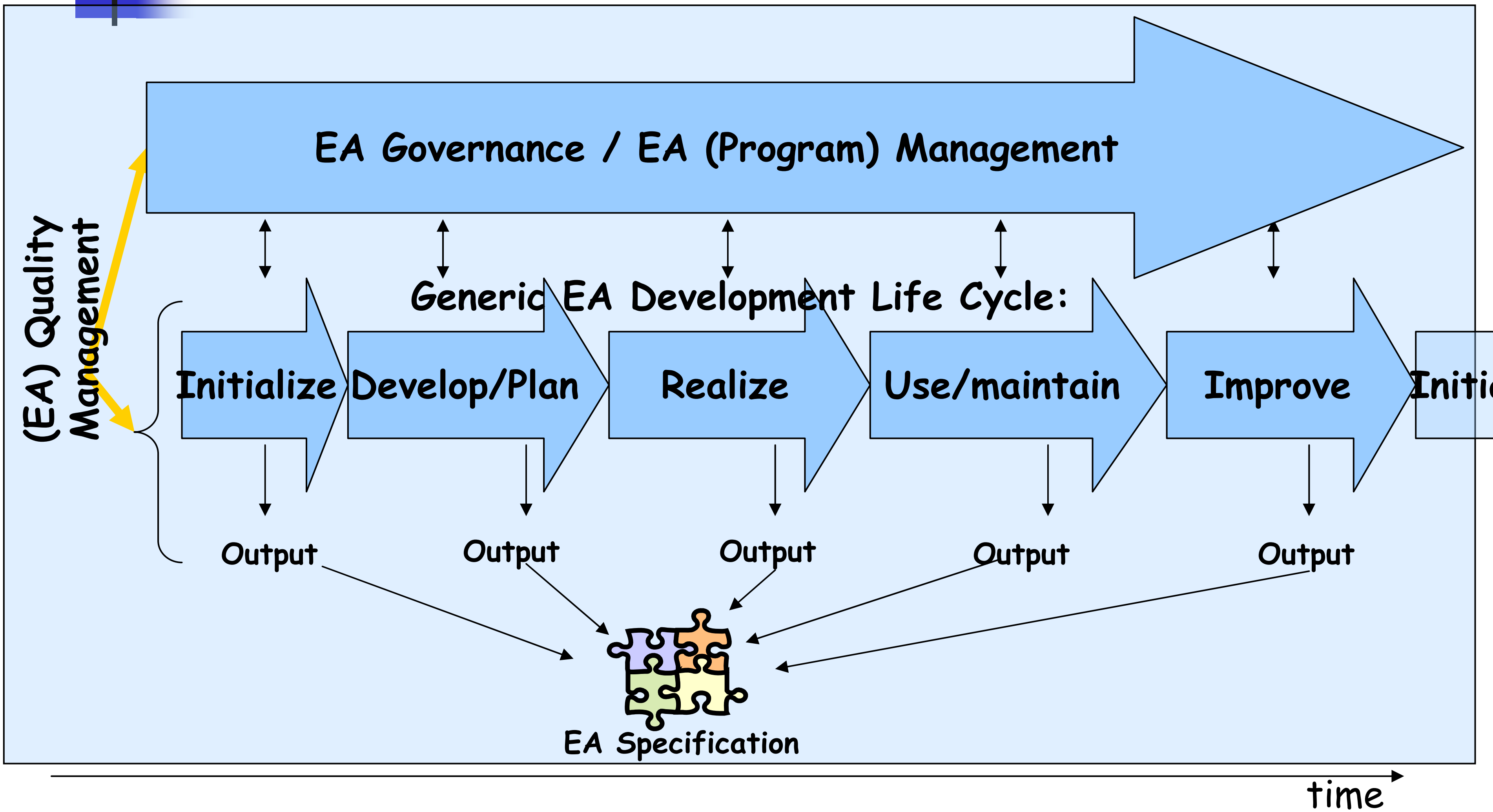
EA Quality Aspect:
Integrating (some) quality management (tasks) into EA governance

EA governance vs. EA development cycles

EA governance process supports the iterative and incremental EA development cycles



Theoretical Perspective to Quality Management of EA



QM Activities within the EA Governance Process

- Define the quality policy and quality objectives
- Define the architectural starting points, such as
  - Key stakeholders
  - Vision, objectives, principles, scope, intended use of the EA, etc.
  - Framework
  - Terms and concepts (basics for common language)
- Establish the EA governance structures (incl. responsibilities)
- Define communication, documentation and review policies
- Define risk and change management strategies
- Do quality measurement planning for EA (→ measure the processes)
- Do resource management (establish the EA team, assign or estimate other resources and train people/develop a training plan)
- Develop the EA methodology (develop the process, select appropriate modeling languages and techniques, and tools)

QM Activities within the EA Development Life Cycle

Initialization	▪ Define/refine scope, vision, objectives etc. ▪ Define the depth of EA ▪ Identify internal and external stakeholders and discover their needs
EA Development	▪ Model the current and the target EA ▪ Ensure traceability ▪ Do migration planning ▪ Do quality control and assurance
Realization	▪ Implement the plans; conduct and support EA conformant projects (→ IS development and project management practices) ▪ Do quality control and assurance
EA Usage	▪ Continuously track for changes and new (business) requirements ▪ Do quality control and assurance
Improvement	▪ Plan for continual improvement ▪ Evaluate the maturity of the current EA → improvement needs ▪ Plan a new development cycle

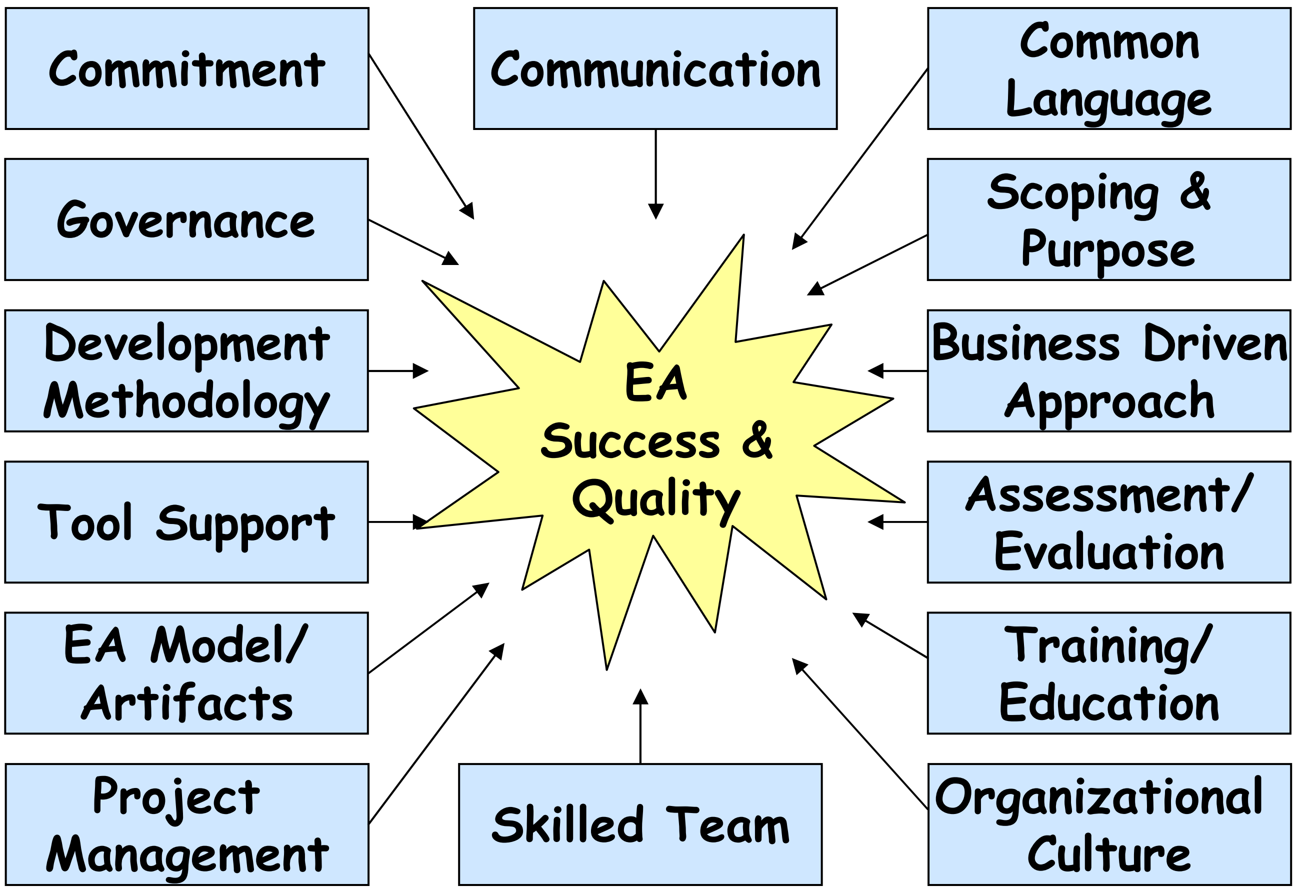
Conclusions 1/2

- A (theoretical) perspective to QM of EA was provided
  - QM activities for EA were derived from general QM activities & EA management/development activities
  - QM activities for EA were integrated into the 1) EA governance process and 2) the phases of the EA development life cycle
- Suggests a vision or a "big picture" of what activities could and should be included in the EA governance and development processes rather than offering a ready-made package for QM of EA to be put into action

Conclusions 2/2

- Preliminary study, strong generalizations cannot be made, but there seems to be a need to
  - shift from investment decisions driven EA development to EA governance driven development
  - increase the maturity of the EA governance and development processes
  - develop metrics for controlling, assessing and evaluating e.g. the quality, maturity and performance of EA

Potential CSFs for EA



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Quality Management Activities in Software Architecture Process

Quality Management of Enterprise and Software Architectures

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Study Description

- *The goal*: To identify SA management related activities that could be suggested to promote the achievement of high quality architectures.
- *Research data*: literature and practitioners' experiences
- *Research method*: literature review, constructive approach, group interview
- *The application of the results*:
  - The identified activities are proposed to be taken into account in the software architecture management process design, development and capability assessment.

Current State of Architecture Management (1/2)

- Architecture management is spread out to many processes in organisations.
  - Architecture management processes are not so clearly separate processes in organisations.
  - Architecture and architectural quality controlling and driving activities may be included in, for example, in investment planning, project management, the organisation's processes management and system development process.

- A need to move from architectures driven by investment planning and system development towards architectures driven by architecture management
  - Single investments on software or a system (e.g. ERP investments) and single system development projects in organisations may drive the organisations' architectures and architectural quality more than organisations' architectural designs and visions (e.g. enterprise architecture).

- A need of architecture management practices and process models that aim at high-quality architectures
  - This study gives answers to the question what activities should or could be executed in architecture management that would focus on the architectural quality.

Current State of Architecture Management (2/2)

- A need to advance the maturity of architecture management processes
- A need for agility in architecture management and development
  - Architecture processes cannot be too heavy (e.g. require a lot of time and resources) although those processes could produce ideal architectures.
- A need for metrics and metric programs for architectural maturity and quality

Results: Quality Management Activities of SA

The QM activities of SA can be divided as follows:

1) Activities that relate to the quality management of SAM process.

These activities are included in the organization's processes and project management and concentrate on the quality of SAM-process (*process quality aspect*)

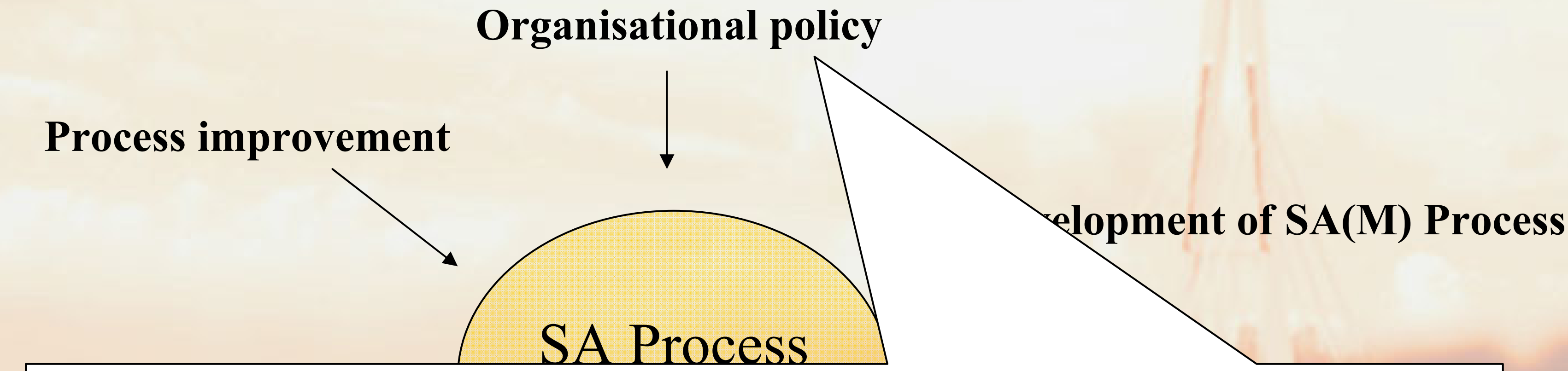
.

2) Activities that relate to the quality management of SA.

These activities are included in the SAM-process phases and concentrate on the achievement of software architecture of good quality (*product quality aspect*).

Quality Management Activities for SAM Process

Quality Management Activities for SAM Process

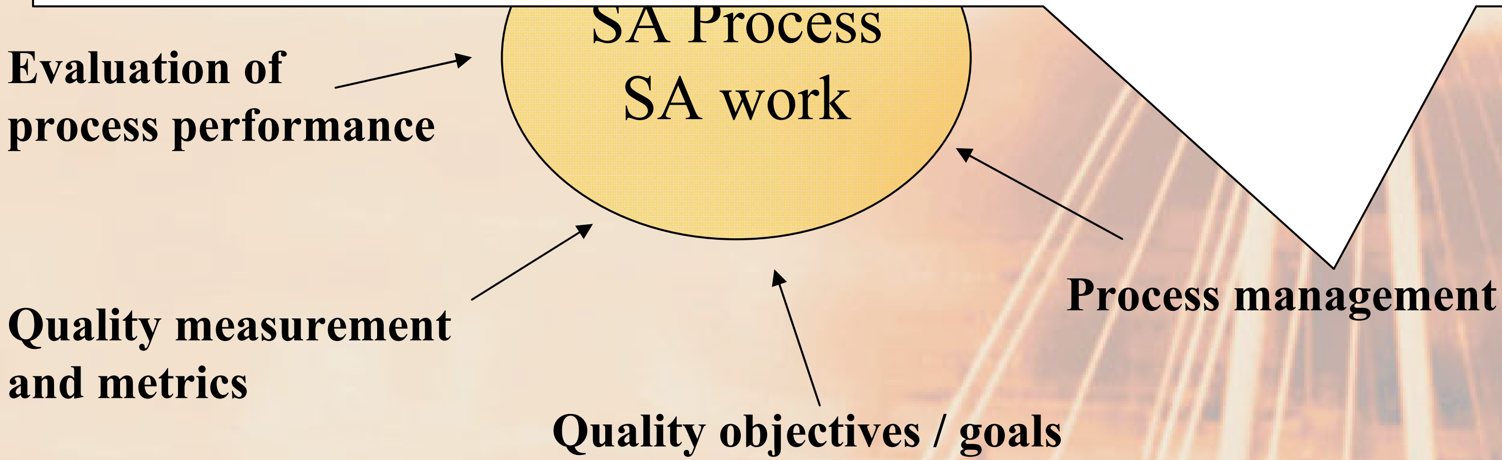


Organisational Policy		
Establishing and maintaining an organisational policy for planning and performing the software architecture management (SAM) process.	[5], [FGI] = according to focus group interview	

Quality Management Activities for SAM Process

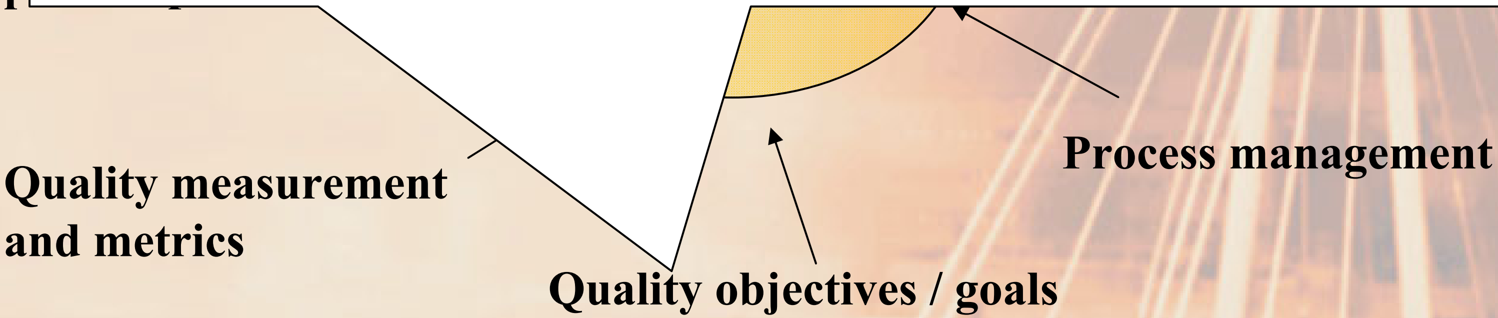
Development of SAM Process		
Planning and developing a process which is able to produce and manage the software architecture in the operating conditions.	[5], [12], [FGI]	Paying attention especially to: • the change management of requirements and architectural designs and • the document management of architectural documents.
Proving then that the process can produce, develop and manage software architectures under operating conditions.	[12], [FGI]	
Optimizing the process features and goals.	[12], [FGI]	
Maintaining the plan for performing the SAM process.	[5]	
Establishing and maintaining the description of the SAM-process.	[5]	
Transferring the SAM-process to operations.	[12]	Implementing the plan for transfer and validating transfer.

Process management		
Providing resources (e.g. staff, time, funding) and assigning responsibility and authority for performing the SAM-process, developing the architecture related work products, and providing the services of the SAM-process.	[5]	
Identifying and involving the relevant stakeholders of the SAM-process as planned.	[5]	
Training and advising the people performing or supporting the SAM-process as needed.	[5], [FGI]	



Quality Management Activities for SAM Process

Quality Objectives / Goals		
Establishing and maintaining quantitative quality objectives for the SAM-process that address quality and process performance based on customer and stakeholder needs and business objectives.	[5], [FGI]	
Establishing general (no project-specific) optimal quality goals for the SAs that are produced by SAM-process.	[12], [FGI]	



Quality Management Activities for SAM Process

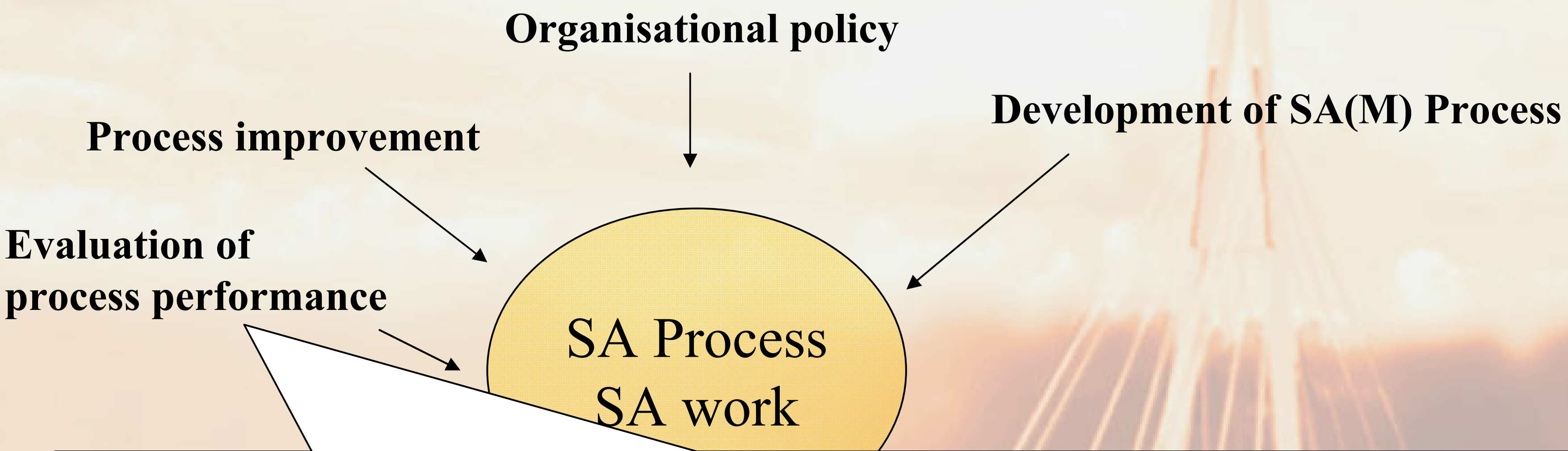
Quality Measurement and Metrics		
Planning process measurements.	[12], [FGI]	Deciding what aspects of the SAM-process to measure and choosing the metrics.
Planning software architecture evaluation.	[12], [FGI]	Deciding what aspects of the software architectures to evaluate and choosing the metrics.

Quality measurement and metrics

Quality objectives / goals

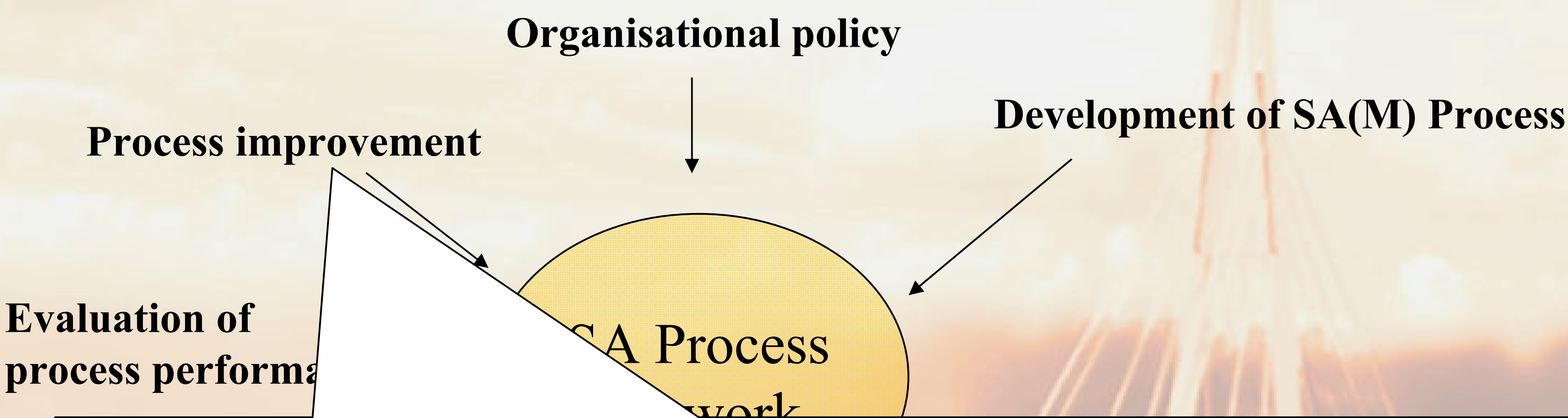
Process management

Quality Management Activities for SAM Process



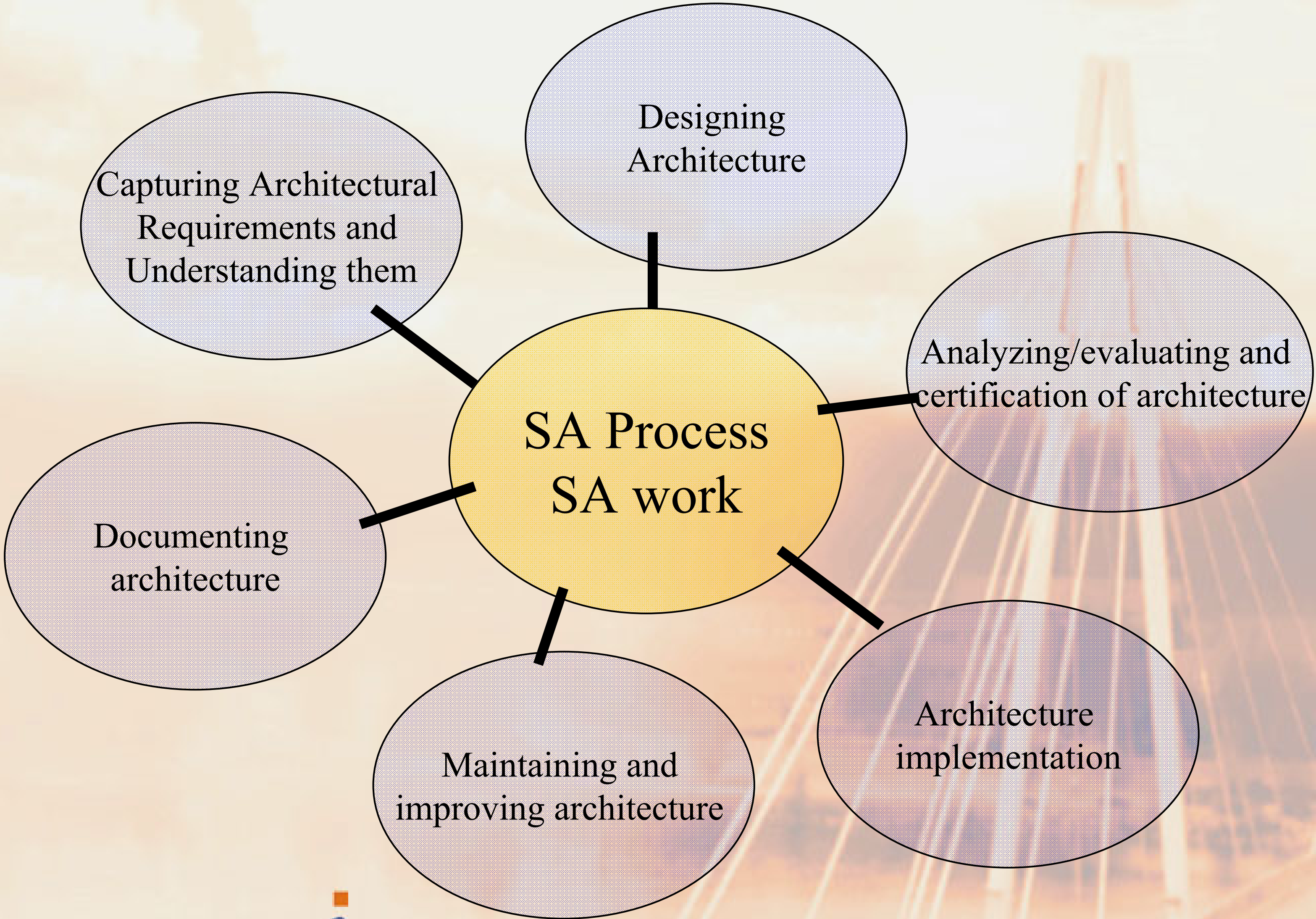
Evaluation of Process Performance		
Evaluating the actual performance of the SAM-process, comparing the actual performance of the process with quality goals and acting on difference.	[5], [12]	
Monitoring and controlling the SAM process against the plan for performing the process and taking appropriate corrective action.	[5]	
Objectively evaluating adherence of the SAM-process against its process description, standards, and procedures, and addressing non-compliance.	[5]	
Reviewing the activities, status, and results of the SAM-process with higher level management and resolving issues.	[5]	

Quality Management Activities for SAM Process

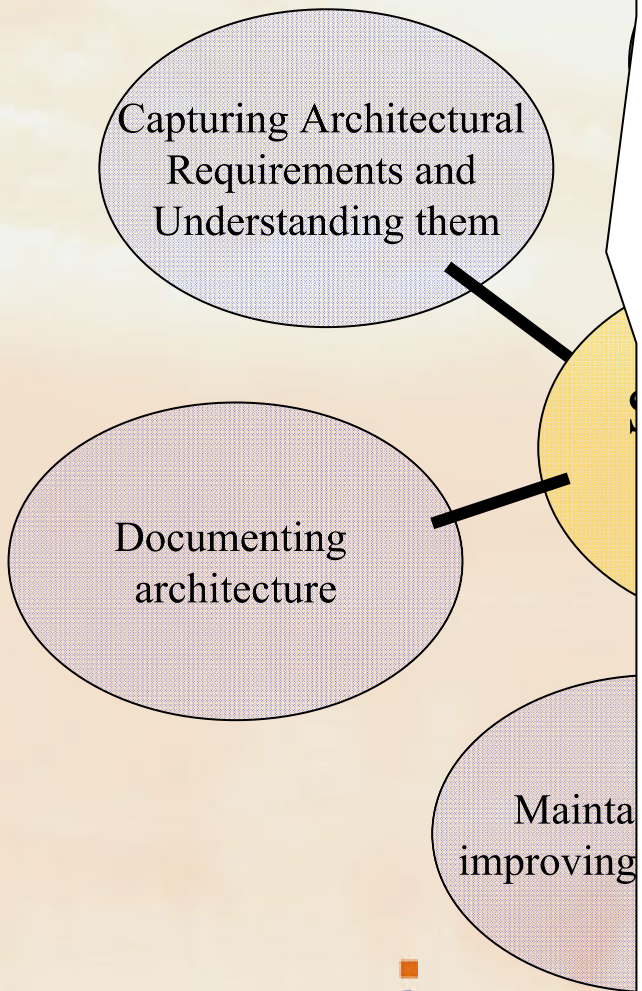


Process Improvement		
Ensuring continuous improvement of the SAM process in fulfilling the relevant business objectives of the organisation.	[5]	
Collecting work products, measures, measurement results and improvement information derived from planning and performing the SAM process and from architectures produced by the SAM process.	[5], [FGI]	Information can be used to support the future use and improvement of the organization's processes, process assets and architectures.
Identifying and correcting the root causes of defects and other problems in the SAM process.	[5]	

Quality Management Activities of SA



Quality Management Activities of SA



Requirements Collection

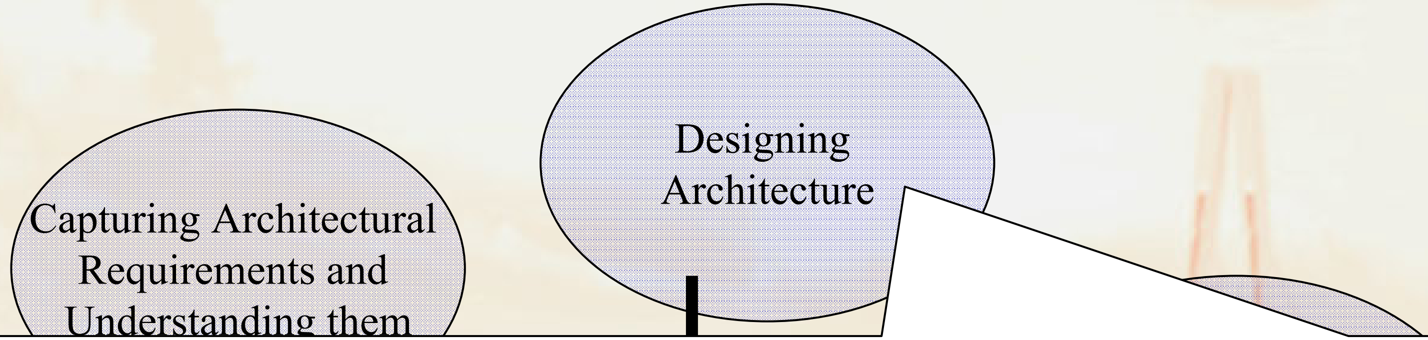
- Planning the collection of requirements. Planning to collect customer and stakeholder needs (“af = adapted from [12]).
- Identifying customers and stakeholders. Identifying both internal and external customers and stakeholders (af [12]).
- Identifying what requirements and boundaries organisation’s strategy and ICT strategies set for the system [FGI].
- Identifying all relevant standards, regulations, and policies (af [12]).
- Describing the existing environment and identifying boundaries that the existing environment sets for the system [FGI].
- Identifying the possible change situations. Identifying how the company’s environment and the system operation environment may change. [FGI]
- Identifying also the long term requirements for architecture [FGI].
- Finally, collecting the requirements. Collecting a list of customers’ and stakeholders’ needs, expectations, constraints, and interfaces in their language (af [5, 12]).

Analysis of Requirements

- Analyzing, validating and prioritizing customers’ and stakeholders’ requirements and needs (af [12]). Grouping together related requirements and needs (af [12]).
- Developing a definition of required functionality and quality attributes for the system (af [5]).
- Identifying architecturally significant needs/requirements by identifying architecturally significant functionality and architecturally significant quality attributes of the requirements definition [FGI].
- Executing language transfer. Translating architecturally significant needs and requirements into the language of a software architecture development team (af [12]).

TIETOT

Quality Management Activities of SA



Preparation for architectural design

• Identifying what is needed so that the architectural designs can be delivered without deficiencies (af [12]). Defining design process and other practices.

• Determining methods for identifying architectural features (af [12]).

Architectural design

Designing and developing a software architecture that can respond to the needs and suit the environment (af [12]).

• Firstly, determining which architectural features and goals will provide the optimal benefit for the customer/stakeholders (af [12]).

• Selecting main structures of architecture by selecting high-level architectural features and goals (af [12], [FGI]).

• Selecting and designing detailed structures of architecture. Developing detailed architectural features and goals (af [12], [FGI]).

• Addressing all relevant standards, regulations, and policies (af [12]) in the design process.

• Optimising architectural features and goals. Optimising the software architecture features so as to meet stakeholder needs as well as customer needs (af [12]).

• Finally, setting and publishing the final architectural design.

Quality Management Activities of SA

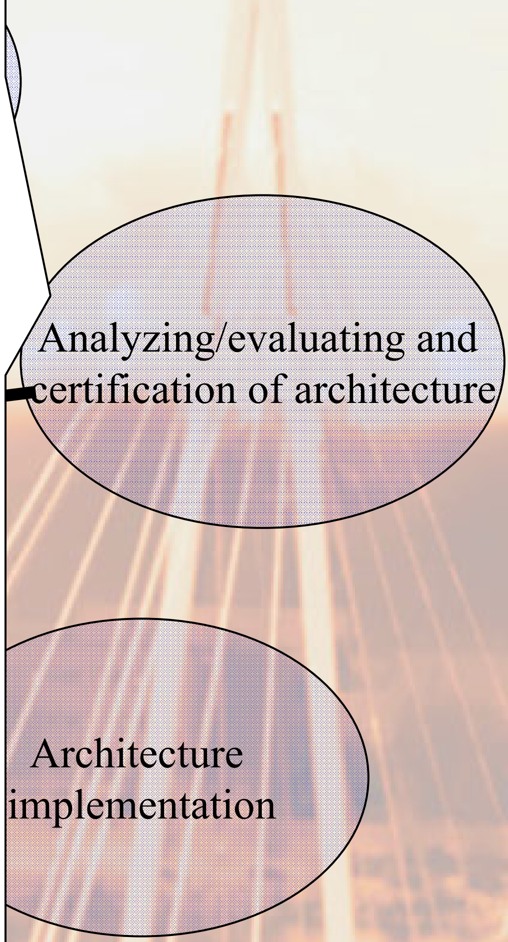
- Establishing project-specific optimal quality objectives for software architecture (af [12], [FGI]).

- Deciding the evaluation criteria and metrics by creating project-specific measurements of quality for software architecture (af [12], [FGI]) and identifying the unit of measurement for each customer need [12].

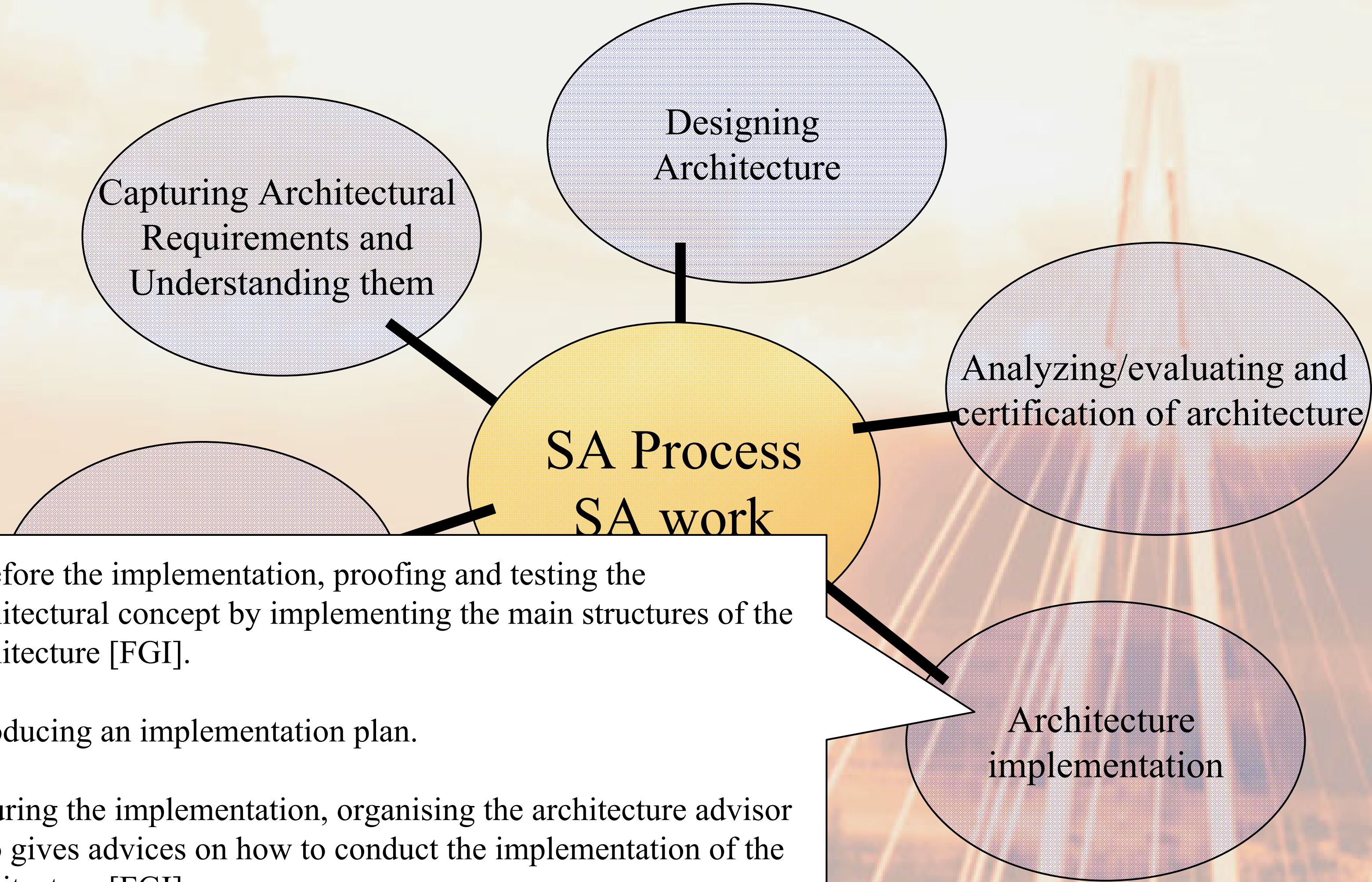
- Deciding the explicit criteria to be used in evaluating alternative architectural designs and design features.

- Executing the evaluations. Evaluating and measuring architectural features in the suitable phases of the system life cycle (af [12], [FGI]).

- Executing the certification of architecture. Architecture certification can be seen as an act of attesting that the system will meet a certain standard or, generally, as an act of verifying conformance with certain requirements.



Quality Management Activities of SA



• Before the implementation, proofing and testing the architectural concept by implementing the main structures of the architecture [FGI].

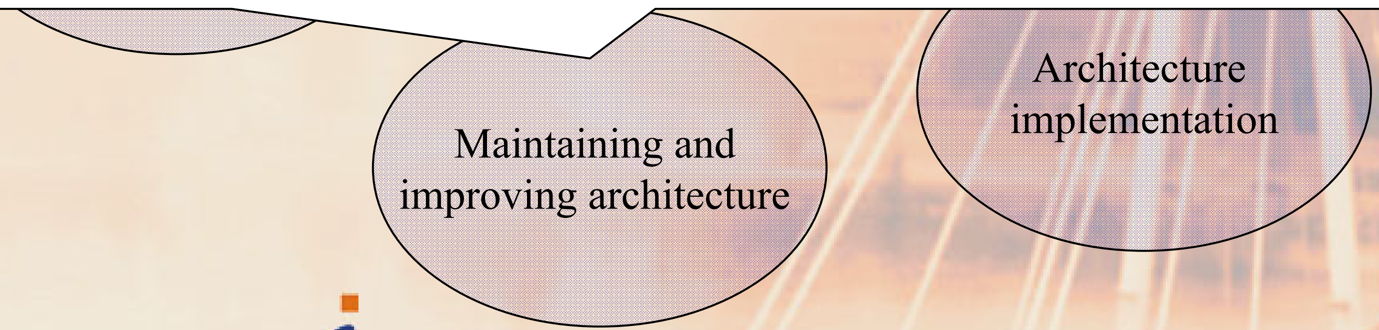
•Producing an implementation plan.

• During the implementation, organising the architecture advisor who gives advices on how to conduct the implementation of the architecture [FGI].

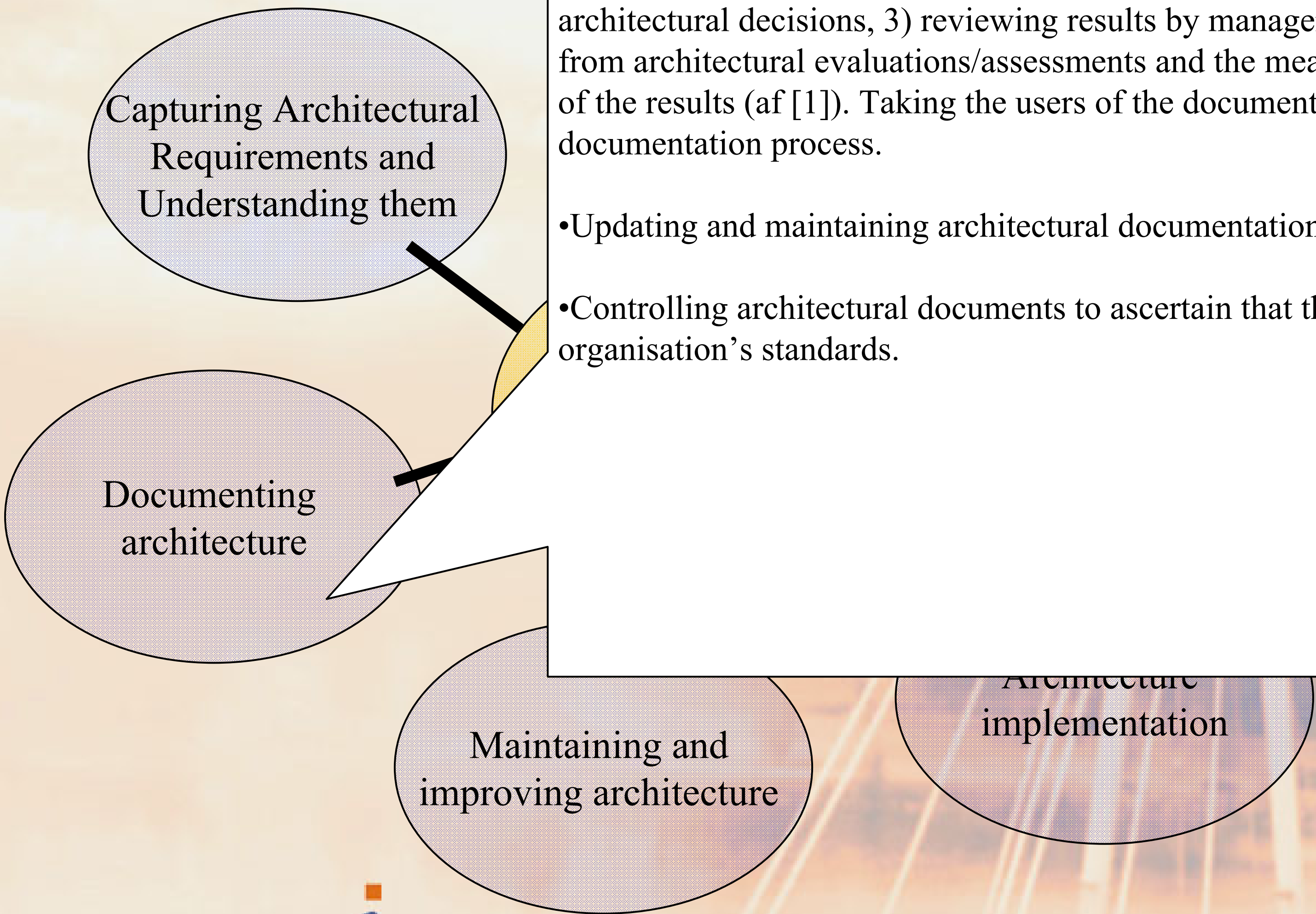
• Collecting feedback from the architecture implementation (e.g. problems occurring in the architecture implementation) [FGI].

Quality Management Activities of SA

• During the system maintenance, identifying and correcting the causes of defects and other problems in the architecture (af [5]).
• Making other minor changes for the architecture (e.g. construction of a new interface to the system in the integration situation) [FGI].
• Identifying the development needs of the architecture.
• Províng the development or improvement needs of the architecture (af [12]).
• Establishing the infrastructure for improvement (af [12]). Identifying the improvement project(s) and establishing project team(s) (af [12]). Providing the teams with resources, training, and motivation to 1) diagnose the causes and 2) stimulate remedies (af [12]).
• Conducting a diagnostic journey from symptom to cause. This includes analyzing the symptoms, theorizing as to the causes, testing the theories and establishing the causes (af [12]).
• Conducting a remedial journey from cause to remedy. This includes developing the remedies, testing and proving the remedies under the operating conditions, dealing with resistance to change, and establishing controls to hold the gains (af [12]).
• Finally, implementing remedies and controls (af [12]).



Quality Management Activities of SA



- Documenting at least the following aspects: 1) input information for architectural design and development, 2) architectural plans including architectural decisions, 3) reviewing results by management, and 4) results from architectural evaluations/assessments and the measures taken because of the results (af [1]). Taking the users of the documentation into account in documentation process.

- Updating and maintaining architectural documentation [FGI].

- Controlling architectural documents to ascertain that they correspond to the organisation's standards.

Summary

- This study identified activities that are suggested to promote the achievement of high-quality architectures.
- Activities relate to the QM of SA process and QM of SA.
- The criticality and execution of these activities in system development need to be assessed based on surveys directed to ICT service providers and user organisations.

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Role of Architecture Evaluations in ICT-companies

AISA-project
Quality Management of Enterprise and Software Architecture

Motivation

- Architecture evaluation is
  a way to get answers to company's business and ICT related information needs, questions and topics of concerns.

- Open questions:
  - What roles and meanings may architecture evaluations have in ICT-companies?
  - How architecture evaluation can be utilized in companies?

Study Description

- Aim:
  - To gain understanding of the meanings and roles, which architecture evaluation and measurement may have in companies
  - To identify triggers for architecture evaluations

- Research data:
  - Focus group interview of five ICT-companies practitioners

Architecture Descriptions (ADs)

- Communication vehicles in architecture evaluations
- Ads can be used :
  - to define the scope and aspects of evaluations
  - to present existing knowledge, decisions and facts relating to company's business and ICT
- ADs in companies:
  - Enterprise architecture descriptions
  - Software architecture descriptions

EA descriptions
Enterprise Architecture Viewpoints

- Business architecture
- Information / Data architecture
- Application / Systems Architecture
- Technical / Technology / Infrastructure architecture
- ….

(Open group, 2006; IT Governance Institute, 2005; Whittle et.al, 2005)

SA descriptions
Software Architecture Viewpoints

- Functional
- Information
- Behavioral / Concurrency
- Development / External
- Deployment
- Operational
- ….

(May, 2005; Rozanski & Woods, 2005)

Results and observations:

Status of architecture evaluations in ICT-companies

- More trigger-based than stabilized work in companies.
- Has several meanings, roles and use purposes in companies.
- A motivation for evaluation define the material and architectural viewpoints to be viewed.
- The bad quality and lack of architecture documentation may have an effect on the possibilities to execute architecture evaluations.

Triggers for Architecture Evaluations

- **Company and business management:**
  Support needs for organisation's structural design (e.g. business process design) and for the distribution of the work (e.g for out-sourcing).
- **Holistic view:**
  Understanding needs relating to the current status of organisation's business and ICT-environment.
- **IT cost management:**
  Financial information needs relating to company's ICT (applications and technical infrastructure).
- **Change management:**
  Change pressures relating to architectures and architectural principles – identification of probability and nature of changes that should be made and decision making about changes.

Triggers for Architecture Evaluations

- **Quality management:**
  Quality questions relating architectural documentation, the company's information/data structures, application and technical infrastructure, as well as systems solutions.
- **Architecture management:**
  Confirming that architecture related work meets expectations e.g. investments correspond to the architectural principles.
- **Architectural choices:**
  Evaluation of architectural alternatives against quality, cost and other aspects.

Quality management related architecture evaluations

A need to produce architectural models and documentations that - can be quickly communicated and - are understandable by many different stakeholders - are cost-effectively kept up to date.	The evaluation the quality of architectural documentation. A need to evaluate: - Policy: do policies (e.g architectural framework) exist for documentation and are they followed? - Intelligibility and usability: are documents easy to understand and use? - Accuracy: are documents truthful and factual? - Cost effectiveness of maintenance: how much effort is needed to keep models and documentation up to date? - Traceability between architectural documents: is there traceability between architectural documents?	Architecture documentation (EA / SA)
A need to have organisation's business environment descriptions of good quality	The evaluation existence and quality of business descriptions (goals, strategy, company's operations) : •existence of business descriptions (e.g. goals, strategy, company's operations) •Accuracy: are the descriptions up to date?	Business architecture documentation
A need to have information / data models of good quality	The evaluation of the quality the information / data models	Information/ Data architecture

Change management related architecture evaluations

A change need in the business or ICT (e.g. a need to move from one solution to another)	The evaluation and identification of the places affected by a change and effects in each architectural viewpoint.	EA viewpoints
An observation that ICT-architecture do not correspond to company's business's requirements	The evaluation how the enterprise architecture should be changed by identifying what chances should be carried out in each architectural viewpoint.	EA viewpoints

Holistic view needs related architecture evaluations (1/2)

A need to enhance the understanding of company's business/ICT	The evaluation of enterprise architecture from different aspects or against different factors e.g. the identification of overlaps.	EA viewpoints
A goal that ICT supports business	The evaluation of how business architecture is supported by other viewpoints (information, applications, infrastructure).	EA viewpoints
A need to enhance the understanding of responsibilities in the company	Identification and evaluation of responsibilities in company (for example who is responsible for customer informations).	Business architecture
A need to understand the state of the company's product portfolio and processes	The description and evaluation of business architecture related aspects.	Business architecture

Holistic view needs related architecture evaluations (2/2)

A need to understand information managed in company	The description of major information entities and responsibilities in information management.	Information / Data architecture
A need to understand the state of the company's application portfolio	The description and evaluation of structures and components of application architecture.	Application architecture
A need to understand quality aspects relating to the company's application portfolio	The evaluation the application architecture against quality aspects and attributes e.g. the identification of overlaps.	Application architecture
A need to understand the current state of technical infrastructure	The description and evaluation of structures and components of technical infrastructure.	Technology architecture

Company and business management related architecture evaluations

A need to make sure that organisational choices are suitable	The evaluation of organisational structures and operations: are those suitable or should those be changed.	Business architecture
The distribution of work	The evaluation of processes: identification of which tasks will be carried out by the company and which are dealt out to partners.	Business architecture
Business process planning	The evaluation of functionality of business processes: e.g. do processes correspond to company's strategy?	Business architecture

Architecture management related architecture evaluations

An observation that ICT-architecture does not correspond to ICT-development projects' needs	The evaluation of how architectural principles or architecture descriptions should be changed.	EA viewpoints
An effort to drive investments to follow up architectural principles	The evaluation of if the investment corresponds and is suitable to the existing architecture and architectural principles.	EA viewpoints
A need to drive technical infrastructure investments to follow the architectural principles	The evaluation of if investments correspond to the principles.	Technology architecture principles

IT cost management related architecture evaluations

A need to understand and manage costs relating to the company's application portfolio	The evaluation of financial aspects and factors relating to application architecture	Application architecture
A need to understand and manage costs relating to technical infrastructure	The evaluation of financial aspects and factors relating to technical infrastructure	Technology architecture

Architecture choices related architecture evaluations

A need to find the best possible system solution and a need to understand the aspects relating the solution	The evaluation of the architectural solution: e.g. evaluation of • quality aspects (evaluation against quality attributes), • flexibility of solution, • the life cycle of solution, • suitability for the situation in question (e.g is solution possible within available time, money and resources).	SA viewpoints (EA viewpoints)
An effort towards long-term technical solutions and need to argue for the long-term technical solutions	The comparison of a long-term and short-term solution.	EA / SA viewpoints

Conclusion

- Architecture evaluations seem not yet to have a stabilized role and meaning in companies.
- Architecture evaluation practices are still immature in general.
- Results of this study:
  Triggers for architecture evaluations were identified.
- Future questions:
  – What kind of stabilized role architecture evaluation could have in organisations?
  – How architecture evaluations and measurement could be linked to an organisation's other measurement and evaluation programs and practices?

AISA Project : Reports

Title	Author(s)	Type and date
Architectural Work Status: Challenges and Developmental Potential. A Case Study of Three Finnish Business Enterprises.	Niemi Eetu	report, 30.8.2006, 21 p.
Architecture Evaluation Methods.	Hoffmann Martin	report, 2.5.2007, 64 p.
Architecture Planning and Decision Making in Companies.	Niemi Eetu and Hämäläinen Niina	report (slides), 6.3.2008, 39 p.
Assessing Architectural Work - Criteria and Metrics for Evaluating Communication & Common Language and Comment.	Ylimäki Tanja	report, 9.2.2007, 37 p.
Bibliography	Niemi Eetu, Ylimäki Tanja,Hoffmann Martin and Hämäläinen Niina	report, 13.8.2007, 93 p.
Enterprise Architecture Risks - An Overview.	Niemi Eetu & Ylimäki Tanja	report, 6.3.2008, 23 p.
Evaluating the Benefits of Architectural Work.	Niemi Eetu and Ylimäki Tanja	report, 26.3.2007, 33 p.
Evaluating Business-IT Alignment in the Architecture Context.	Niemi Eetu and Ylimäki Tanja	report, 4.12.2007, 27 p.
Evaluating Enterprise Architecture Compliance.	Ylimäki Tanja, Niemi Eetu and Hämäläinen Niina	report, 19.4.2007, 20 p.
Evaluation Needs for Enterprise Architecture.	Ylimäki Tanja and Niemi Eetu	report, 18.10.2007, 38 p.
Measurement in Enterprise Architecture Work - The Enterprise Architecture Team Viewpoint.	Hämäläinen Niina, Niemi Eetu and Ylimäki Tanja	report, 16.3.2007, 16 p.
Quality Evaluation of Architectural Documentation and Models.	Hämäläinen Niina	report, 19.12.2007, 30 p.
Quality Management Activities for Enterprise Architecture.	Ylimäki Tanja	report, 4.5.2006, 27 p.
Quality Management Activities in Software Architecture Process.	Hämäläinen Niina	report, 3.5.2006, 18 p.
Success and Failure Factors for Software Architecture.	Hämäläinen Niina, Markkula Jouni, Ylimäki Tanja, Sakkinen Markku	report, 11.1.2006, 25 p.
The Role of Architecture Evaluations in ICT-companies.	Hämäläinen Niina, Ylimäki Tanja, Niemi Eetu	report, 1.11.2006, 23 p.
Towards Critical Success Factors for Enterprise Architecture.	Ylimäki Tanja	report, 11.1.2006, 35 p.

UNIVERSITY OF JYVÄSKYLÄ
INFORMATION TECHNOLOGY
RESEARCH INSTITUTE

Architectural Work Status: Challenges and Developmental Potential A Case Study of three Finnish Business Enterprises

AISA Project Report

Version: 1.0	Date: 30.8.2006
Author: Eetu Niemi	Status: Final

Contents

Summary

This report describes the work done in the third phase of the AISA project's first year. The objective of this phase was to chart the current status of Enterprise Architecture (EA) and Software Architecture (SA) work (architecture planning, development and management), architecture work challenges and needs for development in the case companies. In this report, an evaluation framework for analyzing the architectural work status in the case companies is constructed according to literature and the output from the previous phases of the project.

Data-based case study was chosen as a research method and semi-structured focus group interviews were used to gather information. The Critical Success Factors of EA and SA and architecture maturity models were the basis for the evaluation framework used in the study. The framework consists of 1) the areas of architectural work, 2) the interview questions related to these areas, and 3) maturity levels. The current status of architectural work in the case companies was charted and the challenges and developmental potential of architectural work discussed.

Generally, architectural work in the case companies is currently under development or in initial state. Accordingly, the maturity levels of the architectural work areas were 1 or 2. The strongest areas of architectural work were 1) *Development Framework*, 2) *Communication & Common Language*, 3) *Skilled Team & Training / Education*, 4) *Project Management* and 5) *IT Investment and Acquisition Strategies*. To further develop their architectural work, companies could focus especially on the following areas: 1) *Scoping and Purpose*, especially the benefits and objectives of architectural work and architectures, 2) *Commitment*, 3) *Assessment / Evaluation*, 4) *Governance* and 5) *Business-Driveness*, especially the business requirements of architectures.

1 Introduction

During the recent years, ***Enterprise Architectures (EA)*** have gained considerable attention by business organizations and academia alike. According to the Open Group, a good EA can bring important business benefits, such as making IT operations more efficient, increasing the returns on existing investments and reducing the risks on future investments, and making procurement faster, simpler and cheaper (The Open Group 2002). Moreover, communication, decision-making and managing change can be supported and improved by EA (see e.g. CIO Council 2001; Schekkerman 2004b; de Boer, Bosanque et al. 2005). However, investments on organizational, cultural and technical infrastructure are needed to support the architecting process and result in political, project management and organizational challenges (see e.g. Kaisler, Armour et al. 2005).

EA has been defined by Kaisler et al. (Kaisler, Armour et al. 2005) as follows: “enterprise architecture identifies the main components of the organization, its information systems, the ways in which these components work together in order to achieve defined business objectives, and the way in which the information systems support the business processes of the organization. The components include staff, business processes, technology, information, financial and other resources, etc. Enterprise architecting is the set of processes, tools, and structures necessary to implement an enterprise-wide coherent and consistent IT architecture for supporting the enterprise's business operations. It takes a holistic view of the enterprise's IT resources rather than an application-by-application view.” In brief, EA can be seen as a collection of all models needed in managing and developing an organization (see e.g. Halttunen 2002). EA of ***good quality*** can be briefly characterized as one which is used and brings value to the organization (see e.g. Ylimäki 2005).

Despite its importance, the research on EA is currently fragmented. There have been a large number of studies on EA, for example on architecture frameworks (see e.g. Zachman 1987; FEAF 1999; The Open Group 2002; Schekkerman 2004b; Kim, Kim et al. 2005), architecture maturity evaluation (see e.g. IAC 2003; NASCIO 2003; The Office of Enterprise Technology Strategies 2003; META Group Inc. 2004; NASCIO 2004; IAC 2005; OMB 2005a; OMB 2005b), architectural processes (see e.g. Pulkkinen and Hirvonen 2005; Pulkkinen 2006) and to some extent, architecture critical success and failure factors (see e.g. Boehm 1994; Perkins 2003; Rehkopf and Wybolt 2003; van der Raadt, Soetendal et al. 2004; Ylimäki 2005; Hämäläinen, Markkula et al. 2006). Generally, most of the studies have focused on architecture planning and development methods, but the focus has been moving towards architecture management and evaluation. For example, newer studies have also focused on architecture evaluation metrics (see e.g. Shereshevsky, Ammari et al. 2001; Gustafsson, Paakki et al. 2002; Tvedt, Lindvall et al. 2002; Lindvall, Tvedt et al. 2003; Krueger 2004; Rico 2005) and architecture quality management, including e.g. SA quality attributes (see e.g. Losavio, Chirinos et al. 2003; Svahnberg and Wohlin 2005) and quality management activities (see e.g. Hämäläinen 2005; Woody 2005).

Unfortunately, the number of studies on the current architecture work status in organizations is very low. The studies published have focused on describing and evaluating different aspects of EA, which have been studied in the USA on state level by NASCIO (NASCIO 2005) and in a number of government agencies by GAO (GAO 2002). Additionally, IFEAD has conducted a number of studies on the current trends in EA worldwide (IFEAD 2005) and META Group has studied EA maturity in a large number of organizations worldwide (META Group Inc. 2004). Only GAO and

META Group (GAO 2002; META Group Inc. 2004) have clearly evaluated the maturity of EA. These studies illuminate the current EA work status to some extent; still, it seems that publicly available studies on architectural work status are rare. Therefore, more research is needed on this field, especially on the architecture work status in European private sector organizations. One of the aims of the AISA project (Quality Management of Enterprise and Software Architectures) is to provide a contribution for this field of research.

AISA is a three-year industry collaboration research project in the Information Technology Research Institute in the University of Jyväskylä. Among others, the project concentrates on studying and developing evaluation criteria and metrics for evaluating architectures and architecture processes. In the first year, the following points were studied:

- Architecture success factors
- Architecture quality management tasks
- Architectural work status and developmental potential in companies

This report is the result of the third phase of the AISA project's first year. The objective of this phase was to chart the current status of Enterprise Architecture and Software Architecture (SA) work (architecture development and management), architecture work challenges and needs for development in the case companies. Data-based case study was chosen as a research method since the objective was to disclose matters which would be of interest in the following phases of the project and which would require special attention. Therefore, strict research questions were not defined.

The remainder of this report is organized as follows. In the next section, we describe the research method used in this study. In the section 3, we briefly discuss the current status of architectural work in each of the case companies. In the section 4, the most significant challenges and developmental potential is presented for each of the areas of architectural work, and the last section summarizes the report.

2 Research Method

Empirical qualitative type of research was selected since the field of research is fragmented and lacks established theories and frameworks. Moreover, data-based case study was used as a research strategy, seeing that it is characterized to be appropriate for seeking answers to “how” and “why” type of research questions, doesn’t require control over events studied, focuses on contemporary issues within their context, the issues studied cannot be clearly distinguished from its context, and multiple sources of evidence are used (Yin 1989). Case study is also perceived to be appropriate research strategy for developing theories, provide themes for further research and forming the boundaries of generalization (Stake 2000); therefore, strict hypotheses or research problems were not defined and this study was perceived to disclose issues which would be of interest in the next phases of the project and would require further research.

An evaluation framework was developed for the study in accordance with literature. The evaluation framework for architectural work, case companies and research process used in this study are presented in the following.

2.1 Evaluation Framework for Architectural Work

Publicly available architecture maturity models were examined and their suitability for this study assessed. Most of the models examined were domain-specific and designed for evaluating architecture maturity in public sector organizations in the USA; therefore, the need for a maturity model for evaluating organizations in general was detected. For this study, the construction of an evaluation framework for architectural work was thereby planned.

Output from the previous phases of the project and literature was used in constructing the evaluation framework for assessing the current status of architectural work. The framework consisted of 1) the areas of architectural work, 2) the interview questions related to these areas, and 3) maturity levels. The areas of the framework and part of the questions related to them were derived from the Critical Success Factors of EA and SA (Ylimäki 2005; Hämäläinen, Markkula et al. 2006). More questions were added by deriving descriptions and criteria from various architecture maturity models (DoC 2003; GAO 2003; IAC 2003; NASCIO 2003; The Office of Enterprise Technology Strategies 2003; NASCIO 2004; OMB 2005a). The evaluation framework covered the areas of EA and SA Quality Management as described by Ylimäki and Hämäläinen et al (Ylimäki 2005; Hämäläinen, Markkula et al. 2006). Some related areas were combined and area “IT investment and acquisition strategies” presented by DoC (DoC 2003) was added to arrive to the list shown on Table 1. The table lists the areas and the main questions for each of them.

Table 1. The areas of architectural work

1. Scoping and Purpose - In what ways is architectural work executed in the organization? - To what extent are the objectives and benefits of architectural work identified and documented? - To what extent are the architectural objectives identified and documented?
2. Development Methodology, Framework and Tool Support - Is the architectural framework defined and used? - To what extent is architectural development controlled by an established process? - To what extent are different tools used in architectural development?
3. Architecture Models and Artifacts

- To what extent are the current and objective states of architectures and the transitional plan described and documented?
4. Assessment / Evaluation - To what extent are the needs for architectural and architectural work evaluation and assessment identified? - To what extent are the targets of evaluation and assessment identified? - To what extent are the evaluation criteria and metrics identified? - To what extent are the evaluation points identified? - To what extent are the evaluation practices identified?
5. IT Investment and Acquisition Strategies - How does architectural planning affect investment decisions?
6. Business-Driveness - How are the business requirements taken into account in architectural planning? - Are the business requirements documented? - Is the equivalency between the requirements and architecture assured?
7. Commitment - To what extent is the management committed to architectural approach? - To what extent are other members of the organization committed and involved in architectural work?
8. Project Management - How is the coordination between architecture development projects organized? - Are project milestones defined? - Is architectural evaluation done on the milestones? - Are lessons learned collected during or in the end of the project? - Is the project budgeting and scheduling successful?
9. Governance - To what extent is architectural governance organized, defined and established? - To what extent are the tasks and processes of architectural governance defined? - To what extent are the governance processes defined, documented and implemented? - To what extent are change and risk management taken into account?
10. Communication & Common Language - To what extent and how is communication on architectures and architectural work executed to and between different stakeholders? - To what extent and how are architectural concepts defined and documented? - To what extent and how are communication challenges identified and responded to?
11. Skilled Team and Training / Education - To what extent are the roles and responsibilities of the architecture team members defined? - How is assured, that the team has necessary skills and knowledge? - To what extent are the training and education needs of other stakeholders taken into account?
12. Organizational Culture - To what extent are the cultural challenges for architectural work been identified? - How are the challenges responded to?

Additionally, a maturity level table (Table 2) was assembled for the evaluation of the maturity of the areas presented. The table was based on various architecture maturity models (Chrissis, Konrad et al. 2003; DoC 2003; GAO 2003; NASCIO 2003; OMB 2005a).

Table 2. Maturity levels

Level	Name	Description
0	Undefined	No proof of any kind on architectural approach in the area in question
1	Initial	The need for architectural approach recognized in the area in question. Draft plans may exist but the architectural development is mainly informal (ad hoc), no managed control or governance in place.
2	Under development	The architecture is planned or developed in the area in question according to documented plans (e.g. process,

		method, control) and is somewhat managed. Implementation is not yet carried out.
3	Defined	Architectural descriptions and plans in the area in question are completed, approved and communicated in the organization. Implementation has started.
4	Managed and Measured	Implemented. The architecture process in the area in question is beginning to be considered normal operation. Quality (e.g. process, output) is evaluated and measured.
5	Optimized	Clear proof of architectural benefits (e.g. cost savings) is gained in the area in question.

2.2 Research Data and Case Companies

The case companies were selected in accordance with their collaboration in the project; also, they were thought to be good examples of Finnish companies initiating architecture work and were from different industries. Companies 2 and 3 were ICT user organizations and Company 1 an ICT service provider. Therefore, in the cases of Companies 2 and 3, the internal status of architectural work was studied; in Company 1 however, the focus group's view of the company's customers was studied as well for a more detailed view of the architecture work in Finnish companies.

Company architecture specialist interviews were perceived to be the best method of information gathering, because the overall enterprise view of architectures was thought by the two ICT user organizations to be shared only by few specialists in the companies. In Company 1, a sample of specialists was interviewed. Semi-structured interview was understood to be the most appropriate method of interview, since the themes of the interview would be clear to all participants and prepared questions could be used to make the interview easier to document and execute. The evaluation framework acted as the basis for the interviews.

For each of the three case companies, one interview was executed in the company premises. Option for a second interview existed and was applied as a phone interview in the case of Company 1. The case companies and participants of the interview are shown on Table 3.

Table 3. The case companies and interviewees

Case company	**Industry**	**Number of interviewees**	**Viewpoints of interviewees**
Company 1	Business & IT consulting and development	3	Business and software architecture
Company 2	Banking, finance and insurance	3	Enterprise and software architecture
Company 3	Telecommunications	1	Enterprise architecture

The interviews were carried out by three researchers, from whom one acted as the leader of the interview and two took notes. The interviews were also recorded for reviewing and completing the notes. These measures were thought to increase the reliability and objectivity of the interviews by decreasing the number of researcher-dependent interpretations. The duration of the interviews was from two to four hours.

After the interviews, the notes were checked against the recordings and each other. Subsequently, descriptive text was written on how the work is done on each of the architectural work areas, focusing especially on finding the answers to the research questions defined in the framework and charting the challenges encountered in the areas of architectural work. Documents from the companies, such as organization charts, were used to add information, where appropriate. Moreover, a subjective maturity evaluation was done for each of the areas of architectural work.

Each case company was compiled its own report for confidentiality reasons. In writing the reports, each of the researchers concentrated on a certain set of architectural work areas in all of the reports. After completion of the drafts, they were reviewed by the researchers jointly focusing especially on the maturity evaluation of the areas of architectural work. The summary and conclusions, such as identifying the main challenges and possibilities of development, were done and the consistence of researchers' views was verified. The completed reports were sent to the case companies for reviewing and comments, as also suggested by Stake (Stake 2000). This report was composed from the individual reports by summarizing and combining the information and drawing generalized conclusions.

3 Architecture Work Status

The main findings on the current status of architectural work in the case companies are briefly presented in the following.

3.1 Company 1

The company has extensively developed architecture work methods, models and tools, which can be used in enterprise architecture consultation and system development projects of broad scope. Additionally, several architectural evaluation methods, metrics and criteria have been developed. Moreover, the company has knowledge and skills needed in architectural work and its project management practices are well established. However, it seems that some customer organizations of Company 1 in Finland have less developed architectural work methods and processes, which challenges the utilization of this company's architecture methods and practices in customer projects.

3.2 Company 2

The company has especially invested in planning and developing architectural frameworks and work methods. Architectures are governed by policies; a number of groups and practices have been established for producing, communicating and controlling the policies. Furthermore, planning and development of architectural communication aimed to units which implement the policies is established. Also, the relationship between architectural planning and investments is planned and put into practice.

3.3 Company 3

The company has established a foundation for architectural work by identifying and documenting the objectives and benefits of architectural work as well as architectural objectives; moreover, a plan with phases and schedule has been made for architectural development. Business-driveness is accepted as an objective for architectural work and taken into account in the architectural frameworks. The company also has previous experience on lower level architecture projects. An independent architecture team has been established outside ICT management for the governance of enterprise-level ICT architecture, but business architecture governance is situated elsewhere. Architectural communication to top management is established, but resources are limited and schedules strict for architectural work.

4 Architectural Work Challenges and Developmental Potential

The most significant challenges in the different areas of architectural work are presented in the following. Moreover, suggestions for development are given; these were brought into view in the focus group interviews, project report reviews by the research group, and literature. The average maturity levels of the areas are presented in the next section. For confidentiality reasons, the challenges are discussed on a general level.

4.1 Scoping and Purpose

All of the cases show that the benefits and objectives of architectural work and architectural objectives are usually identified on a general level; also, the identification is somewhat insufficient on occasion. Therefore, the benefits and objectives should be identified, described and documented more accurately and comprehensively; moreover, they should be concretized to clear factors and parameters, which guide attaining these benefits and objectives (see e.g. Boster, Liu et al. 2000; Bredemeyer Consulting 2000; Bernus, Nemes et al. 2003; Buchanan and Soley 2003).

4.2 Development Methodology, Framework and Tool Support

Generally, a specific development methodology for EA development is not defined in most of the case companies; however, methodologies for individual systems and software development projects are generally well developed and a number of system architecture development methodologies are available. Nevertheless, the need for a defined and controllable EA development methodology should be considered, as also addressed by GAO and Lankhorst (GAO 2003; Lankhorst 2005).

The framework for architectural development is defined and documented in all of the three cases; however, there are challenges either in communicating the framework to all relevant stakeholders, or actively using it in architectural development. Therefore, the framework should be communicated and implemented using, for example, briefings for the stakeholders and information on the company intranet. Also, the framework should be actively used. (see e.g. NASCIO 2003; Carbone 2004; OMB 2005a)

Multiple tools such as modeling software are used in architectural work in the case companies. Business process modeling tools are commonly used; moreover, common drawing tools such as PowerPoint and Visio are used in making architectural descriptions. Nevertheless, defined and controlled use of the tools is still partially under development. Additionally, transferring descriptions between tools is considered challenging; consequently, means for this are being considered. Using UML has been discussed, but it is thought to have its limitations in intelligibility. In all of the case companies, tool usage can be developed e.g. by clearly defining 1) the set of tools to be used, 2) the situations in which they are used, 3) the operation of the tools, and 4) the notation to be used. Tool selection has been discussed comprehensively by Rudawitz (Rudawitz 2003), for example.

4.3 Architecture Models and Artifacts

The documentation of architecture descriptions is typically not yet very systematic; on the other hand, the documentation can be defined as well. However, there are generally a number of deficiencies in the current and objective state descriptions of the EA and the transitional plans - they can be fragmented or based on incomplete information, or even don't currently exist. Documentation plans for EA are normally done, but they can also be currently on a preliminary level. Accordingly, the documentation plan should be constructed or finished (see e.g. Kartha 2004) and should be considered, what the relationship between current and objective state descriptions is. Then, missing or fragmented EA descriptions should be constructed or finished (see e.g. NASCIO 2003; van der Raadt, Soetendal et al. 2004; Kaisler, Armour et al. 2005; Lankhorst 2005). Additionally, transitional plans including both short and long-term steps should be constructed or finished if missing or incomplete (see e.g. Armour, Kaisler et al. 1999a; IAC 2005; OMB 2005). In constructing the descriptions and plans, the business requirements should be taken into account (see e.g. Armour, Kaisler et al. 1999b; Bernus, Nemes et al. 2003; Erder and Pureur 2003; van der Raadt, Soetendal et al. 2004).

4.4 Assessment / Evaluation

The possibilities of architectural evaluation have typically not been charted extensively or in detail; nonetheless, evaluations are occasionally made in some of the case companies. In the companies, a defined set of architectural evaluation methods and metrics are rarely established.

Consequently, architectural evaluation and assessment could be improved by charting the needs and possibilities for evaluation thoroughly in detail. The evaluation plan should explain, for example, 1) in which areas of architecture governance is evaluation done, 2) which targets are evaluated, 3) what criteria and metrics are used, 4) in which situations is evaluation done and by whom, and 5) what is the purpose and audience of the evaluation information. (see e.g. Taylor-Powell, Steele et al. 1996; Lopez 2000) Architectural evaluation methods, criteria and metrics should also be developed. The areas to be evaluated could be, for example 1) architectural work/process objectives and benefits, 2) architecture process quality and 3) architectures (see e.g. IAC 2005).

4.5 IT Investment and Acquisition Strategies

Generally, the case companies perceive that investments should be driven by architectural planning and development. Developing the connection between investment process and EA/SA planning is important, because the lack of it is considered to be an architectural risk. The case companies were aware of the need for this connection and it was being or was established in the companies.

4.6 Business-Driveness

The architectural work in the case companies is generally driven by business needs and requirements. However, collecting the business requirements and verifying their traceability to e.g. architectural decisions are considered challenging. Thereby, business-driveness can be increased by e.g. carefully charting the business requirements of EA and SA (see e.g. Rutledge 2000; Bernus, Nemes et al. 2003; Carbone 2005) and by increasing the interaction of ICT and business organizations by personnel selections and utilizing business employees in architectural work. Also, tracing the implementation of requirements in EA conformant systems and software (see e.g. Schekkerman 2004a; Van Eck, Blanken et al. 2004) can be supported by methods such as cross tabulation.

4.7 Commitment

In general, the management of the case companies is committed to architectural approach. In practice however, gaining management support for architectural work is normally challenging. However, in certain cases, the senior management and the management group have become aware of the importance of architectures and have shown interest towards architectural development. In all of the cases, ICT organizations are committed to architectural work, but gaining the commitment of business organization is evidently challenging. Architectural guidelines for the ICT-developers are generally under construction.

Several means can be used to help gaining the commitment of the organization. For example, architectural approach and work can be illustrated and architectural guidelines finished and communicated. Moreover, architecture projects should be bound to business requirements with business cases (see e.g. Schekkerman 2004a; Curran 2005), and project benefits shown (see e.g. IAC 2005) with e.g. simulation or scenarios to gain management support. A consistent development strategy for architectural development could also be useful, as also addressed by Bernus et al (Bernus, Nemes et al. 2003).

4.8 Project Management

All of the case companies have established project management practices. From architectural point of view, the coordination between projects generally operates well, but methods for collecting project management best practices are not established in all of the case companies. Also, companies should consider if architectural evaluation milestones could be imported into project methodology.

4.9 Governance

Architecture governance organization, functions and processes have been partially defined and documented in the case companies. The implementation of architecture governance is generally in initial phase or unfinished and is currently not integrated to the management processes of the organizations. Furthermore, EA governance organization is typically situated under information management; moreover, business connection to governance has not been fully established. In architecture risk management and organizational change management, existing practices are planned to be used.

Several steps could be taken by companies to improve architecture governance: 1) defining governance functions and activities (see e.g. COBIT 2000; Rehkopf and Wybolt 2003; van der Raadt, Hoorn et al. 2005), 2) defining governance responsibilities and authorization (see e.g. META Group Inc. 2000; Carbone 2004; IAC 2005), 3) defining architecture governance and control practices for development projects, 4) defining architectural change management (see e.g. The Open Group 2002), 5) taking into account organizational change management in architectural development (see e.g. Bernus, Nemes et al. 2003; Dale 2003; Hermansen and Caron 2003), 6) considering, if risk management is needed on EA level (see e.g. Pinto and Mantel 1990; Al-Mashari and Zairi 1999; Belout and Gauvreau 2004; OMB 2005b), 7) considering, if architecture governance organization should be situated outside information management and establishing business connection (see e.g. COBIT 2000; Ashmore, Henson et al. 2004), and 8) continuously developing architecture governance.

4.10 Communication & Common Language

Typically, architectural communication between the architecture team and the key stakeholders is established in all of the case companies to some extent. Nonetheless, there is room for development in communication aimed to either management or ICT-developers; besides, communication aimed to business organization generally needs improvement. In general, a number of architectural concepts are defined in the case companies. Additionally, communication challenges have been discussed but not documented or disclosed in all of the cases.

Architectural communication can be improved by making an overall plan of communication (see e.g. META Group Inc. 2000; Coronado and Antony 2002; Rehkopf and Wybolt 2003; IAC 2005), in which especially the following matters should be defined: 1) communication responsibilities, 2) communication needs, 3) communication channels, 4) communication timing and 5) the information needs of the different stakeholders. Additionally, communication challenges should be charted and disclosed.

4.11 Skilled Team and Training / Education

The roles and responsibilities of the architecture team have been defined in the case companies for the most part and the team works full-time. Nevertheless, a person in charge of business architecture or business connection of architectural work has typically not been named. Moreover, a chief architect has usually not been officially named, though generally a certain person works in this role. Normally, the training and education needs of the team or other stakeholders, such as management, have not been thoroughly charted; still, training and education is available and personal training/education plans are implemented but not actively used.

This area can be improved by 1) naming a person in charge for the business architecture, 2) considering, if a named chief architect is needed (see e.g. Akella and Barlow 2004; Passori and Schafer 2004), 3) supporting the training and education of the architecture team, 4) considering the training and education needs of other stakeholders, such as management, ICT-developers, ICT-maintenance, etc. and 5) actively using and controlling the personal training/education plans. (see e.g. Juran and Godfrey 2000; Chrissis, Konrad et al. 2003)

4.12 Organizational Culture

In general, the commitment of either or both management and ICT organization already supports architectural work to some degree. Furthermore, a number of organizational challenges for architectural work have been identified and preliminary solutions considered. Nonetheless, the organizational challenges should be more thoroughly charted and solutions concretized, documented and implemented, since cultural changes are usually inevitable (see e.g. Coronado and Antony 2002).

5 Summary and Conclusions

In this report, an evaluation framework for architectural work was presented. The framework consisted of 1) the areas of architectural work, 2) the interview questions related to these areas, and 3) maturity levels. It was based on the Critical Success Factors of EA and SA and various architecture maturity models. The current status of architecture work in the case companies was then discussed and the most significant challenges and development suggestions for each of the areas of architectural work presented. The summary of the current status of architectural work in the case companies is presented in the following.

Architectural work in the case companies is currently generally under development or in initial state. Accordingly, the maturity levels of the architectural work areas are 1 or 2. The major strength areas in the companies are especially

1) **Development Framework.** Defining and documenting the architectural framework. Still, EA development methodology and tool usage need further definition, development and implementation.

2) **Communication & Common Language.** Architectural communication between the architecture team and the key stakeholders is established to some extent.

3) **Skilled Team & Training / Education.** The roles and responsibilities of the architecture team have been defined and education/training is available.

4) **Project Management.** Established project management practices form a foundation for architectural work.

5) **IT Investment and Acquisition Strategies.** Perceiving that investments should be driven by architectural planning and developing processes or methods for taking architectural policies into account in investment planning.

The companies could focus particularly on the following areas to further develop their architecture work.

1) **Scope and Purpose.** The benefits and objectives of architectural work and architectural objectives should be defined and documented to form a basis for architectural work (see e.g. Boster, Liu et al. 2000; Bredemeyer Consulting 2000; Bernus, Nemes et al. 2003; Buchanan and Soley 2003).

2) **Commitment.** Gaining true commitment of management and business organizations is challenging; nevertheless, especially top management support is essential for architectural work and company initiatives in general (see e.g. Badri, Davis et al. 1995; Quazi, Jemangin et al. 1998; Al-Mashari and Zairi 1999; Perkins 2003). Architecture projects should be bound to business requirements with business cases (see e.g. Schekkerman 2004a; Curran 2005), and project benefits shown (see e.g. IAC 2005) with e.g. simulation or scenarios to gain management support. A consistent development strategy for architectural development could also be made (see e.g. Bernus, Nemes et al. 2003).

3) **Assessment / Evaluation.** The needs and possibilities for evaluation should be charted thoroughly in detail and evaluation methods, criteria and metrics should be developed (see e.g. Taylor-Powell, Steele et al. 1996; Lopez 2000).

4) **Governance.** Architecture governance should be fully defined, implemented and integrated to organization's management processes. A business connection to architecture governance should also be established (see e.g. COBIT 2000; Ashmore, Henson et al. 2004). Additionally, architecture risk management (see e.g. Pinto and Mantel 1990; Al-Mashari and Zairi 1999; Belout and Gauvreau 2004; OMB 2005b) and organizational change management (see e.g. Bernus, Nemes et al. 2003; Dale 2003; Hermansen and Caron 2003) should be taken into account.

5) **Business-Driveness.** Collecting the business requirements and verifying their traceability to architectural decisions are considered challenging. Therefore, the business requirements of EA should be carefully charted (see e.g. Rutledge 2000; Bernus, Nemes et al. 2003; Carbone 2005). Moreover, methods should be utilized in tracing the implementation of requirements in EA conformant systems and software (see e.g. Schekkerman 2004a; Van Eck, Blanken et al. 2004), and the interaction between ICT and business organizations increased.

These results show a certain degree of similarity with other studies on EA maturity. According to GAO, IFEAD and NASCIO (GAO 2002; IFEAD 2005; NASCIO 2005), EA has been widely adopted by organizations. However, the average EA maturity level of all organizations studied worldwide by META Group (META Group Inc. 2004) was just over 2. On the other hand, in most of the public sector organizations in the USA EA maturity level was 1 or 2 according to GAO (GAO 2002).

A number of EA value-adding actions, which correspond with the result of this study, have been emphasized by NASCIO (NASCIO 2005). *EA funding* is gained by senior management commitment, and *EA value proposition*, on the other hand, can be used to gain commitment. Also, *EA marketing and communication* should be used to increase EA awareness. According to NASCIO (NASCIO 2005), *EA performance metrics* should also be developed.

Moreover, a number of EA trends worldwide, studied by IFEAD (IFEAD 2005), show similarity with the status of the case companies. All of the organizations studied have an EA framework and nearly all use tools; mainly Microsoft Visio and Office programs. Most of the organizations also use modeling techniques, which means using mostly organization-specific techniques and BPML in business modeling and UML in systems modeling. Additionally, most of the organizations have their own architects and their education and training is most commonly their own responsibility. Generally, EA governance is under IT management but it seems to be shifting from IT to business.

Some limitations can be found from this study. Firstly, direct generalizations to other organizations cannot be made since only three Finnish business enterprises were studied. Secondly, due to confidentiality the results had to be presented superficially. However, assumptions about architecture work status in European business enterprises can be made according to the results and they provide a valuable contribution to this field of research.

The results of this study can be used in organizations to identify the areas of architectural work which indicate the next steps of development; additionally, the development suggestions given can be used to improve these areas to some extent. However, the evaluation framework used should still be further developed by the research group, especially by prioritizing the areas of architectural work and charting for interrelations, contradictions and other links between them. In the AISA project, the possibility of conducting a longitudinal series of similar studies in the case companies is being considered.

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Architecture Evaluation Methods

AISA Project Report

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Summary

This paper aims at presenting the current possibilities to evaluate enterprise and software architectures, focusing especially on performing an assessment mainly based on architectural descriptions. The essential research questions investigated in this paper are:

- What are the evaluation needs for architecture evaluation?
- What kind of architecture evaluation methods exist?
- Which needs do these evaluation techniques satisfy?
- What do the existing methods fail accomplish?

The studies of previous research resulted in the recognition that there is no methodology for enabling the enterprise architecture evaluation by considering the whole enterprise architecture. Therefore, methods, standards and measures which can be used to evaluate different concerns of enterprise architecture are presented. The evaluation techniques address the concerns of business, information, systems and technology separately. All of the introduced techniques have been developed or tested and validated in a practical environment.

In [1] evaluation needs have been identified by interviewing practitioners. Since it is also an aim of this paper to find approaches satisfying those needs the methods presented in this paper are mapped to those evaluation needs they address.

The methods suggested for the business architecture are:

- governance modelling
- business process modelling and simulation
- financial methods for assessing the value of an IT investment (prediction of expected benefits through IT investment)

The needs concerning the enterprise's information architecture were addressed by the evaluation of the corporate data model which is a structured conceptual model of the organisation's data entities and their relations. The suggested methodology was the *Moody's Framework*.

The systems architecture consists of software systems. A software system is described through software architectural artefacts. Therefore, the evaluation techniques suggested for the systems architecture are methods for software architecture evaluation (*questionnaires, scenario-based methods, design metrics, prototyping, mathematical modelling*). Since the infrastructure which allows the deployment of software applications is also part of the software system the underlying execution environment can be evaluated within the software architecture evaluation. The methods concerning the software system evaluation enable predictions regarding the whole system life cycle. Especially, characteristics, such as performance, cost, reliability and maintenance are essential characteristics in the enterprise architecture context. The suggested methods are able to assess these criteria.

The architecture evaluation depends strongly on conceptual models which are used to share and communicate the architectural knowledge among different stakeholders from different domains. Therefore, conceptual modelling standards are part of the evaluation methods or conceptual models belong to the evaluation input and are the basis for analysis and discussion about architectural decisions.

Contents

1 Introduction

The architecture of a system is the description of the system's structure and its behaviour. The system's structure embodies the components which can be active (e.g. human beings, applications, hardware components) and passive (e.g. communication channels, information storages) ones. The interaction of the components results in a certain system behaviour [2].

Every system has certain groups of stakeholders who have several interests towards the system. Usually, a system is implemented with a certain *vision* about the running system's task and the improvements to the current state achieved by the system. According to [3], the vision can be seen as a long-term purpose of the system. Since that vision is a final ultimate long-term achievement it is necessary to define *goals* which have to be achieved to achieve the final vision. That means the goals are a guideline to the final vision.

Goals are assessable because they are described though three dimensions [4]:

- content (direction of the goal)
- extent (scale of the goal)
- timing (timeframe of the goal)

Content means that the results, which are desired to be achieved, must be defined. The extent dimension quantifies the degree of the achievement and the time dimension fixes the period for achieving the goal.

In the paper [5], goals are seen as the stakeholders' success criteria. These goals are part of the system requirements. Since the architecture is the system's description, it must consider those requirements and it must be possible to assess the architecture regarding them. With accordance to [5], not all system requirements are considered by the architecture. The architecture is focusing on the realisation of so called *needs*. Needs differ from system requirements because needs are more stable over the system's life cycle. A need captures those concerns that will drive key decisions by the architect, such as decisions pertaining to performance, technology or cost drivers. Additionally, a need might be the abstraction or summarization of several detailed system requirements. Since the needs directly relate to the goals and the goals relate to the final vision, it is essential to evaluate the system's architecture regarding the realisation of the needs. The objectives of an architecture evaluation are:

- advancing and transferring architectural knowledge[6]
- identification of insufficiencies which are risks related to the needs [2]
- identification of design decisions and their contribution to the needs
- architectural decision making [6]
- choosing among several candidate architectures or design decisions [2]

The evaluation results are a useful basis for the system's improvement regarding the stakeholders' goals.

The fundamental evaluation process with its components is described, for example, in [7] and evaluation components of enterprise architecture (EA) evaluation are described in [8]. Several of these evaluation components have been investigated in the AISA project but still there seems to be a lack of research on evaluation methods. Therefore, it is necessary to identify methodologies for architecture evaluation in order to achieve the goals (of architecture evaluation) mentioned above. According to [5] architecture evaluation methodology itself must include the following tasks:

- Analysis of Needs, Goals and Vision
- Gather relevant documents and other artefacts related to the architecture
- Evaluate documentation against measures and score results
- Interpret results and identify architecture-related risks
- Documentation of results.

The scope of this paper is to identify architecture evaluation methods which can be applied for the evaluation of enterprise and software architectures, focusing especially on assessing the architectural descriptions regarding the identified needs. The requirements towards an enterprise and a software system are naturally different. Requirements towards software systems focus mainly on quality attributes like efficiency, reliability, security, and maintainability. A quality model for software systems is given in [9] and [10]. The stakeholders' goals towards an enterprise are more varying because of the rather huge complexity of enterprises. Quality attributes are important issues but also less tangible goals which are difficult to measure or predict, such as increased innovation, customer orientation, and market share. Especially, the evaluation of design decisions regarding strategic aims is quite challenging. Also the fact that the enterprise architecture embodies several architectures complicates an evaluation.

The paper is structured in the following way. The next section deals with evaluation needs which have been gained from practitioners through interviews [1]. Section 3 describes approaches for enterprise architecture evaluation concerning EA management processes and EA artefacts. In section 4, the most wide-spread approaches of EA management evaluation, *Maturity Models* and *IT-Business Alignment Models*, are presented. The approaches which address the evaluation of architectural artefacts of different views on enterprise architecture: business, information, software systems, and technology are discussed separately in sections 5-8. Software architecture evaluation methods are presented in the context of architecture evaluation of software systems. In section 9, the approaches are mapped on the needs described in section 2. The last section concludes the paper.

2 Architecture Evaluation Needs

Evaluation needs are essential stakeholders' concerns to the architecture which have to be evaluated. Since the focus of this paper lies on enterprise and software architectures, evaluation needs for both of these are investigated. The evaluation needs are derived from the goals of architecture evaluation and the stakeholder needs regarding the architecture.

Table 1 shows the evaluation needs for enterprise and software architectures. The needs have been identified from interviews with practitioners who are familiar with the stakeholders' concerns. In [1], it is stated that it is difficult for practitioners to directly name evaluation needs; usually certain concerns and needs for information trigger an evaluation. Therefore, the evaluation needs are derived from those triggers.

Table 1 Triggers for architecture evaluation [1]

Triggers for architecture evaluations	**Evaluation needs**	**Evaluation Targets**
	A need for the documentation of good quality	
A need to produce architectural models and documentation that • can be quickly communicated and • are understandable by many different stakeholders • are cost-effectively kept up to date.	The evaluation of the quality of architectural documentation. A need to evaluate: - Policy: do policies (e.g architectural framework) exist for documentation and are they followed? - Intelligibility and usability: are documents easy to understand and use? - Accuracy: are documents truthful and factual? - Cost effectiveness of maintenance: how much effort is needed to keep models and documentation up to date? - Traceability between architectural documents: is there traceability between architectural documents?	Architecture documenta-tion (EA / SA)
A need to have organisation's business environment descriptions of good quality	The evaluation existence and quality of business descriptions (goals, strategy, company's operations) : • existence of business descriptions (e.g. goals, strategy, company's operations) • Accuracy: are the descriptions up to date?	Business architecture documenta-tion
A need to have information / data models of good quality	The evaluation of the quality the information / data models	Information / Data architecture
	Change pressures in organisation	
A change need in the business or ICT (e.g. a	The evaluation and identification of the places affected by a change and effects in each	EA viewpoints

need to move from one solution to another)	architectural viewpoint.	
An observation that ICT-architecture do not correspond to company's business's requirements	The evaluation how the enterprise architecture should be changed by identifying what chances should be carried out in each architectural viewpoint.	EA viewpoints
The understanding of business and ICT environments		
A need to enhance the understanding of company's business/ICT	The evaluation of enterprise architecture from different aspects or against different factors e.g. the identification of overlaps.	EA viewpoints
A goal that ICT supports business	The evaluation of how business architecture is supported by other viewpoints (information, applications, infrastructure).	EA viewpoints
A need to enhance the understanding of responsibilities in the company	Identification and evaluation of responsibilities in company (for example: who is responsible for customer information).	Business architecture
A need to understand the state of the company's product portfolio and processes	The description and evaluation of business architecture related aspects.	Business architecture
A need to understand information managed in company	The description of major information entities and responsibilities in information management.	Information / Data architecture
A need to understand the state of the company's application portfolio	The description and evaluation of structures and components of application architecture.	Application architecture
A need to understand quality aspects relating to the company's application portfolio	The evaluation the application architecture against quality aspects and attributes e.g. the identification of overlaps.	Application architecture
A need to understand the current state of technical infrastructure	The description and evaluation of structures and components of technical infrastructure.	Technology architecture
Company management and process planning		
A need to make sure that organisational choices are suitable	The evaluation of organisational structures and operations: are those suitable or should those be changed.	Business architecture
The distribution of work	The evaluation of processes: identification of which tasks will be carried out by the company and which are dealt out to partners.	Business architecture
Business process planning	The evaluation of functionality of business processes: e.g. do processes correspond to company's strategy?	Business architecture
Management of architectures		
An observation that ICT-	The evaluation of how architectural principles	EA

architecture does not correspond to ICT-development projects' needs	or architecture descriptions should be changed.	viewpoints
An effort to drive investments to follow up architectural principles	The evaluation of if the investment corresponds and is suitable to the existing architecture and architectural principles.	EA viewpoints
A need to drive technical infrastructure investments to follow the architectural principles	The evaluation of if investments correspond to the principles.	Technology architecture principles
	IT cost management	
A need to understand and manage costs relating to the company's application portfolio	The evaluation of financial aspects and factors relating to application architecture	Application architecture
A need to understand and manage costs relating to technical infrastructure	The evaluation of financial aspects and factors relating to technical infrastructure	Technology architecture
	Architectural choices	
A need to find the best possible system solution and a need to understand the aspects relating the solution	The evaluation of the architectural solution: e.g. evaluation of • quality aspects (evaluation against quality attributes), • flexibility of solution, • the life cycle of solution, • suitability for the situation in question (e.g. is solution possible within available time, money and resources).	SA viewpoints (EA viewpoints)
An effort towards long-term technical solutions and need to argue for the long-term technical solutions	The comparison of a long-term and short-term solution.	EA / SA viewpoints

3 Enterprise Architecture Evaluation Methods

Today, more and more companies adopt enterprise architecture frameworks to cope with the changing environment and to improve their performance and competitiveness. Perhaps the most wide-spread frameworks are the Zachman Framework [11], TOGAF [12], FEAF [13] and DoDAF [14]. These frameworks typically combine different views of the enterprise, e.g. business, information, application, and technology architecture. These views should transfer knowledge about the organization towards involved stakeholder roles. Furthermore, they give a guideline for the necessary architectural documentation to describe the current enterprise architecture and also a future one. Unfortunately, there are many different concepts, modelling techniques, tool support, and visualisation techniques for every view. Consequently, there seems to be no coherent view on enterprise architecture. This fact also complicates the evaluation because it seems that there is no method which enables the assessment of the whole enterprise architecture. There are at least two main areas which can be evaluated regarding EA:

- enterprise architecture management and the management process
- architectural artefacts which describe the structure and behaviour of the EA.

Because there are no common EA evaluation methods, we decided to follow the structure given by most of the enterprise architecture frameworks [11], [12], [13] [14] and investigate techniques to evaluate architectural artefacts of the different views starting with the business architecture. Before that, however, concerning approaches to evaluate the EA management and management processes, a summary of the most wide-spread *Maturity Models* and *IT-Business Alignment Models* is presented.

4 Maturity Models and IT-Business Alignment

Existing enterprise architecture assessment techniques basically focus on the improvement of enterprise architecture management and the management process which means that new EA development targets are identified and development priorities are set. Therefore, enterprise maturity models and IT-Business-alignment evaluation are utilized. In the following the concepts of these methods are presented.

One of the first capability maturity models, Capability Maturity Model for Software (CMM), was developed by the Software Engineering Institute, Carnegie Mellon. It enables the assessment and the control of IT-related processes as well as the assessment of organization's development competence. According to [15], architecture maturity involves an organization's ability to organization-wide manage the development, implementation and maintenance of architectures on various levels – e.g. business, information, applications and infrastructure. That means architecture maturity focuses on the evaluation of the entire architecture organization which is responsible for architecture development. The architecture products they create, such as descriptions and models, are not addressed through those maturity models.

Most of the assessment models have been developed by consulting firms such as Gartner [16] and METAGroup [17], and federal agencies or organizations, such as the US Office of Management and Budget (OMB) [18], the US department of commerce (DoC) [19], and the National Association of State Chief Information Officers (NASCIO) [20]. These models generally work the same way as the early CMM. Basically, they use a number of criteria to assess architecture maturity. Typical criteria are, for example, process, governance, communication, technology, and business alignment. For each criterion five maturity levels exist and they are provided with a description of aspects. The individual level of maturity for each of the criteria is based on questionnaires which are answered by certain stakeholder groups. The maturity models differ in the amount of criteria which are investigated. However, no matter which model is applied, they all support the identification of insufficiencies and areas of improvement in the enterprise architecture development process.

Another approach to assess the EA management and development processes is IT-Business alignment. There is a general agreement what alignment entails: the fit between business strategy, IT strategy, organizational structures and processes, and IT structures and processes [21]. The aim of alignment is for IT activities to support those of the entire business [22].

Several alignment assessment models have been constructed. One well-known model is Luftman's strategic alignment assessment model which presents an approach for determining a company's business-IT alignment based on six criteria: communications, competency/value measurements, governance, partnership, skills, as well as scope and architecture [21]. This last criterion is used to evaluate IT maturity. According to [21], each of these six variables is assigned five levels of alignment. The model provides a short description of the aspects of each level. The level of alignment for each individual variable is determined by the answers to 6 or 7 questions. The model also describes the process of conducting an alignment assessment. Luftman created this alignment assessment model based on his extensive research and practical experience.

The Chief Information Officer (CIO) Council, a consortium of US Federal executive agency CIO's, developed an architecture specific alignment and assessment guide [23]. This guide describes a process which consists of three phases, the select phase, control phase, and evaluate phase. First, the select phase entails assessing business alignment; whether and to what degree a proposed investment aligns with business strategy. Second, in the control phase the technical alignment is assessed on how well the technology of investments aligns with the infrastructure architecture. Finally, the third phase evaluates both the architectural products and the architecture development process itself.

5 Business Architecture Evaluation

According to TOGAF [12], the main aspects of the business architecture are:

- Business goals and objectives
- Business functions
- Business processes
- Business roles
- Business data model (the data model is considered in Section 6)

They all have to be documented in an appropriate manner which enables the analysis and evaluation.

Since the business architecture transfers this essential knowledge about the organization to all kinds of stakeholders like business users, business analysts, and technical developers it is strongly relying on conceptual modelling to be understandable for different domains.

5.1 Business Governance Modelling

Vision, goals, objectives and other aspects of the organization’s governance determine the strategies which result into actions to transform the enterprise’s as-is status into the desired to-be status. Since the governance is the foundation for the organizational structures, processes and behaviour it should be documented within the models describing EA. Usually, enterprises only capture the means to achieve goals in models [24]. That makes the traceability, analysis and evaluation of goals rather difficult.

Modelling the corporate governance would bring several benefits to the organization:

- vision, goals, objectives are made explicit
- transparency of transformation drivers [24]
- tracing of decisions and responsibilities
- basis for analysis and evaluation (conflicts, improvement, level of fulfilment)
- basis for planning and changing strategies and processes (linking *why*-knowledge to *how* [24])

One of the few notations that can be used for modelling the business governance is the Business Motivation Model (BMM). It is a meta-model of concepts for modelling the business governance. It has been standardized by the Object Management Group (OMG) in August 2006. Its purpose is to capture business motivation and intentionality by providing a scheme to develop, communicate and organize corporate governance [25]. Central element groups in the BMM are: Means, Ends, Influencer, Potential Impact and Assessments. These central elements are further refined into elements such as *Visions*, *Desired Results*, *Goals*, *Objectives*, *Missions*, *Course of Action*, and *Internal* or *External Influencers*.

The model’s core concept is the connection of Means and Ends. Ends include the elements Vision, Goal, and Objective. Means refer to the concepts of Mission, Strategy, and Tactic. BMM is based on the refinement of vision into goals and objectives, and a mission into strategies for approaching goals, and tactics for achieving objectives. The model also considers the fact that business needs to take into account the numerous influencers that can have positive or negative impact on the business. The assessment whether an influencer is strength/opportunity or weakness/threat is usually gained from the Strength-Weakness-Opportunity-Threat Analysis (SWOT) [26]. The BMM in Figure 1 illustrates the relation between governance aspects. BMM supports the understanding of the relations between intentional aspects of the governance level and also their relation to actions and processes performed by the organisation.

Currently, there seem to be no methods for systematic goal analysis for the EA evaluation which have been applied in a practical or industrial case study. Regarding goal analysis it might be possible to apply the approaches of the goal-oriented requirements engineering, such as Mylopoulos [27], i* [28], and EEML [29], to gain knowledge if goals are conflicting, complete and relevant. However, that is more an idea of further research than a suggestion for the practical use.

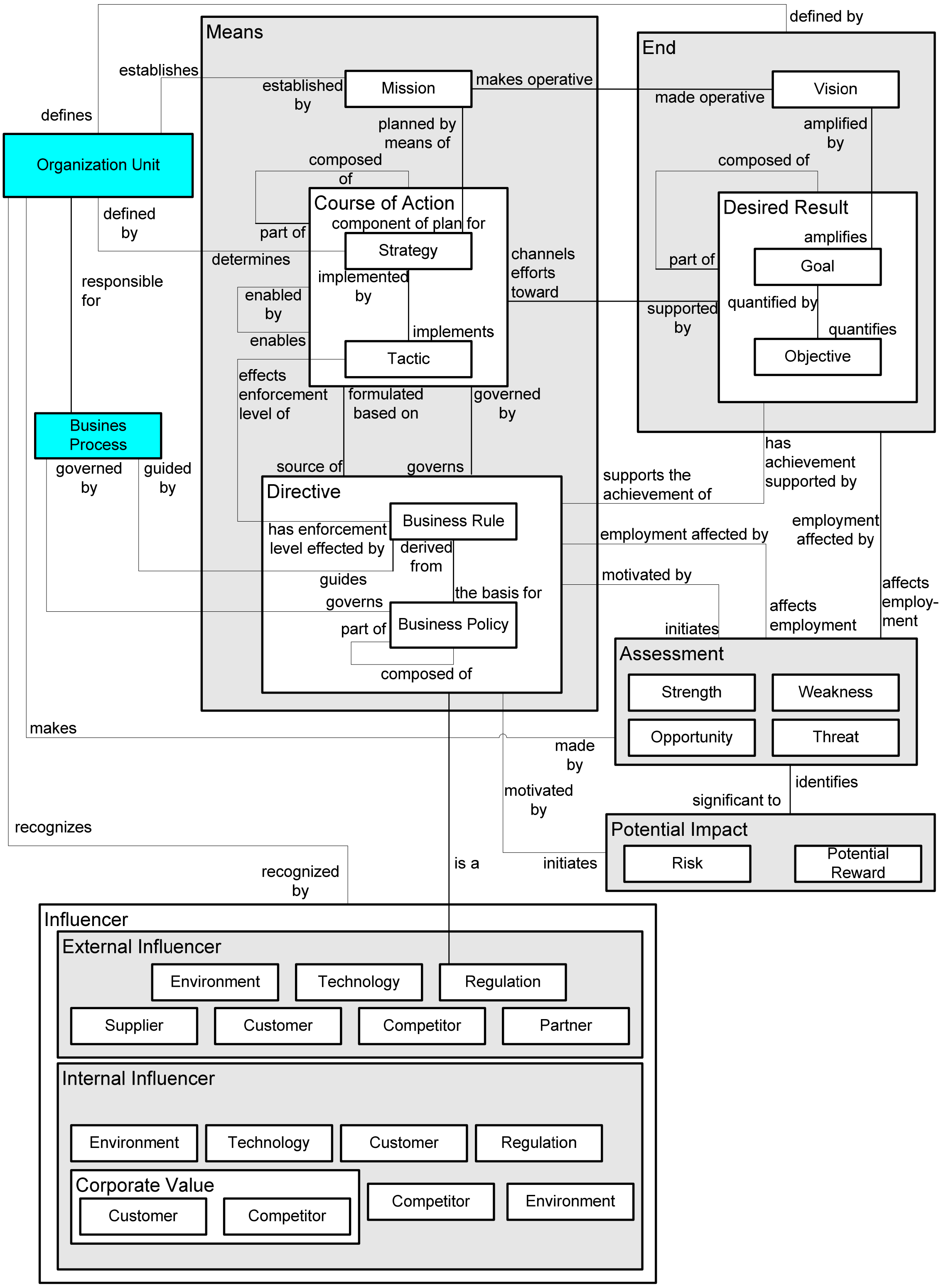

Figure 1 BMM of relations between governance aspects

5.2 Business Process Modelling and Simulation

A quite common means to gain a competitive advantage, regarding costs or innovation, is the optimization of an organization's business processes. The optimization embodies the assessment of necessary infrastructure and applications, and comparison of expected benefits [30]. Business process modelling and simulation are the approaches to achieve the optimization of processes [31].

5.2.1 Business Process Modelling

Business process modelling is the visualization of processes regarding relationships, dependencies, and effects between processes and their activities and resources. This visualization increases the understanding about the processes and supports the validation and improvement for many stakeholders [31]. Business process modelling aims at clarifying the organization's processes to its employees. Usually, even the documentation of processes discloses redundancies and points of improvement. According to [30], 80% of process advancements are achieved by modelling the current status.

Business process modelling consists of the following phases [30]:

- examining and modelling the organizational structure
- examining and modelling the existing business processes (*as-is state*)
- creating a base of the company's business processes
- verifying business processes
- analysing weak points
- modelling advanced business processes (*to-be state*)

There is several business process modelling approaches available. The three common approaches are:

1. Event-Driven Process Chain (EPC)
2. Business Process Modeling Notation (BPMN)
3. Unified Modeling Language (UML)

In the following EPC and BPMN approaches are investigated in more detail. Processes modelled with these two languages can be executed which is essential regarding business process simulation and implementation.

Event-Driven Process Chain (EPC)

The method of event-driven process chain (EPC) has been developed within the framework of *Architecture of Integrated Information System* (ARIS) [32] and is used by many companies for modelling, analyzing, and redesigning business processes. ARIS divides an organization's processes into separate views to reduce the complexity. The views are functions, data, organization, and control [32]:

- The *Data View* contains events and statuses. Events such as *customer's order received* or statuses, like an article description, are data objects. Chen's Entity-Relationship model [33] was adopted into the ARIS framework to create the organization's data model.
- The *Function View* describes the activities to be performed by the process, the individual sub functions, and their relationships.

- The *Organization View* represents the organizational structure. This includes the relationships between organizational units, between employees and organizational units, and employees and roles.
- The *Control View* links functions, organization and data, thus integrating the design results of the different views.

The various elements are connected into a common context by the control flow. The resulting model is the *Event-Driven Process Chain* [34]. The EPC is based on the concepts of stochastic networks and Petri nets. A basic EPC consists of the following elements:

- *Functions* are active elements representing the activities within the company.
- *Events* are created by processing functions or by actors outside of the model
- *Logical operators* (AND, XOR and OR) connect functions and events

Figure 2 illustrates the EPC elements exemplarily on an order process.

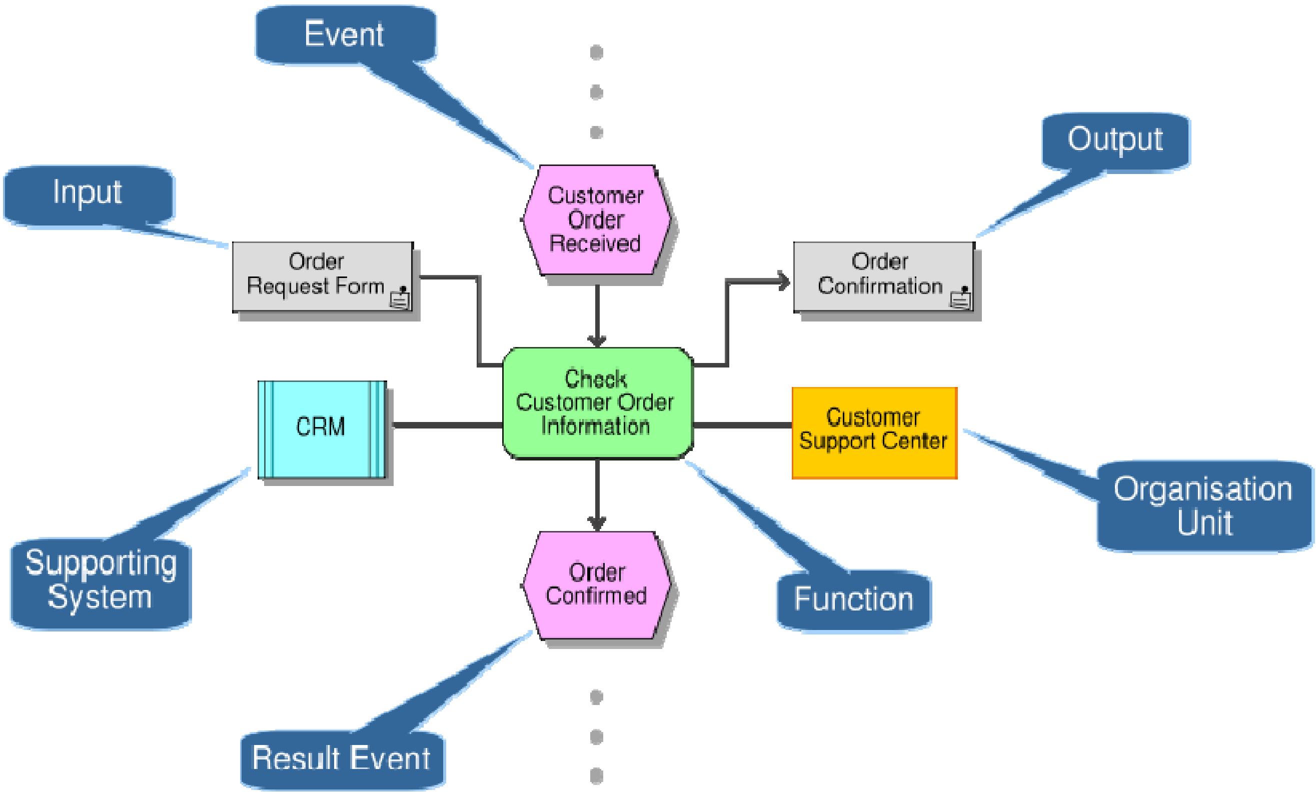

Figure 2 Elements of EPC

BPMN – The Object Management Group (OMG) Standard
The *Business Process Management Initiative* (BPMI) has developed a standard *Business Process Modeling Notation* (BPMN). The BPMN 1.0 specification was released to the public in May, 2004.
.
The primary goal of BPMN is to provide a notation that is readily understandable by all business users, from the business analysts that create the initial drafts of the processes, to the technical developers responsible for implementing the technology that will perform those processes, and finally, to the business people who will manage and monitor those processes [35]. Thus, BPMN is meant to create a standardized bridge for the gap between the business process design and process implementation. BPMN includes four basic categories of elements [35]:

1. Flow Objects
2. Connecting Objects
3. Swimlanes
4. Artifacts

Actually, the first category is the most important one. *Events*, *Activities*, and *Gateways* (represent Decisions) belong to the category of Flow Objects. These elements correspond to the EPC's elements Event, Function and Logical Operators. Connecting Objects include Sequence Flow, Message Flow, and Association which are used for relating the Flow Objects.

The concept of *Swimlanes is used* as a mechanism to organize activities into separate visual categories in order to illustrate different functional capabilities or responsibilities. *Artifacts* allow adding extra context to the diagram. Therefore, BPMN defines Data Object, Group, and Annotation. Figure 3 illustrate a reservation process modelled with BMPN.

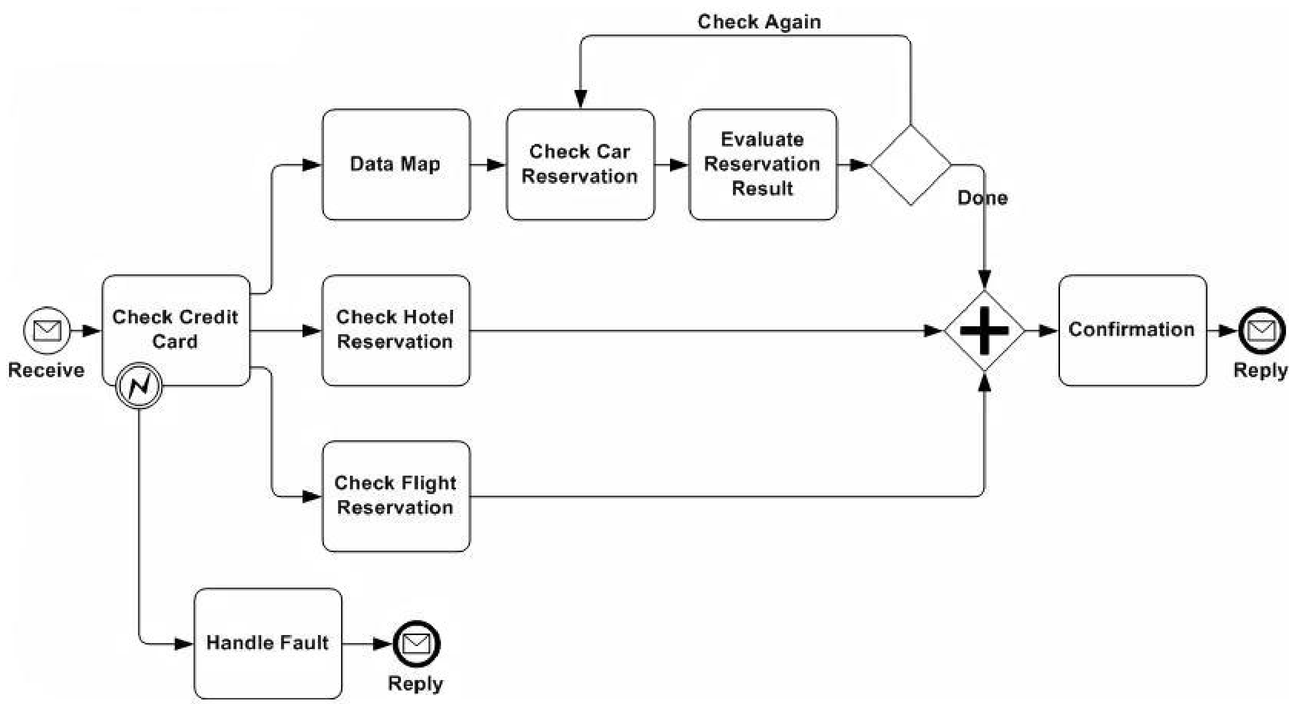

Figure 3 Reservation process in BPMN

5.2.2 Business Process Simulation

While modelling is the visualization of business processes, simulation brings them alive. On the one hand, it is possible to evaluate the current processes (*as-is* state) regarding costs, performance and to analyse the simulation data referring optimization. On the other hand, dynamic simulation is a way to analyze *what-if* scenarios, obtain cost and performance predictions, and validate processes [31]. The predictions, gained from the simulation, support the decision making regarding organizational change and future investments.

In the previous section, the two common description graphical description languages EPC and BPMN were described. The advantage of both of these languages is that the described processes can be executed for simulation as well as for implementation purposes. Because EPC is used within the ARIS framework [32] the created models can be simulated within the ARIS environment with three analysis tools: ARIS Simulation, ARIS ABC (Activity Based Costing), and ARIS BSC (Balanced Scorecard). The simulation with ARIS provides information about the executability of processes, processes' weak points and resource bottlenecks [32] [30].

The process models in BPMN are well understandable by human beings but not by computers. Therefore, BPMN has to be translated into an executable language, such as Business Process Execution Language for Web Services (BPEL) [36] which is emerging as a de-facto standard for implementing business processes on top of web services technology. Numerous platforms support the execution of BPEL processes. Some of these platforms also provide graphical editing tools for defining BPEL processes. However, these tools directly follow the syntax of BPEL which does not support the level of abstraction that BPMN is using during the analysis and design phases of the business processes. BPMN has attained some level of adoption among business analysts and system architects as a language for defining business process blueprints for subsequent implementation [37]. Meanwhile, BPMN is already supported by more than 30 tools, for example Appian Enterprise 5 Business Process Management Suite and BizAgi.

5.3 Financial methods for assessing the business value of IT investments

Organizations use several measures to assess business value, such as return on invest (ROI), net present value (NPV), internal rate of return (IRR), payback period, and economic value added (EVA). According to [38], these measures have five main disadvantages regarding their utilization to measure the business value of IT.

- There are too many measures available and within a single organization different groups use different measures; furthermore, some measures have multiple interpretations which lead to inconsistency.
- These measures generate a value which leads to a wrong credibility because the value is actually based on assumptions and the value itself is only a prediction for the estimated benefit.
- These measures do not take intangible benefits, such as customer satisfaction, into account. Since it is difficult to measure intangible benefits they are completely ignored.
- The financial measures only estimate the direct benefit of an investment but they are not able to calculate further future benefits or opportunities.
- Perhaps the biggest flaw in most financial measurements is the underestimation of risks or even the failure to incorporate any risk at all.

Since, measuring the value of IT-enabled business change will be critical to almost every organization as technology becomes embedded in virtually every business process [38], more efficient measurement tools are needed. In this report, four methodologies which have been developed to overcome the problems of the standard financial measures are addressed:

1. Business Value Index (BVI)
2. Total Economic Impact (TEI)
3. Val IT
4. Applied Information Economics (AIE)

The Business Value Index [39] is a method which was developed by Intel’s IT organization. The method was first applied in 2001. Basically, BVI supports the prioritization of investment options. Tangible as well as intangible can be measured. BVI is a composite index of factors that impact the value of an IT investment. Basically, BVI assesses IT investments along a three dimensional vector consisting of the dimensions:

1. IT business value (that is, impact to Intel's business) represents the tangible and intangible benefits. There are some projects which have significant business value (e.g., responding to a competitor’s threat or customer’s satisfaction) but may not be financially attractive. In these cases value for the organization is captured by this dimension.
2. Impact to IT efficiency measures a projects impact on the IT organization. IT organizations are increasingly developing enterprise architectures, establishing standards, and acquiring core competencies in key skill areas to reduce costs and become more agile [35]. IT efficiency is Intel’s measure to assess a project’s conformance to the established architecture. A project that does not conform organization’s standards and frameworks will be more costly to implement and support and will also entail greater risks [35].
3. Financial attractiveness of an investment is determined using at least three financial metrics; NPV, IRR, and payback period together.

In Appendix 1, an example of using the BVI is shortly described.

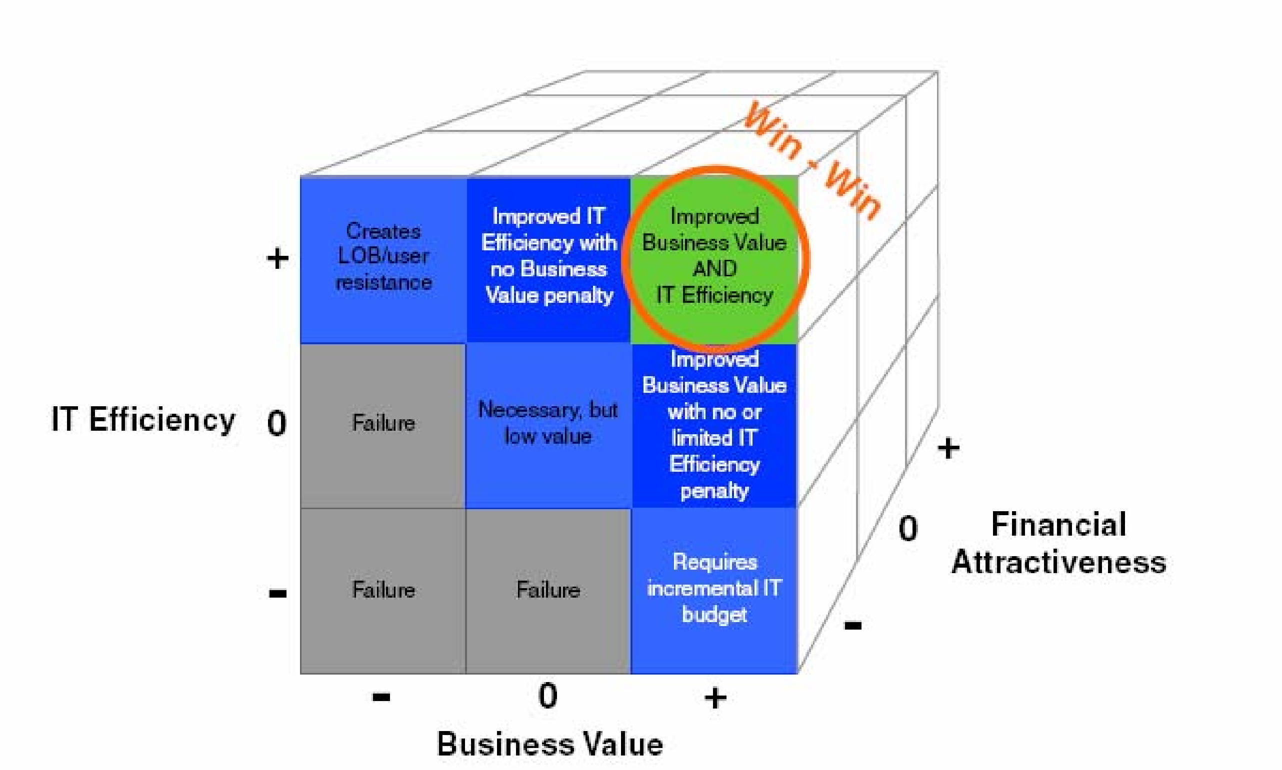

Figure 4 BVI dimensions [39]

The Total Economic Impact (TEI) is Forrester's methodology for assessing IT investments. TEI systematically looks at the potential affects of technology investments across four dimensions [38]:

- Cost — impact on IT.
- Benefits — impact on business.
- Flexibility — future options created by the investment.
- Risk — uncertainty.

The TEI cost dimension considers the changes in IT costs compared with maintaining the current status. Cost changes can be seen as the required investment to bring this new initiative, application, or technology online [38]. These cost changes are usually higher during development or implementation phases and then potentially decrease over time. The impact on IT can be positive if costs are decreasing or negative if costs are increasing [38].

TEI's benefit dimensions regards the impact of IT investments on the non-IT departments. Usually, the initial implementation requires changes to personnel or behaviour in the effected user departments. Users have to be taught using the new systems and in the beginning the efficiency of the departments using new IT systems might suffer. Then the initial benefit is rather small but on a long-term view that will be compensated by an improved productivity gain, or other positive impact.

Future options, or flexibility, can be looked at as the value of the option to take a second or third action in the future [38]. Form this point of view; it is similar to a financial purchase option. Investing in additional infrastructure in excess of today's needs, for example, can enable the deployment of future applications. The standard measurements are not able to estimate the benefits of these applications but their right to take these actions in the future still has value to the organization and the scale of that value should be monetized and communicated [38].

In TEI, the risk analysis translates the initial estimates for cost, benefits, and future options into a range of potential outcomes. Once this range has been determined, by either adjusting the final estimates or by evaluating the effect of risk on the individual components of the cost and benefits, an expected value for this range of possible outcomes can be determined [38]. That means considering the potential risk for the three dimensions Flexibility, Benefits, and Costs a minimum and maximum benefit can be estimated. According to [38], it is called “risk-adjusted ROI”.

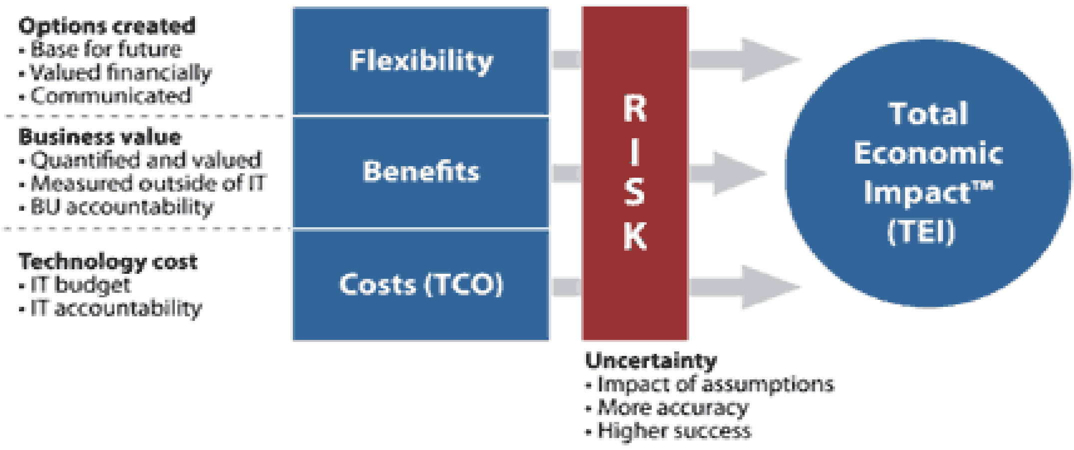

Figure 5 Total Economic Impact (TEI) [38]

A frame work for measuring the IT value, Val IT, has recently been released by the IT Governance Institute (ITGI). It is a governance framework that consists of a set of guiding principles, and a number of processes conforming to those principles that are further defined as a set of key management practices. Val IT, illustrated in Figure 6, comprises three key processes (including 41 key management practices) [40]:

1. Value governance, contains 11 key management practices which cover
   - The establishment of a governance, monitoring and control framework
   - The provision of strategic direction
   - The definition of investment portfolio objectives
2. Portfolio management, includes 14 key management practices covering
   - The establishment and maintenance of resource profiles
   - The definition of investment thresholds
   - Evaluation, prioritization and selection, deferral, or rejection of new investments
   - Management of the overall portfolio
   - Monitoring and reporting on portfolio performance
3. Investment management, consists of 15 key management practices which cover
   - The identification of business requirements
   - The development of a clear understanding of candidate investment programs
   - The analysis of alternatives

- Program definition and documentation of a detailed business case, including benefits details
- Assignment of clear accountability and ownership
- Management of the program through its full economic life cycle.

Since the Val IT framework is rather new there is not much practical experience in applying the framework so far. Much of the framework's content was validated by the Dutch financial services firm ING [41].

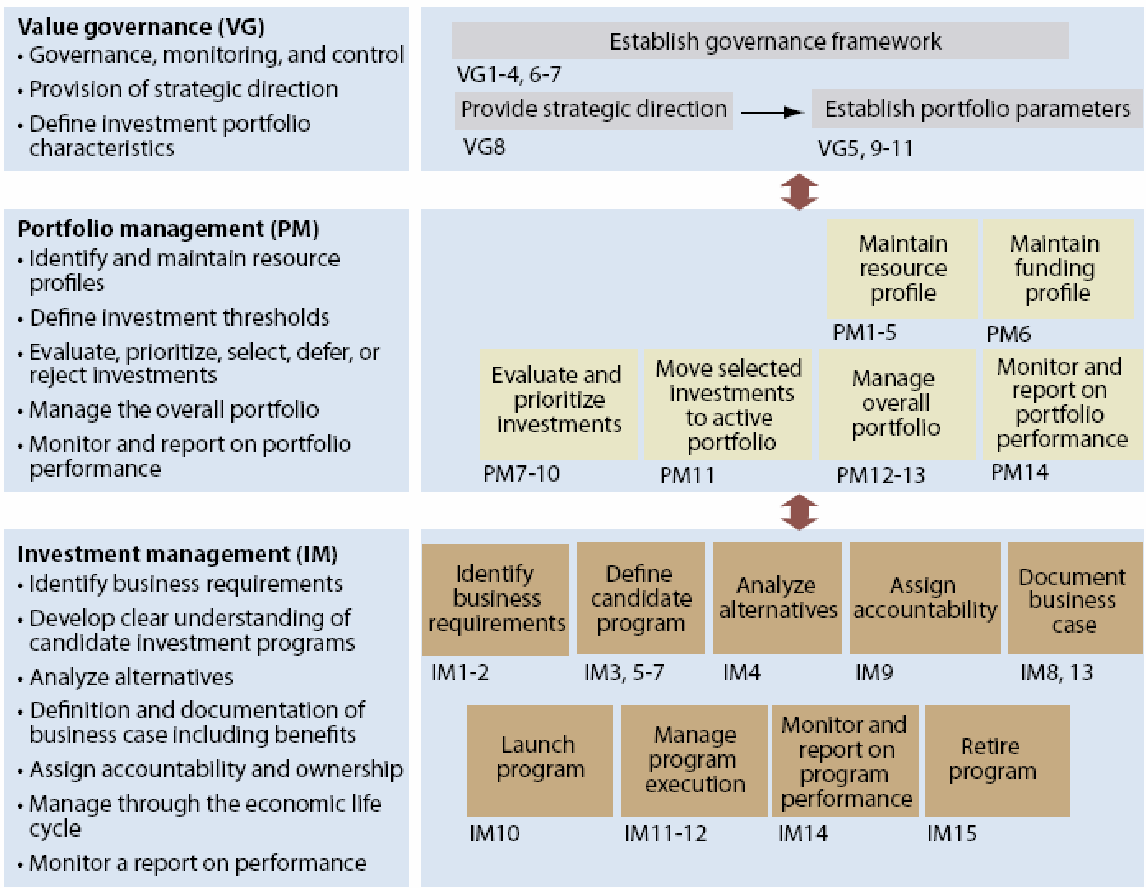

Figure 6 Val IT framework with its key processes and the management practices [42]

The Applied Information Economics (AIE) is a practical application of mathematical and scientific methods to the IT and business decision process [43]. It includes methodologies from economics, operation research, portfolio theory, software metrics, decision/game theory, actuarial science, and options theory into a precise, highly quantitative methodology for assessing IT investments. AIE can be applied across the enterprise to solve some of its most perplexing problems, including the following [43]:

- Using mathematical models to improve cost/benefit analysis (CBA) for better decisions at all levels of IT

- Developing financially-based quality assurance measurements to insure that the implementation of IT decisions are effective
- Developing a strategic plan for information systems based on identifying the best opportunities for economic contribution by information systems.

AIE embodies a number of basic techniques [43], such as *unit of measure* definitions, calculation methods for the value of information, methods for modelling uncertainty in estimates, and treating the IT investment as a type of investment portfolio. These methods are also used by financial services firms to create financial products and they are also used by insurance companies to calculate premiums. The AIE’s key methods are:

- Unit of measure: IT investment also includes intangible or not measurable factors, such as strategic alignment, customer satisfaction, or employee empowerment. Mostly these factors only seem to be immeasurable because they are ambiguously defined. AIE removes this type of ambiguity by focusing on definitions that can be expressed in units of measure.
- Uncertainty analysis: According to [43], all investments have a measurable amount of uncertainty or risk. AIE is able to quantify the risk of a given IT investment, and compare its risk/return with other non-IT investments. AIE quantifies uncertainties with ranges of values and probabilities.
- Calculation of Economic Value of Information: The basic assumption of AIE is that the value of information can be calculated [43]. Since information reduces uncertainty, it supports decision making. The improved decision making results in more effective actions and those actions might lead the higher profits or the achievement of other goals. The relation between the information and its impact on the profit or goal can be expressed in value.
- IT Investments as an Investment Portfolio: AIE also uses the methods of Modern Portfolio Theory (MPT) and considers the set of an organization’s IT investments as another type of investment portfolio [43].

Even though AIE was developed over a decade ago, it has not gained widespread use. The method is mostly applied in the government sector.

To conclude the financial method section, a brief comparison between the methods is presented in Figure 7.According to [38], BVI is the simplest method; especially organizations with no history of applying value methodologies might find BVI easier to implement. It is well-documented and more qualitative in its assessments of benefits and risks although it does incorporate standard financial measures.

TEI adds more rigor around quantifying intangible benefits, risk, and the value of flexibility or future capability resulting from IT investments. Organizations that are risk averse or that plan on making large investments in infrastructure or other capabilities might benefit from using TEI [38].

Val IT takes a governance approach. However, due to its relative immaturity, it is suggested by [38] to be prudent to wait for the methodology to be more fully built out and more experience gained with its use, although much of the Val IT methodology has been in use by ING for a number of years.

Organizations requiring more quantitative rigor may adopt AIE. With its mathematical, statistical, and economic techniques AIE provides investment decision-makers with a high degree of confidence in its results. However, there is a steep learning curve associated with it and it requires significant expertise [38].

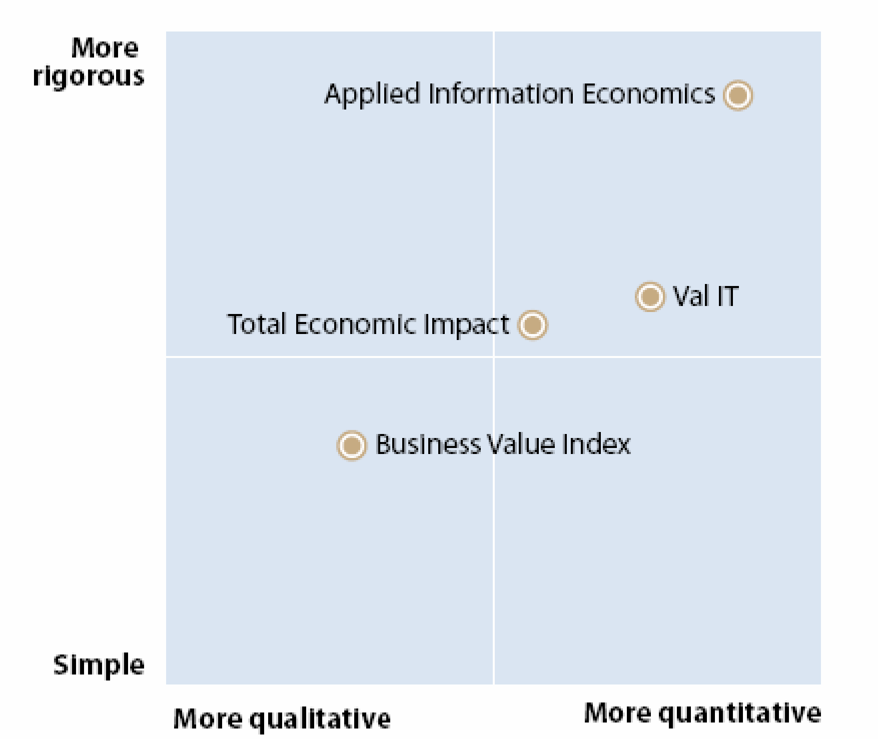

Figure 7 Comparison of methods regarding difficulty of usage and accuracy [38]

6 Information Architecture Evaluation

The Information architecture is a high-level model of information which an organization needs in order to make decision referring the future and required changes and also to perform its operative processes [44]. Storage, sharing and the integrity of information and data within the organisation is performed by Information Systems (IS). IS usually consists of two aspects: the *data architecture* and *data presentation* for operational issues. However, the role of data is much more essential for the IS because the data consists of all available information of the enterprise and the relations between different information. The information is necessary to perform the enterprise's processes. Therefore, the way the data is organized in the IS affects the process in a positive or negative way.

The Data architecture defines how data is stored, managed, and used in a system [45]. It provides criteria for data processing operations that make it possible to design data flows and also control the flow of data in the system. The data warehouse is a common approach for storing and analyzing the data which is created within or outside an organization. A data warehouse consists of a database management system (DBMS) with several databases. The data warehouse or any other database system implements a *corporate data model* [46] which is the relevant issue because it is a conceptual and structured model of the organization's data. The quality of the IS depends on the conceptual data models' quality but there is a lack of quantitative methods to assess the quality of data models. Several frameworks for evaluating a data model's quality have been suggested in [47], [48], [49], and [50]. However, most of these frameworks suggest criteria that may be used to evaluate the quality of data models but an evaluation that is based only on criteria is quite difficult because criteria may be interpreted differently [51]. In this report, one framework which was used already in several companies to evaluate their data models' quality is introduced in the following.

6.1 Moody's Framework for Evaluating and Improving the Quality of Data Models

While studying the previous research, only the *Moody's Framework* for the evaluation of the quality of data models (Entity-Relationship diagrams) was found. The framework was developed in practice and has been applied on a wide range of organizations [51]. The main components of the framework are summarized by the Entity Relationship model shown in Figure 8. The framework defines necessary quality factors which are illustrated in Figure 9. Furthermore, also the assigned stakeholder roles are shown for each of the quality factors. To assess these quality factors the framework embodies a number of evaluation methods, which in some cases are measures (e.g. data model complexity) and in other cases are processes for carrying out the evaluation (e.g. user views). In the following these methods and the quality factor they refer to are presented.

6.1.1 Evaluating the Completeness of NN

The data model is considered as complete if it contains all information required to meet user requirements. This corresponds to one half of the 100 % principle that the conceptual schema should define all static aspects of the Universe of Discourse [52]. Completeness is the most important quality factor because if it is not satisfied, none of the other quality factors matter. An inaccurate or incomplete data model results in a IS which will not satisfy users, no matter how well designed or implemented it is [51].

Generally, completeness can be checked by checking that each user requirement is represented somewhere in the model, and that each element of the model corresponds to a user requirement [53]. Therefore, completeness can only be evaluated in cooperation with business users. The result of completeness reviews will be a list of elements (entities, relationships, attributes, business rules) that do not match user requirements [51].

The Moody's measures for completeness consider mismatches with respect to user requirements. The given metrics should be considered during the review process, so that the model exactly matches user requirements. The completeness metrics are introduced in Appendix 2.

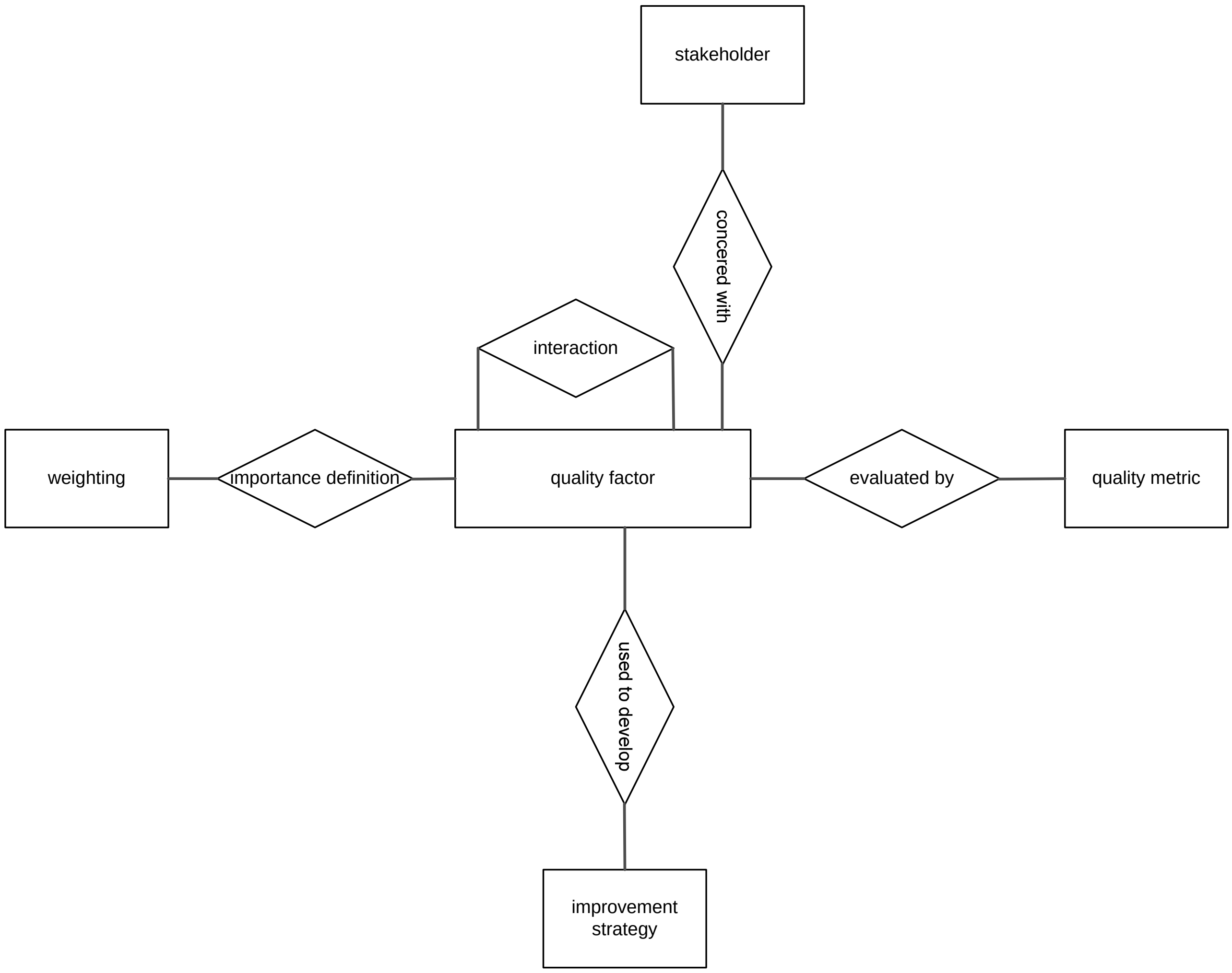

Figure 8: Components of Moody's Framework (Chen notation)

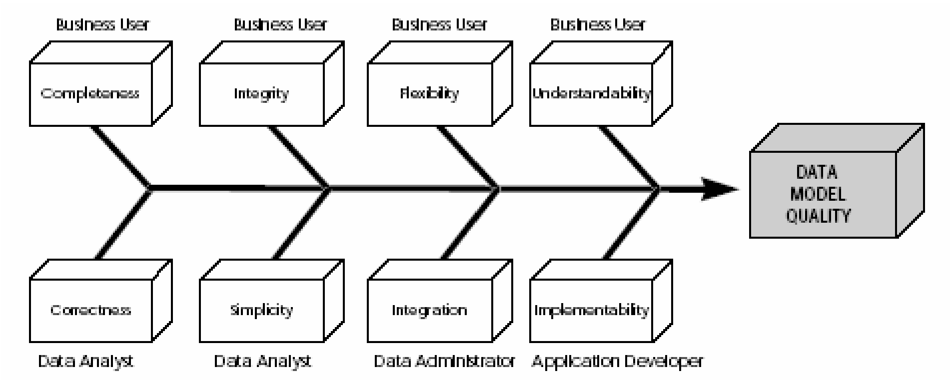

Figure 9 Data Model Quality Factors [51]

6.1.2 Evaluating the Integrity of NN

Integrity is defined as the extent to which the business rules (or integrity constraints) which apply to the data are enforced by the data model [51]. Integrity corresponds to the other half of the 100%

principle that the conceptual schema should define all dynamic aspects of the Universe of Discourse [52]. Business rules define what can and can't happen to the data. Business rules are necessary to maintain the consistency and integrity of data stored, as well as to enforce business policies ([54], [55]). The data model should include all rules which can be applied on the data to ensure they are enforced consistently across all application programs [52].

Like completeness, integrity can only really be evaluated with close participation of business users [51]. The rules represented by the data model may be verified by translating them into natural language sentences. Users can then verify whether each rule is true or false.

The proposed quality measures for integrity take the form of mismatches between the data model and business policies. The Integrity metrics are given in Appendix 2.

6.1.3 Evaluating the Flexibility of NN

Flexibility is defined as the ease with which the data model can cope with business change [51]. The objective is for additions and/or changes in requirements to be handled with the minimum possible change to the data model. Lack of flexibility in the data model can lead to:

- Maintenance costs: of all types of maintenance changes, changes to data structures and formats are the most expensive. This is because each such change has a "ripple effect" on all the programs that use it.
- Reduced organisational responsiveness: inflexible systems inhibit changes to business practices, organisational growth and the ability to respond quickly to business or regulatory change. Often the major constraint on introducing business change

The evaluation of the quality factor Flexibility is complicated by the inherent difficulty of predicting what might happen in the future. Flexibility evaluation requires identifying what requirements might change in the future, their probability of occurrence and their influence on the data model. However, no matter how much time spent thinking about what might happen in the future, such changes remain hard to anticipate.

The proposed flexibility metrics focus on areas where the model is potentially unstable, where changes to the model might be required in the future as a result of changes in the business environment. The purpose of the review process will be to look at ways of minimising impact of change on the model, taking into account the probability of change, strategic impact and likely cost of change. A particular focus of flexibility reviews is identifying business rules which might change. The flexibility metrics are introduced in the Appendix 2.

6.1.4 Evaluating the Understandability of NN

Understandability is defined as the ease with which the data model can be understood [51]. Business users must be able to understand the model in order to verify that it meets their requirements. Similarly, application developers need to be able to understand the model to implement it correctly. Understandability is also important in terms of the usability of the system. If users have trouble understanding the concepts in the data model, they are also likely to have difficulty understanding the system which is produced as a result. The communication properties of the data model are critical to the success of the modelling effort. [51].

Understandability can only be evaluated with close participation of the users of the model such as business users and application developers. In principle, understandability can be checked by checking that each element of the model is understandable. However, this is practically difficult because users might think they understand the model while not understanding its full implications and possible limitations from a business perspective.

The proposed measures for understandability take the form of ratings by different stakeholders and tests of understanding. The purpose of the review process will be to maximise these ratings. The necessary understandability metrics are in the Appendix 2.

6.1.5 Evaluating the Correctness of NN

Correctness refers to the syntactical and grammatical correctness of the model regarding the used modelling language. Further a correct model does not contain redundancies [51]. Correctness can be evaluated easily because there is very little subjectivity involved, and no degrees of quality. The model either follows the modelling language's rules or it does not. Also, the model can be evaluated in isolation, without reference to user requirements [51]. The result of correctness reviews will be a list of defects, defining where the data model does not conform to the rules of the data modelling technique. Many the syntactical and grammatical checks can be carried out automatically using CASE tools.

The proposed quality measures for correctness all take the form of defects with respect to data modelling standards (syntactic rules). We break down correctness errors into different types or defect classes to assist in identifying patterns of errors or problem areas which may be addressed by training or other process measures. The purpose of the review process will be to eliminate all such defects.

6.1.6 Evaluating the Simplicity of NN

Simplicity means that the data model contains the minimum possible constructs [51]. Simpler models are more flexible [56], easier to implement [57], and easier to understand [58]. If there are two data models which meet the same requirement the simpler one should be preferred.

Simplicity can be evaluated easily because it only requires only counting of data model elements. This can be done automatically by CASE tools, or carried out manually. Simplicity metrics are particularly useful in comparing alternative data models [51].

Metrics for evaluating simplicity take the form of complexity measures. The simplicity metrics are given in the Appendix 2.

6.1.7 Evaluating the Integration of NN

Integration is defined as the level of consistency of the data model with the rest of the organisation's data [51]. An approach for achieving corporate-wide data integration is the mentioned corporate data. This data model provides a common set of data definitions which is used to co-ordinate the activities of application development teams so that separately developed systems work together. The corporate data model allows opportunities for sharing of data to be identified, and ensures that different systems use consistent data naming and formats [59].

Integration evaluation is based on comparing data model with the corporate data model. The result of this will be a list of conflicts between the project data model and the corporate data model [51]. This is usually the responsibility of the data administrator (also called information architect, data architect, data manager), who has responsibility for corporate-wide sharing and integration of data. It is their role to maintain the corporate data model and review application data models for conformance to the corporate model.

Most of the metrics for integration consider conflicts with the corporate data model or with existing systems. The purpose of the review process will be to resolve these inconsistencies. In the Appendix 2, the integration metrics are given.

6.1.8 Evaluating Implementability (Feasibility) of NN

Implementability is defined as the ease with which the data model can be implemented within the time, budget and technology constraints of the project [51]. Although it is important that a data model does not contain any implementation relevant information [52] it is also important that it does not ignore all practical considerations. After all, there is little point developing a model which cannot be implemented or that the user cannot afford [51].

The Implementation is assessed by the developers implementing it. The assessment considers feasibility and the relation to the expected costs and time. The process of reviewing the model also allows the application developer to gain familiarity with the model prior to the design stage to ensure a smooth transition [51]. The implementability metrics are introduced in Appendix 2.

As a conclusion, Moody’s Framework seems to be quite heavy because it defines 25 metrics. The author admits that not all metrics are necessary for an evaluation but the framework primary aims at being complete covering all quality factors [51]. Criteria for choosing the metrics should be the metric’s perceived usefulness and ease of calculation.

7 Systems/Application Architecture - Software Architecture Evaluation Techniques

The Systems/Application Architecture defines the software systems which is necessary to process the data and support the business. The software system is described by the *software architecture*. The software architecture basically must describe the software system's components. That means their structure as well as their behaviour and interaction with each other because the whole software system's behaviour results from its components' behaviour. The authors of [2] define software architecture as follows:

> The software architecture of a program or computing system is the structure or structures of the system, which comprise software elements, the externally visible properties of those elements, and the relationships among them.

An architecture evaluation can be performed in different stages of architecture creation process. Actually, the authors of [60], [61] distinguish two possible evaluation phases: the *early* and *late evaluation*. Depending on the stage of the architectural outputs different methods can be applied. In the following the two phases and the evaluation methods are presented.

7.1 Early and Late Architecture Evaluation

Early evaluation is performed when only fragments of the architectural description exist so that mostly the techniques questionnaires, checklists, and scenario-based methods are used for assessment because at this stage there is not enough tangible information available for collecting metrics or simulating behaviour. Mainly the experience of the developers and scenarios based on requirements in the requirement documents are the foundation for the early evaluation. The questionnaires and scenario-based techniques have a stronger focus on evaluating whether the stakeholders' requirements are met by the architecture, and the identification and evaluation of the relevant design decisions implementing these requirements.

Late architecture evaluation is carried out during later stages of the software development process when there is at least a detailed design available on which more concrete metrics can be collected. To ensure the quality control and quality assurance early evaluation and late evaluation techniques should be used in this way. It is possible to ensure that the stakeholders' requirements are considered and implemented in the architecture. This point of view corresponds with [62] because the author proposes first an architectural review which is actually an early evaluation and secondly the determination of relevant quality attributes by applying techniques like architectural metrics [60], simulation ([63], [64]) and mathematical modelling ([62], [65]). In fact, the second proposition, given by [62], has the same purpose as the late evaluation. Next, some techniques are briefly described.

7.2 Questionnaires and Checklist

According to [2], the techniques using questionnaires and checklists are quite similar; both consist of questions regarding the issue if the architecture fulfils functional and non-functional requirements. These questions have to be answered by a group of the software system's stakeholders. That means this evaluation is based on their experience. Questionnaires as well as checklists are assessed statistically. An example of the questionnaire and checklist techniques is presented in Appendix 3.

7.3 Scenario-based Methods

The following explanation is based on the book [60] whose authors developed several scenario-based methods at the Software Engineering Institute at Carnegie Mellon University.

Scenario-based techniques evaluate the software architecture by considering it from a higher abstraction level that means the architectural description must neither be complete nor very detailed. A further commonness is that that these methods define a number of steps which have to be performed to achieve a useful evaluation result. These steps are:

- description of the architecture or the architectures which should be evaluated
- development of scenarios (based on non-functional requirements)
- prioritization of the scenarios according to the quality attributes they should prove
- evaluation the architecture from the high-priority scenarios perspectives
- exposition of the results.

The scenarios describe the desired system's behaviour during performing certain tasks. This behaviour depends on the existence of certain quality characteristics. That means if the architecture enables the fulfilment of certain scenarios proves the implementation of certain quality characteristics. The quality of the evaluation and especially its results depends on the scenarios' quality. Their quality increases by a well done mapping of requirements to scenarios. It is fatal if an important and necessary scenario is missing during the evaluation. Therefore, the scenario development should involve representatives from all stakeholders. Such scenario-based methods are for example:

- Software Architecture Analysis Method (SAAM)
- Architectural Trade-off Analysis Method (ATAM)
- Active Reviews for Intermediate Designs (ARID)
- Architecture-Level Modifiability Analysis (ALMA)
- Family Architecture Assessment Method (FAAM)
- Cost Benefits Analysis Method (CBAM)

The *Cost Benefits Analysis Method* (CBAM) aims at the estimation of factors cost and time related to the benefit of a design decision. So, usually, this method follows after the identification and analysis of design decisions and the trade-offs and risks related to them. In Table 2, a comparison of the above listed methods is presented.

Method	Assessed Quality	Metrics and Tools Support	Process Description	Strengths	Weaknesses	Systems Type Applicable for
SAAM	Modifiability	Scenario classification (direct vs. indirect ones)	Reasonable	Identifying the areas of high potential complexity Open for any architectural description	Not a clear metric Not supported by techniques for performing the steps	All
ATAM	Modifiability	Sensitivity Points, Tradeoff Points Supported by ATA Tool	Good	Scenario generation based on Requirements Applicable for Static and dynamic properties Quality utility tree	Requires detailed technical knowledge	All
CBAM	Costs, Benefits, and Schedule Implications	Time and costs	Reasonable	Provide business measures for particular system changes Make explicit the uncertainty associated with the estimates	Identifying and trading costs and benefits can be done by the participants in an open manner	All
ALMA	Modifiability	Impact estimation, Modifiability prediction Model	Reasonable	Scenario generation stopping criterion	Restricted set of case studies Concentrates on static properties	Business Information Systems
FAAM	Interoperability and Extensibility	Various specialized tables and Diagrams	Very good Detailed process flow	Emphasis on empowering the teams in applying the FAAM session	Only partially proven in one particular environment Concentrates on static properties	System Families

Table 2: Comparison of scenario-based methods [66]

The comparison shows that SAAM, ATAM and CBAM can be applied on any kind of a system. Furthermore, these methods have been applied and validated in several industrial cases. Since ATAM is a successor of SAAM and results in more tangible information regarding risks and trade-offs cause by design decision ATAM will be described in the following. Also the CBAM evaluation is described afterwards because it enables time, cost and benefits analysis.

7.3.1 Architectural Trade-off Analysis Method (ATAM)

The ATAM is so named because it reveals how well the architecture satisfies particular quality goals and since it recognizes that architectural decisions affect more than one quality attribute that means this method enables the identification of trade-offs among several quality attributes. According to [60] the participation of three different groups is usually necessary for performing the ATAM. The groups are the evaluation team, the project decision makers and the architecture stakeholders. The groups and especially the evaluation team are described in more detail in the Appendix 4.

The whole ATAM-based evaluation is divided into four phases. The first phase is called *partnership and preparation*. In this phase basically the evaluation team leadership and the key project decision makers informally meet to work out the details of planned evaluation. They agree on formal issues like logistics, such as the time and place of meetings, statement of work or nondisclosure agreements, and then they agree about a preliminary list of stakeholders.

Furthermore, they decide which architectural documents will be delivered to the evaluation team for performing the evaluation. The actual *evaluation phases* are the second and third phase. The evaluation team uses the second phase for studying the architecture documentation to get a concrete idea of what the system is about, the overall architectural approaches which are chosen, and the important quality attributes. During the third phase the system's stakeholders join the evaluation team and both groups analyze the architecture together. The analysis is based on the elicitation of scenarios. According to [60] the capturing and elicitation of functional and non-functional requirements is part of ATAM.

In the fourth and last phase the evaluation team creates and delivers the final report. The concrete steps which are performed during the ATAM evaluation are described in the Appendix 5.

The ATAM evaluation results in the following outputs:

- architectural approaches documented
- set of scenarios and their prioritization from the brainstorming
- utility tree
- risks
- non-risks
- sensitivity points and trade-off points

7.3.2 Cost-Benefit Analysis Method (CBAM)

CBAM begins where ATAM leaves off because this method enables analyzing the costs, benefits and schedule implications of architectural decisions. Different form the former method CBAM is bridging two domains in software development the architecting process and the economics of the organization. CBAM is adding the costs (and implicit budgets or money) as quality attributes, which need to be considered among the trade-offs when a software system is going to be planned. ATAM (and SAAM) primarily considered the design decisions with respect to architectural quality attributes like modifiability, performance, availability, usability, and so on. CBAM is focusing on costs, benefits and risks which are as important as the other quality attributes and they are relevant to be considered when the architectural decisions are being made. The impulse of the CBAM development came from a set of questions, each of which contributed in shaping the method. These questions were addressed as:

- How can the architectural decisions be measured and compared in terms of their different implications, costs and benefits?
- How can quality attributes be analyzed and trade-off with respects to their costs and benefits involved?
- How can be characterized the uncertainty level associated with these cost and benefits estimates?

The evaluation team (Appendix 6) in accordance with the project scale and goals must appreciate the effort. Looking at the organizational aspects and CBAM steps (Appendix 6) one can say that most of the effort is concentrated in architectural strategies elicitation and cost-benefit-schedule prediction part. A CBAM session takes one or two days. In addition an ATAM allocated is increasing to at least four working days. In terms of man-hours estimation and procedural costs, the CBAM team can provide certain effort values.

CBAM general strengths and outputs are:

- values as a basis for a rational decision making process in applying certain architectural strategies
- business measure that can determine the level of return on investment of a particular change to the system
- help for organizations in analyzing and pre-evaluating the resource investment in different directions by adopting those architectural strategies that are maximizing the gains and minimize the risks
- Since CBAM is built on the general architecture assessment methods like SAAM and ATAM, the method is inheriting their benefits with respect to efficiency.

So far, there is no method that incorporates the economical perspective in the software quality attributes evaluation and trade-off analysis.

7.4 Architectural Metrics

This approach aims at measuring certain attributes of the software architecture which enable assumptions about the architecture's quality. Architectural metrics belong to the group of product metrics as described in [67]. They are derived from quality attributes which are refined quality characteristics. The existing software architectural metrics are quite limited. Furthermore, the so-called architectural metrics are very similar to design metrics. A reason for this is, according to [60], that the existence of a detailed architectural description is necessary to collect metrics. That means that the design description is at a stage where it can be implemented or parts of it are already implemented. Mostly metrics about structural characteristics are collected. These measurements are performed with the help of the architectural descriptions which are commonly presented in UML notation or on the code level; this enables partly tool-based measurements. The architectural metrics reflect class characteristics like the complexity of a class, number of methods, depth of the inheritance hierarchy, coupling, and cohesion. The collected metrics are interpreted for evaluating quality attributes, especially maintainability, testability, understandability, reusability, complexity, and also efficiency. The three common metrics cohesion, coupling, and Cyclomatic Complexity are described in the Appendix 7.

7.5 Prototyping

Prototyping has been described e.g. in [63], [64]. In prototyping, the most important quality attributes are refined into scenarios. The essential functionality to perform these scenarios is implemented in the prototype. The executable prototype can be tested regarding quality attributes at runtime. The gained results are used for further development or correction of the software architecture. The scenarios are mostly implemented without user-oriented and business-oriented aspects of the architecture, what makes the prototyping evaluation approach resource-saving especially regarding time and cost. The prototyping approach is often also called simulation in the literature, e.g. in [62].

7.6 Mathematical Modelling

A mathematical model is an abstract model which describes the system's behaviour or certain aspects of the system's behaviour. The model is used for determining theoretically how the system reacts on certain events. According to ([62], [65]), especially for high-performance computing, reliable systems, real-time systems, etc. mathematical models have been developed, and they can be used to evaluate especially quality attributes related to the runtime behaviour of the system. Different from the other approaches, the mathematical models allow for static evaluation of architectural design models. Mathematical modelling is an alternative to prototyping because both approaches are primarily suitable for assessing runtime behaviour. The approaches can also be combined. Two widely spread types of models are *performance modelling* and *real-time task models*. For example, performance modelling can be used to determine the computational requirements of the individual components in the architecture. These theoretical results can then be used and proofed with the running prototype in a simulation. Since the focus of this work also is on the performance assessment with the help of the architecture performance modelling is a suitable approach. Typical performance models are queuing networks and Markov chains which are based on stochastic and probability-based methods, and other stochastic approaches like stochastic process algebras.

7.7 Summary

While the measurement-based approaches, architectural metrics, and prototyping give concrete values for the evaluation and make it that way a bit sounder, they have the drawback that they can be applied only in the presence of a working artefact. Also the mathematical models are based on detailed description of the whole architecture or at least of some components because the more detailed the model the more realistic are the computed results. Questionnaires and scenario-based evaluations, on the other hand, work just fine on hypothetical architectures, and can be applied much earlier in the life cycle. Actually, these techniques can be seen as architectural review with the main stakeholders because they improve the understanding of the impact of architectural decisions on the system's requirements. Furthermore, even if the architectural description is not in the implemental stage, these approaches are able to identify insufficiencies, weaknesses, and risks. Especially the utilization of ATAM and CBAM is a promising approach to evaluate a software system’s quality and costs.

8 Technology Architecture Evaluation

The Technology Architecture describes the hardware and communication technology which is used within the organization to enable the communication and to deploy the utilized software [68]. Technology architecture includes [11]:

1. Hardware and platforms
2. Local and wide area networks
3. Operating System
4. Infrastructure software such as application servers, database management system and middleware.

The runtime behaviour of the software system supporting the organization's processes is strongly depending on the underlying technology therefore the planning and design of a software system should already consider the underlying platforms. Common software architecture models like Kruchten's *4+1 views* [69] or Soni's model [70] include also a description of the execution environment. Hence, the technology can be evaluated as part of the software system during the software architecture evaluation. Usually, the components used within the technology architecture are commercial-of-the-shelf (COTS) components and their quality characteristics are described by the supplier. However, it is necessary to integrate different components with each other and different implementations have different behaviour concerning runtime characteristics. Therefore the infrastructure can be evaluated by using benchmarking. Benchmarking primary evaluates performance, scalability and reliability of the used infrastructure. The evaluation results gained from benchmarking can be compared to the expected costs which are connected to different COTS components. That cost/benefit consideration supports decision making regarding the questions which COTS components suit best the organization's software systems.

9 Mapping of Methods to Architecture Evaluation Needs

In this section, the presented evaluation methods are assigned to the evaluation needs mentioned in Section 1.

Table 3 shows the mapping of evaluation needs to the presented evaluation methods. The methods which are mapped to the needs are suggestions for assessing the needs and concerns relating to enterprise and software architecture. Furthermore, the satisfaction of the needs is strongly depending on the used input for the evaluation, especially, the architectural artefacts and the skills and experience of the evaluation teams. It should be noticed, that Table 3 takes into account only those needs for which it was possible to find evaluation methods.

The suggested methods evaluate the architecture regarding concerns related to the demanded evaluation needs. However, it is difficult to predict the extent of satisfaction for certain needs because the needs definitions are rather general. Only the application of the methods to the specific EA can answer the question how well the suggested methods satisfy the evaluation needs of a specific organization. Furthermore, the combination of methods might be necessary to improve the fulfilment of certain needs.

Table 3 Mapping of Evaluation needs to methods

Method Name	Technique	Strengths	Practical Proof	Means of Implementation	Addressed Evaluation Needs
Business Architecture					
Governance Modelling	conceptual modelling and review	• vision, goals, objectives are made explicit • transparency of transformation drivers • tracing of decisions and responsibilities • basis for analysis and evaluation (conflicts, improvement, level of fulfilment) • basis for planning and changing strategies and processes	standardized by OMG	Business Motivation Model (BMM)	• observation that ICT-architecture do not correspond to company's business's requirements • enhances the understanding of company's business/ICT • enhances the understanding of responsibilities in the company • make sure that organisational choices are suitable • An effort towards long-term technical solutions and need to argue for the long-term technical solutions
Business Process Modelling	conceptual modelling and review	• visualization of processes regarding relationships, dependencies, and effects between processes and their activities and resources • visualization increases the understanding about the processes and supports the validation	yes	BPMN, EPC, ARIS and many other tools	• change need in the business or ICT (e.g. a need to move from one solution to another) • observation that ICT-architecture do not correspond to company's business's requirements • enhances the understanding of company's business/ICT • enhances the understanding of responsibilities in the company • make sure that organisational choices

Method Name	Technique	Strengths	Practical Proof	Means of Implementation	Addressed Evaluation Needs
		and improvement for many stakeholders • 80% of process advancements are achieved by modelling the current status			are suitable • distribution of work • Business process planning • need to find the best possible system solution and a need to understand the aspects relating the solution • An effort towards long-term technical solutions and need to argue for the long-term technical solutions
Business Process Simulation	simulation	• the current processes (*as-is* state) regarding costs, performance • analyze *what-if* scenarios, obtain cost and performance predictions, and validate processes • support the decision making regarding organizational change and future investments	yes	ARIS Simulation, BPEL	• change need in the business or ICT (e.g. a need to move from one solution to another) • observation that ICT-architecture do not correspond to company's business's requirements • make sure that organisational choices are suitable • Business process planning • need to find the best possible system solution and a need to understand the aspects relating the solution • An effort towards long-term technical solutions and need to argue for the long-term technical solutions
Business Value	priority-based	• supports the	by Intel		• change need in the business or ICT

Method Name	Technique	Strengths	Practical Proof	Means of Implementation	Addressed Evaluation Needs
Index (BVI)	assessment of future investments	prioritization of investment options • tangible and intangible value can be measured			(e.g. a need to move from one solution to another) • effort to drive investments to follow up architectural principles
Total Economic Impact (TEI)	Risk-adjusted Return on Invest calculation	• measures cost, benefits, flexibility, and risk impact on business • risk-adjusted ROI	by Forrester	Forrester's implementation support	• change need in the business or ICT (e.g. a need to move from one solution to another) • understanding quality aspects relating to the company's application portfolio • effort to drive investments to follow up architectural principles
ValIT	Value governance, Portfolio management, and investment management	• Value governance • Portfolio management • Investment management	validated by the Dutch financial services firm ING	support from IT Governance Institute (ITGI)	• change need in the business or ICT (e.g. a need to move from one solution to another) • understanding quality aspects relating to the company's application portfolio • effort to drive investments to follow up architectural principles
Applied Information Economics (AIE)	IT investment assessment through mathematical and scientific methods	• mathematical models • Developing financially-based quality assurance measures • Developing a strategic plan for information systems	not wide-spread because the method is very complex		• change need in the business or ICT (e.g. a need to move from one solution to another) • effort to drive investments to follow up architectural principles

Method Name	Technique	Strengths	Practical Proof	Means of Implementation	Addressed Evaluation Needs
Information Architecture					
Moody's Framework	reviews and metrics	• evaluates data model's quality • provides quantitative measures • coverage of many data model quality aspects	yes	Entity-Relationship modelling, Moody's Framework	• information / data models of good quality • understanding information managed in company
Software Systems Architecture					
SAAM	scenario-based review aims on scenario validation	• knowledge transfer about architectural decisions • identification of areas of high potential complexity		evaluation steps of the software engineering institute, Carnegie Mellon	• understanding the state of the company's application portfolio • understand the current state of technical infrastructure • need to find the best possible system solution and a need to understand the aspects relating the solution
ATAM	scenario-based review regarding system's quality characteristics including scenario validation, trade-off and risk identification	• identifies risks and points of trade-off • enables evaluation of structural and behavioural system characteristics • improves architectural knowledge sharing	yes	evaluation steps of the software engineering institute, Carnegie Mellon	• change need in the business or ICT (e.g. a need to move from one solution to another) • need to enhance the understanding of company's business/ICT • understanding the state of the company's application portfolio • understanding quality aspects relating to the company's application portfolio • understanding the current state of technical infrastructure

Method Name	Technique	Strengths	Practical Proof	Means of Implementation	Addressed Evaluation Needs
					• need to find the best possible system solution and a need to understand the aspects relating the solution • An effort towards long-term technical solutions and need to argue for the long-term technical solutions
CBAM	scenario-based review with focus on cost and benefits	• measurement of design decisions with cost and benefit metric • makes uncertainty explicit associated with the estimates	yes		• change need in the business or ICT (e.g. a need to move from one solution to another) • understanding quality aspects relating to the company’s application portfolio • effort to drive investments to follow up architectural principles • An effort towards long-term technical solutions and need to argue for the long-term technical solutions
Technology/Infrastructure Architecture					
Benchmarking	Measures performance, reliability, and cost	• enables the collection of metrics regarding the system’s performance, reliability and cost • supports decision making	yes	Benchmark test tools	• understanding the current state of technical infrastructure

10 Conclusions

This paper dealt with the topic of architecture evaluation methodologies, especially focusing on methods for enterprise and software architecture evaluation. While there are several methods for evaluating architectural artefacts in the area of software architectures there seems to be a lack of methodologies evaluating enterprise architecture. The most wide-spread approaches are maturity models and IT-Business-Alignment assessment methods. However, they address primarily the enterprise architecture management and development process and not the evaluation of architectural outputs.

Most of the architecture evaluation needs described in this report (Section 2) refer to concerns which have to be assessed through analysis of architectural descriptions. Since enterprise architecture is a composition of different architectural views addressing different concerns, this paper suggested means to assess these views regarding the detected needs. Methodologies to evaluate the business, information, systems and technology architectures were presented. Many methods rely on conceptual modelling to be understandable for different stakeholders from different domains such as managers, business analysts, and developers. Therefore, conceptual modelling standards, such as BPMN, which enhances the understanding, knowledge sharing and the analysis of the structure and behaviour of the organization, are considered as evaluation approaches. The evaluation techniques suggested in this paper are a collection of review methods analyzing conceptual models, simulation approaches, and measures for predictions relating to the changing environment but also metrics for assessing quality attributes. All presented assessment techniques are either based on standards or are developed or validated in a practical environment. In the following, the suggested approaches are briefly summarized.

For evaluating the business architecture the following methods were presented:

- governance modelling (improvement of tracing between vision/goals and processes and tasks)
- business process modelling and simulation (enhancing knowledge and enabling what-if-scenarios)
- financial methods for assessing the value of IT investment (prediction of expected benefits through IT investment)

The needs concerning the enterprise's information architecture were addressed by evaluation of the corporate data model which is a structured conceptual model of the organisation's data entities and their relations. The suggested methodology was *Moody's Framework.*

The systems architecture consists of software systems. A software system is described through software architectural artefacts. Therefore, the evaluation techniques suggested for the systems architecture are methods for software architecture evaluation. Since the infrastructure which allows the deployment of software applications is also part of the software system, the underlying execution environment can be evaluated within the software architecture evaluation. The methods concerning the software system evaluation enable predictions regarding the whole system life cycle. Especially, characteristics, such as performance, cost, reliability and maintenance are essential characteristics in the enterprise architecture context. The suggested methods are able to assess these criteria.

A further conclusion is the fact that architecture evaluation depends strongly on conceptual models which are used to share and communicate the architectural knowledge among different stakeholders from different domains. Therefore, conceptual modelling standards are part of the evaluation methods or conceptual models belong to the evaluation input and are the basis for analysis and discussion about architectural decisions.

This report showed that there are techniques to evaluate enterprise architecture with the help of architectural descriptions. However, the complexity of enterprise architecture and the related variety of concerns complicates reaching an established overall evaluation approach. The problem of developing methodologies enabling the enterprise architecture evaluation in a coherent, efficient, and practical way should be overcome in future research and work.
So far it is only possible to apply different techniques on only single architectural views of EA. Integrating these techniques into the EA evaluation process of a company might be difficult. These techniques are independent of each other and they refer to different standards, description models, and tools which are not compatible to those already used within in the organization.

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Appendix 1. Business Value Index Example

All three dimensions use a predetermined set of criteria including customer need, business and technical risks, strategic fit, revenue potential, level of required investment, the amount of innovation and learning generated, and other factors [39]. Each dimensions' criteria are weighted according to the ongoing business strategy and its importance to the business environment. Changes in business strategy could change the impact of criteria on a certain dimension.

As project managers or program owners evaluate their proposed investments using the BVI tool, they score their project against these criteria on a scale of 0 to 3, depending how the IT investment will likely perform against a range of values set for a particular assessment criteria. The assessment of criteria belonging to the dimension of Business Value is shown in Table 4. Afterwards the single values of the criteria are summed up to a value representing the dimension.

Since every project or program is represented through the three dimensional vector projects can be compared ranked according to their benefits. The comparisons between projects regarding one to three dimensions are possible. Figure 4 illustrates the ranking concerning all three dimensions.

Table 4 Sample Assessment Criteria and Scoring [39]

Criteria	**Weight**	**0**	**1**	**2**	**3**
Customer pull/need	4	Low	Medium	High	Very high
Customer product cost reduction	3	Increase	No impact	Marginal reduction	Substantial reduction
Business strategic fit and impact	3	Low/NA	Medium	High	Very High
Customer performance improvement	3	Decrease	< 5 %	> 5 %	> 10 %

Appendix 2. Metrics for Data Model Quality

Completeness Metrics:

Metric 1: Number of items in the data model that do not correspond to user requirements. Inclusion of such items will lead to unnecessary development effort and added cost.

Metric 2: Number of user requirements which are not represented in the data model. These represent missing requirements, and will need to be added later in the development lifecycle, leading to increased costs, or if they go undetected, will result in users not being satisfied with the system

Metric 3: Number of items in the data model that correspond to user requirements but are inaccurately defined. Such items will need to be changed later on the development lifecycle, leading to rework and added cost, or if they go undetected, will result in users being unsatisfied with the system.

Metric 4: Number of inconsistencies with process model. A critical task in verifying the completeness of the data model is to map it against the business processes which the system needs to support. This ensures that all functional requirements can be met by the model. The result of this analysis can be presented in the form of a CRUD (Create, Read, Update, Delete) matrix. Analysis of the CRUD matrix can be used to identify gaps in the data model as well as to eliminate unnecessary data from the model [59].

Integrity Metrics:

Metric 5: Number of business rules which are not enforced by the data model. Non-enforcement of these rules will result in data integrity problems and/or operational errors.

Metric 6: Number of integrity constraints included in the data model that do not accurately correspond to business policies (i.e. which are false). Incorrect integrity constraints may be further classified as:

- too *weak*: the rule allows invalid data to be stored
- too *strong*: the rule does not allow valid data to be stored and will lead to constraints on business operations and the need for user “workarounds”.

Flexibility Metrics:

Metric 7: Number of elements in the model which are subject to change in the future. This includes changes in definitions or business rules as a result of business or regulatory change.

Metric 8: Estimated cost of changes. For each possible change, the probability of change occurring and the estimated cost for changes made after the implementation should be used to calculate the probability-adjusted cost of the change.

Metric 9: Strategic importance of changes. For each possible change, the strategic impact of the change should be defined, expressed as a rating by business users of the need to respond quickly to the change.

Understandability Metrics:

Metric 10: User rating of understandability of model. User ratings of understandability will be largely based on the concepts, names and definitions used, as well as how the model is presented.

Metric 11: Ability of users to interpret the model correctly. This can be assessed by getting users to instantiate the model using actual business scenarios. Their level of understanding can then be assessed by the number of errors in populating the model. This is a better operational test of understanding than the previous Metric 10 because it measures whether the model is actually understood rather than whether it is understandable [47]. This is much more important from the point of view of verifying the accuracy of the model.

Metric 12: Application developer rating of understandability.

Correctness Metrics:

Metric 13: Number of violations to data modelling conventions. These can be further refined into the following defect classes:

- Diagramming standards violations (e.g. relationships not named)
- Naming standards violations (e.g. use of plural nouns as entity names)
- Invalid primary keys (non unique, incomplete or non-singular)
- Invalid use of constructs (e.g. entities without attributes, overlapping subtypes, many to many relationships)
- Incomplete definition of constructs (e.g. data type and format not defined for an attribute; missing or inadequate entity definition)

Metric 14: Number of normal form violations. Second and higher normal form violations identify redundancy among attributes within an entity (*intra-entity redundancy*). Normal form violations may be further classified into:

- First normal form (1NF) violations
- Second normal form (2NF) violations
- Third normal form (3NF) violations
- Higher normal form (4NF+) violations

Metric 15: Number of instances of redundancy between entities, for example, where two entity definitions overlap or where redundant relationships are included. This is called *inter-entity redundancy*, to distinguish this from redundancy within an entity (*intra-entity redundancy*-Metric14) and redundancy of data with other systems (*external redundancy*-Metric 21)

Simplicity Metrics

Metric 17 is recommended as the most useful of the measures proposed.

Metric 16: Number of entities (E)

Metric 17: Number of entities and relationships (E+R). This is a finer resolution complexity measure which is calculated as the number of entities (E) plus the number of relationships (R) in the data model. This derives from complexity theory, which asserts that the complexity of any system is defined by the number of components in the system and the number of relationships between them ([71], [72]).

Metric 18: Number of constructs (E+R+A). This is the finest resolution complexity measure, and includes the number of attributes in the calculation of data model complexity. Such a metric could be calculated as a weighted sum of the form aNE + bNR + cNA where NE is the number of entities, NR is the number of relationships and NA is the number of attributes. In practice however, such a measure does not provide any better information than Metric 17.

Integration Metrics:

Metric 19: Number of data conflicts with the Corporate Data Model. These can be further classified into:

- Entity conflicts: number of entities whose definitions are inconsistent with the definition entities in the corporate data model.
- Data element conflicts: number of attributes with different definitions or domains to corresponding attributes defined in the corporate data model.
- Naming conflicts: number of entities or attributes with the same business meaning but different names to concepts in the corporate data model. Also entities or attributes with the same name but different meaning to concepts in the corporate data model.

Metric 20: Number of data conflicts with existing systems. These can be further classified into:

- Number of data elements whose definitions conflict with those in existing systems e.g. different data formats or definitions. Inconsistent data item definitions will lead to interface problems, the need for data translation and difficulties comparing and consolidating data across systems.
- Number of key conflicts with existing systems or other projects. Key conflicts occur when different identifiers are assigned to the same object (e.g. a particular customer) by different systems. This leads to fragmentation of data across systems and the inability to link or consolidate data about a particular entity across systems.
- Number of naming conflicts with other systems.
- These are less of a problem in practice than other data conflicts, but are a frequent source of confusion in system maintenance and interpretation of data.

Metric 21: Number of data elements which duplicate data elements stored in existing systems or other projects. This is called *external redundancy* to distinguish it from redundancy within the model itself (Metrics 14 and 15). This form of redundancy is a serious problem in most organizations [51].

Metric 22: Rating by representatives of other business areas as to whether the data has been defined in a way which meets corporate needs rather than the requirements of the application being developed. Because all data is potentially shareable, all views of the data should be considered when the data is first defined [73]. In practice, this can be done by a high level committee which reviews all application development projects for data sharing, consistency and integration.

Implementability Metrics:

The measures of implementability are ratings by the developer:

Metric 23: Technical risk rating: estimate of the probability that the system can meet performance requirements based on the proposed data model and the technological platform (particularly the target DBMS) being used.

Metric 24: Schedule risk rating: estimate of the probability that the system can be implemented on time, based on the proposed data model.

Metric 25: Development cost estimate: this is an estimate of the development cost of the system, based on the data model. Such an estimate will necessarily be approximate but will be useful as a guide for making cost/quality trade-offs between different models proposed. If the quote is too high (exceeds available budget), the model may need to be simplified, reduced in scope or the budget increased.

Appendix 3. Questionnaire and Checklist Example

An example of a questionnaire-based software architecture evaluation is presented in Svahnberg's paper [61]. In this example, the questionnaire used for this evaluation basically aims on the identified necessary system's quality characteristics. According to these quality characteristics, five quality attributes are investigated on four candidate architectures.

The questionnaire contains four parts. The first part covers generic questions like what architecture (e.g. client-server, multi-tier) the participant would prefer based on his/her experience. Moreover, it contains some questions whether there are any architecture types or quality attributes missing. The second part deals with questions to obtain a prioritized list of quality attributes. The third part consists of questions to rate the support given for the quality attributes within each architecture candidate. The fourth part encloses questions to rate which architecture is best at each quality attribute.

Appendix 4. Architecture Trade-Off Analysis Method (ATAM) Participants

Evaluation team is a group of three to five people who are external to the project whose architecture is being evaluated. Each member of the team is assigned a number of specific roles to play during the evaluation. These roles are described in Table 5.

Project decision makers are people who are authorized to speak for the development project or have the right to command modifications to it. This group normally consists of the project manager, the customer who is footing the bill for the development, the architect, and the person commissioning the evaluation.

Architecture stakeholders include developers, testers, integrators, maintainers, performance engineers, users, builders of systems interacting with the one under consideration, and others. Their job during an evaluation is to state the specific quality attribute goals that the architecture should meet in order for the system to be considered a success. This group usually consists of twelve to fifteen people.

Table 5: ATAM Evaluation team roles with their responsibilities [60]

Role	**Responsibilities**
Team Leader	• sets up the evaluation coordinates with client, making sure client's needs are met • establishes evaluation contract • forms evaluation team • sees that final report is produced and delivered (although the writing may be delegated)
Evaluation Leader	• runs evaluation • facilitates elicitation of scenarios • administers scenario selection/prioritization • process • facilitates evaluation of scenarios against architecture • facilitates onsite analysis
Scenario Scribe	• writes scenarios on flipchart or whiteboard during scenario elicitation • captures agreed-on wording of each scenario, halting discussion until exact wording is captured

Proceedings Scribe	• Captures proceedings in electronic form on laptop or workstation, raw scenarios, issue(s) that motivate each scenario (often lost in the wording of the scenario itself), and resolution of each scenario when applied to architecture(s) • also generates a printed list of adopted scenarios for handout to all participants
Timekeeper	• helps evaluation leader stay on schedule • helps control amount of time devoted to each scenario during the evaluation phase
Process Observer	• keeps notes on how evaluation process could be improved or deviated from; usually keeps silent but • may make discreet process-based suggestions to the evaluation leader during the evaluation • after evaluation, reports on how the process went and lessons learned for future improvement • also responsible for reporting experience to architecture evaluation team at large
Process Enforcer	• helps evaluation leader remember and carry out the steps of the evaluation method
Questioner	Raise issues of architectural interest that stakeholders may not have thought of

Appendix 5. ATAM Evaluation Phases and Steps

Partnership and Preparation

First Step
The first step mainly consists of the presentation of the ATAM with its steps and outputs to the three participating groups mentioned above.

Second Step
During the second step the context for the system and the primary business drivers which are the reasons for the system's development are presented to the involved persons. Business drivers are all the functions, information and people enforcing the business goals of an enterprise and ensuring the daily business. Therefore, the system's most important functions, the enterprise's business goals and their relation to the system, any relevant technical, managerial, economic, or political constraints, and the system's major stakeholders are presented.

So actually the desired effect of the system on its environment is described.

Third Step
In the third step, the architecture is presented at an appropriate level of detail that means the presentation is depending on how much of the architecture has been designed and documented; how much time is available; and the nature of the behavioural and quality requirements. The architectural presentation covers technical constraints like the operating system, hardware, or middleware which are intended to be used, and further it shows other systems with which the system must interact. Most important, the architect describes the architectural approaches used to meet the functional and non-functional requirements. The architecture should be described through different views to address different stakeholder roles.

Investigation and Analysis (evaluation)

Fourth Step
During the fourth step the evaluation team identifies the architectural approaches and used patterns and lists them as a basis for further analysis.

Fifth Step
In the fifth step, the quality attribute goals are formulated in detail using a mechanism known as the utility tree. The evaluation team in cooperation with the project decision makers identify, prioritize, and refine the system's most important quality attribute goals, which are expressed as scenarios. The utility tree serves to make the requirements concrete, forcing the architect and customer representatives to define precisely the relevant quality requirements that they were working to provide. A utility tree begins with utility as the root node. Utility is an expression of the overall quality of the system. Quality attributes form the second level because these are the components of utility. Typically, performance, modifiability, security, usability, and availability are the children of utility, but participants are free to name their own as long as they are able to explain what they mean through refinement at the next levels. The third level of the utility tree consists of specific refinements of the quality attributes, for example, performance might be decomposed into *data*

latency and *transaction throughput*. These refinements are the base for the creation of scenarios which form the leaves of the utility tree and they are concrete enough for prioritization and analysis. According to [74], scenarios are the mechanism by which broad and ambiguous statements of desired qualities are made specific and testable. ATAM scenarios consist of three parts:

- *stimulus* which is an event arriving at the system, the event's generator and handler are also named
- *environment* (what is going on at the time)
- *response* (system's reaction to the stimulus expressed in a measurable way)

The definition process of a utility tree is similar to the definition of a quality model for a software product [9] because the overall quality is divided into quality characteristics which are refined in measurable quality attributes which are evaluated by metrics. So metrics are the leaves in a quality model. In the utility tree, scenarios are indicators of certain quality attributes. Of course, a metric is much more concrete because it is a value assigned to an attribute, the scenario in contrast serves to evaluate theoretically whether it is implemented by the architecture. Some scenarios might express more than one quality attribute and so they might appear in more than one place in the tree. To simplify the analysis, these scenarios should be spitted according to different concerns. The refinement process of quality attributes to scenarios might lead to many scenarios which cannot all be analyzed, so this fifth step also includes the prioritization of the scenarios.

This prioritization can be based on a scale from zero to ten or on a relative ranking like high, low, and medium. The latter one is recommended by [74] because it is less time consuming. The ranking is done by the project decision makers. Furthermore, the scenarios are prioritized by the architect regarding the difficulty of satisfying the scenario by the architecture. There also the high, medium, and low ranking is recommended. Now each scenario has an associated ordered pair (importance of scenario for the system, difficulty of satisfying the scenario by the architecture), for example (H,H). The ordered pair (H,H) means, this scenario is very essential for the system and it is difficult to implement it by the software architecture.

The scenarios that are the most important and the most difficult will be the ones where precious analysis time will be spent, and the remainder will be kept as part of the record. A scenario that is considered either unimportant (L,*) or very easy to achieve (*,L) is not likely to receive much attention. The output of utility tree generation is a prioritized list of scenarios that serves as a plan for the remainder of the ATAM evaluation. It tells the ATAM team where to spend its (relatively limited) time and, in particular, where to probe for architectural approaches and risks. The utility tree guides the evaluators toward the architectural approaches for satisfying the high-priority scenarios at its leaves. The utility tree for the ATAM evaluation of video conferencing protocol architecture is shown in Figure 10.

Sixth Step

The following sixth step contains of the analysis of the architectural approaches. The architect explains how the high-ranked scenarios are implemented by the architecture and the evaluation team documents the relevant architectural decisions and identifies and catalogues their risks, non-risks, sensitivity points, and tradeoffs. The architect has to explain which approaches and architectural decisions meet the quality requirements. The upcoming discussion leads to deeper analysis, depending on how the architect responds. The key is to elicit sufficient architectural information to establish some link between the architectural decisions that have been made and the quality attribute requirements that need to be satisfied. At the end of this step, the evaluation team should have a clear picture of the most important aspects of the entire architecture, the rationale for key design decisions, and a list of risks, non-risks, sensitivity points, and trade-off points.

Testing

Seventh Step

The seventh step is stakeholder-oriented because the evaluation team asks the group of stakeholders to brainstorm scenarios which are operationally meaningful regarding the stakeholders' individual roles. These scenarios are also prioritized because of the limited time for analysis. First, stakeholders are asked to merge scenarios they feel represent the same behaviour or quality concern. Then they vote for those they feel are most important.

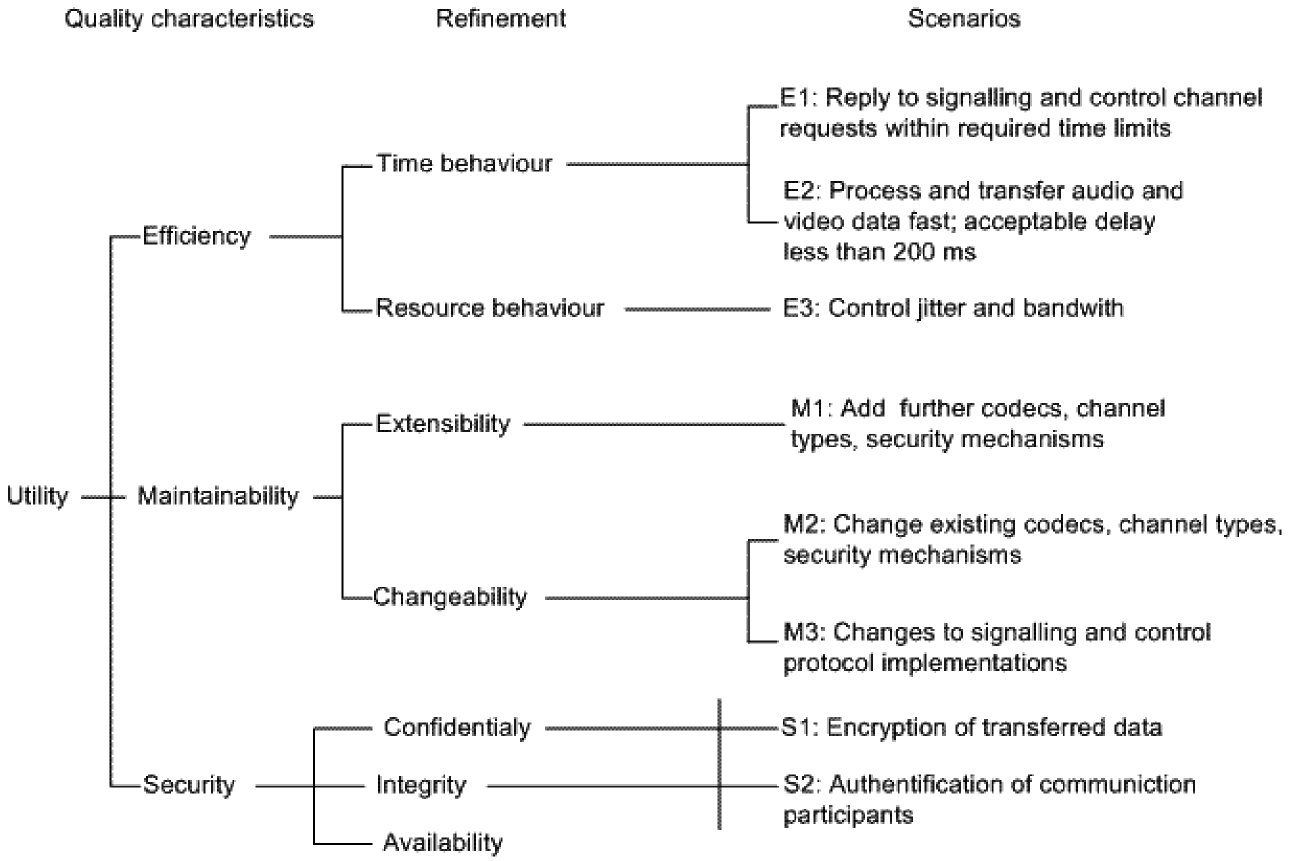

Figure 10: Utility tree for ATAM evaluation

Eighth Step

In the eighth step the architect explains to evaluation team how relevant architectural decisions contribute to realizing each of the chosen scenarios from step seven. During the architect's explanations the evaluation team again identifies and catalogues risk, non-risks, and trade-offs.

Reporting

Ninth Step

Then, in the ninth step, the gained information from the ATAM needs to be summarized and presented once again to stakeholders.

- ATAM's evaluation phase results in the following outputs:
- architectural approaches documented
- set of scenarios and their prioritization from the brainstorming
- utility tree
- risks
- non-risks
- sensitivity points and trade-off points

Finally, the evaluation team groups risks into risk themes. For each risk theme the affected business drivers from the second step are identified. By relating risk themes to business drivers the risk becomes also tangible for non-technical stakeholders like managers.

Appendix 6. Cost Benefits Analysis Method (CBAM) Inputs, Evaluation Steps and Evaluation Roles

Prerequisites and Inputs for CBAM

Since CBAM is building on the ATAM this implies that there will be necessary some prerequisites like:

- Architecture accommodation and presentation necessary for all participants
- Familiarity with concepts like sensitivity points, trade-off points, descriptive scenarios and requirements elicitation where necessary

Inputs in a CBAM evaluation session are:

- Business goals presentation
- Architectural decisions and possible trade-offs (results of ATAM)
- Quality attributes expectation level and economical constraints
- Templates and guidelines for supporting the descriptive scenarios' generation process can be provided.

The architecture ATAM evaluation is also considered input for CBAM.

Steps in a CBAM Evaluation Session

CBAM consists of two phases. First phase is called triage followed by a second phase called detailed examination. The first phase is sometimes necessary in case there are many architectural strategies to be discussed and just a few must be chosen for further detailed examination. Else the evaluation process starts right form the second phase. For both phases in CBAM are prescribed six main steps:

<u>Step 1: Choose Scenarios of Concern and their associated Architectural Strategies</u>
In the first step are chosen the scenarios that concern most the system's stakeholders.
For each of these scenarios there are proposed different architectural strategies that address the specific scenarios.

<u>Step 2: Assess Quality-Attribute Benefits</u>
In the second step are elicited the quality-attributes benefits form participating managers who best understand the business implications of how the system operates and performs.

<u>Step 3: Quantify the Benefits of the different Architectural Strategies</u>
In the third step are elicited the architectural strategies from the participating architects who understand how a certain architectural strategy can achieve the desired level of quality.

<u>Step 4: Quantify the Architectural Strategies' Costs and Schedule Implications</u>
In the fourth step are elicited the cost and schedule information form the stakeholders (both business managers and architects). The evaluation team assumes that within the organization already exists enough experience in estimating time schedules and associated costs.

Step 5: Calculate Desirability
Based on the elicited values resulted in the previous step, the evaluation team the desirability level for each architectural strategy based on the ratio "benefit divided by cost". Further more there is calculated the uncertainty associated with these values, which helps in the final step of making decisions.

Step 6: Make Decisions
Based on the values resulted in step five and the degree of realism of these values there are chosen the best cost-benefit effective architectural strategies which can fulfil best the elicited descriptive scenarios.

CABM Roles
There are three classes of roles participating in CABM:

- *External stakeholders* are having no direct involvement in the software architecture development process. They are the system's stakeholders and their role is to present the project business goals, provide the system quality attributes and their expected level of achievement in a measurable way, and assess the CBAM evaluation results. Examples of external stakeholders are business management team, project management, etc.
- *Internal stakeholders* are having a direct involvement in proposing software architectural strategies that can meet the quality requirements. They have the role of analyzing, defining and presenting the architectural concepts estimating the costs and schedule and uncertainty associated with these strategies. Examples of internal stakeholders are the software architects, system analysts or the architecture team.
- The *CBAM team* has no direct stake in the system's software architectural strategies but conducts the CBAM session. They the role of supporting the system's stakeholders presenting the business goals as such as after the presentation the system's significant quality attributes and their associated scenarios can be easily elicited and formulated. CBAM team also supports the architecting team in addressing the architectural strategies able to satisfy the quality scenarios and estimate the costs, benefits and time scheduling associated with these strategies. CBAM evaluation team consists of an evaluator (team leader or spokesperson), application domain experts, external architecture experts, and a secretary if necessary.

Appendix 7. Examples of Architectural (Design) Metrics

Three common architectural metrics are cohesion, coupling and the Cyclomatic Complexity. They are briefly described in the following.

Cohesion describes the dependencies between methods within a single software component to fulfil a single and precise task. So a high cohesion means that all parts of a component are necessary for fulfilling the task. *Coupling* regards the dependencies between different components. The lower the coupling the more independent are the components from each other and the easier are changes to the system. For many systems, an architecture is desired which aims on a maximal cohesion and a minimal coupling because that supports the system's maintainability. An example of measuring the coupling between modules of software system is given in [75].

Another import metric is the *Cyclomatic Complexity*. According to [76], the Cyclomatic Complexity of a method is the count of the number of paths through the method's source code. Cyclomatic Complexity is normally calculated by creating a graph of the source code with each line of source code being a node on the graph and arrows between the nodes showing the execution pathways. An implementation with a high Cyclomatic Complexity tend to be more error-prone, difficult to test with high coverage, and also more risky regarding maintainability (especially for changeability).

Architecture Planning and Decision Making in Companies

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Content

Research Questions

- What architecture decisions are?
- What different kind architecture decisions exist?
- In which levels / aspects can these decisions be done?
- How information about decision can be managed?
- How architecture decisions can be done rationally?
- How architecture decisions relate to organization's other decision making situations and related processes?

Research Process

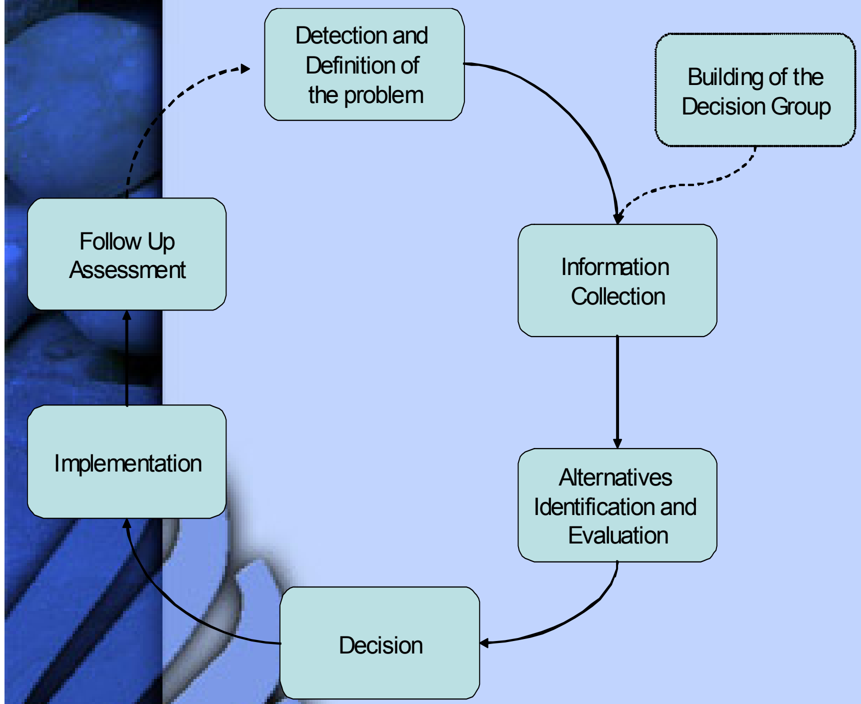
1. Literature review
2. Focus Group Interview
   – Participants: six practitioners from five companies
3. Consolidation and Analysis

Decision and Decision Making

- Commonly, decision making is understood as ***a cognitive process*** leading to the **selection** of a **course of action** among variations
- Begins when a need to do something exists but at the moment it is not known what should be done
- Every decision making process produces a final choice
  - It can be an action or an opinion
- Decision making is a reasoning process
  - can be rational or irrational
  - can be based on explicit assumptions or tacit assumptions
- In practice
  - It is important to consider whether a need to make a decision actually exists
  - It should be noted that decision making involves risk taking

Source: Focus Group Interview.

Decision Making Phases



In practice

• The displayed model depicts a generic decision making process which needs to be contextualized
• There exists iteration between and inside phases, and feedback links (e.g. continuous collection of information)
• Groups both inside and outside the organization may participate in decision making
• Different groups may define alternatives and make the actual decision
• Identifying alternatives is a challenge:
  • Many alternatives may be considered feasible depending on the viewpoint
  • Decision makers may have time to consider only a few alternatives -> selecting them is a decision
  • Insufficient information
• Eliminating non-rational decision criteria is a challenge
• Decision may be outdated at the moment it is made
• Follow-up decisions may arise (a certain decision may set a direction for future decisions) and may be difficult to manage

Source: Power, 2002 (adapted); Focus Group Interview.

2) Decisions and Decision Making

Rational Decision Making

A process for making logically sound decisions which features

- Knowledge of alternatives
- Knowledge of consequences
- Consistent preference ordering
- Decision rule

In practice

- Companies make decisions under the constraints of limited knowledge, resources, and time. Rational criteria sometimes need to be skipped and decisions made on intuition/experience
- Perfectly rational decisions require computational resources; for some decisions accurate ROI/NVP calculations are even impossible to calculate
- Rational decision criteria varies depending on the decision maker (e.g. IT vs. business)
- Rational decision criteria should be disclosed when decisions are planned; decision makers should not interfere with the decision planning process
- Twofold nature of time as decision criteria: may lead to competitive advantage or additional costs in the long-term
- Appropriate decision making may be preferable to perfectly rational decision-making; utilizing perfectly rational criteria may lead to “analysis paralysis” and inappropriate decision implementations
- Utilizing a governance model decreases the number of decisions based on subjective criteria

Sources: Cook et al., 2007; Gigerenzer & Selten, 2002; Shapira, 1997; Focus Group Interview.

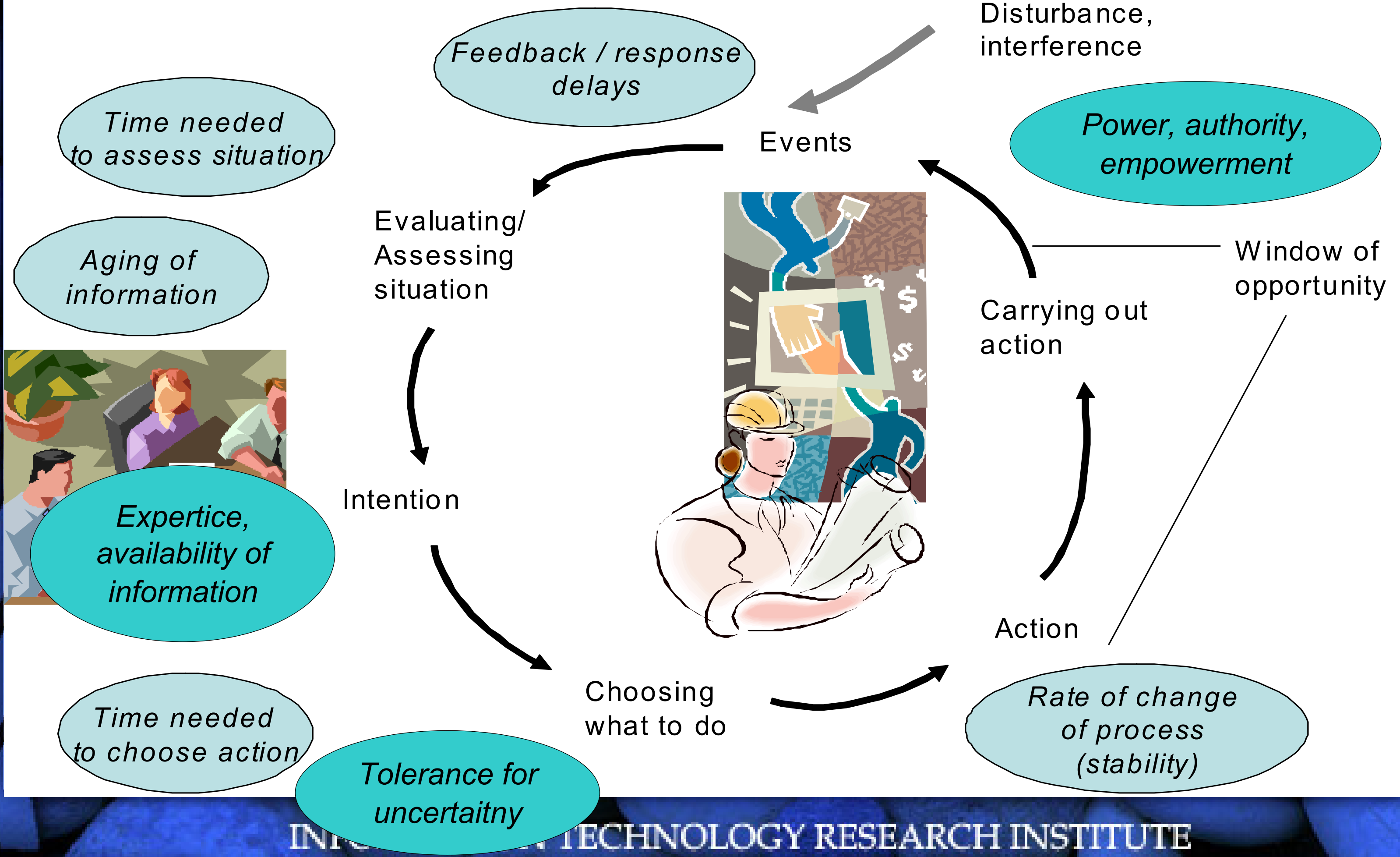
Challenges in Decision Making

- The information may be uncertain
- All relevant information may not be available or accessible
- Different stakeholders may have different information
- Different interpretations of the information exist
- Different things are important to different stakeholders; power conflicts
- There does not exist a good decision making strategy and it is not clear what to do next to reach a decision.
- The risks associated with each alternative are not understood
- Decision alternative and criteria evolution management
- Decision making structure or organization may be unclear or inappropriate; decision planners and makers have different information
- Getting buy-in on a decision

Source: Ullman, 2006; Focus Group Interview.

2) Decisions and Decision Making

Organizational Decision Making



Source: Cook, 2007; Focus Group Interview.

Characteristics of Organizational Decision Making

- Ambiguity
  - information, preferences, interpreting the history of decisions; organizational tolerance for uncertainty
- Decision making in and by organizations is embedded in a longitudinal context
  - Participants in organizational decision making are a part of ongoing processes.
  - Even if they do not take on active roles in all phases of decision making, they are a part of the decision process and its consequences.
  - Decisions in organizations are made in a sequential manner, and commitment may be more important in such processes than judgmental accurary
- Incentives play an important role in organizational decision making
  - Incentives, penalties, and their ramifications are real, salient and may have long-lasting effects.
  - These effects are intensified due to the longitudinal nature of decision-making in organizational settings.
  - Survival is a basic aspect of life in organizations.
- Repeated decisions
  - Many executives may make repeated decisions on similar issues by following rules (rather than by using pure information processing modes)
- Power and Political Issues
  - Power considerations and agenda setting often determine decisions rather than calculations based on the decisions' parameters.
  - Authority relations may have a large impact on the way decisions are made in organizations
  - Predominance of information and empowerment to make decisions are often not connected
  - However, predominance on comprehensive, extensive and holistic information is connected to influence on decisions (c.f. the chief enterprise architect)

Source: Shapira, 2002; Focus Group Interview.

Decision Making Structures in Organizational Decision Making

- Various decision-making structures, organizations or hierarchies are used to reach a decision in organizations
- These include
  - No structure
  - Hierarchy
  - Majority rule / Parliamentary process
  - Consensus
  - Unaminity

However, it should be noted that

- The structure used may vary depending on e.g. the level or type of decision
- The structures are not necessarily related to the organizational structure in question
- Even in the same organization and the same type of decision, the structures used may vary

Source: Schutt, 2001; Focus Group Interview.

Decision Making Levels in Organizations

- **Strategic Management**
  - An ongoing process by which the management of an organization envisions its future and develops the necessary activities to achieve it
  - Involves fitting an organization's internal capabilities to the environment by choosing the best among the possible alternatives
  - Strategy is a coherent, unifying, and integrative pattern of decisions that are based on the environment (e.g. business, industry, competitors) and look to the future
- **Business Unit Management**
- **IT Organization Line Management**
- **IT Portfolio Management**
  - The application of systematic management to large classes of items managed by organization's IT capabilities, enabling the evaluation of their *business value*
  - An enabling technique for the objectives of IT Governance
  - Includes
    - IT project portfolio
    - Application portfolio
- **IT Project Management**
  - Organizing and managing resources in a way that a project is completed within defined scope, quality, time and cost constraints
  - Involves decisions about
    - Activities to be carried out
    - Use of resources
    - Results (e.g. IT solutions)

Sources: Bhushan & Rai, 2004; Goodstein et al., 1993.

Planning vs. Decision making

- Planning is the process of **establishing objectives** and choosing the most suitable **means for achieving these objectives** prior to taking action
- Planning may precede decision making or vice versa
  - Planning is anticipatory decision-making. It is process of deciding before an action is required (e.g. a cyclic process that concludes when enough information is gathered for a final decision)
  - Decision making can involve the selection of a plan to be implemented
  - Company size and maturity level affects the nature of the relationship between planning and decision making (e.g. the need for decision making milestones in the planning process)
- Executing a plan usually requires many *actions*, but may not require any new *decisions*
- A plan may leave open a choice of sub plans at some critical juncture. As a result, there is an additional decision that needs to be made.

Sources: Ackoff, 1981; Krantz & Kunreuther, 2007; Focus Group Interview.

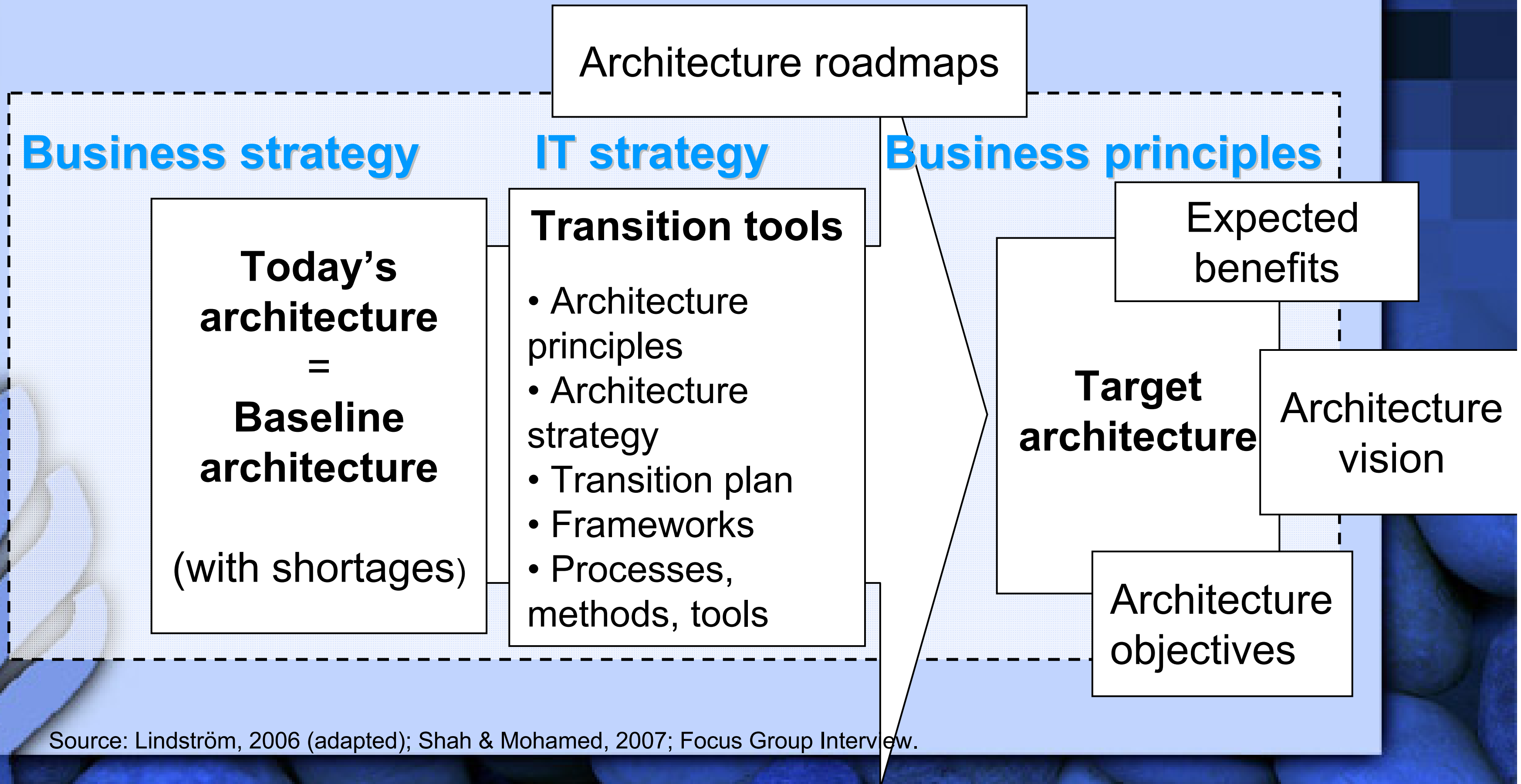
Architecture Decisions in Literature

- A complex architecture can reflect thousands of decisions
- In the software architecture domain, architecture decisions typically define
  - system's key structural elements
  - the externally visible properties of these elements and their relationships
  - how to achieve the architecturally significant needs and requirements
- Architecture decisions relate to different architectural levels (e.g. enterprise, domain, application and component architecture) and should only define elements on that specific level
- Especially on the level of enterprise architecture, planning ahead and setting architecture standards become even more essential and thus architectural decisions may also involve some of the following
  - Selection of an architecture plan (target, transition plan, vision)
  - Decisions relating to the choice of architectural sub plans at some critical juncture
  - Selection of architecture standards, principles and guidelines
  - Decisions about the objectives of architecture work (e.g. by interpreting business goals)

Sources: Tyree & Akerman, 2005; Malan & Bredemeyer, 2002; Bass et al., 1998; Krantz & Kunreuther, 2007 (adapted).

3) Architecture Decisions

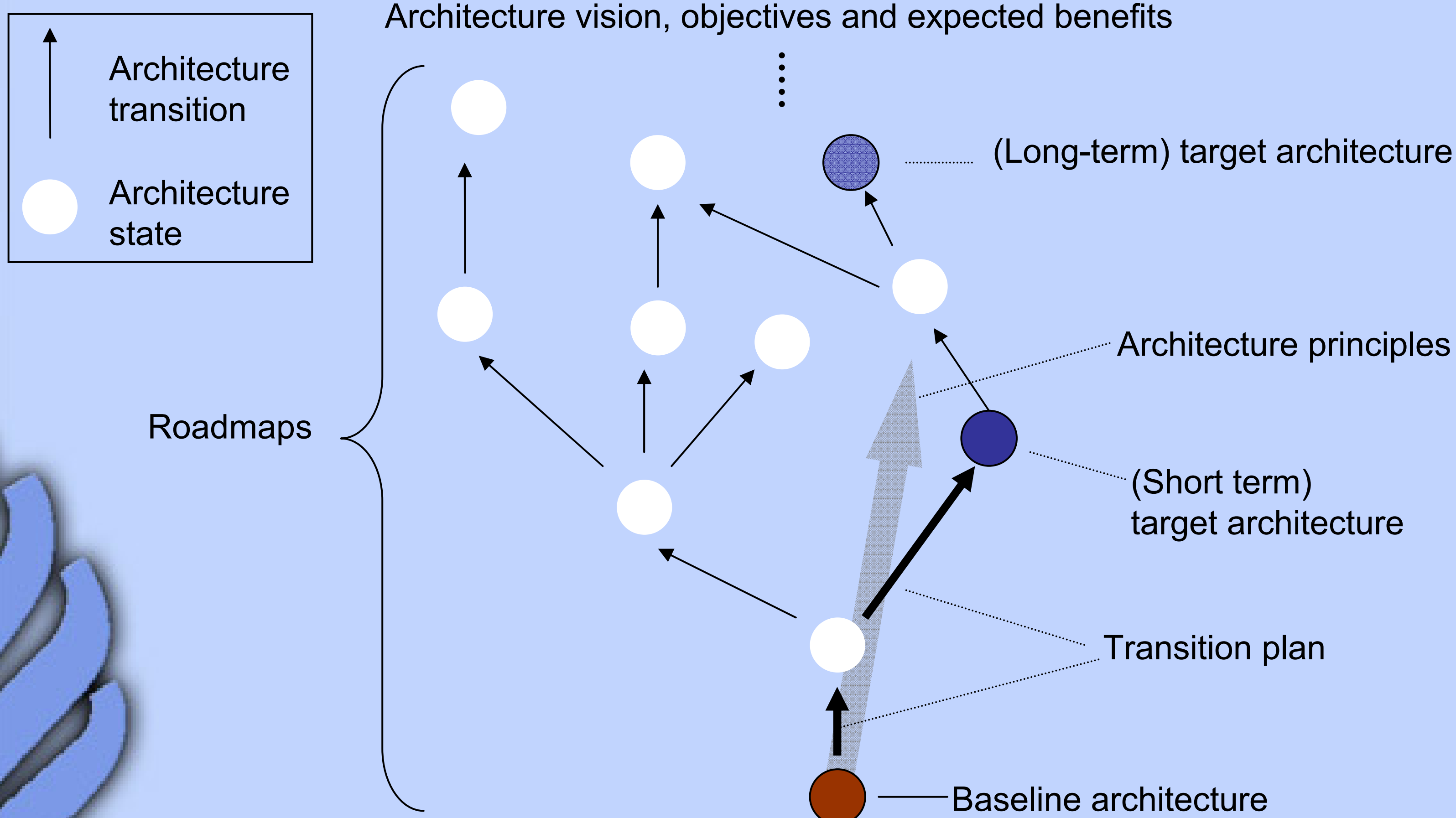
Enterprise Architecture Decision Making Areas



Source: Lindström, 2006 (adapted); Shah & Mohamed, 2007; Focus Group Interview.

3) Architecture Decisions

Enterprise Architecture Transition



Source: Lindström, 2006 (adapted); Shah & Mohamed, 2007; Focus Group Interview.

Baseline Architecture Decisions

- Baseline architecture
  - Contains different layers and existing enterprise architecture components
  - A *starting point* for identifying relationships between components and gaps that should be filled to improve organizational performance
  - Different architectural domains may have different baseline states
- Decisions about ***what*** areas/aspects/components in the enterprise will be developed, improved or changed to improve organizational performance
- The baseline architecture is continuously monitored and necessary decisions are made either
  - officially on higher organizational levels according to the information produced on lower levels
  - on the level in question by setting a new development effort which may be later expanded
- The baseline architecture is monitored by
  - architects and other roles such as controllers and inspectors
  - architecture status evaluations
  - corporate metrics

Source: Shah & Mohamed, 2007 (adapted); Focus Group Interview.

Target Architecture Decisions

- Target architecture
  - Depicts new (or changed) enterprise architecture components
  - Encompasses the strategic initiatives that should be performed to bridge the existing gaps and ensure competitive advantage
  - Different architectural domains may have different target states
  - Should be officially approved and communicated
  - Changes constantly as new target architecture decisions are made and business objectives change
- Decisions about ***how*** the architecture will be developed, improved or changed
  - Choice of target architecture plan (from alternatives)
  - Decisions about
    - new enterprise structures and processes
    - IT resources and infrastructure
    - the strategic initiatives

Source: Shah & Mohamed, 2007 (adapted); Focus Group Interview.

Architecture Roadmap Decisions

- Architectural roadmaps
  - Represent the baseline architecture's *intermediary alternatives* (scenarios) while mitigating the risks and analyzing existing gaps during the shift to the target architecture
  - Highlight the *architectural milestones* performed prior to reaching the target architecture
- Decisions about how to shift from the baseline architecture to the target architecture
  - Selecting among roadmap alternatives
  - Decisions about architectural milestones
- Architectural milestones may not be actively or officially set in practice on a detailed level
  - Setting and following the optimal path toward the target architecture (i.e. optimal transitions) requires considerable resources
  - Milestones are set according to current needs (e.g. when technologies need to be replaced) considering architectural principles and/or the desired target architecture

Source: Shah & Mohamed, 2007 (adapted).

Architecture Transition Decisions

- Transition plan
  - Documents the activities undertaken during the shift from the baseline to the target architecture
  - Specifications of the baseline (as-is) and target (to-be) architecture views in terms of managing the architectural transition's feasibility
  - May include risk assessment, gap analysis, and transition's supporting resources
  - Individual transitions may develop only one or a few architectural domains
- Decisions about the activities to be undertaken during the shift from the baseline to the target architecture
- Architecture transitions plans typically involve short-term decisions
  - Always making transitions in the direction of the target state (i.e. optimal transitions) requires considerable resources
  - Transitions are made when required or feasible (e.g. when technologies need to be replaced) considering architectural principles and/or the desired target architecture
  - Sometimes the transition towards the target architecture has to be postponed by implementing short-term solutions due to financial reasons
  - Short transitions are less risky
- Architecture transition plans may not be officially approved
  - They may be working papers used by the stakeholders carrying out the transition and may or may not be officially approved
  - Usually officially approved in the case of technology decommission (project plan)

Source: Shah & Mohamed, 2007 (adapted); Focus Group Interview.

Architecture
Principle and Guideline Decisions

- Architecture principles and guidelines
  - Contain goals, constraints, and guidelines for any IT use or deployment in the organization
  - Represent a shared understanding on what needs to be done to reach the target architecture
- Decisions about
  - goals for IT development or use (e.g. reusing existing components),
  - architectural constraints for IT development or use (e.g. standardized interfaces, allowed and non-allowed technologies)
  - guidelines for IT development or use (e.g. organization-specific best practices)

Source: Lindström, 2006 (adapted); Focus Group Interview.

Architecture Vision, Objective, and Expected Benefit Decisions

- Architecture vision
  - A high-level ideal image or desired target state of architecture
- Architecture objectives and expected benefits
  - What benefits the organization wants or expects to achieve by enterprise architecture (e.g. flexibility or management of complexity)
  - May be expressed on different levels of abstraction
- Decisions about
  - The selection of structures and components that exist in the ideal or the desired state of the oranization
  - The selection of objectives and expected benefits

Source: Armour et al. 1999.

Information System / Software Architecture Decisions

- Architectural decisions are those that must be made from an overall system perspective and define
  - system's key structural elements,
  - the externally visible properties of these elements and their relationships
  - how to achieve the architecturally significant requirements
- Information system or software architecture decisions are made in
  - Design of architecture (which design decisions to make)
  - Systems / software development (which and why certain design decisions have been made)
  - Architecture evolution (adding or removing design decisions while sustaining consistency)
  - Reuse of software architecture (use of earlier tried and tested combinations of design decisions)
  - Integration of systems (unification of design decisions)

Sources: Jansen & Bosch, 2005; Bass et al., 1998.

Example: Architecture Design Decisions

- Architecture design decisions describe
  - Architectural additions, subtractions and modifications
  - Rationale (The reasons behind the decision)
  - Design rules (mandatory prescriptions for further design decisions)
  - Design constraints (what is not allowed in the future of the design)
  - Additional requirements (what additional requirements does the decision add to the architecture)

Source: Jansen & Bosch, 2005.

Architecture Decision Makers

- Architect
  - Enterprise architect
  - System / software architect
- IT developers (design-level decisions)
- Project decision makers
  - Project manager
  - Steering group
  - Customer
- Strategic planning decision makers
- Portfolio management decision makers
- Business decision makers

Source: Focus Group Interview.

Decision Making Process of an Architect

1) Identifying problem and needs
2) Developing a set of alternatives
3) Assessing their viability
4) Review the decisions with the stakeholders
5) Once the architect obtains buy-in on the choices, further defining the architecture
6) Communicating architecture, decisions and rationales

Source: Tyree & Akerman, 2005.

Enterprise Architecture Decision Principles

- *Make only those decisions that have to be made on the enterprise level to achieve the business strategy and meet the architecture objectives and vision*
- *Provide decision makers on lower levels with the information required for their decision making*
- *Only make decisions that are enforceable and will be enforced*
- *There must be a traceable connection from business strategy to each decision*
- *Prepare for future changes when making a decision; architecture should be agile, adaptable and aligned*
- *It is better to make a decision than tumble into one*
- *Communicate decisions with their rationale*

Sources: Malan & Bredemeyer, 2002; 2004; Focus Group Interview.

Rational Architecture Decision Making

- A knowledge of alternatives: Decision makers have a set of alternatives for action
  - Different architecture alternatives
- A knowledge of consequences: Decision makers know the consequences of alternative actions
  - Consequences of architecture choices can be and are described at least on some level
- A consistent preference ordering: Decision makers have consistent values
  - Defined and accepted goals for architectures
- A decision rule: Decision makers have rules by which they select a single alternative of action on the basis of its consequences for the preferences
  - A defined way how it is proceed in the decision making

Sources: Cook et al., 2007 (adapted); Gigerenzer & Selten 2002 (adapted); Shapira, 1997 (adapted).

Co-Operation in Decision Making (1/2)

- EA decision making is dependent on the organization in question
  - Some organizations avoid establishing additional points or groups for EA decision making
  - EA decision making may be incorporated in various existing decision making points
  - Organizational maturity, business environment and governance model have an effect on how EA decisions are made
  - EA decisions are also made in cooperation with partners
- EA decisions are typically reactive
  - They are made according to the needs of the business
  - Costs and effects are important decision making criteria
  - Different areas of business in an organization may make EA decisions without considering the big picture, which may incur indirect effects (e.g. expenses) in other part of the organization, especially in the long-term

Sources: Focus Group Interview.

Co-Operation in Decision Making (2/2)

- A standardization process
  - that is approached centrally and
  - that is inclusive of the staff expected to adhere to the decisions made in the process

  is more likely to produce practical results and will be in a much better position to achieve adherence
- For enterprise-wide standards, central architects *and* technical staff within business units should get their say before a consensus-based decision is reached
- A standardization process could be especially feasible for architecture decisions with extensive effects in the organization
- In some organizations all architecture decisions are addressed in IT management/business units before implementation

Sources: Leganza, 2001; Focus Group Interview.

Enterprise Architecture Decision Making Levels

- EA vs. Strategic Management
  - EA may be a subordinate of all organizational strategies (i.e. business and IT)
  - EA is only one way of implementing organizational strategies
  - EA has an effect on strategy implementation through process definition and design which in turn affects lower architectural levels
- EA vs. IT Portfolio Management
  - EA may have a ”power of veto” on decisions on how IT implementations are done
  - However, EA does not necessarily define what is implemented (stated on organizational strategy)
- EA vs. IT Project Management
  - EA provides the overall picture to projects through guidance
  - Projects provide feedback on EA’s feasibility

Sources: Focus Group Interview.

Management of Knowledge on Architecture Decisions

- Management of knowledge
  - Identifying, eliciting and storing knowledge and information in repositories
  - Interaction among knowledge workers for explicating and sharing knowledge
- **Decisions** and **their rationale** are important architectural knowledge to share
  - Enables follow-up evaluation and decreases the willingness to question decisions
  - Not sharing decision and rationale information may endorse decision making in silos
  - Even if the decisions made sense when they were made (e.g. under resource constraints), afterwards no context exists around decisions without rationale information
- Architecting environment determines what architectural knowledge is shared and how
  - E.g. decision's characteristics, level of detail, repository, and means of communication
  - Dependent on e.g. governance model, level of decision making, decision making point, organizational structure, business environment
  - EA decisions are typically documented at least on the project level
- Tailoring architectural knowledge sharing
  - Take the architecting environment into account
  - Stimulate stakeholders to share 'their' decisions
  - Consider the effects of the decision: which stakeholders should know about it?
  - Let architecture descriptions address the knowledge need of stakeholders that use them
  - Do not document overly detailed information on the enterprise architecture level
  - Involve all stakeholders who are active in the architecting process

Sources: Farenorst, 2006; Tyree & Akerman, 2005; Focus Group Interview.

Architecture Decision Documentation

Decision characteristics to document

- Issue (the issue addressed by the decision)
- Decision (the selected option)
- Status (decision’s status, e.g. pending, decided, or approved)
- Decision maker
- Assumptions (environmental factors affecting the decision)
- Constraints (additional constraints to the environment)
- Options and alternatives
- Argument (why a certain option was selected)
- Implications (e.g. need to make other decisions, new or changed requirements, new constraints, need for resources)
- Related decisions
- Related requirements (mapping of decisions to objectives or requirements)
- Related artifacts (related architecture, design, or scope documents that the decision impacts)
- Related principles (related architectural principles and the decision’s compliance with them)
- Other notes

Source: Tyree & Akerman, 2005 (adapted).

Summary and Conclusions (1/3)

- EA decisions are high level decisions that can involve
  - Selection of architecture plans (target, transition, vision)
  - Selection of architecture standards, principles and guidelines
  - Decisions about the objectives of architecture work in the organization
- EA decisions are not necessarily official or actively made
  - Baseline architecture is constantly monitored and improvements planned but the big picture is not necessarily taken into account
  - Target architecture state should be officially approved
  - Architecture transition plans can be working papers and the transitions are not necessarily systematic because of short-term business needs and resource restrictions
- Decisions on lower architectural levels (e.g. SA) are typically related to a specific architectural design level and involve
  - Definition of key structural elements,
  - Definition of externally visible properties of these elements and their relationships
  - Decision about how to achieve the architecturally significant requirements

Summary and Conclusions (2/3)

- Rational architecture decision making features
  - Identification of alternatives
  - Identification of consequences of the alternatives
  - Knowledge on preferences and their order (e.g. business and architectural goals)
  - Usage of defined, communicated decision rule to select a single alternative considering its consequences and the preferences
- Architectural decisions should also
  - Be made only if absolutely necessary to achieve business strategy and meet architectural objectives
  - Be traceable to business objectives
  - Not be overly detailed on the enterprise level
  - Take possible future change needs into account (architectural agility, adaptability and alignment)
  - Be enforceable and enforced
  - Be communicated with their rationale

Summary and Conclusions (3/3)

- Architectural decision making is dependent on the organization in question
  - Decision makers involve various roles including architects, project roles and business management roles
  - Decision making may be fragmented to various decision making points in the organizations and decisions are also made in cooperation with partners
  - EA team may have power over some decisions in the organization (e.g. IT portfolio and project planning) but may need approval for their own decisions from various points (e.g. business or IT management)
- Architectural decision making may be reactive and driven by the business
  - Architecture is only one way of enforcing organizational strategies
  - Architecture decisions are made according to the needs of the business
  - Business may make architecture decisions without considering the big picture
  - Business may have knowledge that is not disclosed to architecture decision makers
- Architectural decision making does not typically differ from other decision making in organizations
- There should be a distinct rationale if it is to be separated from other decision making

Implications for Practitioners

- Plan architecture decision making and management:
  - should architectural decision making be separate from other decision making
  - what decisions are necessary to enforce organizational strategies
  - what kind of decision criteria should be used
  - how detailed should decisions be
  - how to build in agility, adaptability and alignment into decisions
  - what kind of decisions should be officially approved
  - where the decisions should be made and by whom
  - who should gather the information required for decisions
  - how are the decisions documented and communicated
  - who enforces the decisions
- Cooperate with stakeholders in decision making; architecture may not have very established, official or influential position on its own
- Communicate architecture decisions with their rationale to relevant stakeholders; merely storing decision documentation in a repository is not sufficient

Further Research

- Should archtitectural decision making be separate from other kinds of decision making and why?
- What kind of standardized process could be used for architectural decision making?
- What kind of reference models could be used to document different types of architecture decisions?
- What feasible generic criteria could be used for different types of architecture decisions?
- What kind of architecture decisions should generically be consciously made and officially approved?
- What would be the best levels or points of decision making for different types of architecture decisions?
- What is the best way share architecture decision knowledge?
- How organizational or architectural maturity or business environment affects architectural decision making and management?

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ASSESSING ARCHITECTURAL WORK – Criteria and Metrics for Evaluating Communication & Common Language and Commitment

AISA Project Report

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Summary

This report describes a part of the work done in the second phase of the AISA project's second year. The aim is to determine a wide selection of possible evaluation criteria and metrics for two of the Enterprise Architecture evaluation targets defined in the previous step of the project, namely 1) Communication and Common Language, and 2) Commitment. These areas can be regarded as prerequisites for the Enterprise Architecture work to succeed. To put it briefly, Enterprise Architecture (EA) can be seen as a collection of all those models necessary for managing and developing an organization.

Evaluation criteria and metrics for both of the evaluation targets were charted based on the literature review and the previous work done in the research project. These initial results were presented, discussed and validated in the workshop participated by seven practitioners and three researchers.

Evaluation of Communication and Common Language was suggested to be conducted with the help of 13 evaluation criteria, including e.g. accuracy, adequacy, comprehensibility, consistency, expertise and timeliness. Evaluation of Commitment was suggested to be conducted with the help of five evaluation criteria, respectively: acceptability, awareness, satisfaction, involvement and participation activeness, and resources (adequacy of resources). For both evaluation targets, a selection of evaluation questions that demonstrate each evaluation criteria was presented. The suggested metrics mainly included on-off measures or focused on identifying the level of satisfaction of a stakeholder.

Communication and common language can be evaluated independently (i.e. not as part of organizational communication studies), but the level of commitment can possibly be derived from the evaluation of the architecture benefits. Basically, if benefits can be demonstrated and the organization has gained value through architecture, commitment has also been reached.

Selection of a few suitable metrics among the set of possible metrics is needed. Furthermore, the selected metrics and the evaluation questions need to be translated into the organization's own terminology. Metrics selection is dependent on the phase of the architecture development, or more specifically, on the level of architecture maturity: simple metrics (e.g. on-off metrics) may be more usable in the beginning of the EA journey, and more detailed metrics (quantitative and qualitative metrics) may be utilized as the EA work is more established.

Especially, the level of commitment is rather easy to define, but the challenge is to find ways to move from a level to the next level. It may be fruitful to ask the stakeholders themselves which actions should be taken to make them accept the EA approach and participate in the EA work more actively.

The set of evaluation questions and metrics presented in this report can be useful for organizations helping them define the few specific metrics for their needs. After having tested the metrics in practice conclusions can be drawn about their suitability and usefulness for evaluating the success of communication and common language, as well as the level of commitment.

Contents

1 Introduction

This report presents a part of the results of the AISA Project's second phase in the second year. The aim of this phase was to determine a wide selection of evaluation criteria and metrics for four evaluation targets: 1) Communication and Common Language, 2) Commitment, 3) Models and Artefacts, and 4) Architectural Work Benefits (representing the evaluation of the whole Enterprise Architecture program). These targets are essential right from the beginning of the EA development. More evaluation targets are described in (Ylimäki & Niemi 2006).

In this report, the focus is on determining the evaluation criteria and metrics for the first two evaluation targets, i.e. Communication and Common Language, and Commitment. Evaluation criteria and metrics for Models and Artefacts are presented by Hämäläinen (2006), and the evaluation of architectural work benefits is reported by Niemi (2006).

The study consisted of the following steps (Figure 1):

1. **Literature review** of Communication Audit and Commitment studies, as well as EA studies was conducted to define the evaluation criteria for 1) communication and common language and for 2) commitment. Also the previous results of the research project and the workshop data – especially the data gathered in the workshop 3 (FGI 2006a) - were utilized in this task. Additionally, existing metrics for the two areas were charted in this step.
2. **Workshop 4, a focus group interview** (Krueger and Casey 2000) of seven practitioners representing the participating organizations, was arranged in October 12, 2006 in order to review, discuss and validate the literature review results.
3. **An analysis and consolidation of the results** of both the workshop (the focus group interview) and the literature review was carried out.

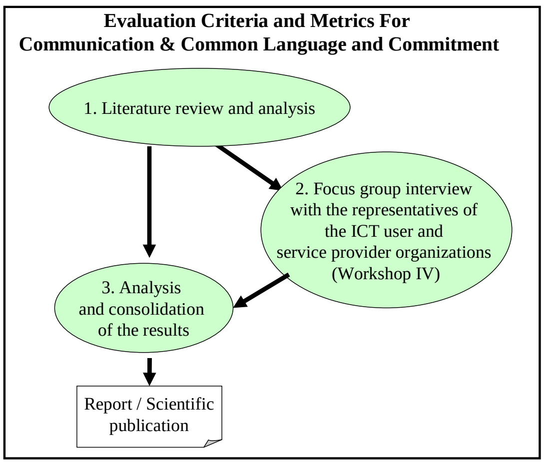

Figure 1. The steps of defining evaluation criteria and metrics for Communication & Common Language and Commitment.

Generally, several sources of evaluation questions and criteria may exist. In this study, specifically, the following sources are applied (based on Fitzpatrick, Sanders, et al. 2004):

1. Questions, concerns and values of stakeholders: This refers to the data gathered in the workshops (conducted as focus group interviews).
2. The use of evaluation models, frameworks, and approaches as heuristics: This refers, for instance, to the existing maturity models for Enterprise Architecture.
3. Models, findings, or salient issues raised in the literature in the field of the program: This refers, for instance, to the previous results of the AISA research project.
4. Professional standards, checklists, guidelines, instruments, or criteria developed or used elsewhere: This refers, for instance, to the Communication Audit and Organizational Commitment studies.
5. Views and knowledge of expert consultants: In this case, this also refers to the interview data gathered in the workshops.
6. The evaluator’s own professional judgment: In this case, this refers to the author’s own professional judgment.

The remainder of this report is organized as follows. In the next section, we discuss the basic concepts of Enterprise Architecture, high-quality Enterprise Architecture, critical success factors for Enterprise Architecture and the Enterprise Architecture evaluation components. In the proceeding sections, evaluation criteria and metrics for both communication and common language, and commitment are described. The last section summarizes the report.

2 Background

In this section, the concepts related to Enterprise Architecture, its quality and assessment are briefly recapitulated. Readers who are familiar to the concepts can move on to the next section.

2.1 Enterprise Architecture

Enterprise Architecture (EA) can be seen as a collection of all those models necessary for managing and developing an organization (Halttunen 2002). It is vital that Enterprise Architecture is derived from the visions and business strategies of an organization (Armour, Kaisler et al. 1999a). More precisely, EA "identifies the main components of the organization, its information systems, the ways in which these components work together in order to achieve defined business objectives, and the way in which the information systems support the business processes of the organization. The components include staff, business processes, technology, information, financial and other resources, etc. Enterprise architecting is the set of processes, tools, and structures necessary to implement an enterprise-wide coherent and consistent IT architecture for supporting the enterprise's business operations. It takes a holistic view of the enterprise's IT resources rather than an application-by-application view." (Kaisler, Armour et al. 2005)

Generally, Enterprise Architecture can be considered to consist of interrelated architectures or architectural views (FEAF 1999; The Open Group 2002). These views can comprise e.g. business architecture, information architecture, systems/application architecture and technology architecture.

2.2 High-Quality Enterprise Architecture

An Enterprise Architecture, to be successful, needs to be understood, accepted and used in everyday business functions, including also the various activities conducted by the top-management. The success needs also to be measured in order to ensure that desired results are achieved. While there is no widely accepted definition of a high-quality EA, we have suggested (Ylimäki 2005; Ylimäki 2006) that ***EA has high quality*** if it

- conforms to the agreed and fully understood business requirements,
- fits for the purpose, which is to gain business value through EA, and
- satisfies the different stakeholders' (e.g. the top management, IT management, architects, developers) expectations in a cost-effective way and understands their current needs as well as the future requirements.

Briefly, different stakeholders profit from the high-quality architecture work and its results. Especially, EA should provide the management a clear view of the top priority projects the organization needs to carry out in the first place. Furthermore, the different views of EA quality presented above implicitly imply that the quality of EA is more than merely the quality of the implemented EA, indicating that it is successfully used. The quality of EA may also refer to the quality of EA documentation, the quality of the EA development process, the quality of EA governance (process), and so forth.

2.3 Critical Success Factors for Enterprise Architecture

Critical success factor (CSF) is a common concept used e.g. in the context of total quality management (Badri, Davis et al. 1995), software architectures (Bredemeyer Consulting 2000) or project management (Clarke 1999). We have suggested (Ylimäki 2005; Ylimäki 2006) that ***critical success factors for Enterprise Architecture*** are the things that have to be done exceedingly well in order to gain high quality EA which in turn enables the business to reach its business objectives and gain more value.

During the first year of the AISA project the set of potential CSFs for EA (Figure 2) was defined (Ylimäki 2005; see also Ylimäki 2006). A brief description of each potential CSF is given in Appendix 1.

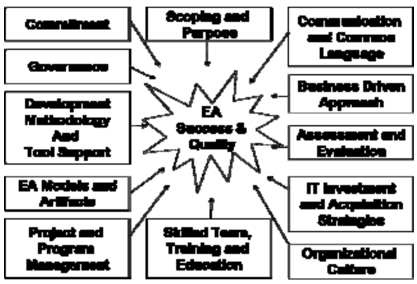

Figure 2. The set of potential CSFs for EA.

2.4 Enterprise Architecture Evaluation Components

Evaluation can be described as "a process of determining merit, worth, or significance" (Lopez, 2000). Evaluation needs to be planned carefully and several building blocks need to be addressed. These building blocks, i.e. evaluation components, are described in Figure 3 (Ylimäki & Niemi 2006, see also Appendix 2).

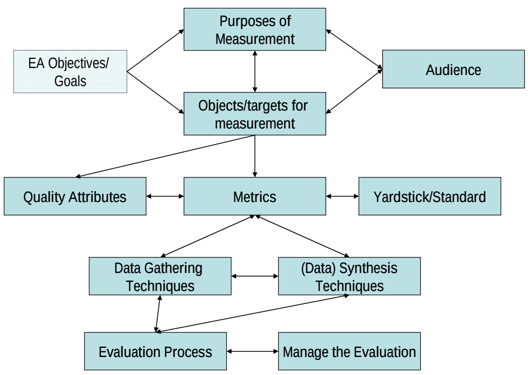

Figure 3. EA Evaluation components.

The CSFs for EA (see Figure 2) can be regarded as the potential evaluation targets to be assessed during the EA evaluation (see Ylimäki & Niemi 2006). In addition, the whole EA program is a potential evaluation target, especially when the benefits of the EA program need to be demonstrated to different stakeholders. In this report, the focus is on determining the evaluation criteria and metrics for two of the evaluation targets: 1) Communication and Common Language, and 2) Commitment. These areas can be regarded as prerequisites for the architectural work.

3 Evaluating Communication and Common Language

In this section, evaluation criteria and metrics for Communication and Common Language will be presented. Communication (and a common language) can be regarded as one of the main factors helping to succeed in the architectural work (Lankhorst 2005; Luftman 2000; META Group Inc. 2000, Rehkopf and Wybolt 2003).

Communication is a field that has been studied for decades. Even communication audit studies – evaluation of organizational communication (both internal and external) – go back to 1970's and beyond. Communication audits can be carried out in many ways (see e.g. Hargie & Tourish 2000), but the most usual and perhaps the most inexpensive way to evaluate communication is to collect information through a questionnaire. For instance, Downs & Hazen's Communication Satisfaction Questionnaire (presented e.g. in Downs, 1988) includes 46 questions. The premise of their work is that the quality and amount of communication in our jobs contribute to both our job satisfaction and our productivity. Another example of questionnaires is presented by Hargie & Tourish's (2000). Their Communication Audit Questionnaire includes 13 sections, each of which many questions or statements.

Based on the above mentioned facts, the definition of evaluation criteria and metrics for architectural communication is to a great extent, an application of communication audit studies. In the following sub-sections, the evaluation criteria for Communication and Common Language, sub-targets of evaluation, as well as metrics for each of the sub-targets are presented. The issues that were especially brought up or stressed in the workshop 4 participated by the practitioners are referred to as (FGI 2006b).

3.1 Evaluation Criteria for Communication and Common Language

The evaluation criteria for Communication and Common Language were mainly derived from the communication audit studies and the previous work done in the AISA Project. The set of 13 evaluation criteria is presented in Table 1. The interviewees agreed with the criteria, but pointed out that in addition to the availability and accessibility of information and systems also the ease of finding the information within the documents and systems is essential (FGI 2006b).

Table 1. The Evaluation Criteria for Communication and Common Language.

Evaluation Criteria	Alternative Criteria	Short Description	References
Acceptability		The definitions of terms in the common vocabulary, as well as the communication strategy/plan, have been approved by the architecture team/the organization.	Author's professional judgment
Accuracy	Clarity Comprehen-sibility	The definitions of terms in the common vocabulary (common language) are correct and unambiguous.	(Spitzberg 1988) Also (FGI 2006a)
Adequacy	Appropriateness Relevance	People get the information they need (to perform their tasks); the information	(Downs 1988)

Evaluation Criteria	Alternative Criteria	Short Description	References
	Correctness Usefulness	received through communication is relevant and correct. The information helps people to perform their tasks.	(Spitzberg 1988) (Eriksson 1999) (Ylimäki & Niemi 2006)
Availability	Accessibility	Availability of information, accessibility of the systems storing the information, availability of the information owners. Ease of finding the information within the systems, documents and so forth (FGI 2006b).	(Vos 2003) (Ylimäki & Niemi 2006) (FGI 2006b)
Communication Activeness		The extent the people are participating in different groups, searching for and giving information, participating in conversations, giving and calling for feedback, and involving others to participate in conversations and groups.	(Paajanen 2000)
Comprehen-sibility	Clarity Transparency	People understand the message (the content) communicated. The message is clear.	(Vos 2003) (Spitzberg 1988)
Consistency	Coherence	The communication provided to different stakeholders is consistent; the message may be the same even though the language (concepts, terms) used may vary depending on the stakeholder group the communication is aimed at.	(Spitzberg 1988) (FGI 2006a)
Credibility	Truth Sincerity Responsiveness	Communication (climate) is trustworthy and open.	(Eriksson 1999) (Vos 2003)
Effectiveness and efficiency		Communication results are achieved with reasonable costs; communication results are compared to the communication costs. Sometimes, effectiveness of communication can be evaluated to the extent the people are satisfied with the communication. → see also Satisfaction	(Vos 2003) (Spitzberg 1988)
Expertise		The stakeholders have proper communication skills.	(Spitzberg 1988)
Extensiveness		The communication reaches all the people (stakeholders) it should reach. Also, the active involvement of stakeholders.	(Vos 2003) (Ylimäki & Niemi 2006)
Satisfaction	Overall Satisfaction	The extent the people are satisfied with the communication (communication climate).	(Paajanen 2000)
Timeliness		People receive the information on time. The information is up-to-date.	(Downs 1988)

3.2 Sub-targets of Communication and Common Language

Since communication is such a large area, sub-targets needed to be defined in order to be able to determine more precise metrics. Similar to definition of the evaluation criteria for Communication, sub-targets of Communication were also derived from the communication audit studies and the previous work done in the research project (such as CSFs for EA). The set of six sub-targets is presented in Figure 4 together with the corresponding evaluation criteria for each sub-target. Evaluation needs of Communication and Common Language are related e.g. to the architectural concepts (i.e. the common language), the communications plan and strategy, and the success of architecture related communication (see also Ylimäki & Niemi 2006). It should be noticed that some of the evaluation criteria are related to Communication and Common Language in its entirety.

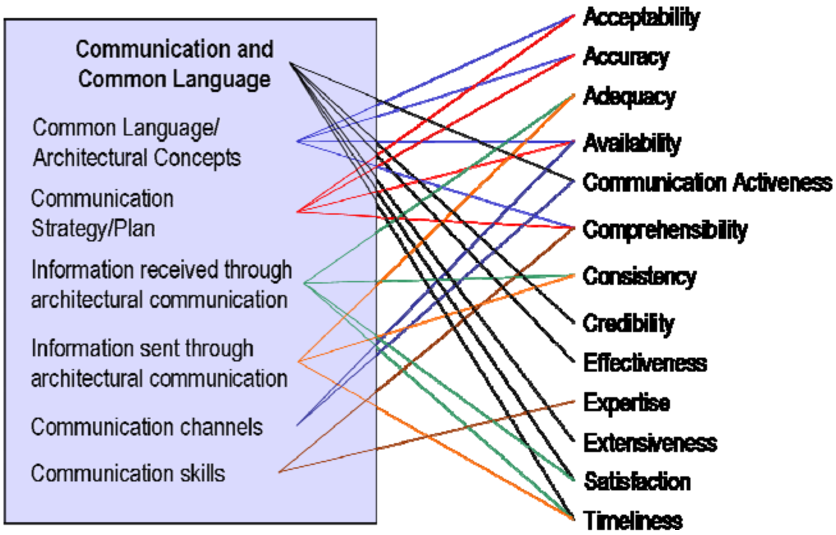

Figure 4. Sub-targets of Communication and Common Language and Corresponding Evaluation Criteria.

3.3 Metrics for Evaluating Communication and Common Language

In this section, suggestions for metrics for each of the sub-targets are represented in table format. In each table, evaluation criteria, evaluation questions (metrics), metric types and possible values are presented, as well as the main references.

3.3.1 Target: Communication Strategy or Plan

In table 2, the metrics for Communication Strategy or Plan are presented. Basically, all development efforts should have a communications plan. However, in the workshop 4 (FGI 2006b), it was brought up that only a few organizations are currently at a point where a communication strategy or plan for EA exists. The main reason for this is that the organizations are usually in the beginning of their EA development, and they consider it useless at that point to do thorough communication planning, because there is not yet enough EA content to communicate about. However, the interviewees stated that communicational issues must be kept in mind right from the beginning of the EA development (FGI 2006b).

Actually, in the beginning of the EA journey, the communication plan might be called as an EA marketing plan, which provides “a single resource that outlines a marketing strategy and plan to address specific goals of the EA Program Manager (EA PM) that will help to improve the profile and acceptance of the EA and EA program. It should assist the EA PM in developing a focused, methodical, and consistent communications approach that clearly articulates the mission, vision, values, and benefits of an EA and EA Program to leadership and staff personnel. The goal of the plan should be to provide a framework and a plan of action that will enable the EA PM to develop and execute EA marketing and communication strategies.” (Brooks 2006)

Table 2. The Metrics for Communication Strategy of Plan.

Evaluation Criteria	Evaluation Question / Metrics	Metric Type & Possible Values	References
Availability	Does an architectural communications strategy/plan exist?	On-off; yes/no	(Ylimäki 2005; 2006)
Availability	Is the communications strategy/plan available to the key stakeholders (e.g. in a file system or in intranet)? If not, why?	On-off; yes/no	Author’s professional judgment
Acceptability	Has the communications strategy/plan been approved by the organization?	On-off; yes/no	Author’s professional judgment
Comprehen-sibility	Has the communications strategy/plan been communicated to the key stakeholders? If not, why?	On-off; yes/no Percentage (of stakeholders informed)	Author’s professional judgment
Comprehen-sibility Also: Effectiveness	Time spent for communicating the communications strategy/plan to the stakeholders?	Time; minutes/hours/ days /weeks	Author’s professional judgment
Comprehen-sibility	How has the time needed for communicating the strategy/plan to stakeholders changed over the last quarter/6 months/year?	Trend, e.g. stayed the same, gone up, gone down Percentage	Adapted from (Downs 1988)
Accuracy	Is the communication strategy/plan up-to-date?	On-off; yes/no Update frequency	Author’s professional judgment

3.3.2 Target: Common Language

In table 3, the suggestions for metrics for common language are presented. In the workshop 4 (FGI 2006b), it was stated that the architecture terminology should, among other things, be simple enough to provide clear and understandable language for effective architecture communication. EA development usually requires co-operation between various organizations (including the organization whose EA is under development, its partners, ICT vendors, consultants and so forth). There is a challenge of establishing a common language, since each of these organizations, and more generally each line of business, has its own specific terminology.

Table 3. The Metrics for Common Language.

Evaluation Criteria	Evaluation Question / Metrics	Metric Type & Possible Values	References
Availability	Are the architectural concepts defined and documented? Specifically, has the concept of EA been defined (what does EA mean in the organization)?	On-off; yes/no	(Ylimäki & Niemi 2006)
Availability	Are the architectural concepts available to the stakeholders (e.g. in a file system or in intranet)? If not, why?	On-off; yes/no	Author's professional judgment
Acceptability	Are the architectural concepts approved by the architecture team/the organization? If not, why?	On-off; yes/no	(Ylimäki & Niemi 2006)
Acceptability Comprehen-sibility	How satisfied are you with the common architectural vocabulary? Are the concepts and terms simple enough, clear and understandable (FGI 2006)? → See also the next two evaluation questions; they measure the clarity and understandability as well. Note: Architectural vocabulary can include architecture, IT, and business related terminology.	Likert scale, e.g. very dissatisfied, dissatisfied, somewhat dissatisfied, indifferent, somewhat satisfied, satisfied, very satisfied	Adapted from (Downs 1988)
Accuracy Comprehen-sibility Also: Effectiveness	Time spent for concept clarification in the beginning of a meeting/project etc.?	Time; minutes/hours	Based on (FGI 2006a)
Accuracy Comprehen-sibility Also: Effectiveness	How has the time needed for concept clarification changed over the last quarter/6 months/year?	Trend; e.g. stayed the same, gone up, gone down Percentage?	Adapted from (Downs 1988)

3.3.3 Target: Information Received through Architectural Communication

In table 4, the metrics for information received through architectural communication are presented. These metrics measure especially the adequacy, consistency and timeliness of the architecture information from the information receiver's point of view. Typically, these metrics are applicable when the EA development has advanced from the initializing phase, and there is actually something to communicate about, i.e. architecture content exists. In the workshop 4 (FGI 2006b), it was brought up that the real challenge is to communicate to the right stakeholders in an appropriate way, in an appropriate language. The metrics in table 4, especially, can demonstrate how this challenge has been addressed in the organization and how satisfied the different stakeholders are with the architecture related information they receive.

Table 4. The Metrics for the Information Received through Architectural Communication.

Evaluation Criteria	Evaluation Question / Metrics	Metric Type & Possible Values	References
Adequacy	How satisfied are you with the amount and/or quality of information about - architectural communication strategy or plan - architectural terminology (common language), especially the definition of EA in the organization - the scope of the EA program in the organization - the EA objectives and policies - the progress of the EA program - the EA initiatives/projects - the EA content (models and other documents) - EA guidance - the business information essential for the EA development? Or: Comparison between the amount of information you get now and the amount of information you need to receive.	Likert scale, e.g. very dissatisfied, dissatisfied, somewhat dissatisfied, indifferent, somewhat satisfied, satisfied, very satisfied	(Hargie & Tourish 2000) (Downs 1988) Also (FGI 2006b)
Adequacy	What other architecture related information you would need to perform your tasks?	Free text	Based on (FGI 2006a)
Satisfaction Effectiveness and efficiency	How satisfied you are with the amount and quality of business information essential for the EA development received from the management/business? (= downward communication)	Likert scale, e.g. very dissatisfied, dissatisfied, somewhat dissatisfied, indifferent, somewhat satisfied, satisfied, very satisfied	Based on (FGI 2006a) see also (Downs 1988)
Consistency	To what extent do you get inconsistent	Likert scale, e.g.	Based on

Evaluation Criteria	Evaluation Question / Metrics	Metric Type & Possible Values	References
	or conflicting architecture related information? Different stakeholders can be specified to collect more detailed information.	Very little, little, Sometimes, often, always Or: daily, weekly, a couple of times a month, a couple of times a year, never	(FGI 2006a) see also (Spitzberg 1988)
Timeliness Also: Effectiveness	Extent to which you receive on time the architecture related information needed to do your job.	Likert scale 1-7, e.g. very dissatisfied - very satisfied	(Downs 1988) (FGI 2006b)
Timeliness	Extent to which you receive architecture related information on time from different sources (stakeholders), such as staff who are accountable directly to me, immediate work colleagues, colleagues in other departments, architecture team, immediate line manager, middle managers, senior managers	Likert scale; e.g. Never on time, rarely on time, sometimes on time, mostly on time, always on time	(Hargie and Tourish 2000)

3.3.4 Target: Information Sent through Architectural Communication

In table 5, the metrics for information sent through architectural communication are presented. These metrics measure, especially the adequacy and timeliness of the architecture information passed on to other stakeholders, as well as the level of upward communication (communication towards the management). These metrics are also typically applicable after the EA development has advanced from the initializing phase.

Table 5. The Metrics for Information Sent through Architectural Communication.

Evaluation Criteria	Evaluation Question / Metrics	Metric Type & Possible Values	References
Adequacy	How satisfied you are with the amount and/or quality of information you send to others about - architectural communication strategy/plan - architectural terminology (common language), especially the definition of EA in the organization - the scope of the EA program in the organization - the EA objectives and policies - the progress of the EA program - the EA initiatives/projects	Likert scale, e.g. very dissatisfied, dissatisfied, somewhat dissatisfied, indifferent, somewhat satisfied, satisfied, very satisfied	(Hargie and Tourish 2000) (Downs 1988)

Evaluation Criteria	Evaluation Question / Metrics	Metric Type & Possible Values	References
	- the EA content (models and other documents) - EA guidance - the business information essential for the EA development? Or: Comparison between the amount of information you send now and the amount of information you need to send.		
Adequacy	What other architecture related information would you need to send to others? To whom?	Free text	Author's professional judgment
Satisfaction Effectiveness and efficiency	How satisfied are you with the amount and quality of information you send to management/business? (= upward communication)	Likert scale, e.g. very dissatisfied, dissatisfied, somewhat dissatisfied, indifferent, somewhat satisfied, satisfied, very satisfied	Based on (FGI 2006a) See also (Downs 1988)
Timeliness Also: Effectiveness	Extent to which you send architecture related information on time to different sources (stakeholders), such as staff who are accountable directly to me, immediate work colleagues, colleagues in other departments, architecture team, immediate line manager, middle managers, senior managers.	Likert scale; e.g. Never on time, rarely on time, sometimes on time, mostly on time, always on time	(Hargie and Tourish 2000)

3.3.5 Target: Communication Channels

In table 6, the metrics for communication channels are presented. These metrics measure especially the availability of different channels in addition to the usage frequency of these channels. In the workshop 4 (FGI 2006b), it was brought up that in addition to the adequacy of channels, they should also be easily available as should be the information accessed through these channels.

Table 6. The Metrics for Communication Channels.

Evaluation Criteria	Evaluation Question / Metrics	Metric Type & Possible Values	References
Availability	Which communication channels you use in your work (in general)? Which channels are used in architectural communication (in general)?	"Checkbox"; e.g. - Face-to-face contact - telephone calls - written communication (memos, letters)	(Hargie and Tourish 2000) (Paajanen 2000)

Evaluation Criteria	Evaluation Question / Metrics	Metric Type & Possible Values	References
	Which channels do you use in architectural communication?	- notice boards - internal architecture related publications - internal architecture related audio-visual material - e-mail - intranet - meetings - briefings - grapevine	
Availability	Are these channels adequate for architectural communication? Are these channels easily available (FGI 2006b)? Is the information easily available through these channels (FGI 2006b)? Each channel can be evaluated separately.	Likert scale, e.g. adequate, indifferent, inadequate	(Paajanen 2000) (FGI 2006b)
Availability	Which other communication channels would you like to use for architectural communication?	Free text	(Paajanen 2000)
Communication activeness	How actively are you using the following channels for architecture related communication: - face-to-face contact - telephone calls - written communication (memos, letters, etc.) - notice boards - internal architecture related publications - internal architecture related audio-visual material - e-mail - intranet (architecture website etc.) - meetings - briefings - grapevine?	Likert scale, e.g. Very little, little, Sometimes, often, always Or: daily, weekly, a couple of times a month, a couple of times a year, never	Adapted from (Paajanen 2000)

3.3.6 Target: Communication Skills

In table 7, the metrics for communication skills are presented. In the workshop 4 (FGI 2006b), it was pointed out that the understandability and clarity of communication is especially essential (see the last row of table 7). Also the ability of architects to communicate the location of information in addition to the information content itself was considered important.

Even though communication skills are regarded as an important asset of an architect, as well as of any IT specialist, hardly any studies focusing on the level of these skills have been conducted. One of the most recent studies conducted by Intel reveals major communication challenges, especially between the top management and the information management (see e.g. Karvonen 2006).

Table 7. The Metrics for Communication Skills.

Evaluation Criteria	Evaluation Question / Metrics	Metric Type & Possible Values	References
Expertise	How satisfied are you with the communication skills of - yourself - your co-workers - the architecture team - the management? More specified questions can be formulated (see e.g. Spitzberg 1988).	Likert scale, e.g. very dissatisfied, dissatisfied, somewhat dissatisfied, indifferent, somewhat satisfied, satisfied, very satisfied	Adopted from (Spitzberg 1988)
Expertise	How much training have you had to improve your communication skills during the last 6 months/year etc.? More specified questions can be formulated to illustrate the usability of the training; such as - How satisfied you are with the communication training you have had? - How useful has the training been?	Likert scale, e.g. No training at all, little training (attended one seminar/workshop/ course), some training (attended a few..), extensive training (attended a large number of …)	(Hargie and Tourish 2000)
Comprehen-sibility	How understandable and clear is the communication/information provided by the architecture team?	Likert scale, e.g. very dissatisfied, dissatisfied, somewhat dissatisfied, indifferent, somewhat satisfied, satisfied, very satisfied	(Ylimäki & Niemi 2006) (FGI 2006b)

3.3.7 Target: Communication and Common Language (in its entirety)

In table 8, the metrics related to the communication and common language in its entirety are presented. Especially, these metrics measure the communication activeness in general, and the credibility and effectiveness of communication. In the workshop 4 (FGI 2006b), especially the existence of feedback was pointed out. Feedback needs to be a two-way road: the architecture team provides architecture guidance for instance to the IT developers and the IT developers should provide feedback to the architecture team, especially in the cases of not being able to follow the architecture guidelines or policies. In these cases, the architecture may need to be changed or modified.

Horizontal communication, i.e. communication between departments, business areas, subsidiaries and so forth, was also considered to be evaluated by the interviewees. However, this should not be evaluated in the conjunction with architectural communication specifically, but in the conjunction with the communication evaluation in general in the organization (FGI 2006b).

Table 8. The Metrics for Communication and Common Language in its entirety.

Evaluation Criteria	Evaluation Question / Metrics	Metric Type & Possible Values	References
Communication activeness	How actively are you participating to - architecture related discussions - architecture development - architecture related briefings, etc.?	Likert scale, e.g. Very little, little, Sometimes, often, always Or: daily, weekly, a couple of times a month, a couple of times a year, never	(Paajanen 2000)
Communication activeness	How actively do you provide architecture related **feedback** to - the architecture team - the management - your co-workers?	Likert scale, e.g. Very little, little, Sometimes, often, always Or: daily, weekly, a couple of times a month, a couple of times a year, never	(Paajanen 2000) (FGI 2006b)
Communication activeness	How actively do you search for architecture related information?	Likert scale, e.g. Very little, little, Sometimes, often, always Or: daily, weekly, a couple of times a month, a couple of times a year, never	(Paajanen 2000)
Communication	From which sources do you search	Checkbox; list of	Author's

Evaluation Criteria	Evaluation Question / Metrics	Metric Type & Possible Values	References
activeness Also: Availability	for architecture related information (persons, systems etc.)? How satisfied are you with these sources?	choices can be provided Likert scale	own professional judgment
Credibility	How satisfied are you with the openness and sincerity of architectural communication?	Likert scale, e.g. very dissatisfied, dissatisfied, somewhat dissatisfied, indifferent, somewhat satisfied, satisfied, very satisfied	Adapted from (Eriksson 1999) and (Vos 2003)
Credibility	How much you trust each stakeholder in architectural communication (in terms of working together)? Note: A list of stakeholders can be provided.	Likert scale, e.g. Never, Sometimes, often, always?	(Hargie and Tourish 2000)
Effectiveness and efficiency?	What do you think are currently the greatest challenges or development needs in the architectural communication?	Free text	(Hargie and Tourish 2000) (Paajanen 2000)
Effectiveness and efficiency?	Changes in the architectural communication related to e.g. - possibilities of communicating with different stakeholders - communication channels available - time resources for communication - flexibility of communication - organization structure - your physical location compared to other stakeholders - attitude towards architectural communication - your communication skills - other stakeholders' communication skills - other, what?	Likert scale, e.g. got worse, indifferent, got better	(Paajanen 2000)
Effectiveness and efficiency	Name an architecture related communication development or improvement effort that has been successful in your opinion.	Free text	(Paajanen 2000)
Effectiveness and efficiency	Name an architecture related communication development or	Free text	(Paajanen 2000)

Evaluation Criteria	Evaluation Question / Metrics	Metric Type & Possible Values	References
	improvement effort that has NOT been successful in your opinion.		
Effectiveness and efficiency	How many architecture related communication challenges identified have been responded to?	Number Percentage (nn % of identified challenges have been responded to)	Based on (Ylimäki & Niemi 2006)
Effectiveness?	Has the success and effectiveness of architectural communication been evaluated?	On-off; yes/no Evaluation frequency?	(Hargie and Tourish 2000) (Downs 1988)
Effectiveness	Communication costs during the last quarter/6 months/year? How have the communication costs changed during the last quarter/6 months/year?	Euros (e.g. based on the hours used in communication) Percentage (change)	Adapted from (Tukiainen 2000)
Extensiveness	The extent to which the architectural communication has reached all the key stakeholders.	Percentage of stakeholders that have been reached by architectural communication	(Ylimäki & Niemi 2006)
Extensiveness	How actively have you been involved in architectural communication e.g. by a colleague or the architecture team? Further details can be collected by specifying a list of stakeholders.	Likert scale, e.g. Very little, little, Sometimes, often, always Or: daily, weekly, a couple of times a month, a couple of times a year, never	Adapted from (Vos 2003)
Satisfaction Also: Effectiveness	How satisfied are you with the architectural communication in general?	Likert scale, e.g. very dissatisfied, dissatisfied, somewhat dissatisfied, indifferent, somewhat satisfied, satisfied, very satisfied	Adapted from (Downs 1988)
Satisfaction Also: Effectiveness	In the past quarter/6 months/year, what has happened to your level of satisfaction of the architectural communication?	3-scale: stayed the same, gone up, gone down Percentage?	Adapted from (Downs 1988)
Satisfaction Also:	How would you change architectural communication to make you more satisfied?	Free text	Adapted from (Downs

Evaluation Criteria	Evaluation Question / Metrics	Metric Type & Possible Values	References
Effectiveness			1988) (FGI 2006b)
Satisfaction Also: Effectiveness	How satisfied are you with the communication between the departments/business areas/subsidiaries etc.? (= horizontal communication)	Likert scale; e.g. very dissatisfied, dissatisfied, somewhat dissatisfied, indifferent, somewhat satisfied, satisfied, very satisfied	Adapted from (Downs 1988) (FGI 2006b)

3.4 Background Information Needed in a Questionnaire

Most of the evaluation questions or metrics for Communication and Common Language measure the satisfaction level of a stakeholder. Typically, the satisfaction level of the stakeholders is assessed by collecting information through a questionnaire. To be able to analyze the collected data, some background information will also be needed. This information may include the following (adapted from Hargie and Tourish 2000; Paajanen 2000):

- Gender: female/male
- Age: e.g. under 20 years old, 21-30 years old, 31-40 years old, 41-50 years old, over 50 years
- Do you work full-time/part-time/temporary full-time/temporary part-time/job-share?
- How long have you been employed in the organization: less than a year/1-5 years/5-10 years/11-15 years/more than 15 years?
- How long have you held your present position: less than a year/1-5 years/5-10 years/11-15 years/more than 15 years?
- What is your present level of managerial responsibility: I don’t supervise anyone/first-line manager/middle manager/senior manager/other, what?
- Where are you employed (department)? A list of departments can be provided.
- What professional group do you belong to? A list of the various professional groups found within the organization can be provided.

It should be noticed that the choices for answering the background questions need to be modified according to the organization’s terminology.

3.5 Summing-up

Evaluation of Communication and Common Language was suggested to be conducted with the help of

- 6 sub-targets in addition to the Communication and Common Language as an evaluation target in its entirety, and
- 13 evaluation criteria in total.

A wide selection of evaluation questions and metrics were presented to stimulate and help the definition of the organization specific questions and metrics. The problem with the evaluation of Communication and Common language is that the suggested metrics are to a large extent relative, or subjective, trying to identify the level of satisfaction of a stakeholder. In addition, some on-off measures are included.

Based on the workshop 4 (FGI 2006b) the following conclusions on the evaluation of Communication and Common Language can be drawn.

For the most part, the Finnish companies are still initializing their EA efforts, and not so many architecture descriptions, models, or other artefacts exist. Hence, the evaluation of communication and common language is not considered to have the first priority. After the EA development advances from the initializing phase and EA processes and practice become more established, communication and common language can be evaluated more accurately.

On the other hand, this report presents a large variety of metrics from which the organization can choose a few metrics that are the most suitable ones for its purposes, according to its needs. It should also be noticed that the metrics and evaluation questions presented in this report are still rather general in nature, and as such, they probably cannot be utilized in an organization. They rather demonstrate the characteristics of the evaluation target to be measured. Hence, they need to be modified, or translated into the language and terminology used in the organization.

Finally, it seems rational that evaluation of communication and common language are related to the phase of the EA development in the organization or, more specifically, to the EA maturity level of the organization. In different phases or maturity levels, different metrics are used. Most typically, simple metrics are needed in the initializing phase, and more advanced metrics (e.g. quantitative metrics) can be adopted in later phases.

4 Evaluating Commitment to the Architecture Approach

The importance of gaining commitment to the EA approach and development can be put as follows: "Without a shared sense of purpose and mission, effective governance structure, and executive leadership and commitment, enterprise architecture will only have a minimal impact" (Nelson 2004). Commitment can be described as "a psychological state of attachment that defines the relationship between a person and an entity" (Abrahamsson & Jokela 2000). Moreover, the relationship can be analyzed in terms of depth, focus and terms (see Figure 5).

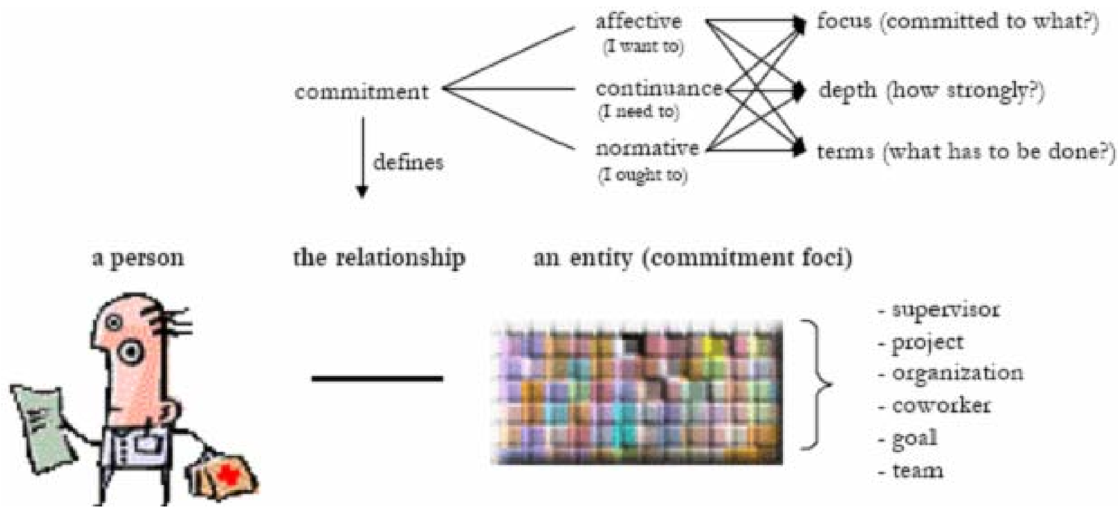

Figure 5. Concept of Commitment (as described in Abrahamsson & Jokela 2000).

4.1 Evaluation Criteria for Commitment

The process of building commitment can be described as a linear model as depicted in the example in Figure 6. Software Engineering Institute (SEI) has introduced a slightly modified version including seven stages of commitment: contact, awareness, understanding, trial use, adoption, institutionalization, and internalization (described e.g. in Carter 2001). These degrees of commitment to change were applied to the commitment to architecture approach, and five evaluation criteria for commitment were defined: awareness, acceptability, satisfaction, involvement and participation activeness, and resources (adequacy of resources) (Table 9). The interviewees (FGI 2006b) especially pointed out the importance of feedback as part of the involvement and participation activeness (see Table 9). It should be noticed, that while speaking of commitment to architecture approach, it is considered to also include commitment to the development efforts the EA generates.

In the workshop 4 (FGI 2006b), it was stressed that if the top management has provided resources for the architecture development, it may have already gone through the lower levels of commitment, at least the levels of awareness and acceptance. Furthermore, the top management's satisfaction will increase if the benefits of EA can be demonstrated.

It was also pointed out that in the beginning of the EA development, gaining the management's commitment is more essential than the organizational buy-in (FGI 2006b). Furthermore, feeling the presence of commitment, for instance in the form of allocated time, participations to workshops, management-by-walking-around or simply in the form of doing one's homework, is crucial. Depending on the organization 'management' may refer either to the top-management, the CFO or other managers near to the architecture team. This also indicates that commitment of the stakeholder groups is connected with the phase of the EA development (or the EA maturity level), i.e. the number of committed stakeholder groups should increase as the maturity advances.

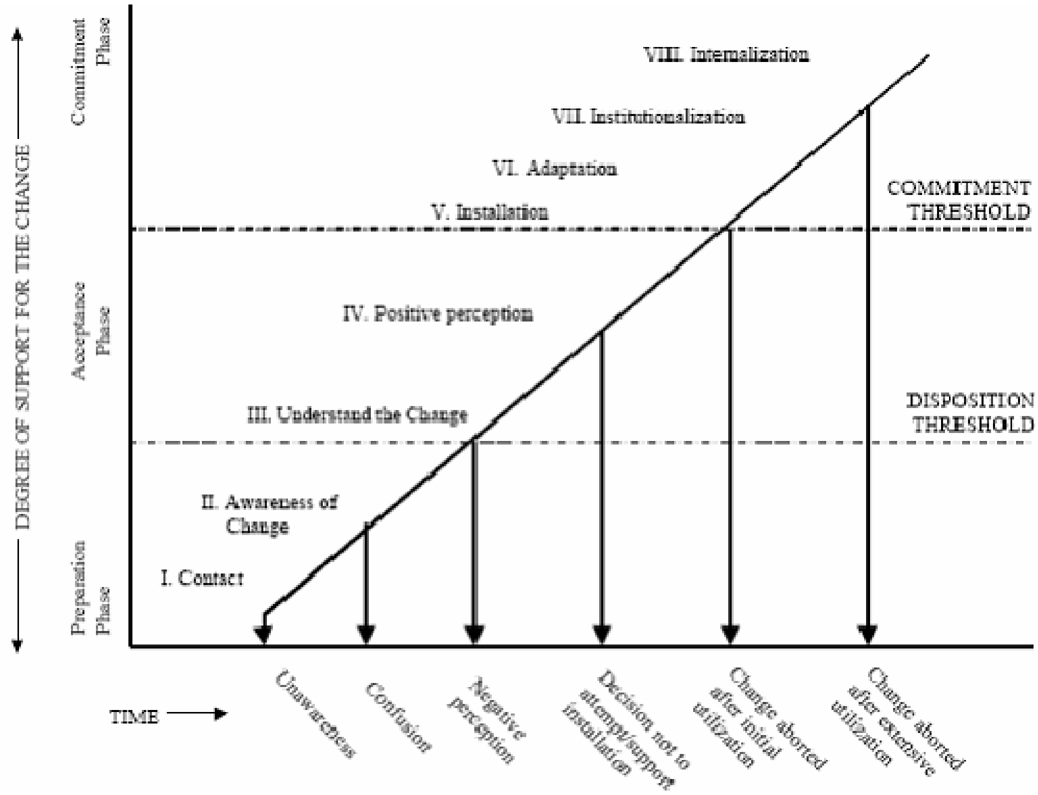

Figure 6. Model of commitment to change (as described in Abrahamsson & Jokela 2000).

Table 9. Evaluation Criteria for Commitment.

Evaluation Criteria	Alternative Criteria	Short Description	References
Awareness		The extent to which the stakeholders - have been informed and know about the EA/architecture approach the organization has adopted - have been informed and know about the purpose of the EA approach, as well as about the EA objectives - identify themselves as EA stakeholders, and even act as such.	(Abrahamsson and Jokela 2000) (Carter 2001) (FGI 2006a)
Acceptability	Comprehen-	The extent to which the stakeholders	(Abrahamsson

Evaluation Criteria	Alternative Criteria	Short Description	References
	sibility	- understand and accept the justifications for adopting the EA/architecture approach - accept the architecture approach (i.e. consider the architecture approach to be a positive and useful development) - support the architecture approach; e.g. by participating in production of artifacts as suggested by GAO (2003) - consider the EA/architecture approach to be important to the success of the organization - consider the EA/architecture approach to be important for their work (tasks).	and Jokela 2000) (Carter 2001) (Motola 2006) (GAO 2003)
(Customer) Satisfaction	Managerial/ Architecture team/ Developer/ User Satisfaction	The extent to which the personnel is satisfied with the EA approach and its results. The extent to which the personnel utilizes architecture guidelines or architecture documentation as a normal part of their work (tasks).	(Department of Veterans Affairs 2001)
Involvement and Participation Activeness		The extent to which the different stakeholders participate e.g. in - architecture development (product development) - architectural work development (process development) - architecture management - architecture implementation projects - architecture related discussions - architecture related briefings - architecture related training. The extent to which different stakeholders provide **feedback** e.g. to the architecture team, to the management, to their co-workers.	Adapted from (Paajanen 2000) (FGI 2006b)
Resources (Adequacy of Resources)		The amount of resources that are addressed (by the management/by sponsors) to the EA work in the sense of time, money, people, technology, processes, authorities etc. Also the ownership of the architecture has been defined with e.g. an executive body that collectively owns the enterprise.	(Motola 2006) (GAO 2003) (FGI 2006a)

4.2 Metrics for Evaluating Commitment

In the following sub-sections, suggestions for metrics for Commitment are presented in table format. For each evaluation criteria, evaluation questions (metrics), metric type and possible values, as well as main references are given.

4.2.1 Criteria: Awareness

In table 10, possible metrics for evaluating the level of awareness of the EA approach are presented. In the workshop 4 (FGI 2006b), it was stressed that in the very beginning of the EA development, it may be unnecessary for the top-management to know about (to be aware of) the EA. It may be more important to start working with the closest colleagues and first sell the idea of EA to your closest superior. After the EA work starts to “make sense” to the architecture team, it is time to go and start selling the EA approach to the top management.

Table 10. Metrics for Evaluating the Level of Awareness.

Evaluation Question / Metrics	Metric Type / Possible Values	References
Have you heard/have you been informed about the EA/architecture approach adopted in the organization?	On-off: yes/no	Based on (FGI 2006a)
If you have heard about the EA/architecture approach, how satisfied you are with the amount and quality of information you have received?	Likert scale 1-7 (very dissatisfied – very satisfied)	Adopted from (Hargie and Tourish 2000) and (Downs 1988)
Have you heard/have you been informed about the purpose of the EA approach and the EA objectives?	On-off: yes/no	Based on (FGI 2006a)
If you have heard about the purpose of EA and the EA objectives, how satisfied you are with the amount and quality of information you have received?	Likert scale 1-7 (very dissatisfied – very satisfied)	Adopted from (Hargie and Tourish 2000) and (Downs 1988)

4.2.2 Criteria: Acceptability

In table 11, the possible metrics for evaluating the level of acceptability of the EA approach are presented. In the workshop 4 (FGI 2006b), no specific comments were made on the presented metrics. Instead, it was pointed out that the question of finding the appropriate ways and practices to move from a level to the next level is more interesting. Furthermore, it was suggested that, actually, this is the kind of question that could be asked from the stakeholders themselves: how would they want to increase their level of commitment to the architecture approach. The answers thus provide information about their expectations with regard to the EA work. It may help the architecture team to focus on issues that *truly are important* to the stakeholders instead of issues the architects *think are important to them*.

Table 11. Metrics for Evaluating the Level of Acceptability.

Evaluation Question / Metrics	Metric Type / Possible Values	References
How is your attitude towards the EA/architecture approach: to what extent do you accept the architecture approach (i.e. consider it to be a positive and useful development)?	Likert scale 1-5 (e.g. very positive - very negative)	Adapted from (Motola 2006)
To what extent do you understand the justification/reasons for adopting the EA/architecture approach in the organization?	Likert scale, which scale?	Author's professional judgment
To what extent do you support the architecture approach?	Likert scale, which scale?	Author's professional judgment
To what extent do you consider the EA/ architecture approach to be important/useful/ essential to the success of - the entire organization - your department - your team - your personal work tasks?	Likert scale 1-5 (e.g. not at all important - very important)	Adapted from (Motola 2006)

4.2.3 Criteria: Satisfaction

In table 12, the possible metrics for evaluating the level of satisfaction to the EA approach are presented. In the workshop 4 (FGI 2006b) it was brought up that, especially the extent of utilization of various architecture outcome might be worth knowing. Additionally, it was stated that satisfaction level of different stakeholders may vary a lot; for instance, the management may be satisfied with the EA results showing decreased costs, while employees dealing with e.g. customer services may be less satisfied with the growing amount of work. This indicates the need of both the "hard measures" (quantitative measures) and the "soft measures" (qualitative measures demonstrating opinions and attitudes) to provide more wide perspective to the EA evaluation.

Table 12. Metrics for Evaluating the Level of Satisfaction.

Evaluation Question / Metrics	Metric Type / Possible Values	References
How satisfied are you with the EA approach and its results?	Likert scale 1-7 (e.g. very dissatisfied - very satisfied	Adapted from (Ross and Weill 2005)
To what extent you utilize architecture guidelines/architecture documentation/ architecture guidance given by architects as a normal part of you work tasks?	Likert scale 1-5 (e.g. Very little, little, Sometimes, often, always. OR: daily, weekly, a couple of times a month, a couple of times a year, never)	Based on (FGI 2006a)

Evaluation Question / Metrics	Metric Type / Possible Values	References
How has your guidelines/documentation/ architecture guidance utilization changed during the last quarter/6 months/year?	Scale: stayed the same, gone up, gone down Percentage?	Author's professional judgment
What kind of improvement is needed to make you utilize the architecture guidelines, documentation or architecture guidance given by architects more often?	Free text	Based on (FGI 2006b)

4.2.4 Criteria: Involvement and Participation Activeness

In table 13, the possible metrics for evaluating the involvement and participation activeness of the EA stakeholders are presented. In the workshop 4 (FGI 2006b), the importance of receiving feedback from the organization members was stressed also in this context: Architecture plans, descriptions, and so forth are not perfect at once, but they need to be iterated and modified according to the feedback. Lack of feedback may result in incorrect decisions and flawed architecture. Moreover, based on the discussion, an evaluation question was added (see the last row of the table 13) to find out the stakeholders' ideas on actions that would make them participate in the architecture development, discussions, and so forth more often.

Table 13. Metrics for the Evaluating the Level of Involvement and Participation Activeness.

Evaluation Question / Metrics	Metric Type / Possible Values	References
Does the EA governance team include executive-level representatives from each line of business? Do they have the authority to commit resources and enforce decisions within their respective organizational units?	On-off: yes/no	(GAO 2003)
How satisfied are you with the extent you participate in - architecture development - architectural work development (process development) - architecture management and guidance - architecture implementation projects - architecture related discussions - architecture related briefings - architecture related training - other, what?	Likert scale 1-7 (e.g. very dissatisfied – very satisfied)	Adapted from (Paajanen 2000)
How many times have you participated in architecture related briefings during the last quarter/6 months/year?	Likert scale 1-4 (e.g. no briefings at all – attended a large number of briefings)	Adapted from (Hargie and Tourish 2000)

Evaluation Question / Metrics	Metric Type / Possible Values	References
How actively are you participating to architecture related discussions/briefings/etc.?	Likert scale (e.g. Very little, little, Sometimes, often, always)	Adapted from (Paajanen 2000)
How many times have you participated in architecture related training during the last quarter/6 months/year? A further question can be added to specify the training attended.	Likert scale 1-4 (e.g. No training at all – extensive training (attended a large number of …))	Adapted from (Hargie and Tourish 2000)
How actively do you provide architecture related feedback to - the architecture team - the management - your co-workers? (See also the evaluation of communication and common language, section 3.)	Likert scale 1-5 (e.g. Very little, little, Sometimes, often, always. OR: daily, weekly, a couple of times a month, a couple of times a year, never)	Adapted from (Paajanen 2000) Also (FGI 2006b)
What kinds of actions are needed to make you participate in the architecture development, discussions, etc. more often?	Free text	Based on (FGI 2006b)

4.2.5 Criteria: Resources (adequacy of resources)

In table 14, the possible metrics for evaluating the adequacy of resources provided to the EA work are presented. In the workshop 4 (FGI 2006b), it was brought up that if a budget for EA exists, top-management commitment has been gained. EA must be considered a continuous process, and thus resources must be assigned for it. However, the architecture team's ability to focus only to the EA work is not that self-evident; the management may prioritize the ad-hoc problem-solving work aiming at short-term solutions ("extinguishing the fires") over the long-span EA development aiming at more persistent solutions.

Table 14. Metrics for Evaluating the Adequacy of Resources.

Evaluation Question / Metrics	Metric Type / Possible Values	References
Does a budget for EA exist?	On-off: yes/no	Based on (FGI 2006a) See also (Motola 2006)
How much funding is directed to the EA development and management/to the entire EA program?	Euros % of IT budget	Based on (FGI 2006a)
How has the EA budget changed during the last quarter/6 months/year?	Stayed the same, gone up, gone down Percentage	Author's professional judgment

Evaluation Question / Metrics	Metric Type / Possible Values	References
Does a schedule for EA development exist?	On-off: yes/no	Based on (FGI 2006a)
How has the schedule for the EA development changed during the last quarter/6 months/year? What kinds of changes are done? Why?	Stayed the same, gone up, gone down Percentage	Author's professional judgment
Has an architecture team (architects) been assigned?	On-off: yes/no	Based on (FGI 2006a)
Have the architecture team member's responsibilities and authorities been defined?	On-off: yes/no	Based on (FGI 2006a)
Has the architecture ownership been defined?	On-off: yes/no	(GAO 2003)
How many persons does the architecture (development/management) team include?	Number	Author's professional judgment
Does a chief architect exist (responsible for ensuring the integrity of the EA development process and the content of the EA products)?	On-off: yes/no	Adopted from (Passori & Schafer 2004) (GAO 2003)
How has the number of architects/persons in the architecture team changed during the last quarter/6 months/year?	Stayed the same, gone up, gone down Percentage	Author's professional judgment
Is the architecture team capable of focusing only to EA/architectural work? Note: Different types of architecture related work (e.g. development, management, guidance, implementation, or training) can be further specified.	On-off: Yes/no Percentage of work hours spent on architectural work	Based on (FGI 2006a)
How has the architecture team's time spent on architectural work changed during the last quarter/6 months/year?	Stayed the same, gone up, gone down Percentage	Author's professional judgment

4.3 Summing-up

Evaluation of Commitment was suggested to be conducted with the help of five evaluation criteria. A selection of evaluation questions that demonstrate each evaluation criteria was presented to stimulate the definition of the organization specific evaluation questions/metrics. Similar to the evaluation of Communication, evaluation of commitment mainly includes on-off measures and focuses on identifying the level of satisfaction of a stakeholder (i.e. deals with subjective metrics).

Based on the workshop 4 (FGI 2006b), the following conclusions on the evaluation of commitment can be drawn.

In the beginning of the EA journey, the management's (referring to the top management, CFO, superiors, etc.) commitment to the EA approach is more crucial than the organizational buy-in. This indicates that similar to the evaluation of communication, commitment is also related to the phase of the EA development in the organization or, more specifically, to the EA maturity level of the organization. Thus, the number of committed stakeholder groups should increase as the maturity advances.

In addition to the evaluation of the level of commitment, it would be interesting to find effective ways to move from a level to the next level: which steps are needed to get awareness and acceptability, and move onwards to the levels of satisfaction and active involvement. One possibility of getting answers to this particular question is to ask it from the stakeholders themselves.

A different view to the evaluation of commitment was also presented: Maybe the commitment does not need to be evaluated as a separate target at all. When the EA benefits, and also the success of communication practices, are assessed, it is possible to draw some conclusions about the level of commitment as well. If any benefits cannot be demonstrated, it is likely that no commitment exists either in the organization, or the level of commitment does not increase from the level of awareness. Additionally, if the EA budget exists, it proves the commitment of the management.

If commitment is, however, measured separately, the presented set of evaluation questions and metrics provide a starting point for organization-specific metrics selection. It should again be noticed, that they possibly do not suit the organization as such, but need to be modified and translated into the organization's own terminology.

Finally, as mentioned in the context of the evaluating communication and common language, the satisfaction level of the stakeholders is most typically studied by collecting information with the help of a questionnaire, and similar background information will be needed in the context of evaluating commitment as well (see section 3.4).

5 Conclusions

In this report, we presented the study which aimed at determining evaluation criteria and metrics for 1) Communication and Common Language, and 2) Commitment. Literature review gave us a set of candidate evaluation questions and criteria for these areas, and the literature review results were discussed and validated in the workshop 4 participated by the seven representatives of the co-operating organizations.

The main conclusions of this study are as follows:

Communication and common language, as well as commitment are important to the success of EA work. Therefore, the success in these areas needs to be evaluated. Communication and common language can be evaluated independently (i.e. not merely as part of wider organizational communication studies), but the level of commitment can possibly be derived from the evaluation of the architecture benefits. Basically, if benefits can be demonstrated and the organization has gained value through architecture, commitment has also been reached.

Selection of a few most suitable metrics is needed, as well as the translation of metrics and the evaluation questions into the organization's own terminology. Metrics selection is dependent on the phase of the architecture development, or more specifically, on the level of architecture maturity: simple metrics (e.g. on-off metrics) may be more usable in the beginning of the EA journey, and more detailed metrics (quantitative and qualitative metrics) may be utilized as the EA work is more established. Also the usability and ease of gathering the data required affect the metrics selection.

Especially, the level of commitment is rather easy to define, but the challenge is to find practical ways to move from a level to the next level. One solution to this problem was presented: It may be fruitful to ask the stakeholders themselves which actions should be taken to make them accept the EA approach and participate in the EA work more actively.

The set of evaluation questions and metrics presented in this report can be useful for organizations helping them define the few specific metrics for their needs. After having tested the metrics in practice conclusions can be drawn about their suitability and usefulness for evaluating the success of communication and common language, as well as the level of commitment.

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Appendix 1. Brief Descriptions of the Potential Critical Success Factors for EA.

CSF	Description/Content
Scoping and Purpose	Includes the definition of architecture (EA/SA) in the organization, the key stakeholder groups, the mission, goals and direction of EA, the purpose of EA and how wide organizationally, how deep and detailed, and how fast should the EA be developed in the organization.
Business Driven Approach	Includes the business linkage of architecture (EA) development, business-IT alignment, the business requirements, as well as the requirements set by the various stakeholders, and the equivalency between the requirements and architecture.
Communication and Common Language	Deals with the definition of architectural concepts (the common vocabulary), the definition of communications plan and strategy, and the success of architecture related communication.
Commitment	Refers to the commitment and involvement of the top-management in the architectural work, as well as the organizational buy-in.
Governance	Relates to issues such as governance (and guidance) structures, roles, responsibilities, processes and activities, change management processes (both the organizational and the architectural changes), and risk management processes.
IT Investment and Acquisition Strategies	Deals with the relationship (and dependency) between architectures or architectural work as well as with the IT investment and acquisition strategies of the organization.
Development Methodology and Tool Support	Deals with issues such as the definition and usage of the architecture frameworks, development methods and tools in architecture development and management.
EA Models and Artifacts	Deals with issues such as developing a documentation plan, collecting and analyzing the business requirements, ensuring that all necessary views are modeled providing a coherent and concise picture of the enterprise (current and future models), and developing a transition plan.
Assessment and Evaluation	Deals with the definition of issues, such as, architecture evaluation targets, architecture evaluation purposes and audience, architecture evaluation process and criteria (metrics), data gathering and analysis techniques.
Skilled Team, Training and Education	Refers to issues such as the capabilities and skills of the architecture team, the architecture/business training of architects, as well as other stakeholders.
Organizational Culture	Deals with issues such as the organization’s readiness to develop and utilize EA, attitudes towards architecture approach, attitudes towards changes in general, and the organizational changes the architecture development may lead to.
Project Management	Deals with issues such as the coordination between various (architecture) projects, utilization of project milestones and checkpoints for architectural evaluation or guidance, taking advantage of lessons learned and best practices as well as being on budget and schedule.

Appendix 2. Enterprise Architecture Evaluation Components.

Component	Description
Purpose	The purpose of the evaluation: - Why are we doing the program? - Why are we doing the evaluation? - What's the point? What do we want to accomplish?
Target	The object under evaluation (to delimit the factors to be considered): - What are we going to evaluate (the whole program, just a particular component, or some components)?
Audience	Potential users of the evaluation information/results: - Who will use the evaluation (results)? - How will they use it? - What they want to know? What questions will the evaluation seek to answer?
Quality Attributes and Metrics	The characteristics of the target that are to be evaluated - What information will help answer the questions? - What information do you need to answer the questions?
Yardstick or Standard	The ideal target against which the real target is to be compared.
Data Gathering Techniques	The techniques needed to obtain data to analyze each criterion/indicator: - What sources of information will be used? - What data collection method(s) will be used? - What instruments (e.g. recording sheet, questionnaire, video or audio tape) will be used? - When will the data be collected (e.g. before and after the program, at one time, at various times, continuously, over time)? - Will a sample be used? - Who will collect the data? - What is the schedule for data collection?
Synthesis Techniques (Data Analysis Techniques)	Techniques used to judge each criterion and, in general, to judge the target, obtaining the results of evaluation: - How will the data be organized or tabulated? - What, if any, statistical techniques will be used? - How will narrative data be analyzed? - Who will organize and analyze the data? - How will the information be interpreted and by whom? - How will the evaluation be communicated and shared? To whom?
Evaluation Process	Series of activities and tasks by means of which an evaluation is performed: - What steps are needed? E.g. planning or preparation (evaluation design), examination (data gathering), decision making (synthesis, analysis, documentation) - When will the steps be conducted? - How long will it take to conduct each step, to collect the data needed? - Who conducts the steps? Who collects the data? - How will the results be documented, reported, communicated? - Who will receive the report? Will it answer their questions?
Manage the	Responsibilities, budget and timeline. Risks.

Component	Description
evaluation	- What resources do you need? - Whose time and how much of it is available to work on evaluation? - How much may the evaluation work cost? - What kind of expertise is needed to conduct the evaluation? - When is the evaluation (information) needed? (the flexibility is needed; evaluation should be adjusted so that it is completed when it will have the maximum impact) - What threats will damage the integrity of the data and the conclusions we want to draw? - Do you foresee any barriers or obstacles?

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Bibliography

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Contents

SUMMARY

This report lists and describes each of the categories of the literature found in the AISA project during the first and second years. The research subject of the AISA project is the quality management of enterprise and software architectures in the development of organizations and information systems, as well as related strategies, methods and tools. The project studies architectural key success factors, and evaluation criteria and metrics both at enterprise and software architecture level. In addition, the project investigates and develops quality management strategies and methods for architectures, particularly evaluation methods.

Main categories and subcategories listed and described in this bibliography are:

- architectural quality
    - quality and architecture,
    - enterprise architecture evaluation
    - software architecture evaluation
    - enterprise architecture success factors, evaluation criteria and metrics
    - software architecture success factors, evaluation criteria and metrics
- architecture evaluation methods
    - enterprise architecture evaluation methods
    - software architecture evaluation methods

In addition to these focus areas, the bibliography lists and describes some major references of relevant general background knowledge. Main categories and subcategories related to these areas listed in this bibliography are:

- architecture management background
    - enterprise architecture management
    - software architecture management
- quality and quality management background
    - quality
    - quality management
    - organizational quality and excellence
    - system quality, quality attributes and metrics

1 ARCHITECTURAL QUALITY

1.1 Quality and Architecture

The quality and architecture category includes all references which discuss the relationship between quality and architecture. Thus, it is a very large category including references related to studying architectural quality criteria, metrics and success factors, evaluation and analysis methods, and discussing the concept of architectural quality in general. The software architecture domain seems to be well represented in the literature, with some discussion on enterprise architecture quality, specifically maturity.

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1.4 Enterprise Architecture Success Factors, Evaluation Criteria and Metrics

In this category, a more in-depth view is taken on enterprise architecture evaluation and various success factors, evaluation criteria and metrics introduced. Enterprise architecture success factors represent areas where work has to be carried out exceptionally well to enable high-quality architecture - areas such as top management support and communication are typically mentioned. In general, the critical success factors approach provides a high-level view on enterprise architecture and enterprise architecture work quality. Evaluation criteria and metrics, on the other hand, can be related to the quality of various architectural views, especially software or system architecture, or the quality of architecture work, such as communication or business-IT alignment. Maturity evaluation approaches have their roots in critical success factors and are thus listed here as well. As with individual enterprise architecture metrics other than maturity, the IT side of enterprise architecture dominates this category.

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1.5 Software Architecture Success Factors, Evaluation Criteria and Metrics

Like the previous category, this category includes similar references in the software architecture domain. Some references discuss software architecture critical success factors, but mostly the focus is on software architecture metrics and quality attributes. Moreover, metrics related to software engineering are introduced in a number of references. Some measurement approaches are also introduced, with several references listed already in the previous category, indicating approaches that can be used in or cover both domains.

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2 ARCHITECTURE EVALUATION METHODS

2.1 Enterprise architecture evaluation methods

This category concentrates on enterprise architecture evaluation methods. Most of the references have been listed in the enterprise architecture metrics domain already – usually the methods and metrics are interrelated. However, the references listed here describe at least one evaluation method for a part of enterprise architecture, not solely metrics. Maturity evaluation methods could have been listed here as well, but we consider them to be related more to enterprise architecture critical success factors. It should be noted that methods for evaluating enterprise architecture as a whole do not yet exist; methods should be adopted and adapted from e.g. the software architecture domain and combined to evaluate the entire enterprise architecture. A description of methods for evaluating the viewpoints of enterprise architecture is presented in AISA project report Architecture Evaluation Methods (Hoffmann 2007).

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2.2 Software architecture evaluation methods

As is the case with software architecture metrics, the evaluation methods and approaches of software architecture are more established than enterprise architecture evaluation methods. Similar to the enterprise architecture domain, also here metrics and methods interrelate and this the categories include a number of same references. It should be noted that as enterprise architecture includes the software architecture domain as well, some of the methods described in these references can be used to evaluate the IT viewpoints of enterprise architecture.

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3 ARCHITECTURE MANAGEMENT BACKGROUND

3.1 Enterprise architecture management

This category includes a wide range of references related to the management and governance of enterprise architecture. The topics range from enterprise architecture frameworks, governance models, and planning and development processes, methods and tools to enterprise architecture stakeholder management and benefit realization process. Moreover, related areas such as information systems management and business-IT alignment are covered. Some references of maturity models are included as well, because they have an integrated enterprise architecture management approach. A few of the references also discuss enterprise architecture on a general level: what the approach actually means, and what is included into enterprise architecture or architecture work.

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3.2 Software architecture management

Similar to the previous topic, this category includes an extensive range of references on software architecture management in general. In this category, the references mostly cover software architecture planning and development frameworks and models. Several references on the concept of software or system architecture, such as architectural views, are also listed. A number of related topics such as information systems management are also included.

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4 QUALITY AND QUALITY MANAGEMENT BACKGROUND

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4.2 Quality management

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4.3 Organizational quality and excellence

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4.4 System quality, quality attributes and metrics

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Evaluating Business-IT Alignment in the Enterprise Architecture Context

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Abstract

In this report, the concept of business-IT alignment is extensively discussed according to literature. Particularly, the various definitions, components, models and benefits, as well as the practical aspect of the alignment concept, are discussed. Furthermore, the concept is addressed in the EA domain, and approaches for its evaluation are described.

Contents

1 Introduction

Alignment between business and IT has been considered important in organizations for over 15 years (Luftman 2000). As a high degree of alignment has been associated with improved business performance by empirical evidence (Chan, Huff ym. 1997; Papp 1999), it is not surprising that business-IT alignment, or business-ICT alignment, has been continuously considered as one of the top concerns of company executives such as CIOs (Luftman 2000; Luftman, Kempaiah ym. 2006) and a great number of studies have been conducted on the subject so far (Luftman 2000; Chan 2002). Alignment has also been considered as one of the key benefits or potential objectives of Enterprise Architecture (EA) (Morganwalp & Sage 2004; Ross & Weill 2005; Goethals, Snoeck ym. 2006; Kluge, Dietzsch ym. 2006; Niemi 2006), a recent approach for organizational management and development.

EA provides a holistic view of an organization, consisting of the viewpoints of business, systems, information and technology (see e.g. de Boer, Bosanque ym. 2005; Kaisler, Armour ym. 2005; Jonkers, Lankhorst ym. 2006). It is widely recognized by academics and practitioners alike, as stated to provide a great number of positive business impacts, including the alignment and integration of strategy, people, business and technology (Morganwalp & Sage 2004; Goethals, Snoeck ym. 2006). However, the relationship between business-IT alignment and EA has not been thoroughly or holistically studied, even though several studies have attempted to clarify the relationship between alignment and various architectural viewpoints, such as business, systems and technology (see e.g. Maes, Rijsenbrij ym. 2000; Slot 2000; Zijden, Goedvolk ym. 2000; Pereira & Sousa 2003; Chen, Kazman ym. 2005; van der Raadt, Hoorn ym. 2005; Wegmann, Balabko ym. 2005; Strnadl 2006; Versteeg & Bouwman 2006; Zarvic & Wieringa 2006).

Moreover, business-IT alignment in itself is a complex issue and difficult to evaluate (Chan, Huff ym. 1997; Chan 2002). Consequently, even a consensus on the concept itself and its characteristics has not been reached (Henderson & Venkatraman 1989; Maes, Rijsenbrij ym. 2000; Avison, Jones ym. 2004; Silva, Plazaola ym. 2006), although numerous definitions (Luftman, Lewis ym. 1993; Reich & Benbasat 1996; Luftman 2000; Maes, Rijsenbrij ym. 2000), models (Henderson & Venkatraman 1993; Chan, Huff ym. 1997; Luftman 2000; Maes, Rijsenbrij ym. 2000; Cumps, Viaene ym. 2006) and metrics (Chan, Huff ym. 1997; Papp 1999; Luftman 2000; Chan 2002; Cumps, Viaene ym. 2006; Tan & Gallupe 2006) have been proposed. Even though the literature on the subject is extensive, numerous researchers argue that it does not, for the most part, provide useful implications to practice (Ciborra 1997; Maes, Rijsenbrij ym. 2000; Avison, Jones ym. 2004; Cumps, Viaene ym. 2006). Nevertheless, evaluating the state of business-IT alignment in organization is important both in understanding the relationship between business and IT, and improving alignment between them (Luftman 2000).

In this study, we aim to explore and discuss the concept of business-IT alignment and its evaluation, particularly in the context of EA. In addition, we also aim to discuss on methods for improving and evaluating alignment in organizations.

Systematic literature review was used as a research method. Initially, a keyword search in four high-quality academic databases[1] and Google Scholar by keywords “business”, “IT” and “alignment” simultaneously. A preliminary set of potentially relevant literature was identified by the search. Subsequently, the literature was charted for references, and forward and backward search (see e.g. Levy & Ellis 2006) utilized to obtain deeper and wider literature background.

This report is organized as follows. First, the concept is extensively discussed on the general level (Section 2). Second, potential interpretations of the concept in the context of EA are discussed (Section 3). Third, methods and models for evaluating business-IT alignment in organizations are described (Section 4). Finally, Section 5 concludes the report.

[1] Academic Search Elite (EBSCO), Electronic Journals Service (EBSCO), Science Direct (Elsevier) and Web of Science (ISI)

2 Concept of Business-IT Alignment

This section discusses the various views of business-IT alignment from literature, including definitions, characteristics, components, benefits, and attainment. Moreover, a brief summary is included.

2.1 Definitions

Many definitions for alignment between business and IT have been proposed in literature. However, the definitions typically miss the complex and extensive nature the phenomenon, and hence do not encompass its whole domain. It is argued that the definitions are ambiguous, and many studies have even be published without a clear definition (Maes, Rijsenbrij ym. 2000). Some vague definitions for alignment include “the extent to which the IS strategy supports, and is supported by, the business strategy” (Luftman, Lewis ym. 1993) and “the degree to which the IT mission, objectives, and plans support and are supported by the business mission, objectives and plans” (Reich & Benbasat 1996).

Later, slightly broader and more accurate definitions have been proposed by a few authors. For example, Luftman (2000) states that “business-IT alignment refers to applying Information Technology (IT) in an appropriate and timely way, in harmony with business strategies, goals and needs”. Moody clarifies and extends the scope of the concept by stating that alignment results from consistent objectives and metrics shared by IT and business alike (Moody 2003). The most extensive definition, considering all the discussion in this section, is the one presented by Maes et al. who define alignment as “the continuous process, involving management and design subprocesses, of consciously and coherently interrelating all components of the business-IT relationship in order to contribute to the organization’s performance over time” (Maes, Rijsenbrij ym. 2000).

Nevertheless, even the term “alignment” itself is not the only one used in literature. For example, alternative terms like *linkage*, *balance*, *fit*, *integration* and *coordination* are used as well (Reich & Benbasat 1996; Luftman 2000; Maes, Rijsenbrij ym. 2000; Avison, Jones ym. 2004; Silva, Plazaola ym. 2006). Moreover, even though some authors (for example Reich & Benbasat 1996; Luftman 2000) argue that the fundamental concepts behind the term remain similar, it seems that a common perception on the concept has not been found so far (Henderson & Venkatraman 1989; Maes, Rijsenbrij ym. 2000; Avison, Jones ym. 2004; Silva, Plazaola ym. 2006; Silvius 2007). In this study, we use the term “alignment” as an abbreviation of alignment between business and IT.

3 Characteristics of Alignment

The main question regarding the characteristics of alignment brought out in literature is whether alignment is a static state (outcome or effect) or a dynamic process (cause) (Maes, Rijsenbrij ym. 2000; Avison, Jones ym. 2004; Cumps, Viaene ym. 2006; Silva, Plazaola ym. 2006). The former view has dominated the literature (Maes, Rijsenbrij ym. 2000; Avison, Jones ym. 2004), but later some authors considered alignment as both a process (e.g. the activities to reach alignment) and a state (the amount of alignment) (Reich & Benbasat 1996; Silvius 2007). Recently, alignment has been regarded as a dynamic, evolutionary process instead of a static outcome by a few authors (Luftman 2000; Maes, Rijsenbrij ym. 2000; Chan 2002; Avison, Jones ym. 2004; Cumps, Viaene ym. 2006). In this respect, alignment needs to be maintained over time by a continuous process (Maes, Rijsenbrij ym. 2000; Avison, Jones ym. 2004; Hu & Huang 2005).

Timeframe of alignment is an interesting question: are business and IT only currently aligned or are their long-term visions or strategies also aligned, indicating potential alignment in the future as well? Literature for the most part addresses only the strategic side of alignment. However, several authors state that alignment should be assured on both strategic and tactical levels (Henderson & Venkatraman 1993; Reich & Benbasat 1996; Bruls 2003). For example, Reich and Benbasat address the issue by identifying two timeframes of alignment, short-term - common understanding of current plans by both business and IT, and long-term – shared IT and business long-term vision (Reich & Benbasat 1996).

3.1 Components

In addition to the characteristics of the alignment itself, the definitions indicate multiple components or “targets” for alignment. Even though authors seem to agree that both business and IT should be aligned with each other (Luftman 2000), the now commonly used term “business-IT alignment” or “business-ICT alignment” does not define which components of business and IT should be aligned. Even the probably most frequently used term “strategic alignment”, which emphasizes that organizations’ IT and business strategies should be aligned (Henderson & Venkatraman 1993; Reich & Benbasat 1996; Chan, Huff ym. 1997; Avison, Jones ym. 2004; Hu & Huang 2005), is still imprecise. Reich and Benbasat (1996) provide a more accurate definition by suggesting that both business and IT mission, objectives and plans should be aligned, and dividing alignment to intellectual (content of plans and objectives) and social (common understanding of plans and objectives) dimensions.

In general, alignment research seems to focus on the strategic component only (Maes, Rijsenbrij ym. 2000), although alignment is understood to encompass at least 1) structural, technology, process and skills (Henderson & Venkatraman 1993; Luftman 2000; Maes, Rijsenbrij ym. 2000; Chan 2002; Weiss & Anderson 2004), 2) knowledge, communication and learning (Reich & Benbasat 1996; Ciborra 1997; Luftman 2000; Maes, Rijsenbrij ym. 2000; Chan 2002; Weiss & Anderson 2004) and 3) metrics (Luftman 2000; Moody 2003; Weiss & Anderson 2004) components as well. Consequently, a number of authors specify the concept further by introducing various alignment models.

3.2 Models

The alignment models introduced aim to capture the complex nature of alignment, taking into account more than merely its strategic side. Particularly, the most cited is the Strategic Alignment Model (SAM), displayed in Figure 1. The model defines four alignment domains: 1) business strategy, 2) IT strategy, 3) organizational infrastructure and processes, and 4) IS infrastructure and processes (Henderson & Venkatraman 1993). The authors also describe four cross-domain alignment perspectives, which display different approaches to attaining alignment – either driven by business or IT strategy. Afterwards, the SAM has been further developed and extended in two distinct lines of research, specifically by Luftman et al. and Maes et al.

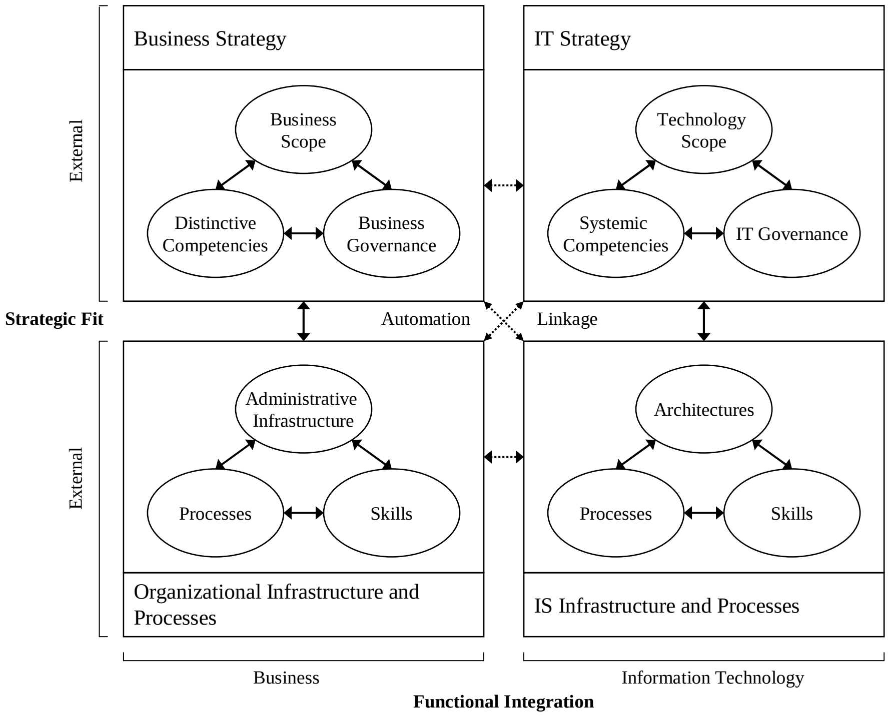

Figure 1. The Strategic Alignment Model (Henderson & Venkatraman 1993).

Building on the SAM, further research on alignment perspectives (Luftman, Lewis ym. 1993), and alignment enabler and inhibitor research (Luftman, Papp ym. 1999), Luftman constructs a strategic alignment maturity assessment method (see Figure 2), comprised of six components of alignment: 1) communications, 2) competency or value measurement, 3) governance, 4) partnership, 5) scope and architecture, and 6) skills (Luftman 2000). Moreover, Maes (1999) further extends the SAM by dividing the infrastructure and processes component into two distinct components (structure and operations) on the vertical dimension, and adding an information and communication component to the horizontal dimension to represent the information, knowledge and communication infrastructure crucial to any organization today.

Subsequently, attempting to provide a basis for further elaboration of the alignment concept, Maes and colleagues (2000) combine this extended version of SAM with Cap Gemini's Integrated Architecture Framework (IAF) (Goedvolk 1999) to develop an unified framework for alignment. The framework, depicted in Figure 3, consists of a 3-D model of three horizontal levels (strategy, structure and operations), four vertical architecture areas (business, information and communication, systems and technological infrastructure), and a third dimension of five design phases (contextual, conceptual, logical, physical and transformational) (Maes, Rijsenbrij ym. 2000). Furthermore, van der Raadt et al. (2005) have also developed an architecture alignment evaluation model, built on previous research including the SAM and Luftman's work, consisting of six sub variables that explain both architecture alignment and maturity. However the model has not been validated this far.

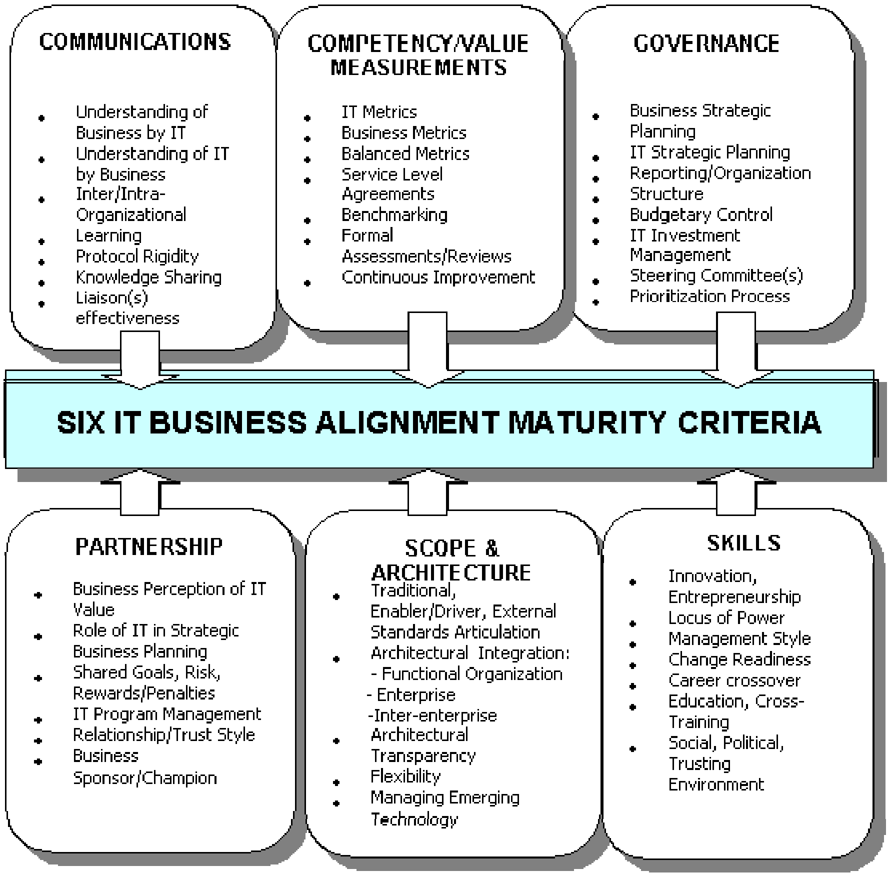

Figure 2. Business-IT alignment maturity criteria (from Luftman 2000).

In addition, alignment models not directly based on the SAM exist. Reich and Benbasat introduce a model of the social dimension of alignment, including four components divided into two antecedents, 1) shared domain knowledge between business and IT executives and 2) successful IT history, and two current practices, 1) communication between business and IT executives and 2) connections between business and IT planning, all found to influence alignment (Reich & Benbasat 2000). This model is further developed by Hu and Huang by adding relationship management as an antecedent and balanced scorecard as a mechanism for alignment (Hu & Huang 2005).

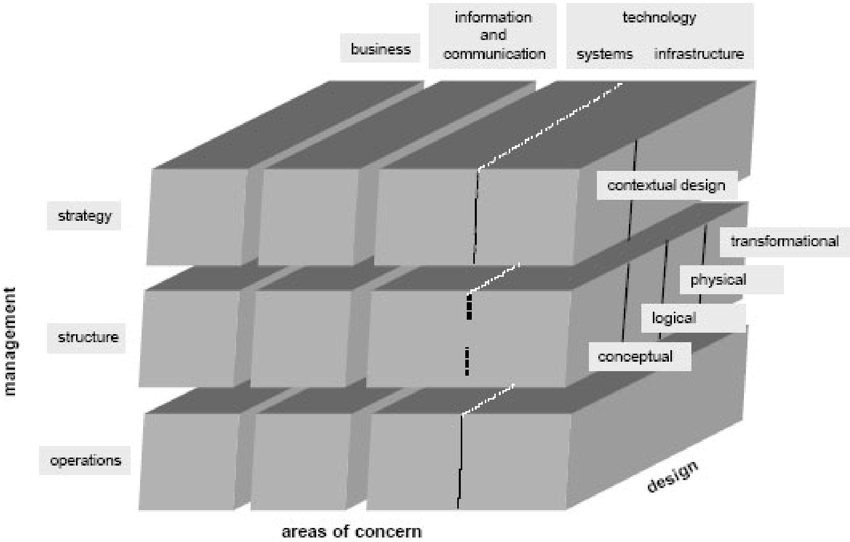

Figure 3. The unified framework for business-IT alignment (from Maes, Rijsenbrij ym. 2000).

Moreover, Chan et al. present a conceptual model which illustrates interrelations between realized business and IS strategy, strategic alignment and business and IS performance, and survey instruments related to these constructs (Chan, Huff ym. 1997). Cumps et al. take a different approach and base their model of alignment capability, competences and resources on the resource-based view of the firm (Cumps, Viaene ym. 2006). However, they draw the alignment competencies from Luftman's work (Luftman 2000).

Altogether, the SAM has remained the most referred model for alignment (Silva, Plazaola ym. 2006), with its extensions by Luftman (Maes, Rijsenbrij ym. 2000). Although it is often argued that the SAM is more a conceptual model, lacking practical implications (Hu & Huang 2005), it has been displayed to have both conceptual and practical value by empirical research (Avison, Jones ym. 2004). In addition, Luftman's alignment maturity assessment method has been validated at more than 50 Global 2000 companies (Luftman 2003) and used extensively in surveys by other authors (Cumps, Viaene ym. 2006; Silvius 2007). The unified framework for alignment (Maes, Rijsenbrij ym. 2000) has also been applied in a number of studies (Slot 2000; Avison, Jones ym. 2004). Although no model or assessment method can comprise the full picture of alignment, Luftman's alignment criteria seems to include most of the factors associated to alignment by research. In addition to the ones discussed above, it includes factors related to entrepreneurial and innovative organizations, stressed by some authors (see e.g. Chan 2002; Moody 2003).

3.3 Benefits

Although the majority of studies on alignment emphasize the importance of the subject, a considerably lower number mentions any benefits potentially attained by alignment. Some of these named benefits include maximization of return on IT investment, enablement of competitive advantage from IS, and increase of company flexibility in reacting to changes (Avison, Jones ym. 2004). However, many companies seem believe that alignment will automatically lead to the creation of new business opportunities through IT, which is a false assumption (Moody 2003). Moody's statement is supported by the fact that there are only a few studies which have been able to support the claims of realized benefits by empirical evidence (see e.g. Chan, Huff ym. 1997; Papp 1999; Chan 2002).

The empirical studies display that alignment impacts positively a company's 1) business performance and 2) IT effectiveness. Papp investigated the impact of a company's alignment perspective (see e.g. Henderson & Venkatraman 1993; Luftman, Lewis ym. 1993) and industry classification to 18 traditional financial measures in 500 companies, displaying that the company's alignment perspective and industry affects the probability of realizing certain results with the measures (Papp 1999). A survey study by Chan et al. indicates that business strategic orientation, IS strategic alignment and IS effectiveness (as measured by end-user satisfaction and strategic impact) improve business performance (as measured by market growth, financial performance, innovation, and company reputation). Moreover, IS strategic alignment was found to be a better predictor of IS effectiveness than IS strategic orientation. (Chan, Huff ym. 1997) In a later case study, Chan (2002) found out that aligning business and IT strategies improved the overall IS function performance.

3.4 Striving for Business-IT Alignment in Practice

Many authors argue that alignment research, even with the models constructed, does not generally provide useful implications to practice (Ciborra 1997; Maes, Rijsenbrij ym. 2000; Avison, Jones ym. 2004; Cumps, Viaene ym. 2006). Still, several researchers have taken a more practical approach on the subject and investigated the factors affecting alignment, or even developed methods or practices for increasing alignment in organizations. The majority of them base their studies on published alignment models, particularly the SAM, which on its own gives an idea of what kind of factors might affect alignment.

Luftman et al. (1999) carried out an extensive survey study on alignment inhibitors and enablers, resulting in the factors displayed in Table 1. Also Leganza (2003) presents a fairly similar list of items as characteristics of unaligned IT organizations. Furthermore, in Luftman's (2000) strategic alignment maturity assessment method, a multitude of critical success factors of alignment are included. Luftman's work has also stimulated further research. Using mainly his alignment criteria, Cumps et al. found out in an extensive survey study that particularly the role of IT in an organization has a substantial effect on the organization's alignment maturity. Conservative, support role of IT was most often associated with low alignment maturity. The results also showed that organizations that build extensive and comprehensive business cases, including a diverse set of components, more probably have high alignment. (Cumps, Viaene ym. 2006)

Originally, Luftman's factors of alignment are not prioritized although research suggests that e.g. alignment on the strategic level may be more important than on the structural level. Moreover, informal interrelationships and structures between business and IT were found to be more important than formal ones. (Chan 2002) Furthermore, business and IT executives' shared domain knowledge was found to outperform the other factors (i.e. IT implementation success, communication, and connections between IT and business planning) in influencing alignment (Reich & Benbasat 2000).

Table 1. Inhibitors and enablers of Business-IT alignment (Luftman, Papp ym. 1999).

	Enablers	**Inhibitors**
1	Senior executive support for IT	IT/business lack close relationships
2	IT involved in strategy development	IT does not prioritize well
3	IT understands business	IT fails to meet commitments
4	Business-IT partnership	IT does not understand business
5	Well-prioritized IT projects	Senior executives do not support IT
6	IT demonstrates leadership	IT management lacks leadership

As discussed earlier in this section, alignment is suggested to be a continuous process. Consequently, such a process should be created and maintained in an organization. However, research provides few managerial implications to this area. A few authors suggest that assuring alignment should be the responsibility of the IT governance function (Symons 2005; Dahlberg & Kivijärvi 2006). In the Integrated IT Governance Framework, alignment is the starting point of the IT governance process, affecting on how IT is organized, resourced, managed and measured (Dahlberg & Kivijärvi 2006). For example, IT investments should be aligned with the organizational strategy (Symons 2005). Moreover, measurement systems, such as the Balanced Scorecard can be used in the process to promote alignment (Hu & Huang 2005). Nevertheless, IT governance should be closely connected to business, and hence constant communication and common understanding is required between top business and IT executives (Symons 2002). However, in many organizations, there may even be challenges in communicating the business strategy to the people responsible for executing it (Symons 2005). Finally, even if both business and IT strategies exist, are communicated and aligned, it may not be enough: to successfully leverage IT in business, IT and business strategy should be the same (Symons 2002).

According to the discussion above, factors affecting alignment encompass the entire organization. They include numerous intangible factors as well, making it difficult in practice to affect or even evaluate them. As a solution, taking into account the holistic nature of alignment, several authors suggest that EA could be an approach for enabling or improving alignment (Maes, Rijsenbrij ym. 2000; Slot 2000; Zijden, Goedvolk ym. 2000; Hirvonen & Pulkkinen 2003; Pereira & Sousa 2003; Weiss & Anderson 2004; van der Raadt, Hoorn ym. 2005; Zarvic & Wieringa 2006). Particularly, a few EA frameworks (Zijden, Goedvolk ym. 2000; Zarvic & Wieringa 2006), and maturity models (Slot 2000) for pursuing alignment have been proposed.

3.5 Summary

Above, we extensively discussed the various views of alignment from literature. According to literature, alignment between business and IT is an evolutionary process, which needs to be maintained over time by planning, design, management, and evaluation activities on both strategic and tactical levels. Moreover, alignment may refer to the extent or amount of alignment, measured by e.g. various maturity models. From the large number of models developed to depict this complex phenomenon, the SAM remains the most commonly referred. In general, several common factors affecting alignment can be derived:

- *strategic* factors, such as business and IT strategies, plans, objectives and vision,
- *structural* factors, such as processes, organizational structure, architectures, governance and competences,
- *social* and *cognitive* factors, such as communication, partnership, learning, and common knowledge and understanding, and
- *measurement* and *evaluation* factors, such as metrics and measurement systems for both business and IT.

Alignment, in turn, is argued to lead to a multitude of benefits, of which several have been empirically substantiated. Practically, alignment is suggested to be the responsibility of IT governance, which in turn needs to be in close relationship with business. However, since research offers little contributions to practice, alignment remains challenging to improve, sustain, or evaluate in practice. Moreover, factors affecting alignment encompass the entire organization, indicating that an extensive, holistic approach would be needed to address these issues. Hence, we continue with the notion, with support from literature (Maes, Rijsenbrij ym. 2000; Slot 2000; Zijden, Goedvolk ym. 2000; Hirvonen & Pulkkinen 2003; Pereira & Sousa 2003; Weiss & Anderson 2004; van der Raadt, Hoorn ym. 2005; Zarvic & Wieringa 2006), that EA could be this kind of an approach.

4 Business-IT Alignment in the EA Context

In this section, we will address alignment in the EA context – how could these two concepts relate to each other. We start by discussing the common characteristics of EA and alignment.

4.1 Common Characteristics of EA and Alignment

As described earlier, EA includes all the models needed in managing and developing an organization, including the viewpoints of business, systems, information and technology (see e.g. de Boer, Bosanque ym. 2005; Kaisler, Armour ym. 2005; Jonkers, Lankhorst ym. 2006). Although the concept in various forms has been discussed by academics for approximately 15 years, the area of research is still fragmented, lacking a consistent view. The studies on EA have attempted to define the concept itself (see e.g. Kaisler, Armour ym. 2005; Lankhorst 2005), and developed various frameworks (see e.g. Sowa & Zachman 1992; The Open Group 2006), and modeling and development methods (see e.g. Lankhorst 2005; Ylimäki, Halttunen ym. 2005; Lam-Son & Wegmann 2006). Recently, EA evaluation aspects, such as maturity evaluation (see e.g. OMB 2005; Niemi 2006) and critical success and failure factors (Rehkopf & Wybolt 2003; van der Raadt, Soetendal ym. 2004; Ylimäki 2006) have gained increasing attention.

The EA critical success factors (CFSs) depict the key areas where things have to be done exceedingly well in order to succeed and achieve the objectives and goals set for the EA (Ylimäki 2006). As can be seen from Figure 4, the factors relate to

- EA scoping and planning,
- EA development, management and measurement practices, organization and processes,
- EA's integration to organization's processes, and
- organizational and social practices, structures and behavior.

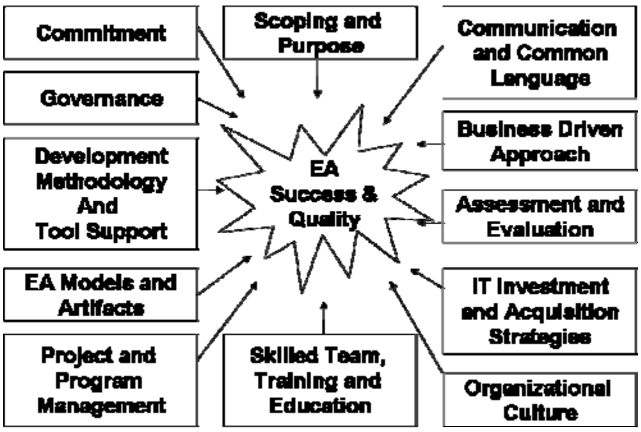

Figure 4. CFSs for EA (Ylimäki 2006).

From the point of view of EA as a holistic view of an organization, as well as its CFSs, EA and EA work seem to encompass the entire organization. Alignment-related factors (see Luftman 2000, for example), even though possibly different in scope and emphasis, seems to deal with organization-wide issues as well, thus requiring a holistic approach for their improvement, management or evaluation. Van der Raadt et al. (2005) also suggest that a same set of factors affect both EA maturity and alignment. Moreover, alignment is regarded as one of the key benefits of EA (Morganwalp & Sage 2004; Ross & Weill 2005; Goethals, Snoeck ym. 2006; Kluge, Dietzsch ym. 2006; Niemi 2006), indicating that EA could be one potential vehicle towards better alignment.

4.2 Relationship between EA and Alignment

The viewpoint discussed in the previous section has been developed further by several authors. Hirvonen and Pulkkinen (2003) suggest that EA development can be seen as a bridge between business and IT development (Figure 5). Therefore, alignment can potentially be achieved through EA. EA as a business-driven approach guides and controls IT investments and projects implementing the investments by developing new ISs (or new IT) that support the business. This implies that in order to reach the desired state of alignment between business and IT via the EA approach, alignment is also required at least between business and EA, EA and investments, EA and projects, and investments and projects, as well as between EA and the actual impacts (benefits, new systems, cost-reduction etc.) of both investments and projects. In addition, alignment may be required between the organization's EA, and its partners' or customers' EA.

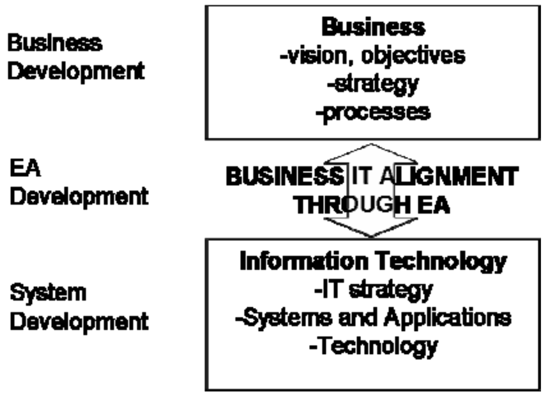

Figure 5: EA development as a bridge between business and IT (adapted from Hirvonen & Pulkkinen 2003).

Interestingly, the above mentioned objects (business, EA, investment, project and so forth) seem to be similar to the objects related to EA compliance and its evaluation (see Ylimäki, Niemi ym. 2007), which include the objects of business, external directions, EA, investment, project, impacts of investments and projects, partners, and customers. EA compliance, indicating conformance with specific specifications, is potentially required between the objects, as depicted in Figure 6. Therefore, we suggest that the same objects may also be the potential objects between which alignment is needed in the EA context to enable the organization to reach alignment between business and IT.

Moreover, other relationships may exist between the concepts of compliance and alignment. It seems that, even if business and EA are compliant (i.e. the business strategies and requirements have been taken into account in EA development, EA plans and models, and so forth), it does not automatically guarantee that business and EA have reached an ideal or desired state of alignment. For example, this could be the case in a situation where the business strategies and requirements themselves take alignment into account insufficiently, are too vague or abstract and interpreted into EA incorrectly. Moreover, a development project aiming at implementing a part of EA may end up in a situation where it cannot follow the EA specifications and instructions, at least not with the existing resources. In both of these situations, it is crucial that workable feedback channel and practices exist to enable projects to provide valuable feedback to the EA development team, as well as, enable the EA team to provide help to projects to be able to proceed. In turn, the team can then analyze possible changes required in the EA plans, policies and models, or even identify development potential in the business strategies and requirements, to be communicated to organizational strategy planning. Because of the challenges mentioned, it seems that even the case of non-compliance or non-alignment, for instance between EA and a project, is not necessarily a disaster: it may reveal false assumptions made in EA development and planning, or even in the formation of the business strategy and requirements (see also The Open Group 2006).

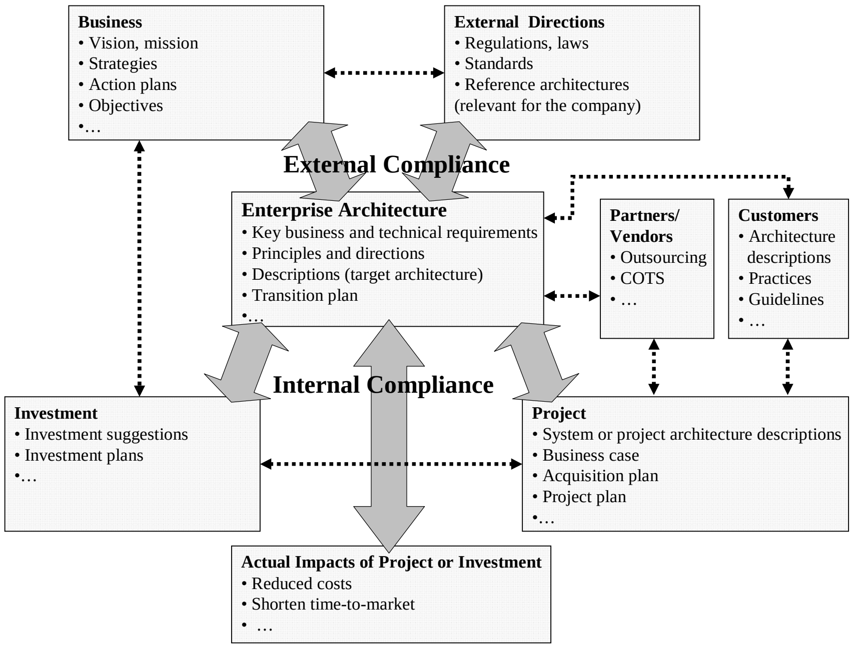

Figure 6. EA compliance objects and their possible relationships to be evaluated (Ylimäki, Niemi ym. 2007).

In addition, the alignment of various architectures, or architectural views, of an organization has been addressed by a few authors. Particularly, business architecture is proposed as a means for embedding business strategy to organization's other architectures, namely organization, process and IT (Versteeg & Bouwman 2006), providing a pragmatic framework for at least one-way alignment between business and IT. Further, Pereira and Sousa (2003) discuss alignment between organization's architectures, specifically business architecture, information architecture and application architecture, providing alignment criteria for the resulting three two-way interrelationships between the architectures. Chen et al. (2005) take a similar approach in developing a method for alignment, addressing alignment between business model, business architecture and IT architecture. Particularly, business architecture may allow the interpretation of business requirements to IT (Rosen, Ambler ym. 2007).

A different approach has been suggested by Slot (2000). He has developed an EA maturity model, building on the work by IAF (Goedvolk 1999), and Maes et al. (Maes, Rijsenbrij ym. 2000). He attempts to associate EA maturity levels with certain EA processes that should be developed or refined in these levels. As a result, an approach suggested to improve alignment is provided. Deducing from this assumption, Slot seems to assume that alignment improves as EA maturity increases. As the maturity of EA refers to the organization's capability to manage the development, implementation and maintenance of its EA (van der Raadt, Soetendal ym. 2004), it could be assumed that having good EA processes leads to high alignment. Van der Raadt et al. (2005) support this notion by suggesting that EA alignment and maturity correlate, but do not explain one another.

4.3 Summary

Deducing from the discussion above, we draw the following conclusions:

1) Both EA and alignment are affected by a large number of factors in an organization
2) Factors affecting EA and alignment are similar to an extent
3) Alignment of architectures is one aspect of alignment
4) EA and EA work potentially improve alignment, but do not explain it on their own
5) EA compliance and alignment are related but compliance does not guarantee alignment.

Hence, two suggestions can be made about the relation between EA and alignment: 1) EA can be regarded as an enabler of achieving, improving and sustaining alignment in organizations, by providing tools for describing and communicating various aspects of an organization (e.g. the business strategy and objectives), as well as for achieving ISs that support the business, and 2) the factors affecting the success of EA and the extent of alignment are somewhat similar, even implying that alignment improvement efforts can be regarded as EA work having a slightly different scope and emphasis.

5 Evaluating Business-IT Alignment

In Section 2, several models for alignment were briefly introduced. In this section, we will focus on some of the models and present the evaluation aspects contained in these models, as well as some sample metrics suggested for these aspects. Furthermore, we will discuss how these models may enable evaluating alignment. The models addressed in this section are

- Luftman's (2000) strategic alignment maturity assessment method,
- Reich and Benbasat (2000): Social dimension of alignment,
- Chan et al. (1997): Four measurement instruments, and
- Symons's (2005) practical suggestions for alignment measures.

The three first models have been validated in practical cases, and hence they can be regarded as a feasible basis for alignment evaluation planning by introducing several evaluation targets and metrics. In addition, Symons (2005) provides some practical quantitative examples of alignment metrics. Other models, not included in this analysis, may also provide viable examples. However, some of the models are not validated or do not sufficiently suit practice these models. For example, the assessment model by van der Raadt et al. (2005) has not yet been validated.

First, Luftman's strategic alignment maturity assessment method (Luftman 2000) consists of five maturity levels: 1) initial/ad hoc process, 2) committed process, 3) established focused process, 4) improved/managed process, and 5) optimized process. Furthermore, as previously described, it contains six criteria (see also Figure 2): 1) communication maturity, 2) competence/value measurement maturity, 3) governance maturity, 4) partnership maturity, 5) scope & architecture maturity and 6) skills maturity. The sub-attributes or practices of the criteria, each with rationale for mapping it to a specific maturity level, are also presented (Luftman 2000; 2003). An excerpt of an evaluation score sheet is provided in Figure 7.

Practice Categories		Practices	Averaged Scores									Average Category Score
			1	1.5	2	2.5	3	3.5	4	4.5	5	
Communications	1	Understanding of business by IT										
	2	Understanding of IT by business										
	3	Organizational learning										
	4	Style and ease of access										
	5	Leveraging intellectual assets										
	6	IT–business liaison staff										
Competency/Value Measurements	7	IT metrics										
	8	Business metrics										
	9	Link between IT and business metrics										
	10	Service level agreements										
	11	Benchmarking										
	12	Formally assess IT investments										
	13	Continuous improvement practices										
Governance	14	Formal business strategy planning										
	15	Formal IT strategy planning										
	16	Organizational structure										
	17	Reporting relationships										

Figure 7. An excerpt of a business-IT alignment score sheet (from Luftman 2003).

Luftman suggests that the maturity evaluation should be carried out by a team of both business and IT managers, typically 10 to 30 participants. The team members should evaluate each of the alignment sub-attributes and determine which maturity level their organization matches. The evaluation can either be done by surveys, in a facilitated group setting, or by their combination. (Luftman 2000; 2003) A smaller set of sub-attributes can also be selected to result in a lighter survey (see e.g. Cumps, Viaene ym. 2006).

Second, Reich and Benbasat (2000) suggest four constructs that affect the social dimension of alignment: 1) communication between business and IT executives, 2) connection between business and IT planning, 3) shared domain knowledge between business and IT executives, and 4) IT implementation success. By social dimension of alignment they mean “the state in which business and IT executives within an organizational unit understand and are committed to the business and IT mission, objectives and plans” (Reich & Benbasat 2000). By measuring these constructs, both short-term and long-term alignment can be evaluated. Examples of measures and practices for each construct are presented in Table 2.

Table 2. Examples of measuring business-IT alignment (from Reich & Benbasat 2000)

Construct 1: Measuring communication between business and IT executives

- Six techniques are used to capture the interaction between business and IT executives:
    - Direct communication: regular or ad hoc meetings, email, or written memos
    - Liaison roles: a named person as liaison between IT and a line function
    - Temporary task forces: IT project team, new product development team
    - Permanent teams/committees: IT steering committee
    - Integrating roles: IT person leads the business quality team
    - Managerial linking roles: product management role
- Data is gathered from interviews validated by written documents (e.g. minutes of meetings).
- Low, moderate or high levels of communication are identified.

Construct 2: Measuring connections between business and IT planning

- Business unit representatives are asked to describe the steps in the most recent IT and business planning process.
- These descriptions are classified according to the types of IT planning describing different levels or degree of connections:
    - Level 1: Isolated – IT and business plans are developed separately
    - Level 2: Architected – IT plans are developed from data and application architectures
    - Level 3: Derived – IT plans are developed during a top-down analysis beginning with business objectives
    - Level 4: Integrated – IT plans are developed and ratified at the same time as other business objectives. Both business and IT executives participate in the planning.
    - Level 5: Proactive – IT objectives precede the formulation of business objectives and are used as input to their development.

Construct 3: Measuring shared domain knowledge
- Measured as work experience: the amount of IT experience among the business executives and amount of business experience among the IT executives.
- Business knowledge may be divided into divisions depending on the line of business of the organization. E.g. in an insurance company business knowledge can be regarded as an aggregate of 1) experience in the insurance industry and 2) experience as a line supervisor or manager
- Each interviewees' education and work history is elicited and rated; examples:
    o High level – more than 10 years in line roles or more than two years in IT management
    o Moderate level – between 3-5 years in line roles or management of a large IT project
    o Low level – under five years in line roles or user level involvement in IT only)

Construct 4: Measuring IT implementation success
- Each interviewee is asked several questions about IT activities during the last two years, including, for example:
    o Name the major projects started in the past two years.
    o How successful were each of the major projects?
    o Overall, how well were the IT plans implemented?
- In addition, open questions are asked about the general IT history within the business unit and major IT decisions are discussed to determine whether they are characterized as successes or failures.
- Based on this data, the overall level of success in IT implementation is rated (high, moderate or low).

Third, IS strategic alignment assessment presented by Chan et al. (1997) deals with four dimensions: 1) Current Realized Business Unit Strategy, 2) Business Performance, 3) IS Effectiveness, and 4) Realized IS Strategy. The authors develop instruments for each of the dimensions, and examples of these are presented in Table 3. The assessment is carried out as a survey, and each of the dimensions is assessed by a different informant in companies.

Table 3. Examples of IS strategic alignment assessment metrics (from Chan, Huff ym. 1997).

Current Realized Business Unit Strategy - Aggressiveness: increasing market share even if it means reduced prices - Proactiveness: first to introduce new products and services - Innovativeness: creativity and experimentation are strengths
Business Performance - Market share gains, sales growth, revenue growth - ROI, cash flow, profitability - Satisfaction with new product or service development

IS Effectiveness - Satisfaction with IS staff and services, e.g. satisfaction with the time required for new systems development - Satisfaction with users' participation in systems projects - IS increase the efficiency of business operations - IS improve decision-making
Realized IS Strategy - Systems used in the business unit help introducing products and services - Systems used in the business unit help monitoring changes in the market share

Finally, Symons (2005) presents some practical quantitative examples of alignment measures. These measures deal with 1) meetings, 2) projects, and 3) budget (see Table 4). For instance, metrics related to meetings indicate that the more frequent the meetings are, the more conceivable is the improved alignment. In addition, the metrics related to projects indicate that in order to achieve alignment, projects should be traceable to strategic business goals. However, without a more explicit framework to guide the evaluation, these metrics should be implemented with caution.

Table 4. Example metrics for alignment (from Symons 2005)

Meetings - Number of IT steering committee meetings - Number of joint IT and business planning meetings - Percentage of IT budget allocated to new initiatives versus sustaining the business
Projects - Number or percentage of current projects that are directly linked to a strategic business goal - Number or percentage of projects in which the business unit provided the ROI or the business case as opposed to IT - Number or percentage of projects with post-implementation audits to determine if the business case or ROI targets were met
Budget - Percentage of IT budget for new initiatives

To conclude, various different approaches exist for evaluating alignment. What seems to differentiate these approaches from each other is that they have a slightly different focus on the issues to be evaluated. They also seem to provide metrics of different granularity compared to each other. Both Luftman (2000; 2003) and Reich & Benbasat (2000) provide a wide selection of evaluation metrics, ranging from soft issues (e.g. communication) to hard issues (e.g. business metrics or skills related metrics). The soft aspects, especially the communication point of view, seems to be missing from the examples provided by Chan et al. (1997) and Symons (2005). However, communication and common understanding is required between business and IT executives (Symons 2002; van der Raadt, Hoorn ym. 2005). Similarly, in her later research, Chan discovered that soft aspects, especially the informal organization structure, may also affect the alignment success (Chan 2002).

We share the viewpoint of Luftman (2000; 2003) and Reich & Benbasat (2000) that both soft and hard issues need to be considered in enabling the success of both alignment and EA work. Therefore, by a combination of both qualitative (soft) metrics and quantitative (hard) metrics, a most pertinent set of metrics for evaluating the extent of alignment can be achieved. It seems that the communication aspect, as one of the major soft issues in enabling both alignment and EA success, should be measured in alignment evaluations.

If alignment is regarded as one of the goals of EA work, the sample metrics presented in this section may provide some ideas for selecting or formulating the organization specific metrics to evaluate the extent of alignment in the EA context. Furthermore, the sample metrics represent the type of metrics that may be incorporated into the set of EA metrics in organization.

6 Conclusion

In this report, the concept of alignment was extensively discussed according to literature. Particularly, the various definitions, components, models, benefits and practical aspect of the concept were discussed. In addition, the concept was addressed in the EA domain, and approaches for its evaluation were described. To summarize the results, we draw the following conclusions:

- Majority of the definitions for alignment are vague: none depicts the full picture of the concept. According to literature, alignment is an evolutionary process, which needs to be maintained over time by planning, design, management, and evaluation activities on both strategic and tactical levels. It is affected by a great number of strategic, structural, social, cognitive, and evaluation-related factors. Furthermore, alignment may refer to the extent or amount of alignment, measurable with e.g. various maturity models.
- EA can be seen as the enabler of alignment: EA approach can be regarded as a bridge between business and IT, and improved alignment is usually one of the goals of EA work.
- Alignment evaluation can be seen as a part of evaluating the EA and its benefits. Especially, if improved alignment between business and IT is defined to be one of the goals of EA work, evaluation is needed to demonstrate whether the goal has been reached, and to what extent has the goal of alignment been reached. Examples of measures to evaluate alignment were presented to provide some ideas to define the organization-specific metrics for alignment.

Moreover, there seems to be a relationship between EA compliance and alignment. Hence, we suggest that the evaluation targets of alignment evaluation in the EA context are the same as the evaluation targets of EA compliance evaluation as described in Figure 7. This raises the question of whether the evaluators of alignment might be the same than the evaluators of EA compliance. Stakeholders that conduct or assist in conducting EA compliance evaluation are suggested to be those stakeholders who deal with or are in charge of the evaluation objects of EA compliance, such as business representative, project manager, CFO, or CIO (Ylimäki, Niemi ym. 2007). However, Jayashetty et al. (2004) claim that an organization needs to have a functional Architecture Review Board (or architecture governance board), which is responsible for evaluating alignment periodically. Still, both the evaluation targets and evaluators of alignment in the EA context remain to be clarified in further studies.

Further research is also needed to study how to successfully apply the existing metrics in defining organization specific metrics for business-IT alignment, or for an EA program in the cases where alignment is one of the major goals of EA work. Further research could also clarify the relationship between EA and alignment in more detail.

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UNIVERSITY OF JYVÄSKYLÄ
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TOWARDS CRITICAL SUCCESS FACTORS FOR ENTERPRISE ARCHITECTURE

AISA Project Report

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Author: Tanja Ylimäki	Status: Final

Summary

This report describes the work done in the first phase of the AISA project. The aim of this phase was to discuss what quality means in the context of Enterprise Architecture, to identify the potential critical success factors for Enterprise Architecture, and to prioritize the factors. In the report an example of prioritization is given.

EA can be seen as a collection of all those models necessary for managing and developing an organization. Generally EA can be considered to consist of interrelated architectures or architectural views, such as business architecture, information architecture, systems/application architecture and technology architecture.

META Group (META Group Inc. 2000) claims that "EA success will be driven by the extent to which corporate line managers comprehend, support, and enforce the architecture. EA efforts that are not successful in gaining line management support will fail, regardless of the architecture's design and engineering quality". Enterprise Architecture of good quality can simply be defined as the one that is used and brings value to the organization.

What are the factors that help gaining an EA of good quality, then? Critical success factors (CSF) are used e.g. in Total Quality Management, Business-IT Alignment, Project Management and Software Engineering to describe the things that must be done exceedingly well in order to succeed. Accordingly, in EA a CSF means the things that must be done exceedingly well in order to succeed in EA efforts, i.e. to develop and implement an EA that brings value to the organization.

Because there is a lack of studies on CSFs for EA, various related domains have been used to give support for defining the potential success factors for EA. Additionally a workshop was arranged for the representatives of the co-operating organizations to discuss, validate and prioritize the findings of the literature review. The following prioritization of the potential CSFs for EA indicates the most important issues in the initial steps of EA development:

- Communication & Common Language
- EA Model / Artifacts
- Commitment
- Business Driven Approach
- Organizational Culture
- Training / Education
- Scoping and Purpose
- Governance
- Assessment
- Development Methodology
- Tool Support
- Skilled Team
- Project Management

When all these factors are taken into consideration as the EA development advances, ate least to some extent, Enterprise Architecture enables – but not guarantees – the business to gain more success.

Contents

1 Introduction

This report is the result of the AISA Project's first phase in the first year. The aim of this phase was 1) to determine what quality means in the context of Enterprise Architecture (EA), 2) to identify the potential critical success factors (CSF) for EA, and 3) to prioritize the potential CSFs for EA. The phase consisted of the following steps (see the left-hand side of Figure 1):

1. Literature review of EA and related areas: Listing, consolidating and grouping the CSF issues → Potential CSFs for EA.
2. Workshop/focus group interview (Krueger and Casey 2000) → Review, discussion, validation and prioritization of the potential CSFs for EA.
3. Analysis and consolidation of the results of the workshop/focus group interview → Report on the CSFs for EA.

The CSFs for software architecture (right-hand side in Figure 1) are reported in a separate document.

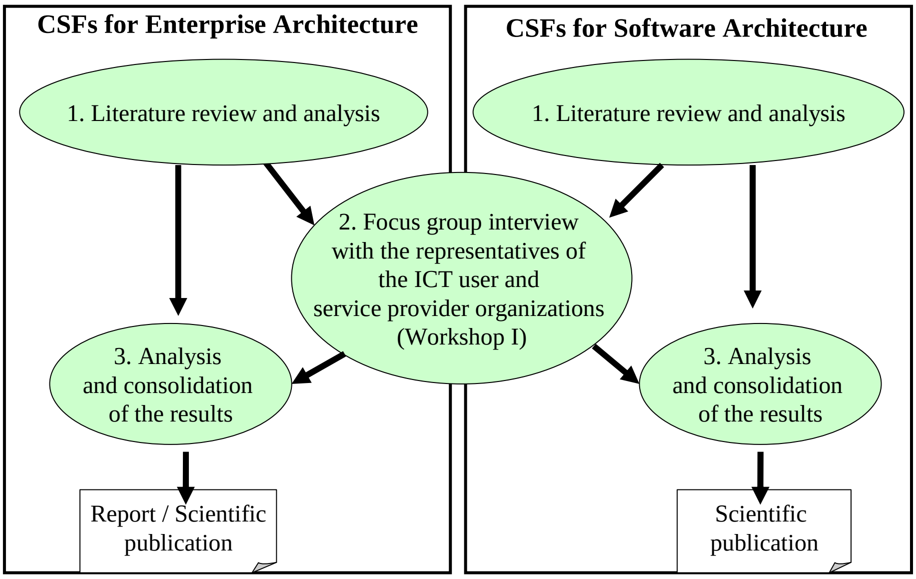

Figure 1. The steps of defining the critical success factors in the first phase of the AISA project.

CSFs are usually studied in the context of Total Quality Management (TQM) to describe the things that are needed in order to gain good quality (Badri, Davis et al. 1995; Claver, Tarí et al. 2003; Dale 2003). In Enterprise Architecture domain hardly any research exists on CSFs. Therefore, we needed to figure out how to find the potential CSFs for EA and how to define the most critical ones that enable an EA of good quality.

In addition to TQM domain, critical success factors have been studied in other domains closely related to Enterprise Architecture approach, such as Business Process Re-engineering, Business-IT Alignment, Project Management and Software Engineering. These several domains were studied to give support for deriving the potential critical success factors for EA (see Figure 2). In the first workshop of AISA project these potential CSFs were discussed and reviewed.

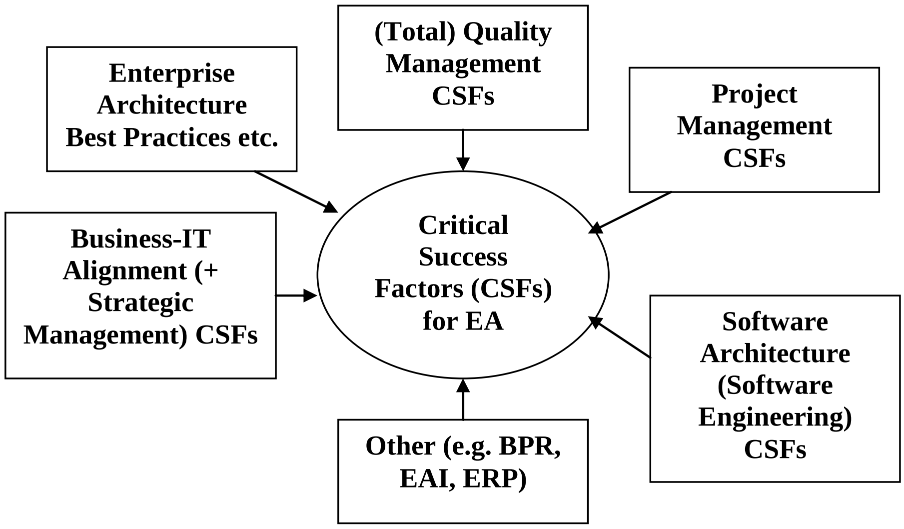

Figure 2. Critical Success Factors for Enterprise Architecture are derived from several related domains where critical success factors have been studied.

In the Appendix 1 there is a table showing a collection of relevant studies in Enterprise Architecture related domains that was used in addition to various EA references to develop a list of the potential CSFs for EA.

The remainder of this report is organized as follows. In the next section, we discuss the main concepts of enterprise, architecture, and Enterprise Architecture, as well as the concept of quality and what it means in the context of Enterprise Architecture, concluding with the definition of the concept of critical success factor. In the proceeding section, the set of potential critical success factors for EA is described, and the last section summarizes the report.

2 Background

In this section we describe the main concepts relating to Enterprise Architecture, quality and what quality means in the context of Enterprise Architecture. We conclude by defining the concept of critical success factor.

2.1 Enterprise, Architecture & Enterprise Architecture

To be able to define the concept of Enterprise Architecture, we first discuss briefly the concepts of enterprise and architecture separately (See (Ylimäki, Halttunen et al. 2005) for more information).

A rather simple view of an ***enterprise*** is “a group of people organized for a particular purpose to produce a product or provide a service” (O'Rourke, Fishman et al. 2003). Enterprise can be seen analytically as consisting of the components people, organizational structures, processes, corporate culture, strategies tasks, the information adherent to these and technologies (Rood 1994). Enterprise can be seen also more synthetically (The Open Group 2002):

”... "enterprise" in this context is any collection of organizations that has a common set of goals and/or a single bottom line. In that sense, an enterprise can be a government agency, a whole corporation, a division of a corporation, a single department, or a chain of geographically distant organizations linked together by common ownership.”

Architecture can be defined generally as “the design of any type of structure whether physical or conceptual, real or virtual” (O'Rourke, Fishman et al. 2003). A more precise definition of architecture given in the recommended practice (IEEE 2000):

“The fundamental organization of a system, embodied in its components, their relationships to each other and the environment, and the principles governing its design and evolution.”

Besides these rather static definitions of architecture, it can be understood more functionally to gain an understanding what activities are associated with architecture:

- Architectures are described with different models for different viewpoints, layers or dimensions of the architecture to lay out different aspects of the system or enterprise for analysis and planning of designs, evaluation of them, and documentation of the implemented constructs (Zachman 1987; Spewak and Hill 2000; The Open Group 2002).

- Architecture descriptions are used for further specification, design and development work on systems that are within the architecture or adjoin it over an interface. Architecture descriptions are in the case of enterprise architecture very probably created by different roles and different people than those who use them for this further work.

Enterprise Architecture (EA) can be seen as a collection of all those models necessary for managing and developing an organization (Halttunen 2002). It is vital that Enterprise Architecture is derived from the visions and business strategies of an organization. Only then the enterprise architecture enables the organization to achieve its business goals (Armour, Kaisler et al. 1999a).

Lately the concept of Enterprise Architecture has been defined as follows (Kaisler, Armour et al. 2005):

Enterprise Architecture "identifies the main components of the organization, its information systems, the ways in which these components work together in order to achieve defined business objectives, and the way in which the information systems support the business processes of the organization. The components include staff, business processes, technology, information, financial and other resources, etc. Enterprise architecting is the set of processes, tools, and structures necessary to implement an enterprise-wide coherent and consistent IT architecture for supporting the enterprise's business operations. It takes a holistic view of the enterprise's IT resources rather than an application-by-application view."

Generally Enterprise Architecture can be considered to consist of interrelated architectures or architectural views (FEAF 1999; The Open Group 2002). These views can comprise e.g. business architecture, information architecture, systems/application architecture and technology architecture (see Figure 3). ***Business architecture*** models e.g. the business processes (and possibly deals with re-engineering of those processes), ***information architecture*** is a high-level model of information needed in performing the organization's processes (Halttunen 2002), and ***systems/applications architecture*** refers to the integrated structural design of a system its elements and their relationships depending on given system requirements (Bernus, Mertins et al. 1998). Within the systems architecture single software is described through the ***software architecture***. Software architecture (Bass, Clements et al. 1998) of a program or computing system is the structure(s) of the system, which comprise software components, the externally visible properties of those components, and the relationships among them. Finally, ***technology architecture/infrastructure*** can be seen as a design of how the information system is implemented using diversified technologies.

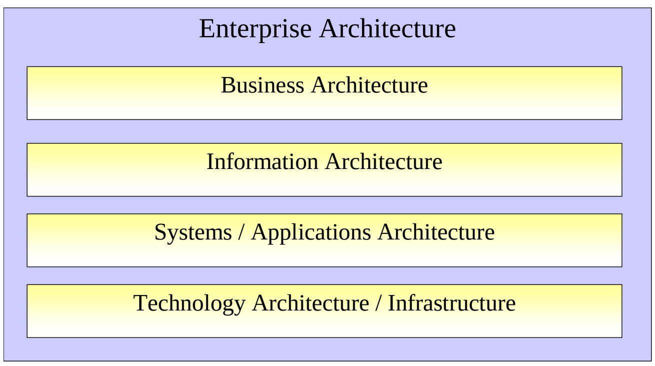

Figure 3. Enterprise Architecture comprises several architectures of different levels.

2.2 Success and Quality of Enterprise Architecture

In this section we will briefly discuss the concepts of successful Enterprise Architecture and quality in the context of Enterprise Architecture.

Successful Enterprise Architecture

META Group (META Group Inc. 2000) has claimed that "EA success will be driven by the extent to which corporate line managers comprehend, support, and enforce the architecture. EA efforts that are not successful in gaining line management support will fail, regardless of the architecture's design and engineering quality." 15% of all architecture efforts will fail due to misalignment between the maturity and readiness of the architecture effort within the IT organization and the business (META Group Inc. 2000). Moreover, the architecture effort's success is only measurable by the degree to which it contributes to the business' success (Rehkopf and Wybolt 2003). Successful Enterprise Architecture is one that is understood, accepted and used in every day business functions. The success needs to be measured in order to ensure that results are achieved.

Quality of Enterprise Architecture

There seems to be very few studies where the quality of EA has been discussed. Therefore, in this report we aim at a preliminary definition on quality of EA, based on studies in EA and related domains (see the domains in Figure 2).

Generally, quality (of a product, service, etc.) has for example the following characteristics (Lecklin 2002; Dale 2003):

- conformance to agreed and fully understood requirements
- fitness for purpose or use
- satisfying customer expectations and understanding their needs and future requirements in a cost-effective way.

If these ideas are applied to Enterprise Architecture domain, we could suggest that an Enterprise Architecture has a good quality if it

- conforms to the agreed and fully understood business requirements,
- fits for the purpose, which is to gain business value through EA, and/or
- satisfies the different stakeholders' (e.g. the top management, IT management, architects, developers) expectations in a cost-effective way and understands their current needs as well as the future requirements.

There are also other views, such as:

- In the context of computer systems (Braa and Øgrim 1994) say that "when a computer system is well adapted to the organization, it can be said to be of high organizational quality". If this same idea is transferred to Enterprise Architecture domain, we could suggest that when Enterprise Architecture is well adapted to the organization, it can be said to be of high organizational quality.

- Enterprise Architecture quality refers to the high maturity of Enterprise Architecture (Department of Commerce (USA) 2003; Government Accountability Office (GAO) 2003; National Association of State Chief Information Officers (NASCIO) 2003). The different maturity models can be regarded as tools that enable gaining good quality.

- Enterprise Architecture of good quality is the one that brings value to the organization. There are two things to remember about value: 1) Value does not unfold naturally from building an EA, it requires a systematic analysis, a lot of business thinking and political orchestration to succeed (Boster, Liu et al. 2000). 2) Value actually "involves two interacting concepts: financial efficiency and business effectiveness. Financial efficiency results from reducing costs or enhancing the financial yield from investments. Business effectiveness results when the company increases its market share, beats competitors, improves quality or cements a tighter relationship with customers." (Buchanan and Soley 2003)

Consolidating the ideas presented above we could suggest an alternative definition of the ***Enterprise Architecture of good quality***: it is the one that is understood, accepted and used in every day business functions; and the EA is measured in order to ensure that the quality requirements are met. In the AISA workshop it was suggested that the quality of EA could be measured e.g. to the extent it supports 1) the information system development projects, 2) the top management's business decisions, and 3) ICT enhancement in the organization from the CIO's point of view.

The different views to EA quality presented above implicitly imply that the quality of EA is more than merely the quality of the implemented EA indicating that it is successfully used. The quality of EA may also refer to e.g. the quality of EA documentation, the quality of the EA development process, and/or the quality of EA governance (process).

2.3 Critical Success Factors

Critical success factor (CSF) is a common concept used e.g. in the context of total quality management, software engineering or project management (see references in the Appendix 1). Various definitions exist for critical success factor:

1. "An element that contributes to the success of a project, without which the project will fail." (it.csumb.edu/departments/data/glossary.html)

2. "One of a few organisational activities that, if done well, should result in the strategic success of an organization." (www.engmanage.co.za/terms_strategy.htm)

3. "The things that must be done exceedingly well to really succeed." (www.otte.vic.gov.au/publications/benchmark/resources/docs_what/what02_glossary.htm)

4. "The limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organization'. They are the few key areas where 'things must go right' for the business to flourish. As a result, the CSFs are areas of activity that should receive constant and careful attention form management. The current status of performance in each area should be continually measured, and that information should be made widely available." (Ward and Peppard 2002)

5. A limited number of factors the business success of failure depends on. CSFs are the things that have to fall into place in order to reach the business objectives. (Lecklin 2002)

However the CSF is being defined, it is important to notice that 'critical' factors should be differentiated from 'important' factors (Ward and Peppard 2002). Generally CSFs are also both time sensitive and time dependent, so they should be re-examined as often as necessary to keep abreast of the current business climate (McNurlin and Sprague 2002). Furthermore, a CSF usually consists of more than one key indicators or statements concerning characteristics within a CSF.

Based on the different definitions given above we can say that ***critical success factors for Enterprise Architecture*** are those things that have to be done exceedingly well in order to gain a high quality Enterprise Architecture which in turn enables the business to reach its business objectives and gain more value. However, EA is not the silver bullet, and the EA success does not happen over night. As (Boster, Liu et al. 2000) put it: "The development of an EA is often perceived with great expectations of benefits and value. Unfortunately, reality can be cold and hard… The EA effort merely helps the organization analyze IT costs and understand IT problems. It provides an opportunity to get more value from the architecture, but realizing that value takes time and a long-term strategic process."

3 Potential Critical Success Factors for EA

In this section we present the results of the literature review and the workshop, where the potential critical success factors for EA were reviewed and discussed.

Potential critical success factors for EA based on the literature review are related to the topics depicted in the Figure 4.

Figure 4. Potential critical success factors for EA.

The potential success factors were discussed in the first workshop of AISA project in September 15th, 2005 in order to review, discuss and gather perceptions about them. Discussion was guided by questions like: Do the practitioners think the potential CSFs are valid in their work? Are all issues taken into consideration? Can the CSFs be prioritized? In addition to these general level questions, each factor was discussed separately. In the Appendix 2 the main discussion topics are listed.

Prioritization of the CSFs was done with the help of an evaluation form which each participant filled in the workshop (see Appendix 3). In Table 1 the outcome of the prioritization is presented. Communication, common language, commitment and EA model/artifacts were regarded the most critical factors (average over 2.5). Development methodology, tool support, team work and project management were regarded as the least critical factors (average less than 2.0). It was also suggested that project management should not be on the list at all.

Table 1. Critical success factors for Enterprise Architecture prioritized.

Potential CSF	**Avg.**
Communication	2,8
EA Model / Artifacts	2,8
Commitment	2,8
Common Language	2,6
Business Driven Approach	2,4
Organizational Culture	2,4
Training / Education	2,4
Scoping and Purpose	2,3
Governance	2,2
Assessment	2,0
Development Methodology	1,8
Tool Support	1,8
Skilled Team	1,8
Project Management	1,6

Scale: 1,0 = not at all critical
2,0 = somewhat critical
3,0 = very critical

In the following each CSF is discussed in more detail. At this point no factors are dropped out.

3.1 Communication & Common Language

"Communicating what an EA is and how it will benefit the organization is paramount to its success." (META Group Inc. 2000)

In order to share knowledge, to achieve a common understanding, agreement and a shared view of the EA scope, vision, objectives, developed models and other artifacts, and to gain commitment to the EA effort, it is vitally important to ***communicate with all the stakeholders*** (Bredemeyer Consulting 2000; Luftman 2000; Rehkopf and Wybolt 2003; The Office of Enterprise Technology Strategies 2003; Industry Advisory Council 2005; Lankhorst 2005).

In the AISA workshop it came up that because EA deals with large and diversified issues, and it is usually divided into smaller pieces conducted by several projects, there is a need to communicate between these projects in order to rationalize the project work, to help work distribution and to increase co-operation.

Furthermore, communication should be proactive, i.e. everyone should be told in advance what is happening, including e.g. the scope, objectives and activities of the project (Sumner 1999; Nah, Lau et al. 2001).

How to support communication, then? First, a common language is a must; there is a need to adopt or develop ***a common, well-defined vocabulary of terms and concepts*** used (Hilliard, Kurland et al. 1996; Jonkers, Lankhorst et al. 2004; Lankhorst 2005; Motwani, Prasad et al. 2005; Ylimäki and Halttunen 2005). Ideally, because there are also business people (that may not be so technically oriented) involved in EA project, the language used should be understandable by them (Boster, Liu et al. 2000). On the other hand, the architecture team, and especially the enterprise architect (or the chief architect) should be able to use the language the audience can comprehend (Ylimäki and Halttunen 2005). Hence, ***enterprise architect can be seen as an interpreter*** between the various stakeholder groups analyzing and combining their views and opinions – that may even be contradictory – into commonly acceptable and agreeable format. To some extent it is also rational that ICT people (CIO, architects, developers etc.) understand the firm's business environment and are ***able to communicate in business terms*** (Luftman, Papp et al. 1999; Teo and Ang 1999; D'Souza and Mukherjee 2004).

In the AISA workshop it was suggested that in addition to definition of the basic architectural terms and concepts, other common concepts for all stakeholders may include e.g. concepts of the (system) development methodology, and concepts related to the development and investment processes of the enterprise to enable a broader view to the issue.

Second, ***various channels and means of communication*** should be utilized to enable the stakeholders to get the information needed (Rudawitz 2003). Examples of these are the following:

- personal communication, e.g. meetings, forums, teleconferences,
- electronic communication, e.g. video, audio, website, and
- "hardcopy" communication, e.g. message carrier and/or thought provoker.

It should be noticed that different stakeholder groups may require different channels and media in order to be reached. "An Architecture Portal" is one possible channel for distributing the EA information (Rehkopf and Wybolt 2003). This website should include architecture information e.g. about processes, practices, standards, metrics, engineering models, training, checklists/forms, and governance. Usually various descriptions (graphical or textual) are the most important means of communications (Department of Commerce (USA) 2003; Lankhorst 2005). These are discussed in more detail in the EA model section.

Third, there is the ***time aspect of communication***. Communication should be regular and frequent, there should be channels for feedback, and it should be regarded as an ongoing process (Porter and Parker 1993; Al-Mashari and Zairi 1999). Successful communication needs to be focused and timing is of crucial importance (Clarke 1999). This encourages team work, increases motivation and ensures the involvement of all key players (Clarke 1999).

Communication policies, channels, principles etc. need to be defined in a ***communications plan*** or in a ***communications strategy*** (META Group Inc. 2000; Coronado and Antony 2002; Rehkopf and Wybolt 2003; Industry Advisory Council 2005).

3.2 Commitment

"A motivated management team is the primary key to architecture success."
(META Group Inc. 2000)

Top management leadership, sponsorship, involvement and ***commitment*** are critical success factors that are mentioned almost in all papers and studies both in the EA domain as well as in the related domains (see the table in the Appendix 1). Furthermore, commitment must be long-term (Ashmore, Henson et al. 2004; D'Souza and Mukherjee 2004; van der Raadt, Soetendal et al. 2004) and strong leadership motivates employees to participate (Porter and Parker 1993). In the AISA workshop it came up, that even though the top management commitment has existed on the conversational level already for a long time, it has not yet become very concrete or put into action.

In addition to the top management commitment ***organizational buy-in*** is also needed. Obtaining EA support from within an organization requires buy-in from stakeholders that represent all of the various business and technical components (Bredemeyer Consulting 2000; Belout and Gauvreau 2004; Industry Advisory Council 2005; OMB FEA Program Management Office 2005). In order to get this acceptance the EA must be made attractive to the customers (e.g. developers and business stakeholders); they must perceive that EA efforts add value and aid them in their jobs (Ambler 2005). Also identification and utilization of a ***thought leader*** of the organization (Sumner 1999; Industry Advisory Council 2005) or a project champion (Somers and Nelson 2001) to facilitate and market the approach to stakeholders may help getting the acceptance. (Rehkopf and Wybolt 2003) puts it this way:

"Do not crash the party when you're not invited. Seek the "willing victims" of the organization who perceive hints of value in the discipline of architecture. These partners of the architecture group become a very credible sales force when they communicate the benefits and results of the architecture partnership to their peers."

Furthermore, ***politics*** has an important role in the acceptance of architecture (The Open Group 2002) and in the success of an IT project (Belassi & Tukel 1996). In the AISA workshop it was brought up that, especially, silo thinking and strict profit responsibilities may be barriers to EA success, if each department in an organization acts on a stand alone basis, not interacting or co-operating with other departments, focusing only to the departmental bottom line. Also the role of architecture has impact on the commitment: in the first place EA should be seen as ***a mentor and a guide*** helping business and ICT decision making, not only as an auditing or controlling mechanism. In addition to these, EA is also an important communication tool within the organization.

3.3 Scoping and Purpose

"If there is a clear strategic vision for the enterprise, it seems logical to have an equally broad vision for the systems that support that strategy."
(Armour, Kaisler et al. 1999a)

Before starting to design an EA, the ***mission – goals and direction*** – should be made clear (Pinto and Mantel 1990; Belout and Gauvreau 2004; Turner and Müller 2005); what the objectives of the organization are (Somers and Nelson 2001), why it wants to apply the EA approach (finding a business case), what the existing problem is that it wants to solve through EA (Bredemeyer Consulting 2000). In the AISA workshop it was suggested that someone should be responsible for the ***mission statement*** or the ***"declaration of will"*** indicating what the organization really wants. Furthermore, EA should also be prepared to the future problems encountered in the organization. Quarter based economy impedes the long-term thinking that EA requires; it is sometimes difficult to justify the top management that the investment that seems expensive at the moment will save money in the future.

The next thing to do is to get everyone on the same wavelength, to ***get everyone to share the same architectural vision***. Management, developers, designers, as well as other stakeholders must all have realistic expectations about the project (Reel 1999; Armour and Kaisler 2001).

The EA (project) scope should be clearly defined (Clarke 1999; Lam 2005). Scoping relates to the questions of how wide organizationally, how deep and detailed, and how fast an EA should be developed (Industry Advisory Council 2005). In the literature there is a lot of advice given about scoping. Most of them relate to the following issues:

- ***Continuous improvement approach***. Start small and grow the EA slowly (Kaisler, Armour et al. 2005). Always start with the doable and the critical. Adjust the breath or depth of your architectural effort so you can produce concrete results in six months. (Armour, Kaisler et al. 1999b). In order to be able to do this the organization needs to understand what is important to the business (Ramsay 2004).

- ***Prioritize*** (Ramsay 2004), ***break large projects down into sub-projects*** or work packages ("bite sized chunks") (Clarke 1999), and think long term (Ramsay 2004). In the AISA workshop it came up that scoping may be a painful task to do. Sometimes the topic may be almost too large and complicated to encompass and therefore breaking it into manageable pieces is an uneasy job, especially, if there is not enough time available to think over and discuss this issue.

Finally, the EA should definitely be ***holistic*** in scope (Lankhorst 2005) and be ***specific to the enterprise*** (Ashmore, Henson et al. 2004). It should take into account all aspects of the enterprise, such as business, information, applications, technology, standards and policies (META Group Inc. 2000; The Office of Enterprise Technology Strategies 2003; Schekkerman 2004).

3.4 Business Driven Approach

"Developing enterprise architectures without first determining strategic business requirements is a sure recipe for failure"
(Perkins 2003)

Business linkage is elementary in developing an Enterprise Architecture (META Group Inc. 2000; Department of Commerce (USA) 2003; The Office of Enterprise Technology Strategies 2003; Carbone 2004; Ramsay 2004; The MITRE Corporation 2004; Baker and Janiszewski 2005). Furthermore, it is also suggested that EA should be build around business processes (Harmon 2004). Business driven approach is about defining the ***business requirements*** and ensuring that they are also met. In other words there should be ***clear alignment between business and IT*** (Henderson and Venkatraman 1993; Al-Mashari and Zairi 1999; Van Eck, Blanken et al. 2004; Lam 2005). Enterprise Architecture "must address the need to directly align business and technology drivers in a way that is comprehensible and transparent to all key stakeholders, with a continued process of tracing enterprise architecture initiatives to the business strategy" (Schekkerman 2004).

In the AISA workshop it was brought up that in addition to business requirements also the ***requirements set by external stakeholders*** should be taken into consideration. External requirements are set e.g. by legislation, standards, even by the business owners and partners. Furthermore, the architectural vision was discussed. It was acknowledged that a strong architectural vision is needed, but the vision can be the one kept within the architecture team only. This vision should, nevertheless, be compatible with the business objectives and business vision and strategies. When budgets, time tables and other resources as well as the boundaries set by the business are taken into account, a realistic objective or the vision that can be realized is reached.

3.5 Development Methodology

"The key to EA success is not the final product, but the process an organization follows to create it."
(META Group Inc. 2000)

In the literature a lot of requirements for methods to develop and maintain EA in the ever changing business environment are presented. Whether you create a method of your own or use existing ones, the following issues should be kept in mind. First of all they should be ***structured, well-defined and documented*** including e.g. processes, guidelines, best practices, drawing standards and other means to promote quality of the architectures as well as support for tracking architectural decisions and changes (Lankhorst et al., 2005).

Definition of architecture and guiding principles are also suggested. Architecture principles are simple, direct statements of how an organization wants to use IT. They establish a context for architecture design decisions by translating business criteria into language and specifications that technology managers can understand and use; they put boundaries around decisions about system architecture (Armour, Kaisler et al. 1999a). Guiding principles are critical to any architecture framework; they provide consistent, shared vision for developing new architectures; and they are used to ensure that development initiatives are in line with the enterprise's overall strategic goals (Armour, Kaisler et al. 1999a)

It is suggested that an ***successful architecture process*** is top-down and/or bottom-up, business-strategic-driven, customer-focused, practice-oriented, situational, model-based, disciplined, rigorous, repeatable, future-oriented, and widely usable with reasonable costs (Perkins 2003; Morganwalp and Sage 2004; van der Raadt, Soetendal et al. 2004), as well as iterative and incremental (Armour, Kaisler et al. 1999a; Bredemeyer Consulting 2000; Ramsay 2004; Ambler 2005). It should also provide means to visualize precisely the relevant aspects for a particular group of stakeholders (Lankhorst et al., 2005).

Furthermore ***reuse of principles, processes and artifacts*** etc. should also be considered (Kaisler, Armour et al. 2005).Usually modification to existing methods are needed in order to better fit for your company environment. It is also suggested that the development iterations should be kept short; e.g. 6-12 months at most if possible (Armour and Kaisler 2001), because the EA must have immediate significant impact on the organization within the first six months of its completion (Ashmore et al. 2004). However, in the organizations that are just about to begin the EA approach it takes more time to gain the common understanding and agreement before taking any actual steps of development.

In addition to the methods, ***enterprise architecture frameworks*** are suggested to be applied or used as a baseline for developing a custom framework (OMB FEA Program Management Office 2005). A framework can be seen as a structure which defines the scope, the set of outputs and possibly the methods to create the outputs for EA (National Association of State Chief Information Officers (NASCIO) 2003; Carbone 2004). For example the Zachman framework is a two-dimensional logical structure for classifying and organizing the descriptive representations of an enterprise that are significant to the management of the enterprise as well as to the development of the enterprise's systems, but it does not include any kind of method (process) to create the representations (Zachman 1987). The different frameworks are used e.g. for the purpose of categorization and to communicate the EA descriptions or other output from the development process. In the AISA workshop it was stated that an organization has to develop a framework of its own – possibly based on an existing framework – because it is strongly related to the organization's culture and ways of doing things. It might be too difficult to gain agreement and commitment within an organization when trying to adopt an existing framework as such. Another point of view was that because EA field is still somewhat immature, there are still very few best practices available, or they are not regarded or identified as good references e.g. due to busy project schedules.

Several different methods (processes) and frameworks for Enterprise Architecture are briefly described e.g. in (Ylimäki, Halttunen et al. 2005).

3.6 EA Model & Artifacts

"By keeping your enterprise architecture artifacts simple you increase the chances that your audience will understand them, that project teams will actually read them, and that you will be able to keep them up to date over time."
(Ambler 2005)

The development method used guides the creation of Enterprise Architecture artifacts. As the models (descriptions, graphics etc.) are a valuable help in communicating the architecture to the various stakeholder groups, it is important that ***all the necessary levels or views of the architecture are modeled***; e.g. business view, information view, application view and technical view. Other views are also possible depending on the framework and methodology used as well as the needs of the organization. These views should focus on the concerns of each stakeholder groups leaving out all the information that is unnecessary (Lankhorst 2005).

Furthermore, the models should address both the ***current situation*** (as-is descriptions), ***future situation*** (to-be descriptions) and the ***transition plan*** telling how (and when) to get to the target architecture (Armour, Kaisler et al. 1999a; Industry Advisory Council 2005; OMB FEA Program Management Office 2005). Essential in creating these different views is that they are ***coherent*** and give ***a concise picture of the enterprise*** (National Association of State Chief Information Officers (NASCIO) 2003; van der Raadt, Soetendal et al. 2004; Kaisler, Armour et al. 2005; Lankhorst 2005), and provide guidance to application developers, IT managers, and end-users that need to plan, budget, implement and use IT (National Association of State Chief Information Officers (NASCIO) 2003).

Other ***requirements for EA models and descriptions*** are as follows:

- Must meet the business requirements (van der Raadt, Soetendal et al. 2004)
- Traceability between the business requirements and models (Armour, Kaisler et al. 1999b), as well as between the business requirements and architectural decisions (Erder and Pureur 2003)
- Conformance to the principles and standards (Armour, Kaisler et al. 1999b; van der Raadt, Soetendal et al. 2004)
- Modifiable and flexible in reacting to changes (National Association of State Chief Information Officers (NASCIO) 2003)
- Well documented, current and available for use by stakeholders (Hilliard, Kurland et al. 1996; Baker and Janiszewski 2005) providing for easy access – e.g. web-enabled, easy to view, with traverse and query functionality (National Association of State Chief Information Officers (NASCIO) 2003)
- Efficient and complete (Bernus 2003):
    - "An enterprise model is efficient if it conveys the intended meaning concisely between the parties producing or using the model."

  - "An enterprise model is complete relative to a process using it if the resources performing the process can create (and behave according to) the intended interpretation of the model for the use of the process"
- Clear, readable, comprehensible and including dependencies (Bredemeyer Consulting 2000; The MITRE Corporation 2004; van der Raadt, Soetendal et al. 2004)
- Verified ("is the model correctly built?") and validated ("does the model correspond accurately to the reality, does it take into account the needs and context"?) (Chapurlat, Kamsu-Foguem et al. 2003; Industry Advisory Council 2005).

The list of requirements for successful descriptions and other artifacts seems to be exhausting. However, in practice the models and documents do not need to be 100 % perfect, they just need to be good enough (Ambler 2005), and ***simplification, clarification and minimization are key to long-term architecture success*** (Dikel, Kane et al. 1995). In the AISA workshop it was suggested that because everything cannot possibly be documented, it is more important that the architect explains the models and artifacts to stakeholders. In addition, it is useful to define who to contact when more information is needed, i.e. the ownership of models and other artifacts should be clear.

3.7 Tool Support

Usage of a ***set of tools that work together*** and enable successful enterprise modeling language adoption, visualization and analysis of architectures as well as maintenance of the EA is recommended e.g. by (Perkins 2003; Kaisler, Armour et al. 2005; Lam 2005; Lankhorst 2005). Tools are also a valuable help in communicating the architecture to the different stakeholder groups (Baker and Janiszewski 2005).

In the AISA project it was brought up that tools used for EA modeling should be compatible both with the tools used for business process modeling and analysis and with the tools used for system/software development in order to decrease the need to do the models all over again when moving to the single system development phase.

A proper EA tool should have e.g. the following features (Menefee and Rudawitz 2003; Lankhorst 2005):

- Modeling technology: the tool provides a framework within which the EA information itself is modeled and maintained.
- Artifact repository built on database technology.
- Unrestricted ability to link EA information, artifacts and concepts in the EA.
- Simple ability to update, add, replace, and change the EA information.
- Ability to produce a web accessible result to the enterprise (web publishing).
- Provide both graphical and textual data.
- Support intuitive graphical navigation paradigm.

More information about the EA tools can be found e.g. in (Ylimäki, Halttunen et al. 2005).

3.8 Governance

"Architectural governance is a key element to ensuring that the EA vision is maintained across the enterprise".
(Baker and Janiszewski 2005)

Governance and management are terms that have various definitions in the literature. In general, governance deals with the management and organizational aspects of architecture (van der Raadt, Hoorn et al. 2005). It can also refer to "how an organization makes decisions, sets priorities, allocates resources, designates accountability, and manages its architectural processes" (Baker and Janiszewski 2005). However, the term itself is defined, the organization needs to identify and define its governance activities (COBIT 2000; van der Raadt, Hoorn et al. 2005).

Established governance structure is identified as a critical factor in literature (META Group Inc. 2000; The Office of Enterprise Technology Strategies 2003; Carbone 2004; Industry Advisory Council 2005). Effective governance process – i.e. the one that is defined, established, repeatable and auditable – enables e.g. better IT decisions, keeps IT and business accountable for linking technology to business objectives (Rehkopf and Wybolt 2003).

Critical elements in EA governance are e.g. the following (The Open Group 2002; Curran 2005; van der Raadt, Hoorn et al. 2005):

- selling the idea to gain broad acceptance to the governance plans
- setting the right metrics to measure the effectiveness of EA (e.g. EA governance metrics, EA compliance metrics, business alignment metrics)
- establishing the right organizational roles, responsibilities and authorizations
- establishing processes and communication and coordination means, such as feedback, discussion and reports of progress, and coordination committees.

The governance team can be organized in several ways. One possibility is to set up an architecture (review) board to facilitate the governance activities – e.g. ensuring that the implementation of the Enterprise Architecture is conducted in conformance to the transition strategy (The Open Group 2002; Leganza 2003). ***Architecture policies, principles and architecture compliance strategy*** guide the work of the architecture governance team (The Open Group 2002; van der Raadt, Hoorn et al. 2005). The need for an ***"EA statute book"*** guiding the EA was also acknowledged in the AISA workshop.

In addition, effective ***change management environment*** is needed (Bolton 2004; Kaisler, Armour et al. 2005) where the assessment of the impact of changes is done beforehand and the evolution of architectures is carefully planned (Lankhorst et al., 2005), see also (Al-Mashari and Zairi 1999; Nah, Lau et al. 2001; Somers and Nelson 2001; Kaisler, Armour et al. 2005; Motwani, Prasad et al. 2005; Motwani, Subramanian et al. 2005). In the AISA workshop it was pointed out that all possible changes in the future cannot be considered, it would only result in a solution that is too complicated. A decision has to be made about the possible changes in the business environment (e.g. a future merger) or in the business requirements that are taken into account in the architecture design. Moreover, it is important that the governance team has the ability to handle unexpected crises through effective ***risk management*** (Pinto and Mantel 1990; Al-Mashari and Zairi 1999; Belout and Gauvreau 2004).

Finally, governance activities should be integrated into the enterprise governance process and leadership behaviours and structures as a continuous program that invites participation across the enterprise (COBIT 2000; Ashmore, Henson et al. 2004).

3.9 Measuring the EA Success

"Implementing and using architecture metrics proactively provides the basis for demonstrating the value of your EA."
(Baker and Janiszewski 2005)

Measurement, assessment and/or evaluation of Enterprise Architecture are undertaken as a part of the EA governance. Essential questions relating to the measurement are 1) ***what*** is measured, assessed or evaluated, and ***why*** 2) and ***how*** the work is done, ***what metrics*** should be used and ***when*** the measurement activities should be conducted. Measurement and evaluation should be a ***continuous process*** (Claver, Tarí et al. 2003; Dale 2003; National Association of State Chief Information Officers (NASCIO) 2003) conducted e.g. during each step of the (development) process (Bredemeyer Consulting 2000).

What should be measured, assessed or evaluated then? In the following some examples are suggested (Hilliard, Kurland et al. 1996; National Association of State Chief Information Officers (NASCIO) 2003; Morganwalp and Sage 2004; Curran 2005; Industry Advisory Council 2005; Saleh and Alshawi 2005):

- EA descriptions/documentation
- EA processes,
- EA maturity,
- Value of EA, business value added by EA (business-IT alignment)
- Effectiveness of EA
- Completeness and correctness of EA
- EA adoption
- People (competency and skills)
- Work environment (culture, leadership, structure).

There are ***no established metrics available*** for evaluation or assessing EA. It is, however, recommended that the metrics should be developed as early as possible in the development process (Industry Advisory Council 2005) and the measurement should be proactive (Baker and Janiszewski 2005). In quality management domain it is suggested that procedures and expectations for high quality are established before any other development begins and progress is tracked and a "post-mortem analysis" is conducted to enable learning from mistakes (Reel 1999). These ideas can be adopted in EA assessment as well.

In the following ***some examples for metric categories*** are presented (Luftman 2000; Industry Advisory Council 2005):

- Business metrics combined with IT metrics
- EA program impact metrics
- EA and EA program maturity measurement
- Quality metrics
- Usage of the EA by the business units of the organization.

For example, META Group's Enterprise Architecture Program Maturity Assessment helps organization in the first place to identify the things that are stopping it from being as effective as it can be, i.e. the critical constraints (META Group Inc. 2004). ***Different tools can be used*** for evaluation and assessment of EA, such as benchmarking, reviews, quality function deployment, and maturity models (Luftman 2000; Dale 2003; Erder and Pureur 2003; Schekkerman 2003; Industry Advisory Council 2005).

In the AISA workshop the following perceptions on the EA measurement were brought up:

- Scenarios could be one possible way to evaluate EA.
- One metrics could be the number of system environments used within an organization. EA should actively strive for decreasing the number of environments or systems in the long haul instead of building new systems only. One implication of this can also be the decreased overlap in systems.
- Another possibility is to analyze the support the (system development) project group received from EA.
- One problem in evaluating e.g. an architectural decision is the fact that the effects and consequences may not be seen beforehand or right after the decision has been made, but it may take years before the implications can be measured.

In the later phases of the AISA project metrics and tools for EA measurement and evaluation will be studied in more detail.

3.10 Skilled Team

Enterprise Architecture development requires ***teamwork*** between representatives from all key stakeholder groups; business domains, senior management, business partners, customers (Schekkerman 2004). Key stakeholder groups may vary from one line of business to another. For example in the paper industry, presence of the production equipment developers may be required. Many requirements have been set for the team, e.g. the team must understand the importance of strategic information, be capable of analyzing and documenting the business requirements in business language, must be dedicated to the project, must have sufficient resources, must practice effective project management, must be skilled and experienced (Perkins 2003). In order to have a team full of proficient people experienced external consultants can be hired or internal staff can be trained (Al-Mashari and Zairi 1999; Sumner 1999; Perkins 2003). Additionally, the need for a ***chief architect*** has been acknowledged (Akella and Barlow 2004; Passori and Schafer 2004). He/she should have (a strong) business perspective or ***business skills*** in addition to technical knowledge (Boster, Liu et al. 2000). Business skills are seen important also for other team members (Al-Mashari and Zairi 1999; Bredemeyer Consulting 2000; Nah, Lau et al. 2001). An architect needs to be able to work in ***various roles*** as follows (Rehkopf and Wybolt 2003):

- ***Visionary***: envisioning what is possible and creating the future state, along with transition plans to get there
- ***Translator***: matching the business objectives and business needs to technology and vice versa
- ***Engineer/system designer***: creates specific instances of the architecture
- ***Auditor***: ensuring the compliance with current and future architecture and the overall integrity of the system
- ***Consultant***: consulting and educating on the use of the architecture, advising and coaching on system and infrastructure design and implementation.

In the AISA workshop the following skills were also regarded as important for an architect:

- ***Be able to criticize*** even his/her own thoughts, be able to identify both strengths and weaknesses in his/her own suggestions for solutions, as well as to identify the assumptions he/she has made.
- ***Be capable of abstract thinking***, conceptualizing and finding the most relevant issues. Architect acts as a funnel that filters the most essential facts from the large information pool.
- ***Has the courage to question things***, to bring up different point of views, to ask if he/she does not understand something and to discuss and debate with different stakeholders.
- Even though the architect is not an actual sales person, he/she should ***be able to sell thoughts and ideas***. But still, a certain amount of humbleness and modesty is required; it is more important to get things done and improved than to get personal credit and glory.
- ***Architect is the interpreter*** between the different stakeholder groups trying to achieve a common view to EA issues, and still taking every one's opinions into account. Also diplomatic skills are valuable in this task.
- Finally, an architect should ***be capable of expressing himself both in writing and visually*** (ability to draw clear graphic pictures).

Skills of an architect are also discussed in (Ylimäki and Halttunen 2005).

3.11 Training & Education

"Without adequate training and with unrealistic expectations, many of these new projects will ultimately fail."
(Pinto and Kharbanda 1996)

Training has been acknowledged as an important part of enhancing quality (Luftman 2000; Industry Advisory Council 2005; Kaisler, Armour et al. 2005) See also (Badri, Davis et al. 1995; Quazi, Jemangin et al. 1998; Nah, Lau et al. 2001; Somers and Nelson 2001; Claver, Tarí et al. 2003). Training and education also provide one way of gaining EA awareness and acceptance. Training is needed at least in the following levels:

1. ***General EA education*** should be provided for all stakeholders
2. Architects should have training in ***best-practices, methods, tool usage*** etc. (Coronado and Antony 2002; Basu 2004; Curran 2005)
3. Business managers should be educated about IT, and IT managers should be educated about business (Morganwalp and Sage 2004)

In addition, according to the discussion in the AISA workshop the following aspects of training should be noticed:

- Education related to the new technologies, e.g. what are the possibilities offered by them, what are the costs of utilizing them, and how compatible are they with the existing technologies?
- Architects should be provided education related to the strategies of the organization, the common EA framework, the EA vision and objectives, the target architecture, as well as the modelling techniques.
- Training is not only about teaching architects, but it is also about the things that architects teach to other stakeholders.
- Training and education are terms that should actually be avoided when communicating with the top management. A more successful approach is to ask the management how they feel and think about these issues and to discuss with them to figure out how they perceive EA. Usually this requires interpersonal communication.

Finally, training should be viewed as a ***continuous process*** where people receive appropriate courses at appropriate level of detail for their need (Porter and Parker 1993; Al-Mashari and Zairi 1999; Dale 2003; Tarí 2005).

3.12 Organizational Culture

"Developing a thorough understanding of an enterprise's architecture capability increases the potential and value of an EA program."
(META Group Inc. 2000)

In addition to many other things the Enterprise Architecture development should take the organizational culture into consideration aiming at good organizational and cultural fit (Sumner 2000; Lam 2005). An essential issue is the ***organization's readiness to develop and use Enterprise Architectures***. Cultural readiness is about the integration of EA and company culture. It also includes aspects like ***attitudes towards change*** both by the management and employees, ***communication environment, risk management*** etc. (Mann and Kehoe 1995; Rudawitz 2003; Motwani, Prasad et al. 2005). It should be noticed that in many cases EA implementation and deployment requires cultural changes (Coronado and Antony 2002). Organizational support for EA development and deployment depends e.g. on the following variables (Luftman 2000; Rudawitz 2003; van der Raadt, Soetendal et al. 2004; van der Raadt, Hoorn et al. 2005):

- Organization's ability to accept and adapt to changes in general, and organizational acceptance of architecture-driven changes
- Trusting environment (both socially and politically)
- Open communication
- Organizational involvement in the architecture program
- Flexibility of an organization in adjusting to its environment.

These issues were found important also in the AISA workshop. Moreover organization culture, especially the ***organizational structure***, has impact on the success of EA; if the EA issues are discussed only within a department or other profit center the perspective is too narrow to accomplish good and sustainable solutions. Also the communication culture within the organization should encourage the architects to challenge each others' views and opinions, to debate the possible architectural solutions with each other. Architects should have the courage to question things without being branded as troublemakers. In other words, "an organizational culture which is conducive to continuous improvement and in which everyone can participate" should be created (Dale 2003).

3.13 Project Management

"In the continuing quest for better project management skills and techniques, experience plays a crucial role."
(Pinto and Kharbanda 1996)

Enterprise Architecture development is usually conducted though projects and project management skills play a crucial role as cited above. Project management and project success are areas where a lot of research has been done. The following ***critical factors in project management*** should be kept in mind also in EA projects (Belassi and Tukel 1996; Al-Mashari and Zairi 1999; Nah, Lau et al. 2001; Coronado and Antony 2002; Westerveld 2003; Lam 2005; Motwani, Subramanian et al. 2005; Turner and Müller 2005):

- realistic scope, size and value, plans
- realistic scheduling
- requisite financial and human resources
- risk management
- uniqueness of project activities
- density of a project
- life cycle
- urgency (project prioritization and selection)
- project organizational structure
- project champion, sponsor
- top management support
- project management skills
- continuous measures of project success (quality).

Also in project management the leadership is an important factor helping to conduct a successful project. Project leader is the one to motivate the team, marshals resources, negotiates with stakeholders, cheerleads the development process, and constantly keeps an eye on the ultimate goal: the successfully completed project (Pinto and Kharbanda 1996). Leadership style and competence, personality, inner confidence and self-belief are elements that help the project leader in his/her job (Turner and Müller 2005).

In the AISA workshop project management was the only issue that was suggested to be dropped out from the list, or that it would be renamed to be ***Program Management*** instead including issues needed in managing various development programs conducted in the organization. However, it was acknowledged that it is vitally important that the project objectives, tasks, schedules, resources, budgets etc. are set right. The issue that project management in practice is lacking are the ***milestones***; the check points when the steering group can ascertain whether the project is doing the right things and the intermediate objectives are reached. If not, the group should decide what to do and how to continue. Finally, the organization should be able to learn from the past projects; e.g. how realistic were the schedules and budgets, what went wrong and what went right. ***Lessons learned*** should be gathered, analyzed and stored to be available for later projects.

4 Conclusions

In this report we presented the potential CSFs for EA derived from EA and related domains. The CSFs are the things that need to be done exceedingly well in order to succeed in EA efforts and in order to gain an EA of high quality. Literature review gave us a set of candidate CSFs, which were reviewed and discussed in the workshop participated by the representatives of the co-operating organizations.

The quality of EA is a concept that has not an established definition. We suggested a preliminary definition for an EA of good quality: it is the one that is understood, accepted and used in every day business functions; and the EA is measured in order to ensure that the quality requirements are met. The quality of EA could be measured e.g. to the extent it supports 1) the information system development projects, 2) the top management's business decisions, and 3) ICT enhancement in the organization (from the CIO's point of view).

The success of EA is influenced by several various – and to some extent interrelated – factors. The workshop participants were asked to prioritize the CSFs. Even though the prioritization is preliminary, it supports the expectation we had beforehand – communication, common language, commitment and EA model/artifacts are critical issues in EA success. A little surprising is the fact that development methodology and skilled team were not considered that critical factors, and also the governance and assessment are considered less critical factors. This may result from the fact that the EA development in the participating organizations is in its early phases, and therefore, it is more important, and even vital, to gain understanding and commitment through effective communication and common language, utilizing the EA models and other artifacts in this effort, than to figure out the governance structures or evaluation metrics. These issues will gain more attention when the EA development advances. Hence, it seems that prioritization of the CSFs for EA depends on the organization's EA maturity level. However, further research is needed to clarify 1) the concept of EA of good quality – can quality be dynamic indicating that the interpretation of good quality changes in the course of time, 2) how the EA maturity level, or other organizational changes, acquisitions or mergers affect the prioritization of the CSFs, and 3) the dependencies or interactions between the potential CSFs for EA.

Some changes to CSFs were also suggested: 1) Project management should not be on the list at all, or it should be titled program management instead, and 2) EA model & Documentation (see Figure 4) should be renamed as EA model & Artifacts, because the connotation of the term documentation may be too narrow if understood as written documentation only.

Compared to the critical success factors for software architecture (Hämäläinen, Markkula et al. 2006) a lot of common issues were found, only the emphasis of these issues will vary. In EA more stress is laid e.g. on commitment and communication, whereas in the software architecture level the e.g. role of requirement management is underlined. A good EA can be seen as an umbrella supporting both the software architecture work and the system development work.

Based on the workshop and the literature review we suggest that the most critical success factors for EA dressed up in the form of principles are the following:

- ***Communicate, communicate and communicate***. Use the language the audience can comprehend. Let the enterprise architect act as an interpreter between different stakeholder groups. Give people time to think, discuss and understand what EA is all about.
- ***Keep the EA models and artifacts simple enough*** (limit the number and type of EA outputs you develop and use). Use the architect to explain and teach the models to stakeholders.
- ***Get business involvement and organizational buy-in***. Make EA attractive to the stakeholders, let them perceive the value of EA.
- ***Define the business requirements***. Develop an EA that enables business-IT alignment. Ensure that the business requirements are met.
- ***Aim at good organizational and cultural fit***. Take the organization's ability to accept changes and its readiness to develop and implement EA into consideration.
- ***Train both the architects and the stakeholders***. Discuss the EA issues with the top management.
- ***Define the EA scope clearly***. Find the business case and formulate the "declaration of will"; what the organization really wants and where it is heading to. Start small and grow the EA slowly.
- ***Set up supporting governance infrastructure*** (e.g. a key set of business-oriented projects, metrics, marketing the architecture, processes and policies), be prepared to future changes and assess the EA impact and value.
- ***Build your own framework***. Build the EA iteratively and incrementally. Utilize existing methods and tools.
- ***Assign the architecture team members full time*** if possible. Give the team time to establish their concepts, frameworks, ways of working and communicating.
- ***Make realistic schedules and budgets***. Use the available resources effectively.

Finally, ***enthusiasm*** is also needed (Carbone 2004). EA development does not happen overnight. If the team can not work full time, it will take a lot longer than six months to have any concrete results. Also the turbulence within the organization (mergers, outsourcing etc.) prolongs the time frame. Likely, it will take two or more years before the effects are to be seen. And still, even if all these issues are considered and an EA of good quality has been reached, it does not guarantee the business success, it only enables it.

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Appendix 1. References in the Enterprise Architecture (EA) related areas for potential critical success factors for EA.

(Total) Quality Management	**Business-IT Alignment**	**Project Management**	**Software Architecture/ Software Engineering**	**Other domains (e.g. BPR, EAI, ERP)**
(Badri, Davis et al. 1995)	(D'Souza and Mukherjee 2004)	(Belassi and Tukel 1996)	(Bredemeyer Consulting 2000)	(Al-Mashari and Zairi 1999)
(Basu 2004)	(Henderson and Venkatraman 1993)	(Belout and Gauvreau 2004)	(Dikel, Kane et al. 1995)	(Chapurlat, Kamsu-Foguem et al. 2003)
(Braa and Øgrim 1994)	(Luftman, Papp et al. 1999; Luftman 2000)	(Clarke 1999)	(Hilliard, Kurland et al. 1996)	(Lam 2005)
(Claver, Tarí et al. 2003)	(Motjolopane and Brown 2004)	(Pinto and Kharbanda 1996)	(Reel 1999)	(Motwani, Subramanian et al. 2005)
(Coronado and Antony 2002)	(Teo and Ang 1999)	(Pinto and Mantel 1990)		(Nah, Lau et al. 2001)
(Dale 2003)		(Saleh and Alshawi 2005)		(Somers and Nelson 2001)
(Erder and Pureur 2003)		(Turner and Müller 2005)		(Sumner 1999), (Sumner 2000)
(Lecklin 2002)		(Westerveld 2003)		
(Mann and Kehoe 1995)				
(Motwani, Prasad et al. 2005)				
(Porter and Parker 1993)				
(Quazi, Jemangin et al. 1998)				
(Tarí 2005)				

Appendix 2. Main discussion topics in the AISA workshop I.

- What kind of characteristics does an EA of good quality have?
- Are the potential CSFs relevant and valid in practice? Are all issues taken into consideration?
- Can the CSFs be prioritized? How?
- Is there co-operation or integration between IT management and business management?
- What kind of characteristics does a good communication have? Do business and IT people understand each other? If not, why not?
- What kind of organization culture helps gaining a successful EA?
- What kind of frameworks, methods and tools are used in EA design, implementation and governance?
- What kind of characteristics does a good EA model/descriptions/documentation have?
- How to involve, motivate and commit different stakeholder groups to EA approach?
- Is the EA success measured somehow in the organizations? What is measured and what kind of metrics is used? What should be measured? What kind of metrics should be used?
- What kind of skills is needed from the architects/architecting team?
- What kind of education/training is needed for different stakeholder groups?
- What would be the most important piece of advice for an organization that is about to start the EA development?

Appendix 3. Evaluation form for critical success factors for Enterprise Architecture

Evaluate how critical you consider each potential factor.
Use the following scale:
1 = not at all critical, 2 = somewhat critical, 3 = very critical.

Potential CSFs	1	2	3
Scoping and Purpose			
Business Driven Approach			
Communication			
Common Language			
Organizational Culture			
Development Methodology (and Framework)			
EA Model / Documentation			
Tool Support			
Commitment			
Governance			
Assessment			
Project Management			
Skilled Team			
Training / Education			

UNIVERSITY OF JYVÄSKYLÄ
INFORMATION TECHNOLOGY
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Evaluating the Benefits of Architectural Work

AISA Project Report

Version: 1.03 Date: 26.3.2007
Authors: Eetu Niemi & Tanja Ylimäki Status: Final

Summary

This report is one of the results of the second phase of the AISA project's second year. The objective of this phase was to chart possible evaluation criteria and metrics for the four architectural work (encompassing architectural planning, development and management on all levels of architectures in an enterprise) evaluation sub-targets defined in the previous phase of the project, namely 1) Communication and Common Language, 2) Commitment, 3) Models and Artifacts, and 4) Architectural Work Benefits, representing the evaluation of the whole Enterprise Architecture program (see Ylimäki and Niemi 2006 for more details).

This report describes the organizational benefits of architectural work, and evaluation criteria and metrics for quantifying the realization of benefits in an organization. The benefits, metrics and evaluation criteria were charted by an extensive literature review and two focus group interviews of practitioners. As the benefits are great in number, the focus group (Interview 2) suggested a classification for them, based on the basic needs of a business enterprise. Moreover, a practical view of architectural work benefits and their evaluation developed by the focus group (Interview 2) is introduced, since the evaluation criteria and metrics provided by the research did not seem to suit practice on their own, without a guiding reference model. Additionally, the contribution of this study to practice, and themes for further research are discussed.

Contents

1 Introduction

Architectural work encompasses architectural planning, development and management on all levels of architectures in an enterprise. Enterprise Architecture (EA), on the other hand, contains all models needed in developing and managing an organization, and takes a holistic view of an enterprise's structure, business processes, information systems and technological infrastructure (see e.g. de Boer, Bosanque et al. 2005; Kaisler, Armour et al. 2005; Jonkers, Lankhorst et al. 2006). It has become one of the major interests of both business and academia, and is claimed to provide a vehicle for realizing a multitude of benefits in organizations. Nonetheless, a great number of investments need to be made to support architectural work (see e.g. Kaisler, Armour et al. 2005) and be justified by demonstrating its positive effects to the key stakeholders (see e.g. Morganwalp and Sage 2004).

However, presenting the organizational benefits of architectural work is difficult since measuring its effects is demanding and the EA itself is constantly changing (Morganwalp and Sage 2004). Academic research has almost omitted the subject of architectural work benefit and value realization, focusing instead mostly on architecture frameworks (see e.g. Sowa and Zachman 1992; Greefhorst, Koning et al. 2006; The Open Group 2006), and architecture development methods and tools (see e.g. Bernus, Nemes et al. 2003; Lankhorst 2005; Fatolahi and Shams 2006). Recently, a few contributions have been made in the domain of EA evaluation (see e.g. Morganwalp and Sage 2004; Niemi 2006a; Ylimäki 2006c). However, the evaluation and measurement – and even the definition of – the organizational benefits and value of architectural work seem so far to have escaped the attention of academic research.

Nevertheless, the need for defining the potential benefits of architectural work is evident. It might even be the prerequisite for selecting the architectural work objectives, measuring the realized benefits and value of architectural work, and thus providing a rationale for the key stakeholder support and investments in architectural work (see e.g. Kamogawa and Okada 2005). One of the aims of the AISA project (Quality Management of Enterprise and Software Architectures) is to provide a contribution for this field of research.

This report is one of the results of the second phase of the AISA project's second year. The objective of this phase was to chart possible evaluation criteria and metrics for the four Evaluation sub-targets defined in the previous phase of the project, namely 1) Communication and Common Language, 2) Commitment, 3) Models and Artifacts, and 4) Architectural Work Benefits, representing the evaluation of the whole Enterprise Architecture program (see Ylimäki and Niemi 2006 for more details). This report pursues to describe the organizational benefits of architectural work, and to present evaluation criteria and metrics for quantifying the realization of benefits in an enterprise. Evaluation criteria and metrics for Models and Artifacts are presented by Hämäläinen (Hämäläinen 2006), and the evaluation of Communication and Common Language, as well as Commitment is reported by Ylimäki (Ylimäki 2006a).

The remainder of this report is organized as follows. In the next section, we describe the research method used in this study. In Section 3, we briefly discuss the architectural work benefits and present a categorization for them proposed by the focus group. In Section 4, we discuss the evaluation of architectural benefits and present a practical view of architectural work benefits and their evaluation. Finally, Section 5 summarizes the report.

2 Research Process

In the following, the research process of this study is described as steps. A research paper (Niemi 2006b) was written from the first three steps (architectural work benefit research), in which the benefits and their categorization are described in more detail.

1. **Literature review on architectural work benefits.** Literature on EA and architectures in general was charted for references of benefits using both academic and general search engines on the Internet. Moreover, additional literature was found by studying the references sections of the found papers. Literature by both academia and practitioners was included in the review for a more diverse view of benefits. Subsequently, closely related benefits were combined for a more compact list of benefits by the discretion of the author. Based on reviewing the literature, a preliminary list of 27 architectural work benefits was composed.

2. **Focus group interview on the architectural work benefits.** A focus group interview (see e.g. Krueger and Casey 2000) of seven practitioners from the five co-operating organizations (Table 1) was organized in August 2006 as a workshop (later referred as Interview 1). Each organization provided one or two persons to the interview. The objectives of the interview were 1) to review the literature review results, and 2) to collect additional, experience-based information. The interview was carried out in a group, because group influence was thought to stimulate the discussion; however, confidential information may thus be undisclosed. The interview was moderated by one researcher, while the other two took notes. In addition to the notes taken, the interview was also audio-recorded.

Table 1. Focus group companies

Case company	Number of employees (year 2005)	Industry
Company 1	28 000	Retail and service
Company 2	14	IT consultation and service
Company 3	1 500	Business & IT consulting and development, part of an international company with over 300 000 employees.
Company 4	12 000	Banking, finance and insurance
Company 5	5 000	Telecommunications

3. **Composing a categorization of architectural work benefits**. The results from the literature review and the focus group interview were analyzed and combined into a categorization of EA benefits.
4. **Literature review on architectural work benefit evaluation**. Literature on EA, information systems (IS), architectures in general, and managerial accounting was charted for references of evaluation criteria and metrics using search engines on the Internet and references sections of papers. After studying the papers found and the lack of a guiding evaluation model or framework noted, the architectural work benefits were selected as a starting point for charting metrics and evaluation criteria. The criteria and metrics found were analyzed for defining the architectural benefits they could be used to evaluate or measure. In a number of cases, the criteria and metrics could be assigned according to the literature, but some had to be assigned by the discretion of the author. As a result, metrics and evaluation criteria for 23 architectural work benefits could be defined. Seven of these were emphasized on the basis of anticipated

focus group interests. To further categorize the criteria and metrics, they were assigned to a variety of Evaluation sub-targets. Moreover, their types were defined. As a result, a list of evaluation criteria and metrics assigned to the architectural work benefits (Appendix 1) was constructed. Additionally, a Powerpoint-presentation including the categorization of the benefits, and the seven emphasized benefits and their related metrics and evaluation criteria, was produced for the next step.

5. **Focus group interview on architectural work benefit evaluation**. Another focus group interview (later referred as Interview 2) was organized in October 2006 with seven practitioners from the co-operating companies (Table 1) using similar conventions as previously. As before, the interview pursued 1) to review the literature review results, and 2) to collect additional, experience-based information.
6. **Reporting**. The focus group interview results were analyzed and presented with the architectural work benefits, and benefit evaluation criteria and metrics.

3 Architectural Work Benefits

In this section, we briefly discuss the result of the research on architectural work benefits. Moreover, we present the focus group's perception on the categorization of the benefits. In the following, the variety of benefits is presented. More detailed analysis and the composed categorization of the benefits are included in (Niemi 2006b).

The architectural work benefits identified in the study are displayed in Table 2. As can be seen, the benefits range from abstract, high-level benefits such as integration or agility of the enterprise, to more concrete, lower-level benefits such as shortened cycle times or cost savings. Moreover, the items listed in the table can be seen as being either architectural work benefits, characteristics of EA or architectural work, or areas of architectural work from which benefits could be gained. For example, standardization and integration activities may lead to cost savings, and all of these are mentioned as architectural work benefits in the literature. Despite these challenges, there is no established model for organizing or classifying the architectural work benefits. One possible classification has been proposed by (Giaglis, Mylonopoulos et al. 1999) and applied to the area of architectural work in (Niemi 2006b). Despite the classification divides the benefits into four categories on the account of their measurability and the potential to attribute them to EA or architectural work, it does not assist in defining relationships between the benefits.

Table 2. Architectural work benefits, in alphabetical order

	Architectural Work Benefit		Architectural Work Benefit
1	Evolutionary EA development & governance	15	Improved staff management
2	Provides a holistic view of the enterprise	16	Improved strategic agility
3	Improved alignment to business strategy	17	Increased economies of scale
4	Improved alignment with partners	18	Increased efficiency
5	Improved asset management	19	Increased interoperability and integration
6	Improved business processes	20	Increased market value
7	Improved business-IT alignment	21	Increased quality
8	Improved change management	22	Increased reusability
9	Improved communication	23	Increased stability
10	Improved customer orientation	24	Increased standardization
11	Improved decision making	25	Reduced complexity
12	Improved innovation	26	Reduced costs
13	Improved management of IT investments	27	Shortened cycle times
14	Improved risk management		

The focus group generally agreed with the proposed architectural work benefits and considered the variety of benefits sufficient in the both interviews. However, in the second interview, the group considered the definition of interdependencies between benefits even more important: the direct and connected indirect benefits of architectural work should be identified. Moreover, distinguishing the benefits realized from EA and architectural work from other potential factors affecting the realization of benefits was regarded as a significant challenge by the focus group.

From practical point of view, the focus group (Interview 2) proposed three main categories into which the proposed architectural work benefits could be categorized. They are based on the basic targets and needs of a business enterprise and its owners. In the second interview, the group also proposed several interdependencies between the categories and benefits, which could be studied further. The categorization was considered to suit enterprise's needs better than the classification of the benefits proposed by the author (Niemi 2006b). The categories proposed by the focus group are

- **Costs**,
- **Growth**, and
- **Flexibility**.

By flexibility, the focus group meant the enterprise's ability to respond to changes in the business environment, and the speed of enterprise's changes compared to the swiftness of the changes in the environment. Flexibility is vital in ensuring future profit potential for the enterprise. Depending on market trends, either costs or growth is the most essential benefit category. However, there may be a conflict between growth and flexibility: the enterprise may grow without having flexibility, but if the market situation changes, great challenges arise since the enterprise is difficult to manage without enough flexibility.

According to the focus group, flexibility is also connected to complexity. Practically, reducing the complexity of an enterprise's systems, processes or structure is difficult. Even when it is possible, the complexity may merely be reduced by replacing multiple components with a larger one, or hiding the complexity behind larger components. These methods do not necessarily save any costs, and also make the components more difficult to modify when needed. In fact, reducing complexity may decrease flexibility and even increase costs.

4 Benefit Evaluation and Measurement

In this section, the results from the research on architectural work benefit evaluation and measurement are discussed. Also, the focus group's (Interview 2) practical view of architectural work benefits and their evaluation is presented.

4.1 Architectural work benefit evaluation in literature

Generally, literature does not propose guiding evaluation models or frameworks for evaluating architectural work benefits, with the exception of qualitative metrics developed for business-IT alignment (Luftman 2000). However, a few models have been proposed for quantifying some benefits or the business value of architectural work in general. For example, EA Value Realization model (Kluge, Dietzsch et al. 2006), EA Effectiveness Framework (Kamogawa and Okada 2005), Real Options (Saha 2004; Schmidt 2005) and Return on Investment (ROI) (Saha 2004; Schmidt 2005; Rosser 2006) are all proposed as models or frameworks for calculating the business value of architectural work. Still, these approaches do not seem to provide enough detail for using them in practice. For example, the components and metrics of ROI are not presented in detail, possibly because of their organization-dependence. On the other hand, multiple generic business performance metrics are proposed in managerial accounting literature, and EA and IS literature also proposes some metrics for performance evaluation.

For these reasons, the benefits identified in the previous step of the study were selected as a basis for charting metrics and evaluation criteria for quantifying architectural work benefits and business value. In a number of cases, the criteria and metrics could be assigned to the benefits according to the literature, but some had to be assigned by the discretion of the authors. To further categorize the criteria and metrics, they were assigned to the following of evaluation sub-targets by the discretion of the authors:

- Customer
- Decisions
- Documentation
- Employee base
- Finances
- Inventory
- IT Assets
- Organization
- Process (with examples of various processes such as production, delivery and R&D)
- Product/Service
- Product/Service base
- Project
- Standards
- Value Chain

Also, the benefit in question was included as an evaluation sub-target. In business-IT alignment, the targets proposed by (Luftman 2000) were used. Moreover, the types of metrics were defined as either objective (quantitative) or subjective (qualitative), and producing information related to finance, time or numbers in general (e.g. amounts or classes). The benefits and their assigned evaluation criteria and metrics are presented as an appendix in alphabetical order. In this study, evaluation criteria and metrics were assigned to 23 benefits of the total 27. From these, seven were emphasized on the account of anticipated focus group (Interview 2) interests, and thus include a greater number and more detailed criteria and metrics. The emphasized benefits were:

- Improved business-IT alignment
- Improved customer orientation
- Improved decision making
- Improved strategic agility
- Increased efficiency
- Increased reusability
- Increased standardization

4.2 Practical View of Architectural Work Benefits and Their Evaluation

Presenting evidence on realized architectural benefits to management was considered a vital condition to architectural work by the focus group (Interview 2). In the second interview, the focus group familiarized themselves with the metrics related to improved business-IT alignment, increased efficiency and increased reusability. Moreover, they addressed the evaluation of complexity. The focus group suggested that the efficiency metrics would encompass the category of costs well, but stated that the proposed metrics are too great in number and would not suit practice without a guiding reference model. During the second interview, the focus group members developed a more practical view of the architectural work benefits and their evaluation (later referred as the practical view), based on the three categories of benefits (costs, growth, and flexibility). In the following, the practical view is discussed according to the second focus group interview results.

4.2.1 Overview

The practical view (Figure 1) uses the three categories of architectural work benefits as a basis for constructing architectural work and corporate evaluation and measurement system. The view takes into account three viewpoints of evaluation: 1) corporate metrics consulted by the architecture team, 2) metrics of the architectural work itself, and 3) metrics of architectural work results. It illustrates 1) corporate level targets (the three architectural work benefit categories), 2) layered hierarchy of metrics, 3) relationships between architectural and corporate metrics 4) architecture team/unit role and position, and 5) role of architectural work ROI.

4.2.2 Basics of Evaluation

The focus group considered the fundamental fact of evaluation to be its effect on guiding the actions of individuals. By selecting certain metrics for the evaluation of employees, the metrics themselves have an effect on the work of the employees in question. As a result, the whole enterprise is guided by the metrics. However, the metrics that should be used to evaluate employees vary – they could be dependent on e.g. the unit, function, subunit or team of employees in question. According to the focus group, 3-5 metrics would be sufficient per evaluation unit (such as individual, team, subunit, unit or function). However, the metrics should be of high substance and hence be selected carefully, taking into account the goals of the evaluation (e.g. guiding the actions of an enterprise). In addition, it is essential that architectural work metrics are connected to other corporate metrics.

4.2.3 Hierarchy of Metrics

The basic idea of the practical view (depicted in Figure 1) is to organize the metrics and benefits according to an enterprise's basic business needs. In the view, the hierarchy of metrics is layered according to the organization structure, and hence the number of layers varies in different organizations. From top to bottom, the view concretizes corporate level targets to lower level metrics. The viewpoints of management and employees are considered in the practical view. Therefore, the measurement system implemented according to the practical view provides information to both evaluators and those being evaluated.

The hierarchy starts from the corporate level, where metrics for the enterprise's most important targets, such as costs, growth and flexibility, are implemented. From there, the management implements the metrics derived from the top level targets to the unit or function level below, which includes business and support functions (e.g. sales, marketing, finance, delivery, human resources and research & development). For example, employee satisfaction could be a metric of human resources, and customer satisfaction represents a metric used in sales.

From the unit or function level, middle management implements metrics for subunits or teams of employees, and from there, metrics are implemented to individual employees. In addition, projects usually have their own metrics as well as the architecture team or unit. For each unit, function, subunit, team and individual, 3-5 metrics should be implemented. In addition to implementing the metrics from top to bottom, feedback from bottom to top is also needed to preserve the links and compatibility between the metrics on adjacent levels.

According to the focus group (Interview 2), managing the integrity of the measurement system as a whole is vital. The hierarchy of metrics should be low enough to preserve the chain of causalities between the metrics on adjacent levels. If the hierarchy grows too high, it may result in inconsistent metrics on the lower levels of the hierarchy. The size of the hierarchy is dependent on the size of the enterprise, 5-6 levels would be a feasible example.

4.2.4 Architectural Work Benefit Evaluation

The focus group (Interview 2) suggested a simple approach to architectural work benefit evaluation. The idea is to provide the management of an enterprise with 3-5 metrics which can be used to evaluate architectural work benefits. By using the metrics, the architecture team or unit should rationalize that benefits are received from architectural work in enterprise functions and units. For example, the holistic architectural view of an enterprise, which a high-quality EA can provide, can be used in projects over and over again, without constructing the architecture separately in the beginning of every project and thus resulting in greater efficiency, speed and accuracy.

Moreover, the focus group stated that management could be also interested in architectural work ROI, because normal investment planning basically applies in architectural work. Towards management, the focus group preferred the use of hard, quantitative metrics. Results from the use of qualitative metrics, such as surveys, may be used to support and fine-tune the results from hard metrics to either direction. For instance, the success of architecture related communication or commitment to the architectural work can be evaluated using surveys (see e.g. Ylimäki 2006a).

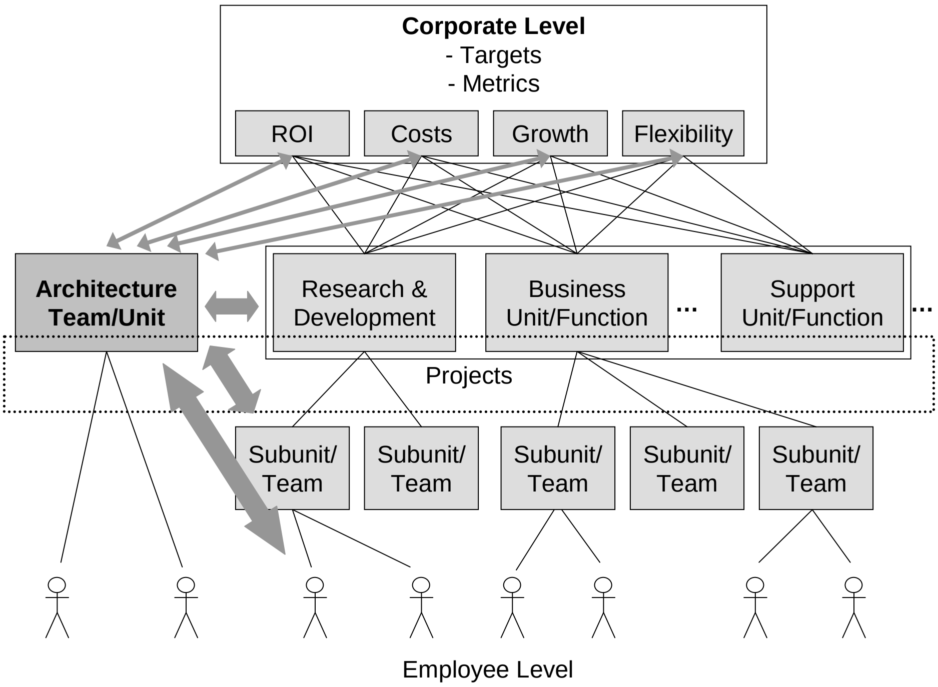

Figure 1. The practical view of architectural work benefits and their evaluation (developed by the focus group)

In addition to rationalizing the architectural work towards management, the focus group also stated that evaluating architectural work benefits is important to the architecture team's motivation as well: if architectural work is not considered relevant in the enterprise, the work itself is probably not of very high quality.

4.2.5 Architectural Work ROI

The ROI of architectural work was considered to be one of the important metrics for presenting architectural work benefits to the management. It can be used to measure whether the architectural work carried out is profitable in the long-term. Basically, it measures how well the architectural work supports the attainment of business goals.

4.2.6 Communicating Evaluation Results

Taking into account the viewpoints and needs of various stakeholders in architectural communication, including also evaluation results, was emphasized by the focus group (Interview 2). Different stakeholders may be interested in receiving different information in different forms. For example, a project manager may not be interested in architectural work benefits on the enterprise level as much as top management. In general, architectural communication should take into account 1) what is to be communicated, 2) to whom the communication is aimed, and 3) when is the right time to communicate (see Ylimäki 2006a for more details).

4.2.7 Evaluation Challenges

The focus group (Interview 2) identified several challenges of architectural work benefit evaluation. Firstly, a baseline or standard for evaluation results does not exist. If architectural work is carried out in an enterprise, this situation cannot be compared with the situation when architectural work has not been initiated. Secondly, there may be conflicts between being able to present short-term and long-term benefits. On one hand, architectural work benefits should be presented as soon as possible to gain management support, but on the other hand, architectural work is long-term by nature. According to the focus group, management is not interested in matters outside the time scale of the current corporate strategy (e.g. 3-5 years), but the architecture team has to carry out more long-term planning. Some metrics may not show benefits until after five years, which is too long time – a time scale of one year would be more appropriate. However, if the architecture team concentrates only on producing short-term benefits, they end in “extinguishing fires”, without a possibility to plan in the long-term. The challenge is to find a mutual understanding of the time scale of presenting benefits between management and the architecture team, and a balance between producing short-term and long-term benefits.

Since the initial stages of architectural work usually produce least benefits according to the focus group (Interview 2), being able to present quick wins is essential in gaining management support. The focus group considered the presentation of quick wins difficult. If the architecture is flexible, it should be possible to present quick wins. However, if flexible architecture is currently in the initial stages, benefits are received only in the long-term. In fact, architectural work may even decrease efficiency and increase cost in the beginning, because of new and modified processes and methods. The focus group did not present other solutions to this challenge than utilizing the selling skills of architects in rationalizing architecture projects and investments to the management.

5 Conclusion

In this report, the organizational benefits of architectural work were described, and evaluation criteria and metrics for quantifying the realization of benefits in an organization presented. The benefits, metrics and evaluation criteria were charted by an extensive literature review and two focus group interviews of practitioners. As the benefits are great in number, the focus group (Interview 2) suggested a classification for them, based on the basic needs of a business enterprise. Moreover, a practical view of architectural work benefits and their evaluation developed by the focus group (Interview 2) was introduced, since the evaluation criteria and metrics provided by the research did not seem to suit practice on their own, without a guiding reference model.

The research described in this report may benefit practitioners in several ways. Firstly, the architectural work benefits may be used as a basis for defining the objectives of architectural work in an enterprise. Secondly, architectural work may be rationalized, specifically to the management, in the initial stages by presenting the potential benefits which could be realized by architectural work. Thirdly, the benefits and their related metrics and evaluation criteria can be used as a basis for developing a measurement system for quantifying the value of architectural work. The practical view not only illustrates on a general level how architectural work benefits may be measured, but also presents a reference model for a generic corporate measurement system.

Moreover, the research provides a multitude of themes for further research theme. Firstly, the architectural work benefits should be further analyzed to classify them and to define their interrelations. The classification suggested by the focus group (Interview 2) could be used as a starting point for defining the interrelationships between the benefits, which would provide a causal chain of benefits and their related metrics. Secondly, the practical view developed by the group provides a basis for attributing feasible metrics to e.g. various levels, functions and units included in the view, for clarifying the role and organizational position of the architecture team, and for committing further research on defining the components of architectural work ROI.

Although these are important directions of further research, the essential question of attributing gained benefits to architectural work remains mostly unanswered. The practical view might be used as a starting point for clarifying this connection between gained benefits and architectural work. However, this seems to be a significant challenge, because a great number of factors affect the realization of benefits (see e.g. Boster, Liu et al. 2000; Ylimäki 2006b). Also, the prioritization of benefits is company-specific, depending on the company strategy. Therefore, defining a generic set of EA benefits with respective metrics is difficult. Moreover, balancing between presenting short-term and long-term benefits is a challenge for the architecture group. Finally, it is even argued that the benefits cannot be directly measured (Rosser 2006). In any case, EA should be communicated effectively to realize the benefits (see e.g. Rosser 2006; Tash 2006).

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Appendix 1: The Benefits of Architectural Work

Examples of process-related sub-targets are marked with prefix *.

Increased efficiency

Evaluation sub-target	Metrics	Type	Sources
Decisions	Time required to make a decision	Objective/ Subjective Time	(Morgan 2005)
Documentation	Costs avoided through elimination of redundant/duplicative/overlapping documentation	Objective Financial	(GAO 2003; SETLabs 2004)
	Number of documents/models/descriptions	Objective Number	
Finances	- Costs of transactions - Overhead costs - Infrastructure costs	Objective Financial	(Drury 1992; Morgan 2005)
	Accordance to budget (organization-level/business-unit level/department-level group level)	Objective Number	(Drury 1992)
	- Revenue growth - Profitability - Cash flow - Return on Investment - Return on Equity - Economic Value Added - Market share	Objective Financial	(Drury 1992; Morgan 2005; Papalexandris, Ioannou et al. 2005)
IT Assets	Number of assets - systems - software products - licenses - servers, etc.	Objective Number	(Rosser 2006)
	Number of overlapping and redundant assets	Objective Number	(SETLabs 2004)
	- All IT costs - Maintenance costs - Operations cost	Objective Financial	(SETLabs 2004; Rosser 2006)
	System/Software performance	Objective Number	
	System/Software Implementation duration	Objective Time	
	Costs avoided through elimination of redundant/duplicative/overlapping assets	Objective Financial	(GAO 2003; SETLabs 2004)
Organization	Number of redundant/duplicative/overlapping - functions, departments, groups/teams and positions	Objective Number	(SETLabs 2004)
	Costs avoided through elimination of redundant/duplicative/overlapping functions/departments/groups/teams/positions	Objective Financial	(GAO 2003; SETLabs 2004)

Evaluation sub-target	Metrics	Type	Sources
Process	Cycle time	Objective Time	(Drury 1992; Morgan 2005; Papalexandris, Ioannou et al. 2005)
	Throughput	Objective Number	(Drury 1992; Morgan 2005; Papalexandris, Ioannou et al. 2005)
	Costs	Objective Financial	(Drury 1992; Papalexandris, Ioannou et al. 2005)
	Errors (number/time/cost)	Objective Number/ Time/ Financial	
	Number of redundant/duplicative/overlapping processes	Objective Number	(SETLabs 2004)
	Costs avoided through elimination of redundant/duplicative/overlapping processes	Objective Financial	(GAO 2003; SETLabs 2004)
***Delivery**	Time from order to delivery	Objective Time	(Drury 1992; Morgan 2005)
	Number/% of on-time deliveries	Objective Number	(Drury 1992)
	Cost	Objective Financial	(Drury 1992)

***Production**	Time
	- Total cycle time
	- Manufacturing time
	  - Processing time
	  - Inspection time
	  - Wait time
	  - Move time
		Objective Time	(Drury 1992; Morgan 2005; Papalexandris, Ioannou et al. 2005)

	Production throughput	Objective Number	(Drury 1992; Morgan 2005; Papalexandris, Ioannou et al. 2005)
	Production cost	Objective Financial	(Drury 1992; Papalexandris, Ioannou et al. 2005)
	Manufacturing cycle efficiency (value-adding activities/non value adding activities)	Objective Number	(Drury 1992)

Evaluation sub-target	Metrics	Type	Sources
***Customer interface (Customer service, marketing and sales)**	- Cross-selling - Customer Complaints - Complaint resolution - Hours with customer - Segmentation - Query time - Costs	Objective Number/ Time/ Financial	(Drury 1992; Papalexandris, Ioannou et al. 2005)
***R&D**	Product/service development duration	Objective Time	(Drury 1992; Rosser 2006)
	Cost to develop new product/service	Objective Financial	(Drury 1992; Rosser 2006)
	Number of new products	Objective Number	(Papalexandris, Ioannou et al. 2005)
	Number of patents	Objective Number	(Papalexandris, Ioannou et al. 2005)
	R&D costs	Objective Financial	(Papalexandris, Ioannou et al. 2005)
Project	Accordance to budget	Objective Financial	(Rosser 2006)
	Accordance to schedule	Objective Time	(Rosser 2006)
	Number of redundant/duplicative/overlapping projects	Objective Number	(SETLabs 2004)
	Costs avoided through elimination of redundant/duplicative/overlapping projects	Objective Financial	(GAO 2003; SETLabs 2004)
	Scope	Objective Number	
Efficiency in general	Stakeholder opinion on EA's value to improving efficiency of -Processes -Projects -Decision making -Communication, etc.	Subjective e.g. Likert-Scale	

Increased reusability

Evaluation sub-target	Metrics	Type	Sources
IT Assets	Number of reusable components - Systems - Programs - Code - Modules - Methods - Processes - Documentation - Tools, etc.	Objective/ Subjective Number	(Rosser 2006)
	Number of components currently in reuse	Objective Number	(Rosser 2006)

Evaluation sub-target	Metrics	Type	Sources
	Number of reuses / component	Objective Number	(Rosser 2006)
	Costs avoided through reuse	Objective Financial	(Poulin and Himler 2006)
Process	Number of reused - Processes - Process modules - Work products, etc.	Objective Number	
	Costs avoided through reuse	Objective Financial	(Poulin and Himler 2006)
***Investment process**	Number of reused investment process components (establishment) - Documents - Calculations - Decision-making models	Objective Number	
	Costs avoided through reuse	Objective Financial	(Poulin and Himler 2006)
Project	Number of reused - Project models - Project documentation - Project products	Objective Number	
	Costs avoided through reuse	Objective Financial	(Poulin and Himler 2006)
Reusability in general	Stakeholder opinion on EA's value to reusability	Subjective e.g. Likert-Scale	

Increased standardization

Evaluation sub-target	Metrics	Type	Sources
Documentation	Documentation/model/description compliance to defined EA/standards	Objective Number	
	Costs avoided through use of standards	Objective Financial	
IT Assets	Number of assets - Systems - Software products - Licenses - Servers - Etc.	Objective Number	(Rosser 2006)
	Number of overlapping and redundant assets	Objective Number	(SETLabs 2004)
	Number of standardized/unstandardized interfaces	Objective Number	
	Costs avoided through use of standards	Objective Financial	
Process	Process compliance to EA/defined standards (e.g. methods, documentation, processes, tools)	Objective Number	

Evaluation sub-target	Metrics	Type	Sources
	Process repeatibility (level of standardization)	Objective Number	
	Costs avoided through use of standards	Objective Financial	
***Investment process**	Number of EA/standard compliant investments	Objective Number	(GAO 2003)
	Feedback/change requests for EA received from the investment process	Objective Number	(GAO 2003)
	Costs avoided through use of standards	Objective Financial	
Project	Project compliance to EA/defined standards (e.g. methods, documentation, processes, tools)	Objective Number	
	Costs avoided through use of standards	Objective Financial	
Standards	Number of standards	Objective Number	
	Number of standards currently used	Objective Number	
	Number of uses/standard	Objective Number	
Standardization in general	Stakeholder opinion on EA's value to standardization	Subjective e.g. Likert-Scale	

Improved decision making

Evaluation sub-target	Metrics	Type	Sources
Decisions	Documentation and analysis of past decisions after an interval -> quality of decisions	Subjective Number	
	Time required to make a decision	Objective/ Subjective Time	(Morgan 2005)
	Savings through reduced time to make a decision	Objective Financial	
Process	Support/consulting required (times/cost/time)	Objective Number/ Financial/ Time	
	Savings through reduced support/consulting	Objective Financial	
***Investment process**	Number of EA/standard compliant investments	Objective Number	(GAO 2003)
	Feedback/change requests for EA received from the investment process	Objective Number	(GAO 2003)

Evaluation sub-target	Metrics	Type	Sources
	Savings through reduced support/consulting	Objective Financial	
Project	Architectural guidance required (times/cost/time)	Objective Number/ Financial/ Time	
	Other support/consulting required (times/cost/time)	Objective Number/ Financial/ Time	(Morgan 2005)
	Savings through reduced support/consulting	Objective Financial	
	Stakeholder opinion on architectural guidance to projects	Subjective e.g. Likert-Scale	
Decision making in general	Stakeholder opinion on EA's value to decision making (e.g. access to information)	Subjective e.g. Likert-Scale	(Rosser 2006)

Improved customer orientation

Evaluation sub-target	Metrics	Type	Sources
Organization	- Revenue growth - Profitability - Cash flow - Market share	Objective Financial	(Drury 1992; Morgan 2005; Papalexandris, Ioannou et al. 2005)
Customer base	- Retention - Acquisition - Value - Size - Profitability/Cost of customership - Segmentation - Products/services per customer	Objective Number/ Financial	(Papalexandris, Ioannou et al. 2005)
Inventory	Inventory level	Objective Number	(Drury 1992; Morgan 2005; Papalexandris, Ioannou et al. 2005)
	Cost	Objective Financial	(Drury 1992; Morgan 2005; Papalexandris, Ioannou et al. 2005)
	Cycle time	Objective Financial	(Drury 1992; Morgan 2005; Papalexandris, Ioannou et al. 2005)
Process	Cycle time	Objective Time	(Drury 1992; Morgan 2005; Papalexandris, Ioannou et al. 2005)
	Throughput	Objective Number	(Drury 1992; Morgan 2005; Papalexandris, Ioannou et al. 2005)
	Costs	Objective Financial	(Drury 1992; Papalexandris, Ioannou et al. 2005)

Evaluation sub-target	Metrics	Type	Sources
*** Delivery**	Time from order to delivery	Objective Time	(Drury 1992; Morgan 2005)
	Number/% of on-time deliveries	Objective Number	(Drury 1992)
	Cost	Objective Financial	(Drury 1992)

***Production**	Time
	- Total cycle time
	- Manufacturing time
	  - Processing time
	  - Inspection time
	  - Wait time
	  - Move time
		Objective Time	(Drury 1992; Morgan 2005; Papalexandris, Ioannou et al. 2005)

	Production throughput	Objective Number	(Drury 1992; Morgan 2005; Papalexandris, Ioannou et al. 2005)
	Production cost	Objective Financial	(Drury 1992; Papalexandris, Ioannou et al. 2005)
	Manufacturing cycle efficiency (value-adding activities/non value adding activities)	Objective Number	(Drury 1992)
***Customer interface (Customer service, marketing and sales)**	- Cross-selling - Customer Complaints - Complaint resolution - Hours with customer - Query time - Costs	Objective Number/ Time/ Financial	(Drury 1992; Papalexandris, Ioannou et al. 2005)
	Stakeholder satisfaction on EA's value to customer interface (sales/marketing/customer service)	Subjective e.g. Likert-Scale	
***R&D**	Product/service development duration	Objective Time	(Drury 1992; Rosser 2006)
	Cost to develop new product/service	Objective Financial	(Drury 1992; Rosser 2006)
	Number of new products	Objective Number	(Papalexandris, Ioannou et al. 2005)
	Number of patents	Objective Number	(Papalexandris, Ioannou et al. 2005)
	R&D costs	Objective Financial	(Papalexandris, Ioannou et al. 2005)
Product/Service	Product/service quality as measured by customers	Subjective e.g. Likert-Scale	(Drury 1992; Morgan 2005; Papalexandris, Ioannou et al. 2005)
	Product/service quality as measured by standards/audits	Objective/ Subjective Number	(Drury 1992; Morgan 2005; Papalexandris, Ioannou et al. 2005)
	Brand recognition as measured by customers	Subjective e.g. Likert-Scale	(Papalexandris, Ioannou et al. 2005)

Evaluation sub-target	Metrics	Type	Sources
	Price compared to competitors	Objective Financial	(Papalexandris, Ioannou et al. 2005)
	Segmentation	Objective Number	(Drury 1992)
Customer orientation in general	Customer satisfaction	Subjective e.g. Likert-Scale	(Drury 1992; Morgan 2005; Rosser 2006)

Improved business-IT alignment

Evaluation sub-target	Metrics	Type	Sources
Communications	Stakeholder opinion on - Understanding of business by IT - Understanding of IT by business - Inter/Intra-organizational - Learning - Protocol Rigidity - Knowledge Sharing - Liaison(s) effectiveness	Subjective e.g. Likert-Scale	(Luftman 2000)
Competency/ Value	Stakeholder opinion on - IT Metrics - Business Metrics - Balanced Metrics - Service Level Agreements - Benchmarking - Formal Assessments/Reviews - Continuous Improvement	Subjective e.g. Likert-Scale	(Luftman 2000)
Governance	Stakeholder opinion on - Business Strategic Planning - IT Strategic Planning - Reporting/Organization - Structure - Budgetary Control - IT Investment Management - Steering Committee(s) - Prioritization Process	Subjective e.g. Likert-Scale	(Luftman 2000)
Partnership	Stakeholder opinion on - Business Perception of IT Value - Role of IT in Strategic Business Planning - Shared Goals, Risk, Rewards/Penalties - IT Program Management - Relationship/Trust Style - Business Sponsor/Champion	Subjective e.g. Likert-Scale	(Luftman 2000)
Scope and Architecture	Stakeholder opinion on - Traditional, Enabler/Driver, External - Standards Articulation - Architectural Integration - Architectural Transparency - Flexibility Managing Emerging Technology	Subjective e.g. Likert-Scale	(Luftman 2000)

Evaluation sub-target	Metrics	Type	Sources
Skills	Stakeholder opinion on - Innovation, Entrepreneurship - Locus of Power - Management Style - Change Readiness - Career crossover - Education, Cross-Training - Social, Political, Trusting Environment	Subjective e.g. Likert-Scale	(Luftman 2000)

Improved strategic agility

Evaluation sub-target	Metrics	Type	Sources
Decisions	Time required to make a decision	Objective/ Subjective Time	(Morgan 2005)
IT Assets	System/Software Implementation duration	Objective Time	
Organization	Response time to an business demand	Objective Time	(Rosser 2006)
Process	Number of alterations to a process to respond to a business demand	Objective Number	(Drury 1992)
	Cost required to change a process to respond to a business demand	Objective Financial	(Drury 1992)
	Time required to change a process to respond to a business demand	Objective Time	(Drury 1992)
***R&D**	Product/service development duration	Objective Time	(Drury 1992; Rosser 2006)
	Cost to develop new product/service	Objective Financial	(Drury 1992; Rosser 2006)
Product/Service	Number of alterations to product/service to fit a new trend	Objective Number	(Drury 1992; Morgan 2005)
Project	- Planned change projects in the organization initiated by business demands - Unplanned urgent change projects in the organization initiated by business demands	Objective Number	(Rosser 2006)
	Successful change projects (if criteria exists)	Objective Number	(Rosser 2006)
	Change project accordance to budget	Objective Number	(Rosser 2006)
	Change project accordance to schedule	Objective Number	(Rosser 2006)
	Change project accordance to planned output	Objective/ Subjective Number	(Rosser 2006)
Strategic agility in general	Stakeholder opinion on EA's value to improving strategic agility	Subjective e.g. Likert-Scale	

Provides a holistic view of the enterprise

Evaluation sub-target	Metrics	Type	Sources
Holistic view of the enterprise in general	Stakeholder opinion on EA model/description	Subjective e.g. Likert-Scale	

Improved alignment to business strategy

Evaluation sub-target	Metrics	Type	Sources
Customer base	- Turnover - Increase - Value - Size - Especially profitable customers	Objective Number	
Customer	Customer satisfaction	Subjective e.g. Likert-Scale	(Drury 1992; Morgan 2005; Rosser 2006)
Inventory	Cost	Objective Financial	(Morgan 2005)
Investment process	Costs	Objective Financial	(Morgan 2005)
IT Assets	- IT costs - Maintenance Costs - Operation Costs	Objective Financial	(SETLabs 2004; Rosser 2006)
Organization	- Costs of transactions - Overhead costs - Infrastructure costs	Objective Financial	(Morgan 2005)
Production	Production time	Objective Time	(Morgan 2005; Papalexandris, Ioannou et al. 2005)
	Production throughput	Objective Number	(Morgan 2005; Papalexandris, Ioannou et al. 2005)
	Production cost	Objective Financial	(Papalexandris, Ioannou et al. 2005)
Product/Service	Product/service quality as measured by customers	Subjective e.g. Likert-Scale	(Morgan 2005; Papalexandris, Ioannou et al. 2005)
	Product/service quality as measured by standards	Objective Number	(Morgan 2005; Papalexandris, Ioannou et al. 2005)
	Product/service revenue	Objective Financial	(Morgan 2005)
	Product/service profit margin/net profits	Objective Financial	(Morgan 2005)

Evaluation sub-target	Metrics	Type	Sources
Project	Accordance to budget	Objective Number	(Rosser 2006)
R&D	Product/service development duration	Objective Time	(Rosser 2006)
	Cost to develop new product/service	Objective Financial	
Alignment to business strategy in general	Stakeholder opinion on EA's value to alignment with business strategy	Subjective e.g. Likert-Scale	

Improved alignment with partners

Evaluation sub-target	Metrics	Type	Sources
Value Chain	Throughput time	Objective Time	
	Costs	Objective Financial	
Aligment with partners in general	Stakeholder opinion on - EA's value to alignment with partners - The organization as a partner	Subjective e.g. Likert-Scale	

Improved asset management

Evaluation sub-target	Metrics	Type	Sources
Inventory	Inventory level	Objective Number	(Morgan 2005; Papalexandris, Ioannou et al. 2005)
	Cost	Objective Financial	(Morgan 2005; Papalexandris, Ioannou et al. 2005)
	Cycle time	Objective Financial	(Morgan 2005; Papalexandris, Ioannou et al. 2005)
IT Assets	- IT costs - Maintenance Costs - Operation Costs	Objective Financial	(SETLabs 2004; Rosser 2006)

	- Number of assets
	  - systems
	  - software products
	  - licenses
	  - servers, etc.
		Objective Number	(Rosser 2006)

	Number of overlapping and redundant assets	Objective Number	
Asset management in general	Stakeholder opinion on EA's value to asset management	Subjective e.g. Likert-Scale	

Improved business processes

Evaluation sub-target	Metrics	Type	Sources
Organization	New capabilities, features and services implemented	Objective Number	(Rosser 2006)
Process	Cycle time	Objective Time	
	Costs	Objective Financial	
Processes in general	Stakeholder opinion on EA's value to improving business processes	Subjective e.g. Likert-Scale	

Improved change management

Evaluation sub-target	Metrics	Type	Sources
Project	Successful change projects (if criteria exists)	Objective Number	(Rosser 2006)
	Change project accordance to budget	Objective Number	(Rosser 2006)
	Change project accordance to schedule	Objective Number	(Rosser 2006)
	Change project accordance to planned output	Objective/ Subjective Number	(Rosser 2006)
	Stakeholder opinion on EA's value to change management in projects	Subjective e.g. Likert-Scale	
Change management in general	Stakeholder opinion on EA's value to change management	Subjective e.g. Likert-Scale	

Improved innovation

Evaluation sub-target	Metrics	Type	Sources
Customer	Customer satisfaction	Subjective Number	
IT Assets	System/Software implementation duration	Objective Time	
Organization	New capabilities, features and services implemented	Objective Number	(Rosser 2006)
Product/Service	Product/service quality as measured by customers	Subjective e.g. Likert-Scale	(Morgan 2005; Papalexandris, Ioannou et al. 2005)
	Product/service quality as measured by standards	Objective Number	(Morgan 2005; Papalexandris, Ioannou et al. 2005)

Evaluation sub-target	Metrics	Type	Sources
Product/Service base	- Size - Increase - Decrease	Objective Number	
R&D	Product/service development duration	Objective Time	(Rosser 2006)
	Cost to develop new product/service	Objective Financial	(Rosser 2006)
	Number of new products	Objective Number	(Papalexandris, Ioannou et al. 2005)
	Number of patents	Objective Number	(Papalexandris, Ioannou et al. 2005)
	R&D costs	Objective Financial	(Papalexandris, Ioannou et al. 2005)
Innovation in general	Stakeholder opinion on EA's value to innovation	Subjective e.g. Likert-Scale	

Improved management of IT investments

Evaluation sub-target	Metrics	Type	Sources
Investment process	Costs	Objective Financial	(Morgan 2005)
	Time	Objective Time	
IT investment management in general	Stakeholder opinion on EA's value to management of IT investments	Subjective e.g. Likert-Scale	

Improved risk management

Evaluation sub-target	Metrics	Type	Sources
Risk management in general	Stakeholder opinion on EA's value to risk management	Subjective e.g. Likert-Scale	

Improved staff management

Evaluation sub-target	Metrics	Type	Sources
Employee base	- Number of employees - Acquisition - Turnover	Objective Number	(Papalexandris, Ioannou et al. 2005)
	- Skill pool - Skill variance - Skill overlap	Subjective/ Objective Number	
	Employee costs	Objective Financial	

Evaluation sub-target	Metrics	Type	Sources
	Training/education costs	Objective Financial	(Papalexandris, Ioannou et al. 2005)
	Training/education time	Objective Time	(Papalexandris, Ioannou et al. 2005)
	Safety & Health - number of days absent - number of work injuries - health costs - insurance costs	Objective Number/Financial	(Papalexandris, Ioannou et al. 2005)
	Employee opinion on staff management - work satisfaction - salary - training - career possibilities - safety&health - etc.	Subjective e.g. Likert-Scale	
Staff management in general	Stakeholder opinion on EA's value to staff management	Subjective e.g. Likert-Scale	

Increased market value

Evaluation sub-target	Metrics	Type	Sources
Finances	Market value	Objective Financial	

Increased quality

Evaluation sub-target	Metrics	Type	Sources
Documentation	Documentation quality as measured by standards	Objective/Subjective Number	
	Documentation quality as measured by stakeholders	Subjective Number	
Decisions	Documentation and analysis of past decisions after an interval -> quality of decisions	Subjective Number	
Process	Number of disruptions, failures and delays	Objective Number	(Rosser 2006)
Product/Service	Product quality as measured by customers	Subjective Number	(Morgan 2005; Papalexandris, Ioannou et al. 2005)
	Product quality as measured by standards	Objective Number	(Morgan 2005; Papalexandris, Ioannou et al. 2005)
Project	Successful projects (if criteria exists)	Objective Number	(Rosser 2006)
	Project accordance to budget	Objective Number	(Rosser 2006)

Evaluation sub-target	Metrics	Type	Sources
	Project accordance to schedule	Objective Number	(Rosser 2006)
	Project accordance to planned output	Objective/ Subjective Number	(Rosser 2006)
IT assets	- Downtime - Availability	Objective Time	(Rosser 2006)
	Performance	Objective Number	
Quality in general	Stakeholder opinion on EA's value to different aspects of quality	Subjective e.g. Likert-Scale	

Increased stability

Evaluation sub-target	Metrics	Type	Sources
Organization	Response time to an business demand	Objective Time	(Rosser 2006)
	Market share	Objective Number	
	General financial metrics (e.g. profitability)	Objective Financial	
	Short-lived products/services	Objective Number	(Rosser 2006)
Project	- Planned change projects in the organization initiated by business demands - Unplanned urgent change projects in the organization initiated by business demands	Objective Number	(Rosser 2006)
Stability in general	Stakeholder opinion on EA's value to stability	Subjective e.g. Likert-Scale	

Reduced complexity

Evaluation sub-target	Metrics	Type	Sources
Decisions	Time required to make a decision	Objective/Subjective Time	(Morgan 2005)
	Documentation and analysis of past decisions after an interval -> quality of decisions	Subjective Number	
Documentation	Costs avoided through elimination of redundant/duplicative/overlapping documentation	Objective Financial	(GAO 2003; SETLabs 2004)
	Number of documents/models/descriptions	Objective Number	
IT Assets	- Number of assets - systems - software products - licenses - servers, etc.	Objective Number	(Rosser 2006)

Evaluation sub-target	Metrics	Type	Sources
	- Number of redundant/duplicative/overlapping assets - Number of interfaces	Objective Number	(SETLabs 2004)
	- IT costs - Maintenance Costs - Operation Costs	Objective Financial	(SETLabs 2004; Rosser 2006)
	Costs avoided through elimination of redundant/duplicative/overlapping assets	Objective Financial	(GAO 2003; SETLabs 2004)
Organization	Number of redundant/duplicative/overlapping - functions - departments - groups/teams - positions	Objective Number	
	Costs avoided through elimination of redundant/duplicative/overlapping functions/departments/groups/teams/positions	Objective Financial	(GAO 2003)
Process	Number of processes	Objective Number	
	Number of redundant/duplicative/overlapping processes	Objective Number	(SETLabs 2004)
	Costs avoided through elimination of redundant/duplicative/overlapping processes	Objective Financial	(GAO 2003; SETLabs 2004)
Project	Successful projects (if criteria exists)	Objective Number	(Rosser 2006)
	Project accordance to budget	Objective Number	(Rosser 2006)
	Project accordance to schedule	Objective Number	(Rosser 2006)
	Project accordance to planned output	Objective/ Subjective Number	(Rosser 2006)
	Number of projects	Objective Number	
	Number of redundant/duplicative/overlapping projects	Objective Number	(SETLabs 2004)
	Costs avoided through elimination of redundant/duplicative/overlapping projects	Objective Financial	(GAO 2003; SETLabs 2004)
Complexity in general	Stakeholder opinion on EA's value to reducing complexity of - processes - projects - documentation - models - methods - tools	Subjective e.g. Likert-Scale	

Reduced costs

Evaluation sub-target	Metrics	Type	Sources
Finances	- Costs of transactions - Overhead costs - Infrastructure costs	Objective Financial	(Morgan 2005)

Evaluation sub-target	Metrics	Type	Sources
Process	Costs	Objective Financial	
Inventory	Cost	Objective Financial	(Morgan 2005; Papalexandris, Ioannou et al. 2005)
***Investment process**	Costs	Objective Financial	(Morgan 2005)
IT Assets	- IT costs - Maintenance Costs - Operation Costs	Objective Financial	(SETLabs 2004; Rosser 2006)
Project	Accordance to budget	Objective Number	(Rosser 2006)
	Costs	Objective Financial	(Rosser 2006)
Cost reduction in general	Stakeholder opinion on EA's value to reducing various costs	Subjective e.g. Likert-Scale	

Shortened cycle times

Evaluation sub-target	Metrics	Type	Sources
Finances	Cash flow metrics - average days for collection - age of account receivable - cash-to-cash cycle time	Objective Time	(Morgan 2005)
Inventory	Cycle time	Objective Financial	(Morgan 2005; Papalexandris, Ioannou et al. 2005)
IT Assets	System/Software implementation duration	Objective Time	
Process	Cycle time	Objective Time	
***Delivery**	Time from order to delivery	Objective Time	(Drury 1992; Morgan 2005)
***Production**	Production time	Objective Time	(Morgan 2005; Papalexandris, Ioannou et al. 2005)
***R&D**	Product/Service development duration	Objective Time	(Rosser 2006)
Project	Accordance to schedule	Objective Number	
Cycle time reduction in general	Stakeholder opinion on EA's value to reducing various cycle times	Subjective e.g. Likert-Scale	

EVALUATING ENTERPRISE ARCHITECTURE COMPLIANCE

UNIVERSITY OF JYVÄSKYLÄ
INFORMATION TECHNOLOGY
RESEARCH INSTITUTE

AISA Project Report

Version: 1.0	Date: 19.4.2007
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Summary

This report describes the results of a study focusing on Enterprise Architecture (EA) compliance. Many companies are currently interested in finding ways to ensure EA compliance. However, existing literature on the subject is rare, consisting mostly of standards (such as TOGAF) and US Government sources. Hence, we consider EA compliance as an important area of further research.

The objective of this research, carried out in the AISA project, was to define and chart approaches and practices for EA compliance and its evaluation. This report addresses the concept of EA compliance by presenting its various aspects and discussing EA compliance evaluation issues, such as evaluation goals and objectives, evaluation targets and evaluators.

In general, compliance seems to have various meanings; it may indicate conformance with laws and regulations, organization's internal plans, policies, and standards, organization's internal practices (e.g. project procedures and guidelines), partners' practices and policies, as well as public standards.

Similarly, compliance has also several meanings in the context of EA. In this study, the concept of EA compliance is suggested to have both internal and external aspect: 1) internal EA compliance refers to ensuring that investments (as well as projects implementing the investments) are conformant with EA and its policies and guidelines, and 2) external EA compliance refers to ensuring that EA is conformant with the business objectives and strategies.

One of the main goals of EA compliance evaluation is to ensure that the organization is moving towards the target architecture. Basically, this can be done in two ways: 1) By directing a project or investment to comply with EA – the proactive approach, or 2) by assuring the compliance between the actual impacts of investment or project and EA – the reactive approach. Additional benefits are that EA compliance evaluation helps to ensure the usability and appropriateness of EA policies, EA frameworks, EA descriptions and so forth and provides valuable feedback to the architecture group.

A set of evaluation objects between which the EA compliance may be evaluated are suggested. These objects include: business, investments, EA, projects, external directions, partners, customers, and the actual impacts of investment or project. The compliance evaluation target can therefore be defined as the relationship between the objects. Stakeholders conducting or assisting the compliance evaluation are those dealing with or in charge of the above mentioned objects. Usually, the EA compliance evaluation is carried out with the help of documents related to each object.

In this study, the practitioners brought also out that the focus of the concept of EA compliance may vary according to the EA maturity level. Furthermore, EA compliance seems to have a dynamic nature; it can currently be on an acceptable level, but while the organization's operating environment is constantly changing, non-compliance may be reality in the next moment.

Finally, examples of evaluation practices are given to stimulate the organization-specific planning of EA compliance evaluation.

Contents

1 Introduction

Currently, many companies actively develop their Enterprise Architecture (EA) processes, and EA compliance activities are part of these processes. However, the meaning of the concept of EA compliance does not seem to be clear. In addition, there does not seem to be a clear understanding on how to evaluate EA compliance. Also, the existing literature on EA compliance is rare, consisting mostly of standards, such as TOGAF (The Open Group 2006), and various US Government sources (see e.g. CIO Council 2001; GAO 2003; NIH 2006). Hence, we consider EA compliance as an important area of further research.

This report considers features of EA compliance: what it is and how it can be evaluated. Specifically, we are interested in finding answers to questions, such as 1) what are the aspects of EA compliance?, 2) what are the meaning and goals of EA compliance evaluation?, 3) what are benefits of EA compliance evaluation?, and 4) how can EA compliance evaluation be carried out?

The remainder of this report is organized as follows. In the next section, we shortly present the research phases of the study. In section 3, we discuss the concept of compliance both on a general level and in the context of EA. In section, 4, the goals and benefits of EA compliance evaluation are described. Following this, in section 5, EA compliance evaluation issues, such as the evaluators, more specific evaluation targets, timing of evaluation, and some examples of the evaluation practices, are described. The last section summarizes the report and highlights the main conclusions for practitioners.

2 Research Method

The study consisted of the following steps (Figure 1):

1. **Literature review** of scientific articles, organizations' public EA compliance method descriptions (mostly various US Government sources), and standards (such as TOGAF) was conducted to chart the area of EA compliance.
2. **A focus group interview** (Krueger and Casey 2000) of seven practitioners representing the participating organizations, was arranged in December 14, 2006 in order to review, discuss and validate the literature review results. In Table 1, the participants are described.

Table 1. Participants of the focus group interview.

Case company	Number of employees (year 2005)	Industry	Number of interviewees
Company 1	28 000	Retail and service	1
Company 2	14	IT consultation and service	2
Company 3	1 000	Business & IT consulting and development, part of a large international company with over 300 000 employees	2
Company 4	12 000	Banking, finance and insurance	1
Company 5	5 000	Telecommunications	1

3. **An analysis and consolidation of the results** of both the focus group interview and the literature review was carried out.

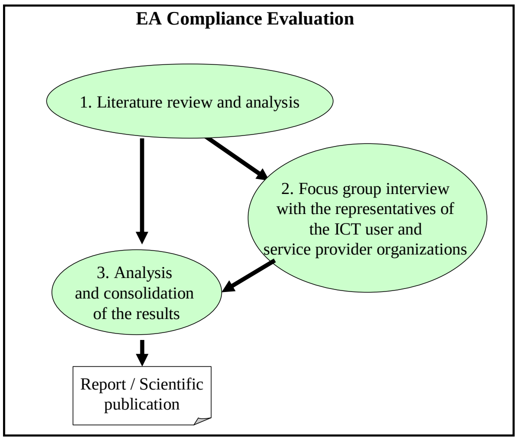

Figure 1. The steps of determining the aspects of EA compliance and its evaluation.

3 The Concept of Compliance

In this section, the concept of compliance is discussed both on a general level, as well as in the context of EA.

3.1 Compliance on a General Level

The concept of compliance does not seem to have a single all-encompassing definition in general. Compliance has, for example, been defined as

- "the act of complying; acquiescence", or "a disposition to yield to or comply with others" (Collins English Dictionary)
- "performance according to standards" (Quality Assurance Project 2006)
- "the ability to reasonably ensure conformity and adherence to organization policies, plans, procedures, law, regulations, and contracts" (Internal Auditing Standards Board 1995)
- "in management, the act of adhering to, and demonstrating adherence to, a standard or regulation." (Wikipedia; http://en.wikipedia.org/wiki/Compliance)
- "an affirmative indication or judgment that the supplier of a product or service has met the requirements of the relevant specifications, contract, or regulation; also, the state of meeting the requirements. In ISO terms, compliance to regulations." (PEER Center 2006)
- a way to ensure "that business processes are executed as expected" (Cannon and Byers 2006)
- "Compliance is about […] laws and regulations" (Allman 2006).

Compliance seems thus to be a multifaceted concept: it may indicate conformance of an object's (e.g. a product, process, service etc.) characteristics' (e.g. documentation and models) with at least one or more of the following:

- business requirements
- organization's internal plans, policies, and standards
- organization's internal practices (e.g. project procedures and guidelines)
- standards
- regulations and laws, and
- partners' practices and policies.

3.2 Enterprise Architecture Compliance – the Many Faces of the Concept

In this section, the concept of compliance in the context of EA is briefly addressed, and a suggestion of a definition for EA compliance is presented.

Like we pointed out in the previous section, compliance is currently a multifaceted concept with no well-defined description. When it comes to EA compliance, the concept seems to be even vaguer for the time being.

Based on the various definitions of compliance, an initial definition for the concept of EA compliance was generated to be discussed in the focus group interview. We suggested that **Enterprise Architecture Compliance** is

> an affirmative indication or judgment that individual projects and investments will meet or have met the Enterprise Architecture related requirements, i.e. comply with the relevant specifications, such as established or approved enterprise architecture descriptions, policies, compliance criteria, and business objectives.

Processes related to EA compliance are, for example, architecture compliance review process and project impact assessment. These can be defined, for instance, as follows.

Architecture Compliance Review Process evaluates a single project against the agreed "architectural criteria, spirit, and business objectives" (The Open Group 2006). This definition is based on the aim to ensure the compliance of individual projects with the technical architecture (The Open Group 2006). On the other hand, Architecture Compliance Process has also been described as a "process by which the Enterprise Architecture will be used and enforced in the day to day decision making by the Enterprise" (Spurway and Patterson 2005).

Project Impact Assessment evaluates the "project-specific views of the enterprise architecture that illustrate how the enterprise architecture impacts on the major projects within the organization" (The Open Group 2006).

In the proceeding sections, the EA compliance is discussed in the sense of its evaluation.

4 Goals and Benefits of EA Compliance Evaluation

In this section, the key goals and benefits of EA compliance evaluation are briefly discussed.

4.1 Key Goals of EA Compliance Evaluation

There seem to be two major goals for EA compliance evaluation:

1. **Directing a project or investment to comply with EA – the proactive approach** (Spurway and Patterson 2005) (see also CIO Council 2001; Paras 2005; Aziz, Obitz et al. 2006; NIH 2006; The Open Group 2006):
   - Direction and guidance of investments and projects to ensure that the organization is moving towards the target architecture,
   - Supporting projects and investments by defining how and when the EA assets are to be used with the IT solution delivery process and IT investment decision making, and
   - Encouraging the organization, especially IT projects, to utilize the EA specifications and guidelines
2. **Assuring the compliance between the impacts of investment or project and EA – the reactive approach** (Spurway and Patterson 2005) (see also GAO 2003; NIH 2006):
   - EA assessment of IT projects and investments,
   - Definition of EA reviews and assessments conducted within the IT solution delivery process, and
   - Investment follow-up with regard to EA descriptions.

These main goals were also mentioned to be essential by the practitioners in the focus group interview.

In addition, on the basis of the previous focus group interviews and discussions with EA practitioners in the AISA project, we suggest the following additional goal. The idea has also been disclosed in the context of non-compliance by TOGAF (The Open Group 2006).

3. **Ensuring the usability and appropriateness of EA policies, EA frameworks, EA descriptions, business objectives and so forth**:
   - Evaluation through experience-based feedback from projects and investment processes,
   - Basis for improvement, and
   - Identifying where e.g. the EA standards, policies and principles themselves may require modification.

4.2 Benefits of EA Compliance Evaluation

In addition to the three major goals of EA compliance evaluation briefly described above, TOGAF provides a rather extensive list of goals of architecture compliance review. We consider them as project-related benefits of EA compliance evaluation. These benefits of EA compliance evaluation include, for instance, the following issues (see The Open Group 2006 for more information):

- Enables to catch errors in the project architecture early.
- Ensures the application of best practices to architecture work.
- Supports the architecture development to
    - Identify services that are currently application-specific but might be provided as part of the enterprise infrastructure.
    - Decide between architectural alternatives, since the business decision-makers typically involved in the review can guide decisions in terms of what is best for the business, as opposed to what is technically more pleasing or elegant.
    - Identify risks: an Architecture Compliance review tends to look primarily at the critical risk areas of a system, it often highlights the main risks for system owners.
    - Identify and communicate significant architectural gaps to product and service providers.
    - Take advantage of advances in technology.
- Supports the development and improvement of processes and practices to
    - Document strategies for collaboration, resource sharing, and other synergies across multiple architecture teams.
    - Identify key criteria for procurement activities.
- Supports the management, for instance, in the following ways:
    - The output of the architecture compliance review is one of the few measurable deliverables to the CIO to assist in decision-making.
    - Communicate to management the status of technical readiness of the project.
- Increases communication between business, IT and management personnel:
    - Architecture reviews can serve as a way for the architecture organization to engage with development projects that might otherwise proceed without involvement of the architecture function.
    - Architecture reviews can demonstrate rapid and positive support to the enterprise business community: The enterprise architecture and architecture compliance helps ensure the alignment of IT projects with business objectives.

5 Aspects of EA Compliance Evaluation

In this section, EA compliance evaluation is discussed in terms of

- More precise evaluation targets of compliance: what is evaluated, which objects are compared with each other?
- Evaluators: who does the evaluation?
- Levels of compliance: what is the “amount” of compliance?
- Timing of evaluation: when the evaluation is done? and
- Evaluation practices: how the evaluation can be carried out?

5.1 Evaluation Targets

According to the literature reviewed, EA compliance evaluation usually deals with the following three high-level objects: the EA itself, project or investment process, and the output of a project or investment process (CIO Council 2001; GAO 2003; Spurway and Patterson 2005; Aziz, Obitz et al. 2006; NIH 2006; The Open Group 2006). The EA compliance evaluation target can therefore be defined as the relationship between these objects. The high-level objects are displayed in Table 2 together with the potential low-level items, mentioned by the literature, to be utilized in evaluating the relationship between these objects (i.e. in evaluating EA compliance).

Table 2.Examples of EA compliance evaluation objects.

Evaluation object	**Items to be evaluated**	**References**
Enterprise Architecture	- Architectural descriptions (target architecture) - Transition plan - Principles	(CIO Council 2001; GAO 2003; Spurway and Patterson 2005; Aziz, Obitz et al. 2006; NIH 2006; The Open Group 2006)
Project / investment process	- Architectural descriptions (project or system architecture) - Business case - Acquisition plan - Project plan	(CIO Council 2001; GAO 2003; Aziz, Obitz et al. 2006; NIH 2006)
Project / investment process output	- Architectural descriptions (project or system architecture)	(GAO 2003; Spurway and Patterson 2005; NIH 2006)

Based on the literature review and the focus group interview, the following high-level objects between which possible EA compliance evaluation targets can be determined, were suggested:

- **Business**; including e.g. vision, mission, strategies, and plans of actions.
- **Investment** that is needed to fulfill the business vision and mission.
- **Project**; the tool to implement the investment.
- **Enterprise Architecture**; a holistic view to the entire enterprise or organization aiming at better business-IT alignment.
- **External Directions**; including e.g. regulations, standards, or reference architectures that need to be taken into consideration in the business operations or IT development.
- **Partners**; they may provide their own procedures, guidelines or constraints in out-sourcing engagements or when an organization purchases COTS products.
- **Customers**; in some cases the organization's customer's EA, practices or guidelines need also to be taken into consideration when evaluating EA compliance.
- **Actual Impacts of the Project or Investment** indicating whether and how long a step, a transition, has been taken towards the target architecture state.

Moreover, the practitioners in the focus group interview brought out that initial definition of EA compliance seems to give too limited a view of the concept. Hence, it was suggested that **EA compliance could be divided into internal and external compliance**:

- **Internal compliance** basically refers to the compliance between investments – as well as the projects that implement the investments – and EA and its policies and guidelines. In addition, it may refer to the compliance between the impacts of the investments and projects and EA in order to ensure that expected results and affects have actually been achieved.

- **External compliance** is about the compliance between the EA and the business objectives or strategies of the organization; are the EA guidelines, framework, target state, and so forth, in line with the business requirements. External compliance is suggested also to refer to the organization's ability, with the help of its EA, to react to the changing environment of the organization, as well as to the conformance with the laws and regulations the organization needs to obey.

The evaluation objects, as well as the evaluation targets of internal and external compliance, are described in Figure 2. Compliance between the objects is depicted with arrows. Block arrows depict either internal or external compliance, and small dotted arrows other possible connections between the objects of compliance evaluation. Additionally, examples of lower-level items belonging to each object are included in the figure to illustrate the possible documents or descriptions that can be utilized in the compliance evaluation, based on the focus group interview and the literature displayed in Table 2.

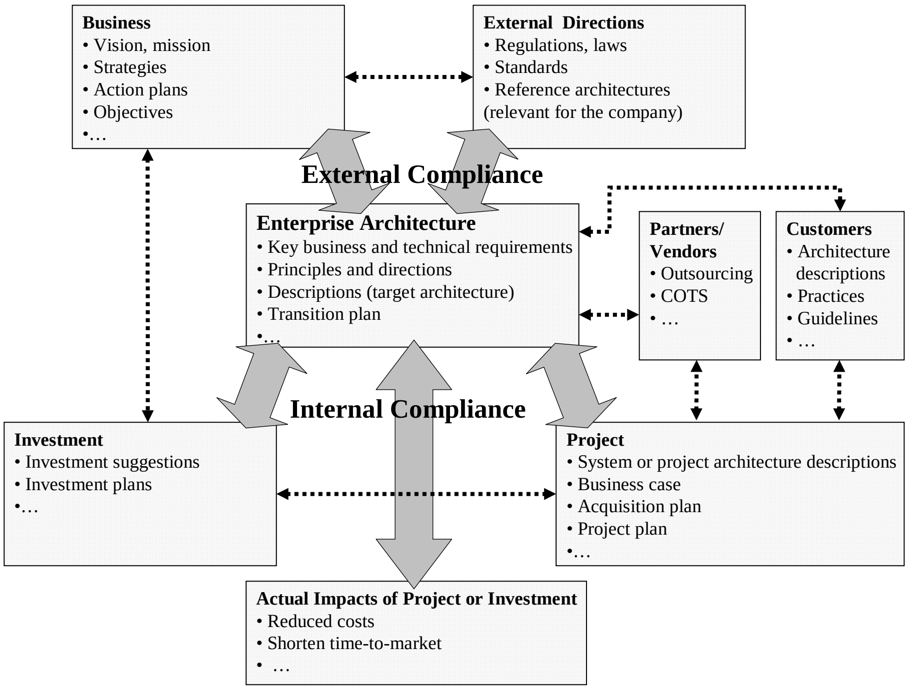

Figure 2. Internal and external EA compliance evaluation targets (blow arrows), as well as several other possible EA compliance evaluation targets (dotted arrows), can be defined between the various objects of EA compliance evaluation (the figure is derived from the focus group interview results).

According to the discussion about the concept of EA compliance there are internal and external compliance, and both should be evaluated. In addition, there is a set of other possible evaluation targets (i.e. relationships between the evaluation objects) that may require consideration in the organizations as well.

External compliance evaluation targets

First of all, compliance (on an acceptable level) is required between Business and EA. It should be evaluated especially in the case of top management or strategy change, helping to assure that EA stays compliant with the altered business strategy, objectives, or other business requirements. Another external compliance evaluation target is the compliance between External Directions and EA. Evaluation of this relationship is required especially if a reference architecture (such as eTOM[1] or TOGAF) is applied in the organization.

Internal EA compliance evaluation targets

Similarly, compliance evaluation is required between EA and Investment, Project and the actual impacts of both investment and project. In the focus group interview, it was stressed that it is possible that a project may succeed and fulfill its objectives, but the investment the project implemented fails – the impacts of the investment were not as expected. Additionally, compliance between project and EA may include two levels

[1] The enhanced Telecom Operations Map; URL: http://www.tmforum.org/

(adapted from The Open Group 2006): (design) process compliance (are we doing things right?) and content compliance (are we doing the right things?). In a project, EA compliance could be used as a project metric to ensure that projects stay compliant with EA even when people change. EA compliance should also be assessed throughout the project's lifecycle. (Paras 2005)

Other possible compliance evaluation targets

There are several other possible compliance evaluation targets depicted in Figure 2 that may require attention in the organizations. First, compliance could be assured between External Directions and Business to ensure that all necessary regulations, laws, standards, and so forth, are conformed to. Second, it may be assured that there is compliance between Business and Investment.

Third, compliance is also required between EA and partners and vendors, especially in mergers and outsourcing cases. The merger or outsourcing partner may have their own EA policies and guidelines, and the organization needs to be compliant with them. If a project utilizes COTS products, the products characteristics may affect the compliance between EA, the project, and its impacts. In addition to COTS products, IT vendors and other service providers may provide practices, methods and architecture documents to projects, affecting EA compliance. Fourth, in close customerships, compliance may also be required between an organization's and its customer's EA, practices and guidelines. Moreover, EA compliance in projects carried out to customers could be addressed as well, helping to assure that the project is compliant with the customer's EA, practices and guidelines. Finally, it should be assured that a project is compliant with the investment it is supposed to implement.

5.2 Evaluators

Literature does not state precisely which stakeholders should carry out EA compliance evaluation. However, Spurway and Patterson (Spurway and Patterson 2005) provide examples on two classes of EA compliance evaluation roles:

1. *Project roles*, which provide necessary project documentation needed in EA compliance evaluation, and
2. *Architecture roles*, which carry out the actual compliance evaluation and support Project roles in the identification and creation of necessary documentation.

Hence, we initially suggested that the architecture group and a project or investment representative are the two primary stakeholders that perform the EA compliance evaluation (adapted from Spurway and Patterson 2005; NIH 2006). The architecture group is in a key role in EA compliance evaluation by providing guidance and direction to projects and possibly by conducting formal compliance reviews as part of EA governance processes/practices. Usually, there are two types of EA compliance related guidance (adapted from NIH 2006): 1) guidance provided to projects and investments automatically (push), or 2) guidance asked by project or investment representatives (ad hoc or pull).

This viewpoint of two major evaluators was, however, considered too limited by the focus group participants. Instead, it was suggested that the possible EA compliance evaluators are those stakeholders (or roles) that have the responsibility in the area of the evaluation targets presented in Figure 2. These possible evaluators are listed in Table 3.

Table 3. Possible evaluators of EA compliance based on the focus group interview results.

Evaluator	**Description**	**Responsi-bility Area**
Business Developer Process Owner Business Architect	Stakeholder that has the responsibility of business (process) development, or business architecture, performs or assists in evaluating the compliance between Business and EA (i.e. external compliance). In addition, this stakeholder may perform or assist the compliance evaluation between Business and External Directions or between Business and Investment.	Business
EA Team Enterprise Architect	Stakeholder that provides direction and guidance (push or pull/ad hoc) for projects and performs or assists in evaluating both the external compliance between EA and Business or External Directions, and the internal compliance between EA and Investment, Project or the impacts these have in the organization. In addition, this stakeholder may evaluate the compliance between EA and Partners or Customers (their policies and guidelines). Evaluation is possibly conducted with the help of (formal) compliance reviews.	Enterprise Architecture
Investment Representative e.g. Controller	Stakeholder that participates in evaluating whether the planned investment is in line with the organization’s strategies and goals.	Investment
Project Representative e.g. Project Manager, Technical Architect	Stakeholder that is responsible for a project management or project content may carry out self-evaluation of the compliance between the project and EA. However, the focus group stated that a project manager may not be aware enough about EA to be able to do self-evaluation. In addition, this stakeholder may participate in conducting compliance evaluation between Project and Partners, Customers or Investments.	Project

Evaluator	Description	Responsi-bility Area
Representative(s) of Out-sourcing or IT/Service Provider Partner(s)	Stakeholder that assists in evaluating whether Partner's policies and guidelines, even Partner's EA, are taken into account in organization's EA work and projects.	Partners

In addition to the stakeholders mentioned in the table above, there may be another stakeholder who could be regarded as a possible evaluator of EA compliance: an EA governance board, also referred to as an architecture board (see e.g. The Open Group 2006) or an EA steering committee (see e.g. CIO Council 2001). If an EA governance board exists in an organization (including representatives from various stakeholder groups), it may have – among many other things – the responsibility of evaluating the compliance between business and EA. Thus, the problematic situation where the EA team evaluates its own work can be avoided. In addition, EA governance board may conduct or assist in conducting (formal) compliance reviews regarding other EA compliance evaluation targets as well.

5.3 Levels of Compliance

Definition of the levels of compliance is more or less an organization specific decision. In this section, we present two examples of how these levels can be defined. First, TOGAF (The Open Group 2006) defines six levels and they are illustrated in Figure 3.

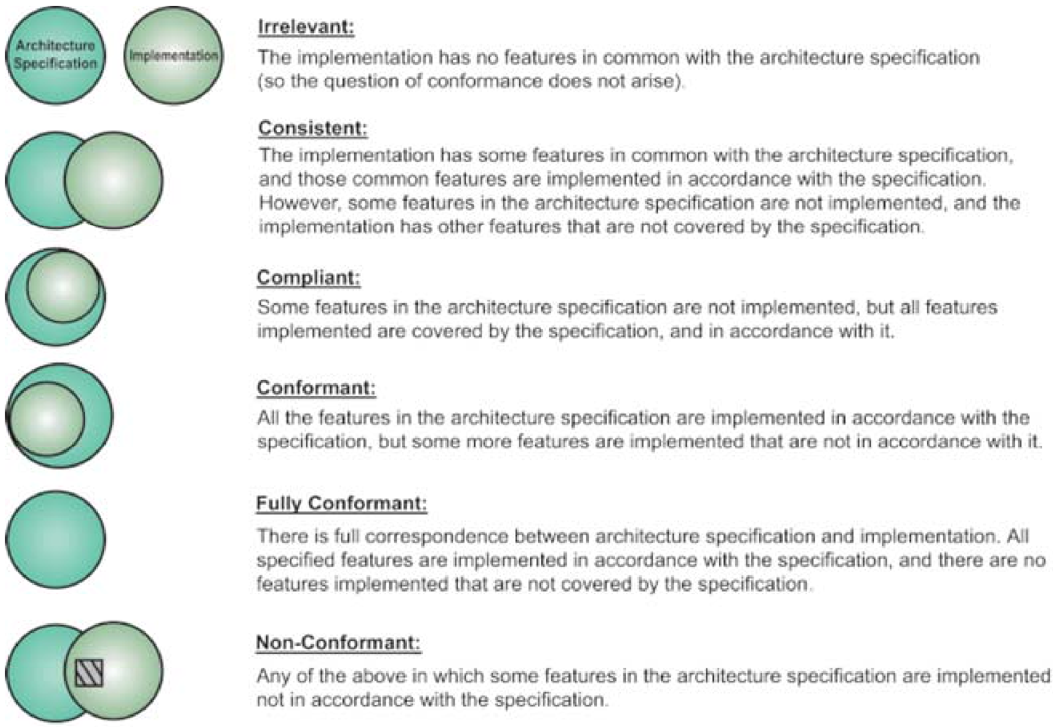

Figure 3. The levels of Architecture Compliance in TOGAF (The Open Group 2006).

Second, Departmenf of Defence (BTA 2006) defines only three levels of compliance:

- Compliant
    - Compliant with the requirements/EA, or
    - Compliant with conditions.
- Compliant – non conflicting (system is not associated with EA)
    - Supports no EA capabilities, OR
    - Premature in system's lifecycle to assess against EA capabilities.
- Non-compliant
    - Does not meet the requirements
    - Justification for not fulfilling the requirements is needed
    - May induce a request for change

Also non-compliance can be a positive situation: "While compliance to architecture is required for development and implementation, non-compliance also provides a mechanism for highlighting areas to be addressed for realignment or areas for consideration for integration into the architectures as they are uncovered by the compliance processes" (The Open Group 2006). This aspect was also pointed out by the focus group participants: compliance evaluation is an important means of receiving feedback, especially about how usable has the EA been, is there a need to change something about the EA and its specifications or processes, or should even the business requirements be reconsidered?

5.4 Timing of Compliance Evaluation

In this section, we will briefly discuss at which points the EA compliance should be evaluated. TOGAF (The Open Group 2006) suggests that "timing of compliance activities should be considered with regard to the development of the architectures themselves" and that compliance reviews should be held "at appropriate project milestones or checkpoints in the project's lifecycle". These checkpoints may include the following:

- Project initiation
- Initial design
- Major design changes
- Ad hoc (when needed).

In the focus group discussion, the following milestones were added to the list by the practitioners:

- End of the project
- Evaluation of the actual impacts afterwards
- Evaluation of the compliance later in the system life-cycle (e.g. when the next release of the system is published).

In addition, TOGAF (The Open Group 2006) advises to take the architecture compliance review at “a point in time when business requirements and the enterprise architecture are reasonably firm, and the project architecture is taking shape, well before its completion. The aim is to hold the review as soon as practical, at a stage when there is still time to correct any major errors or shortcomings, with the obvious proviso that there needs to have been some significant development of the project architecture in order for there to be something to review.”

Furthermore, the practitioners presented some business change situations where compliance evaluations may be needed. These are, for example:

- **Mergers:** Alignment is needed between two or more different businesses as well as different Enterprise Architectures.
- **Out-sourcing:** Partners may provide their own visions, practices, and so forth that need to be considered.
- **Top-management or strategy changes:** The impacts are usually extensive, and change management becomes an important issue.

5.5 Practices for Compliance Evaluation

In this section, we will shortly list some examples of tools or procedures to support carrying out EA compliance evaluation.

Examples of Validation Processes:

- Architecture Compliance Assessment Process (Eurocontrol 2006)
- TOGAF 8 Architecture Compliance Review Process (The Open Group 2006)
- Federal Enterprise Architecture Investment Process and Architecture Project Assessment Framework (CIO Council 2001)
- National Institutes of Health Enterprise Architecture Compliance Process (NIH 2006)

Examples of Compliance Checklists:

- USIGS Architecture Compliance Checklist (NIMA 1998). The checklist is intended to be used when reviewing requirements documents (e.g. mission needs), acquisition documents (e.g. system specifications), requests for changes and engineering change proposals related to any of the above.
- TOGAF 8 Architecture Compliance Review Checklists (The Open Group 2006)

An example of an Architecture Compliance Plan (BTA 2006): “A document required for systems that are not fully compliant and provides

- a detailed assessment of the system’s current degree of compliance,
- the required actions to achieve full compliance,
- the key milestones and proposed deadline to achieve full compliance, and
- any risks and dependencies that are associated with achieving full EA compliance.“

6 Conclusions

In this report, we presented the study which considered the various aspects of the concept of EA compliance. This section summarizes the report, and highlights the main conclusions of this study for practitioners.

The concept of compliance has many facets. It may indicate an object's characteristics' conformance with laws and regulations, organization's internal plans, policies, and standards, organization's internal practices (e.g. project procedures and guidelines), partners' practices and policies, as well as public standards. However, in the focus group interview, the practitioners brought out that compliance on a general level mainly refers to conformance with laws and regulations.

In this report, the concept of EA compliance was suggested to have both internal and external aspect. Internal EA compliance refers to ensuring that investments (as well as the projects implementing the investments) are conformant with EA and its policies and guidelines. Furthermore, it may refer to the compliance between the impacts of the investments and projects and EA in order to ensure that expected results and affects have actually been achieved. External EA compliance refers to ensuring that EA is conformant with the business objectives and strategies. In addition, it may refer to the organization's ability, with the help of its EA, to react to the changing environment of the organization, as well as to the conformance with the laws and regulations the organization needs to obey.

EA compliance evaluation can be regarded as a part of EA governance. The architecture group is in a key role in EA compliance evaluation by providing guidance and direction to projects and possibly by conducting formal compliance reviews. The main goal of EA compliance evaluation is to ensure that the organization is moving towards the target architecture. Basically, this can be done in two ways: 1) By directing a project or investment to comply with EA – the proactive approach, or 2) by assuring the compliance between the actual impacts of investment or project and EA – the reactive approach. Additionally, EA compliance evaluation helps ensure the usability and appropriateness of EA policies, EA frameworks, EA descriptions and so forth and provides valuable feedback to the architecture group.

This report introduced a group of evaluation objects between which the EA compliance, internal or external, can be evaluated (i.e. EA compliance evaluation targets are the relationships between the objects). The objects include: business, investment, EA, project, external directions, partners, customers, and the actual impacts of investment or project. Stakeholders conducting or assisting the compliance evaluation are those dealing with or in charge of the above mentioned objects. Usually, the EA compliance evaluation is conducted with the help of documents related to each object.

Examples for practices for EA compliance evaluation can be found; nevertheless, each organization needs to make its own decisions on various issues, such as

- Audience/stakeholders: Who is interested in the EA compliance evaluation results? Whom the results are presented to?
- Responsibilities: Who conducts the evaluation?
- Timing: When the evaluation is conducted, at which milestones?
- Process and practices:
    - How the evaluation is conducted? Which processes and tasks are needed?
    - Which project or investment related artifacts are compared to which EA related artifacts?
    - Compliance levels: How many levels of compliance need to be defined? Is there a need to define specific levels of compliance?

In this report, we briefly discussed the evaluators and timing issues, as well as presented some examples of evaluation practices to stimulate the organization-specific planning of EA compliance evaluation.

Finally, the practitioners in the focus group interview brought out that also the following aspects should be kept in mind when planning the EA compliance evaluation:

- **EA compliance has a dynamic nature**: The environment of the organization is constantly changing, and so is its architecture. Therefore, compliance – internal or external – can be evaluated to be on an appropriate and acceptable level at the moment, but it does not guarantee that this is the case next week, or next month.

- **EA compliance depends on the EA maturity level:** Both the meaning and content of EA compliance may vary according to the EA maturity level. It was suggested that in the lower levels of maturity (i.e. in the beginning of the EA development work), EA compliance and its evaluation actually equals quality assurance, and especially the impacts of architecture development and architecture work are a focal issue. After the architecture work has become a more established process in the organization, the various aspects of EA compliance (internal and external compliance) will become more current.

Further research could provide more generic practices and reference models for systematic EA compliance evaluation. Especially, the process of compliance evaluation as a part of EA governance practices should be further clarified to determine the possible triggers for starting a compliance evaluation.

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Enterprise Architecture Risks - An Overview

AISA Project Report

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Abstract

Enterprise Architecture (EA) is a modern approach for managing and developing organizations and enabling them to tackle with the challenges induced by constant changes and increased complexity in their environment. However, as an extensive and strategically important program, EA is not without risks. Therefore, this exploratory study aims at 1) providing an overview of generic risks that can potentially be related to EA in organizations, 2) suggesting a classification scheme for the risks to facilitate their management, and 3) discussing the nature of EA risk management. Data is collected by a literature review and a focus group interview of practitioners involved in EA. As a result, a classification scheme for EA risks is suggested, potential risks related to the elements of the scheme presented, and EA risk management discussed.

Contents

1 Introduction

In the modern turbulent business environment, companies are constantly encountering challenges in coping with the changes and complexity in the market. Moreover, the companies have to manage the complexity of their information and communication technology (ICT) environment brought on by the many decades long legacy of ICT, and to assure that ICT supports the business as well as possible. To facilitate companies in responding to these challenges, a recent approach called Enterprise Architecture (EA) has emerged in the last decade (Veasey 2001; Morganwalp and Sage 2004; Goethals et al. 2006; Hjort-Madsen 2006; Kluge et al. 2006). Consequently, the approach has become one of the major concerns of practitioners and academics, and it is being implemented in a multitude of companies and government organizations worldwide.

Basically, EA is a holistic approach for managing and developing an organization, adopting an overall view of its business processes, information systems (IS), information and technological infrastructure (de Boer et al. 2005; Kaisler et al. 2005; Jonkers et al. 2006). EA includes a set of principles, methods and models used to describe the current and future state of an organization, as well as a transition plan top describe the steps needed to transform from the current to the target state (Armour et al. 1999a; Lankhorst 2005). The transformation is usually conceptualized as a continuous, iterative process (Armour et al. 1999b; Kaisler et al. 2005; Pulkkinen and Hirvonen 2005).

EA can be conceptualized from a number of different viewpoints. These include products (and services), processes (Armour et al. 1999a; Jonkers et al. 2006; Rosen et al. 2007), implementations (c.f. Armour et al. 1999b; Kaisler et al. 2005) and impacts (Morganwalp and Sage 2004; Jonkers et al. 2006). EA processes include a collection of planning, development and management processes (Armour et al. 1999b; Pulkkinen and Hirvonen 2005). EA products, in turn, include e.g. EA principles, methods and models (Armour et al. 1999a; Lankhorst 2005), which can be complemented with various services, for instance EA guidance (Armour and Kaisler 2001; The Open Group 2006). Since a typical use for EA is its implementation, it can also be considered a separate viewpoint. Implementations include organizational elements (e.g. organizational structures, processes and information systems) implemented according to or in compliance with EA (Armour et al. 1999b; Kaisler et al. 2005), and other usage of EA in the organization's functions, such as strategy management, investment management, project definition and support, IT governance and system development (Rehkopf and Wybolt 2003; Lankhorst 2005; Bucher et al. 2006; Andersin and Hämäläinen 2007; Emery et al. 2007). EA impacts, on the other hand, may arise from all of these viewpoints.

Because EA is an extensive program, it requires considerable investments and may thus result in many political, project management and organizational challenges (Kaisler et al. 2005). As with any investment, also EA investments (investments related or driven by EA) involve risks which need to be identified and managed (Saha 2006). Organizations investing in EA may face unexpected materialized risks related to business and ICT alike, threatening the success of the EA program. Moreover, since EA is a critical management tool materialized risks can have serious consequences in the organization utilizing EA.

The extensive, continuous and iterative nature of the approach further complicates EA risk identification and management. Unpredictable effects may arise from EA processes (e.g. planning, development, management, maintenance and use) or may be associated with any of the levels of EA products (e.g. business, information, information systems, technology) (Baldwin et al. 2007). Being such a fuzzy target, research on EA is fragmental (see e.g. Niemi 2007), and on the subject in question extremely scarce. However, risks have been extensively discussed in generic risk literature (see e.g. Crouhy et al. 2001; Lam 2003; Reuvid 2005) and even in specific contexts such as ICT and IS (see e.g. Boehm 1991; Benaroch 2002; Sherer and Alter 2004; Keyes 2005; Benaroch et al. 2006).

In this exploratory study, we aim to provide an overview of generic risks that can potentially be related to EA in companies and to investigate classification schemes for the risks to help tackle with the multitude of potential risks. Moreover, we aim to discuss the nature of EA risk management and its connection to organizational risk management. Consequently, the study contributes to practice and research alike. For practitioners, the results provide a list of risks associated with EA, which can be used as a checklist in risk identification, and initiate discussion on EA risk management. For researchers, the results provide a basis for developing identification and mitigation strategies for the presented risks, and conducting further research on EA risk management.

This report is organized as follows. First, we describe the research process and methods used. Second, we discuss the theoretical background of the study. Third, we present the classification scheme of EA risks selected for this study. Fourth, we give an overview of generic risks related to EA. Fifth, we discuss the nature of EA risk management. The report ends with summary and conclusions.

2 Research Process and Methods

This study employed the qualitative research paradigm and used literature review and focus group interview as methods for gathering information. The study was structured as follows:

1) *Literature review* was carried out systematically. First, generic literature on risks was charted using high-quality academic databases and generic search engines on the internet to provide an overview of risks encountered in organizations. Subsequently, literature on risks related particularly to EA, business and ICT was similarly charted to supplement the overview. Literature by both academia and practitioners was included in the review for a more diverse perception. The sets of risks identified in literature were compared by the authors to assess their completeness and suitability to the EA context. Furthermore, potential classifications for the risks were charted and one feasible classification scheme was adopted to facilitate comprehension of the review results. The classification also included a set of generic risks to be used as a basis for discussion in the next phase of the study. A suggestion of the nature of EA risk management was also made according to literature.

2) *Focus group interview* (see e.g. Krueger and Casey 2000) of 5 practitioners from three Finnish organizations carrying out EA work was organized. The organizations were either independent companies, or parts of domestic enterprises. Moreover, they represented different industries and employed from under 20 to several thousand people. The objectives of the interview were 1) to validate the literature review results in a practical context, and 2) to collect additional, experience-based information. Notes were taken from the interview and it was also audio-recorded.

3) *Consolidation and analysis of the results* was done by combining the results from the literature review and the interview.

3 From General Risks to Enterprise Architecture Risks

This section describes the combined results of both the literature review and the focus group interview.

3.1 Definitions and Conceptualizations of Risk

The Collins English Dictionary defines risk as "the possibility of incurring misfortune or loss". However, in risk literature many authors do not even provide a definition for the term. This may be partly explained by the complex nature of risks. First, they have many characteristics such as *exposure* (maximum amount of damage suffered), *severity* (amount of damage that is likely suffered), *volatility* (variability of potential outcomes), *probability* (how likely a risky event occurs), *time horizon* (the time exposed to the risk), *correlation* (amount of correlation between different risks) and *capital* (how much capital is needed to cover losses) (Lam 2003). Second, all risks are temporal and can thus be materialized in complex chains of risks and mitigations over time (Alter and Sherer 2004). Third, risks are not always negative but may also have positive consequences when they materialize (Alter & Sherer 2004).

As a result, risk seems to have been conceptualized in several ways, each accentuating different risk characteristics. For example, Sherer and Alter (2004) identify various types of conceptualizations of risk from IS literature, such as risks as different types of negative outcomes (risk components), risks as factors leading to a loss (risk factors), risk as probability of negative outcomes, and risk as difficulty in estimating outcome. To broaden the scope of the study and to take into account both causes (risk factors) and effects (risk components), we consider risk both as a factor leading to a negative outcome and as the negative outcome itself (cf. Sherer and Alter 2004). Consequently, in this study, we defined EA risks as

1) any factors that may lead to negative outcomes in the EA program, and
2) any negative outcomes resulting from these factors.

However, the focus group participants commented that in practice the negative outcomes may be considered more important since they represent the actual results. Moreover, it was brought out that the two definitions should be better distinguishable from each other. In practice, it is difficult to disentangle the myriad of risk factors and outcomes as there are more than one level of outcomes.

3.2 Risk Classification Schemes

The amount of different risks identified in literature is extensive. Hence, many authors propose classifications for the risks presented in their papers. Typically, the risk categories depict the more or less abstract function, task, object or entity the risk is related to. For example, generic risk management literature divides risks to various classes such as business, market, operations and credit risks (Crouhy et al. 2001; Lam 2003). In the domain of IS and ICT, the risks identified in literature encompass factors related to the development of systems and software, as well as factors arising outside the scope of development (Benaroch 2002; Saha 2006). To classify these kinds of risks, Keyes (2005) proposes categories such as project, technical and business risks. Similarly, Benaroch (2002) divides ICT investment risk components into three categories: firm-specific, competition and market risks, each consisting of more specific risk areas such as financial, political, environmental and project.

Risks can also be classified on other grounds. For instance, Bandyopadhyay (1999) addresses ICT risks on three levels, namely application, organizational and interorganizational levels, depicting the level in the ICT environment the risk is related to. Moreover, risks can be classified on the account of how known they are: the risks could be known, predictable or unpredictable (Keyes 2005). However, few authors accommodate the temporal nature of risk to their classification schemes. Yet, Sherer and Alter (2004) present an extensive synthesis of IS risks from literature, classified by generic IS life cycle phases (initiation, development, implementation, and operation and maintenance). Moreover, the authors classify risks by work system (see Alter 2002; Alter 2003) components, namely customers, work practices, participants, information, technologies, environment, infrastructure and strategies, creating a generic model of risks potentially adaptable to any work system. The risks presented are conceptualized as both risk factors and risk components.

3.3 Views of Enterprise Architecture Risk

The reviewed literature included few papers exclusive on EA risks. Drawing from the discussion of ICT investment risks by Benaroch (2002), Saha (2006) discusses EA investment risks and options, presenting EA investment risk factors divided into the categories of organization specific, competitive, market and technical risks. Baldwin (2007), on the other hand, states that EA risks can exist on and between the various levels of EA products (e.g. business, information, information systems, technology).

Some authors also present results that can be applied to the EA risk context. Especially EA challenges (see e.g. Rehkopf and Wybolt 2003; Kaisler et al. 2005) and EA critical success factors (see e.g. Ylimäki 2006) could indicate potential areas where risks may arise. ICT risk literature, again, refers to architectural risks (see e.g. Avritzer and Weyuker 1998), typically uncovered by architecture reviews or audits, including a great number of technological and project management related factors. However, they seem clearly limited in the EA context, because EA adopts much more extensive view of an organization than traditional software development.

4 Enterprise Architecture Risk Classification Scheme

The work system framework of risks (see Sherer and Alter 2004) was adapted to this study because of its genericity and extensive literature base. The authors also acknowledge that generic work system risks apply to the IS context (Sherer and Alter 2004), suggesting that they may apply to the EA context as well. Furthermore, because a risk classification scheme should consider the conceptualization of risk in question, it is an advantage that the work system framework of risks shares the same conceptualization with this study. The model also provides a meaningful context to classify risks, understandable by not only technically-oriented persons but business personnel as well (Sherer and Alter 2004). Many other classification models utilize insufficiently defined, abstract categories, which may be difficult to comprehend by practitioners. Finally, the model already includes a set of generic risks based on an extensive literature basis, also including factors mentioned in EA risk literature (Saha 2006). However, it should be noted that even though the model takes the temporal nature of risk into account by classifying the risks by IS life cycle phases, this viewpoint was not covered in our study because of time limitations in the focus group interview.

Alter (2003) defines work system as “a system in which human participants and/or machines perform work using information, technology, and other resources to produce products and/or services to internal or external customers”. Originally, the author argues that the work system construct should replace the “IT artifact” as the central concept of the IS domain, because the contemporary IS domain is work system-centric rather than ICT-centric (Alter 2003).

However, as EA can be considered from at least the four viewpoints presented in the first section (process, product, implementation and impact), the adaptation of the framework to the EA context may not be straightforward. Therefore, we had to define how the viewpoints are represented by the framework. In our adapted framework, EA processes are represented with the *Work Practices* element, supported by *Participants*, *Information* and *Technologies*. EA products and services are naturally covered by the *Products and Services* viewpoint. EA implementations and impacts, on the other hand, are represented by the *Customer* element since customers implement the EA products and services, and expect the implementations to result in planned impacts. Moreover, implementations (e.g. a new information system developed according to EA) themselves can also be considered to be part of *Environment* and *Infrastructure* elements, and even *Information*, *Technologies* and *Work Practices*, if these elements include EA implementations.

The revised work system framework is depicted in Figure 1. The framework includes nine elements which all contribute to the operation of the system. Conforming to the original definitions (see Alter 2002), we define the elements for our adapted framework as follows.

- *Customers* are the internal and external users of EA products (e.g. principles, methods and models) and services (e.g. EA guidance) (adapted from Alter 2002). A typical use for EA products is their implementation, meaning both the implementation of organizational elements according to or in compliance with EA (see e.g. Armour et al. 1999b; Kaisler et al. 2005), and other use cases (see e.g. Rehkopf and Wybolt 2003; Lankhorst 2005; Bucher et al. 2006; Andersin and Hämäläinen 2007; Emery et al. 2007). Customers might include, for example, organization’s management, project managers, ICT developers and partners (see e.g. Niemi 2007).

- *Products and Services* include all EA products and services produced by the work system (adapted from Alter 2002).
- *Work Practices* consist of EA processes (e.g. planning, development and management) and the practices and methods utilized in their operation (adapted from Alter 2002).
- *Participants* include persons who perform any work in the EA work system (adapted from Alter 2002). These include a broad range of roles carrying out work in any of the EA processes, such as enterprise and domain architects, ICT developers and project managers (see e.g. Niemi 2007).
- *Information* consists of any information used or created by the EA work system participants as they produce the EA products and services (adapted from Alter 2002). To produce EA products, information on the entities to be depicted by the products (e.g. organizational structures, processes, systems, applications and services) is required.
- *Technologies* include all kinds of tools and techniques used by the EA work system participants to carry out their work (adapted from Alter 2002). Several tools, such as Rational Rose and UML, are available for modeling EA (see e.g. Kaisler et al. 2005).
- *Environment* encompasses the organizational, cultural, competitive, technical and regulatory factors that have an impact on the operation of the EA work system although it is not directly dependent on them (adapted from Alter 2002). For example, management support and organizational culture have an effect on the architectural performance of an organization (see e.g. Ylimäki 2006).
- *Infrastructure* consists of human, informational and technical resources that are required in the operation of the EA work system although they are situated and managed externally (adapted from Alter 2002). In addition to organizational information systems and training and support staff (see Alter 2002), these resources include sources of information necessary for the production of EA products and services. These sources of information, in turn, may include subject matter experts with knowledge and experience in a specific domain (e.g. business, information, information systems or technology) and various organizational descriptions and plans (see e.g. Babers 2006).
- *Strategies* include both the strategy of the EA work system and the strategy of the organization where the system operates (adapted from Alter 2002).

The focus group participants also agreed that the framework is generic enough to be used to depict an EA work system. Nevertheless, several additional points regarding the framework were brought out. First, it was emphasized that the temporal nature of EA should be taken into account. Specifically, the focus group agreed that each of the elements has its own life cycle (i.e. each element changes in a different rate), and even inside the elements different objects (e.g. technologies and work practices) may have particular life cycles. Therefore, we suggest that the work system elements should be connected to the life cycle phases of EA (c.f. Sherer and Alter 2004).

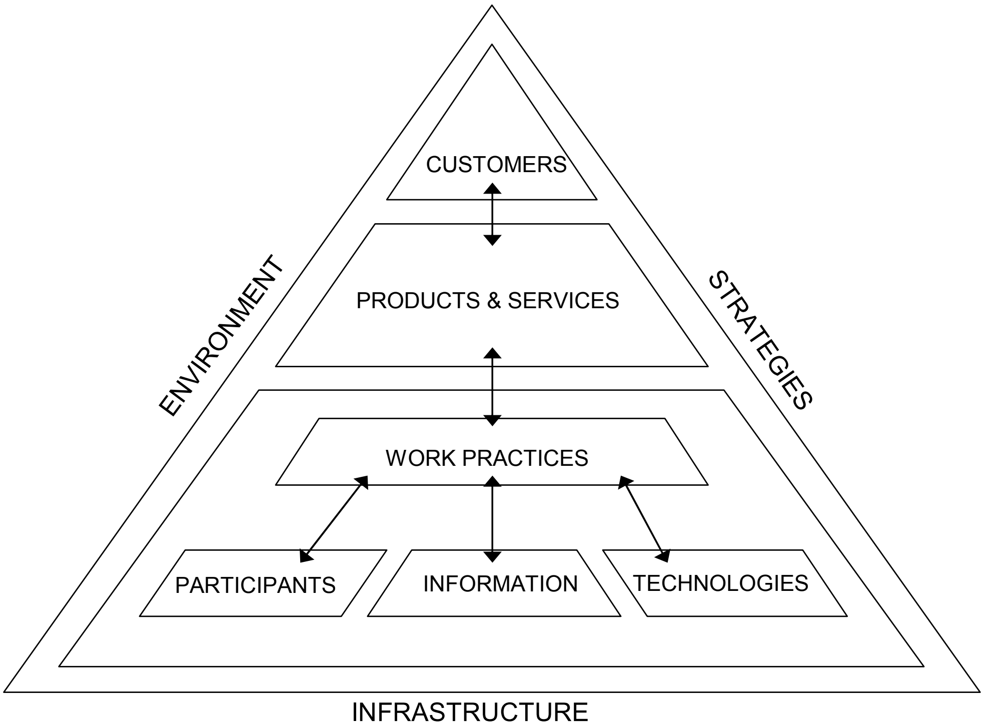

Figure 1. The revised work system framework (Sherer and Alter 2004)

Second, EA products and implemented EA can also be conceptualized from the temporal perspective. Individual EA products, such as architectural models depicting different viewpoints of the organization, have particular life cycles, as well as their implementations such as information systems and processes. The focus group stressed that it is always necessary to consider planned and implemented, as well as outgoing EA implementations. This presents the challenge of depicting the implemented EA in the framework, since it also is a source of risks not to be disregarded. In our adapted framework, the implementation viewpoint is included to the customer element. However, in the future it might be necessary to add an extra element for implementation to signify its importance.

Third, the focus group brought out that as well as all of the elements should implicitly include the temporal dimension, should they similarly include the aspects of security and competence. The focus group stated that competence is at least related to technology, work practices, participants, products and services, and customers. However, we consider that competence should be related to all elements that include stakeholder effort. Therefore, risks relating to the lack of competence may arise in at least the elements of participants, customers, infrastructure and environment; they are not merely related to participants as suggested in the original framework (c.f. Sherer and Alter 2004). Nevertheless, the focus group stated that lack of competence in this context refers more to the lack of common understanding about EA than to the lack of skills. Regarding organizational security, it was suggested that it should be similar, implicit aspect that crosses every element in the framework. Lack of security in the elements of EA work system was considered a risk by the focus group, and should not be included merely to the information element (c.f. Sherer and Alter 2004). According to the group, security influences EA and vice versa.

Fourth, the role of partners in carrying out work on EA was accentuated. However, it was commented that partners cannot be associated with one particular element due to their different roles in the operation of the system. According to the focus group, partners can directly carry out operative tasks in the EA work system, act as suppliers of necessary EA or ICT products and services, or even offer whole outsourced service interfaces for the operation of the EA work system. Moreover, the group accentuated that partners might as well be a source of risks, a point missing in the original framework (c.f. Sherer and Alter 2004). Consequently, we suggest that partners should be considered as participants if they have a role which involves performing operational tasks in the EA work system. If partners act as product or service providers or outsourcing partners, they can be considered as infrastructure. Internally managed ICT products, on the other hand, could be included into technologies.

Fifth, it was stated that the different roles of the management of the organization similarly make it difficult to classify management to any single element. According to the focus group, management is an important stakeholder of EA, providing necessary resources, steering EA by making architecturally significant decisions, observing and measuring the work system, and utilizing EA in organizational decision-making. Management does not directly carry out work in the system, but is a significant facilitator, user and also a developer of EA since its decisions set the general direction for the work in the system. Therefore, we consider management to be part of not only the environment (c.f. Sherer and Alter 2004) but also the participants, customers and infrastructure elements, depending on its role in the organization in question.

5 Potential Enterprise Architecture Risks

The generic work system risks presented by Sherer & Alter (2004) were adapted to be utilized as a basis for discussion in the focus group interview. The focus group participants generally agreed with the generic risks presented, but provided a number of additional risks and examples of risks' realization in practice.

The EA work system risks are displayed in Table 1, including both 1) factors that may lead to negative outcomes in the EA program, and 2) potential negative outcomes resulting from these factors. The table includes both the original risks (see Sherer and Alter 2004) and the additional risks mentioned in the focus group interview. Moreover, examples of risks' realization in practice, brought out in the interview, are displayed. The information from the interview is displayed in *italics*.

Table 1. Generic EA work system risks and examples of their realization (adapted from Sherer and Alter 2004; complemented by the focus group)

EA work system element	**Factors leading to negative outcomes**	**Negative outcomes**
Customers	▪ Disagreement regarding the requirements for EA products and services *- Insufficient source information on EA for producing products and services* *- Inconsistent requirements because of different competencies in comprehending products and services* ▪ Difficulty in using EA products or services *- Insufficient competence for using EA products and services correctly* *- Inadequate instructions and training* ▪ *Inadequate implementation of EA products and services* *- Inadequately high or low compliance between EA and its implementations* *- Inadequate temporal planning of implementation* *- Inadequate EA guidance to the implementation project (e.g. incorrect content or timing)* *- Inadequately narrow or wide scope of the implementation project* ▪ *Insufficient organizational security*	▪ Lack of use of EA products and services ▪ Dissatisfaction of customers ▪ *Misuse or misinterpretation of EA products* ▪ *Insufficient realization of EA objectives*

EA work system element	Factors leading to negative outcomes	Negative outcomes
Work Practices	▪ Poorly designed EA processes *- Burden of obsolete work practices* ▪ Incompatibility between work practices and other EA work system elements *- Lack of approval, authorization or need for work practices* ▪ Insufficient resources ▪ Inadequate planning and control mechanisms *- Insufficient comprehension of objectives* *- Insufficient observation of work practice feasibility* *- Insufficient feedback mechanisms from the customers and participants* ▪ *Insufficient organizational security*	▪ Inadequate EA process performance ▪ *Insufficient predictability of outcomes* ▪ *Insufficient documentation*
Products and Services	▪ Inadequate quality or cost of EA products or services to customer *- Inadequately high EA quality (positive risk)* *- Inadequately high initial costs* ▪ Incompatibility between customer requirements and EA products or services *- Inadequately simple or complex EA* *- Insufficient flexibility of EA* ▪ *Insufficient organizational security*	▪ Lack of use of EA products and services ▪ Dissatisfaction of customers
Participants	▪ Inadequate management of EA processes *- Lack of measurement of participants' work* *- Unclear organization and responsibilities* ▪ Lack of competence *- Incompatibility between participants and technology* *- Inadequate instructions and training* ▪ Lack of motivation and interest *- Lack of measurement of participants' work* *- Inadequate instructions and training* ▪ Poor conflict management ▪ Incompatibility between characteristics of participants and processes ▪ *Insufficient organizational security*	▪ Inadequate EA process performance ▪ Personnel problems

EA work system element	**Factors leading to negative outcomes**	**Negative outcomes**
Information	▪ Insufficient information quality *- Insufficient reliability of information (e.g. documented information vs. tacit knowledge)* *- Insufficient or vast amount of information* *-Insufficient information integrity* ▪ Insufficient information accessibility *- Unobtainable information even when access rights are correct* ▪ Insufficient information presentation ▪ Insufficient information security	▪ Inadequate EA process performance ▪ Participant frustration ▪ Information loss or theft
Technologies	▪ Inadequate usability of technology ▪ Inadequate technology performance for EA processes ▪ Technology errors ▪ Incompatibility between technologies Which all may result from e.g. *- Inappropriate technology (e.g. too old or new technology)* *- Unorthodoxly applied technology* ▪ *Dependence on technology providers* ▪ *Insufficient organizational security*	▪ Inadequate EA process performance ▪ Participant frustration
Environment	▪ Insufficient management support *- Insufficient resources (time, personnel, money) directed to the EA work system* ▪ Inconsistencies with organizational culture ▪ *Inconsistencies with partners or legislation* ▪ Incompatibility between environment and the EA work system *- Incompatibilities between EA and reality* *- Insufficient flexibility of EA* *- Insufficient competence for understanding EA* ▪ High level of turmoil and distractions ▪ *Insufficient organizational security*	▪ Diminished EA work system performance
Infrastructure	▪ Inadequate human infrastructure *- Unclear who to ask for input information for EA* *- Insufficient competence for participating in work on EA* *- Infrastructure consists of separate silos* ▪ Inadequate information system infrastructure *- Infrastructure consists of separate silos* ▪ Inadequate technical infrastructure ▪ *Insufficient organizational security*	▪ Diminished EA work system performance

EA work system element	**Factors leading to negative outcomes**	**Negative outcomes**
Strategies	▪ Poor alignment between organizational strategy and the EA work system *- Unclear or missing "big picture" of EA* *- Inadequate control of the effects of organizational strategy change on EA* ▪ Inadequate EA work system strategy for accomplishing work system goals *- Incorrect comprehension of strategy* ▪ *Insufficient organizational security*	▪ Ineffective EA work system performance

6 Enterprise Architecture Risk Management

In general, risk management can been seen as an activity of balancing 1) risk and reward and 2) processes and people (Lam 2003). Basically, the goal of risk management is to help the organization in achieving its objectives (Lam 2003). A proactive risk strategy enables the organization to plan and prepare for possible risks (Keyes 2005). Preparing for the known, predictable and unpredictable risks (Keyes 2005) requires a feasible risk management process, which usually consists of the following three phases (Bandyopadhyay et al. 1999; Lam 2003):

- Risk awareness and identification: Understanding of the various risk characteristics supports identification of the possible risks involved in any activities carried out in an organization. Furthermore, the actual severity and probability of a potential risk are even more crucial issues to be taken into consideration. A risk-aware organization addresses most risk management issues before they become too big problems.
- Risk measurement and analysis: Measurement is needed to be able to manage risks. Risk measurement seems to be a challenging task in any organization. Tools like scenario analysis (Lam 2003) or risk assessment based on critical success factors (see e.g. Keyes 2005) can be exploited in risk measurement and analysis.
- Risk control basically means the actions taken based on the risk measurement results.

In the EA domain, EA risk management supports the attainment of EA objectives (c.f. Lam 2003). Successful EA, in turn, supports the attainment of organizational objectives, such as organizational flexibility and agility (see e.g. Hoogervorst 2004). Likewise, unsuccessful EA can have serious consequences in the organization. EA is also essentially a tool for facilitating organizational risk management (see e.g. Morganwalp and Sage 2004), a viewpoint also shared by the focus group. In the focus group interview, it was underlined that general risk management practices should be applied in the EA domain as well. Even though EA-related risks are not currently considered in detail in organizations, there seems to be the need of identifying, measuring and controlling EA risks as well. Basically, EA risks can be considered as one category or type of risks the organization's risk management needs to deal with; consequently, EA risk management should not be separate from organizational risk management.

EA risk management can be seen as one of the tasks of the EA management (governance). The EA management team, assisted by everyone carrying out EA work, should identify possible risks. For example, a risk table may be used as a simple tool including each risk's category, probability of occurrence, and assessed impacts (Keyes 2005). These identified EA risks may also provide a feasible basis for EA metrics selection and vice versa. In EA risk measurement, self-assessment of quantitative measures (risk indicators) may be applied (Lam 2003) and risk measurement can bee seen as a responsibility of the EA management team. Finally, the EA management team should take actions based on the EA risk measurement results. However, the risk management responsibilities brought out here may be different in reality, as it was brought out in the interview that they are dependent on the organization of EA management in the specific company.

The focus group stated that EA planning is scenario-based, so it is important to consider the risks related to each scenario. Therefore, EA risks are one criterion for EA-related decision-making which aims at optimizing the risk-benefit ratio. Furthermore, risks still need to be managed and their outcomes measured in the decision follow-up. The relationship between EA risk management and EA decision-making and follow-up is described in Figure 2. Based on the focus group interview, the arrow from benefits and negative outcomes back to the risk factors was added to describe the cyclic nature of risk process; once in a while it is necessary to review the risk factors again to take into account any changes in the environment. This may also involve a follow-up decision.

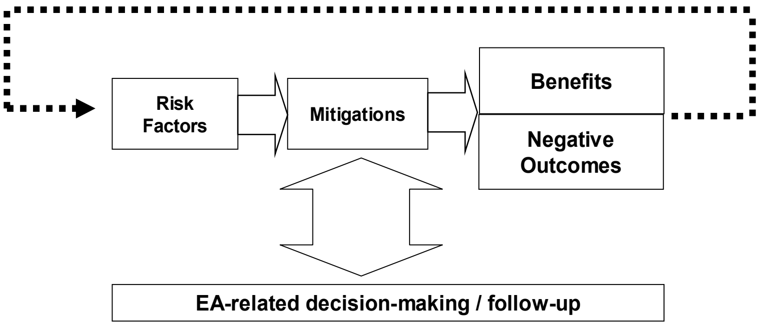

Figure 2. EA risk management vs. EA-related decision-making (adapted from Benaroch et al. 2006; complemented by the focus group)

The interview results also suggest that many of the EA related risks can be avoided – or at least mitigated – with the help of efficient and adequate communication on EA issues using a common language that is understandable by each stakeholder. According to the focus group, poor knowledge on EA in the organization is a risk since it impairs the identification of EA risks. Also a proper documentation of EA products and services supports risk mitigation. The focus group agreed that EA risk management is linked to EA maturity (c.f. Ylimäki 2007): in the lower maturity levels EA risk management does not necessarily need to be a defined process, but in higher levels of maturity risk management needs to be improved as the EA processes, products and implementations becomes more specified. It is also important to define EA risk limits (c.f. Lam 2003): the focus group stated that putting too much resources on EA risk management is a risk as well - the EA does not need to be perfect.

One obstacle to managing EA risks, brought out by the focus group, is the fact that it may be difficult to define the "owner" of the risk: who has the responsibility of dealing with EA risks; business management, EA management or some other stakeholder? Who is responsible of a single risk factor or its outcome? According to the focus group, responsibilities are definable on a project scope, but especially in those cases where a risk extends over two or more departments or lines of business (or any other silos in the enterprise) and is not connectable to any single project, responsibility issues may create challenges.

7 Summary and Conclusions

This study aimed at providing an overview of generic risks that can potentially be related to EA in companies by a literature review and a focus group interview of practitioners. Furthermore, potential classification schemes for the risks were charted from literature, and one of the schemes – the work system framework – was selected and discussed in the focus group interview. The framework also included a set of generic work system risks, which were also discussed in the interview. In addition, EA risk management was discussed. In this study, EA risks were conceptualized both as 1) factors that may lead to negative outcomes in the EA program, and 2) negative outcomes resulting from these factors. The latter was considered more important aspect in practice by the focus group interviewees.

Although the focus group participants agreed that the work system framework is generic enough to be used to depict an EA work system, they brought out several comments regarding to the framework:

- The life-cycle aspect of all of the EA work system elements should be more explicit in the framework. Particularly, both EA products and implementations have distinct life cycles, which should be considered.
- Implemented EA is an important source of risk in the EA work system so it should potentially be regarded.
- All of the EA work system elements are affected by the level of organizational security.
- Every EA work system element that involves human effort is prone to risks related to lack of competence. However, lack of competence in this context should be more conceptualized as the lack of common understanding about EA than the lack of skills.
- Both partners and management may have diverse roles in the operation of the EA work system so they cannot be associated with only one specific element.

The focus group also generally agreed with the generic EA work system risks presented, but provided a number of additional risks and examples of risks' realization in practice, which were added to the initial list of EA work system risks. Practitioners can use these results to identify typical risks related to each element in the EA work system, and to assure that risk management practices have been planned for all relevant risks. Moreover, the EA work system framework may be used to structure the EA approach in organizations, regarding other aspects than risks as well.

Regarding to EA risk management, the focus group interview results suggest that

- Even though EA-related risks are not currently considered in detail in organizations, there seems to be the need of managing them.
- EA risk management should be in a close connection or a part of organizational risk management. In turn, EA facilitates organizational risk management.
- The risk-gain ratio in EA-related decision-making should be optimized and decision follow-up implemented as a continuous activity.

- Communication, common language and sufficient EA documentation are important EA risk mitigation strategies.
- Clear risk management responsibilities are important in the EA context. In addition to the level of EA risks related to a single development project, more extensive responsibilities for risks should be defined.

As the validation of the results was rather limited in the course of this study, more empirical research is still needed. Especially, the EA risks presented should be further analyzed for their significance in practice and more concrete examples of their realization uncovered. Moreover, as the temporal nature of EA risks was not thoroughly investigated in this study, the risks should be studied with regard to time; for example, which risks are especially related to which steps in the EA program, levels of EA maturity, or phases of the EA life cycle. Uncovering the actual causal chains of risks is also an important area of further research, as well as the different levels of risks; in this study, only two levels were included. Following lines of research could also focus on quantifying the effects of the realization of EA risks on the organizational level. Also, implementing EA risk management as an organized, continuous activity that is linked to the organization's generic risk management is a challenge which requires further investigation.

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EVALUATION NEEDS FOR ENTERPRISE ARCHITECTURE

AISA Project Report

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Date: 18.10.2006
Authors: Tanja Ylimäki, Eetu Niemi
Status: Final

Summary

This report describes the first results of the second phase of the AISA project's second year. The first step of this phase aimed at 1) determining which aspects (components) need to be addressed while planning Enterprise Architecture (EA) evaluation and 2) identifying the evaluation needs for EA.

EAs are generally seen as blueprints which identify the focal parts of the organization (such as people, business processes, technology, information, and information systems), as well as the means that identify how these different parts collaborate to achieve the desired business objectives.

To determine the components needed when planning an evaluation program, a literature review was carried out. In order to define the evaluation needs for EA, the following components need to be addressed: 1) evaluation purposes, 2) audiences (stakeholders that require evaluation results), and 3) evaluation targets. Additionally, because the EA objectives provide input for defining these components, they are also considered in this study. To determine the evaluation needs for EA in terms of these components, another literature review was carried out. Moreover, the potential Critical Success Factors (CSF) for EA, which were defined during the first year of the research project, provided us as a feasible starting point for defining, in particular, the EA evaluation targets. The above components depicting the EA evaluation needs were discussed and validated in the focus group interview of seven practitioners from the participating organizations in August 8, 2006.

A general conclusion is that various evaluation purposes and various audiences may exist in an organization. The evaluation components are also dependent upon each other. For instance, the EA evaluation targets depend, at least, on the EA objectives, the evaluation purposes, and the audiences. Samples of what the evaluation components may include are provided in the report to stimulate the discussion in the organizations planning their EA evaluation.

The most important targets to be evaluated – especially in organizations that are in the early phases of their EA development – seem to be 1) scoping and purpose of EA, 2) communication and common language, 3) commitment and 4) EA models and artifacts. Additionally, because some of the evaluation questions cannot be incorporated into any specific CSF, the entire EA program is considered as a separate evaluation target. Perhaps the most pivotal, and the most difficult, question related to the entire EA program, is the question of evaluating and demonstrating the business value of EA.

It should also be remembered that EA evaluation should not be conducted in isolation; it must be compatible with, or integrated into, the other evaluation or measurement systems used in the organization.

The next steps of the project will proceed with selecting some of the evaluation targets for further scrutiny. Quality attributes will be refined and simple and usable metrics will be defined for each of these evaluation targets.

Contents

1 Introduction

This report describes the first results of the AISA Project's second phase in the second year. The first step of this phase aimed at 1) determining which aspects need to be considered while planning Enterprise Architecture evaluation and 2) identifying possible evaluation needs for Enterprise Architecture. The step consisted of the following tasks (Figure 1):

1. Literature review and analysis: Determining the evaluation components was carried out by a literature review. The initial evaluation needs for EA (in terms of evaluation components) were determined based on a previous study done in the research project, updated and complemented by a literature review.
2. Workshop/focus group interview (Krueger and Casey 2000): Review, discussion and validation of the evaluation needs for EA was carried out in a workshop participated by seven practitioners from the co-operating companies. The workshop took place in Helsinki, August 8th 2006. Three researchers participated to the workshop; one acted as a leader of the workshop discussion and two took notes. The workshop discussion was also recorded for reviewing and completing the notes.
3. Analysis and consolidation of the results: The discussion in the workshop (focus group interview) was analyzed with the help of the tape-recordings and notes. Evaluation needs were derived from the issues brought out during the workshop discussion. These results were combined with the literature review results to be represented in this report.

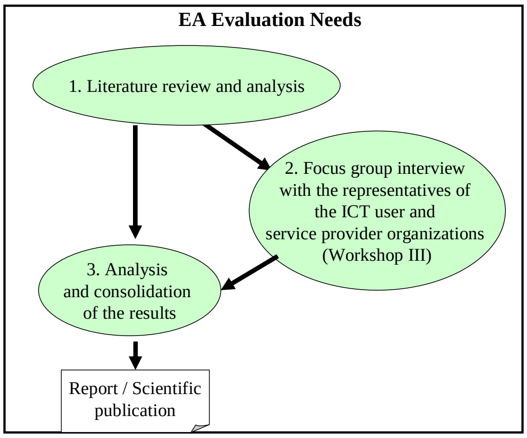

Figure 1. The steps of defining the evaluation needs for EA.

The remainder of this report is organized as follows. In the next section, we shortly describe the main concepts of Enterprise Architecture, quality, and evaluation. In the proceeding section, the evaluation needs for EA are described in terms of appropriate evaluation components. Following this, the implications for the practitioners are discussed and the last section summarizes the report.

2 Enterprise Architecture and Quality

Architecture is generally defined as "the fundamental organization of a system, embodied in its components, their relationships to each other and the environment, and the principles governing its design and evolution" (IEEE 2000). Besides this rather static definition of architecture, it can be understood more functionally to gain an understanding of what activities are associated with architecture:

- Architectures are described with different models for different viewpoints, layers or dimensions of the architecture to lay out different aspects of the system or enterprise for analysis and planning of designs, evaluation of them, and documentation of the implemented constructs (Zachman 1987; Spewak and Hill 2000; The Open Group 2002).

- Architecture descriptions are used for further specification, design and development work on systems that are within the architecture or adjoin it over an interface. Architecture descriptions are in the case of EA very probably created by different roles and different people than those who use them for this further work.

Enterprise Architecture (EA) can be seen as a collection of all those models necessary for managing and developing an organization (Halttunen 2002). It is vital that Enterprise Architecture is derived from the visions and business strategies of an organization. Only then the enterprise architecture enables the organization to achieve its business goals (Armour, Kaisler et al. 1999a). Lately the concept of Enterprise Architecture has been defined as follows (Kaisler, Armour et al. 2005):

Enterprise Architecture "identifies the main components of the organization, its information systems, the ways in which these components work together in order to achieve defined business objectives, and the way in which the information systems support the business processes of the organization. The components include staff, business processes, technology, information, financial and other resources, etc. Enterprise architecting is the set of processes, tools, and structures necessary to implement an enterprise-wide coherent and consistent IT architecture for supporting the enterprise's business operations. It takes a holistic view of the enterprise's IT resources rather than an application-by-application view."

2.1 High-Quality Enterprise Architecture

An Enterprise Architecture, to be successful, needs to be understood, accepted and used in everyday business functions, including also the various activities conducted by the top-management. The success needs also to be measured in order to ensure that desired results are achieved. The success, and also the quality, of EA could be measured, for example, by the extent it supports 1) the information system development projects, 2) the top management's business decisions, and 3) ICT enhancement in the organization from the CIO's point of view.

While there is no widely accepted definition of a high-quality EA, we have suggested (Ylimäki 2005; Ylimäki 2006) that ***EA has high quality*** if it

- conforms to the agreed and fully understood business requirements,
- fits for the purpose, which is to gain business value through EA, and
- satisfies the different stakeholders' (e.g. the top management, IT management, architects, developers) expectations in a cost-effective way and understands their current needs as well as the future requirements.

The different views of EA quality presented above implicitly imply that the quality of EA is more than merely the quality of the implemented EA, indicating that it is successfully used. The quality of EA may also refer to the quality of EA documentation, the quality of the EA development process, the quality of EA governance (process), and so forth.

2.2 Critical Success Factors for Enterprise Architecture

Critical success factor (CSF) is a common concept used e.g. in the context of total quality management (Badri, Davis et al. 1995), software architectures (Bredemeyer Consulting 2000) or project management (Clarke 1999). We have suggested (Ylimäki 2005; Ylimäki 2006) that ***critical success factors for Enterprise Architecture*** are the things that have to be done exceedingly well in order to gain high quality EA which in turn enables the business to reach its business objectives and gain more value. However, EA is not the silver bullet, and the EA success does not happen over night. The EA effort "provides an opportunity to get more value from the architecture, but realizing that value takes time and a long-term strategic process" (Boster, Liu et al. 2000).

During the first year of the AISA project potential CSFs for EA (Figure 2) were defined (Ylimäki 2005; Ylimäki 2006). A brief description of each potential CSF is given in Table 1.

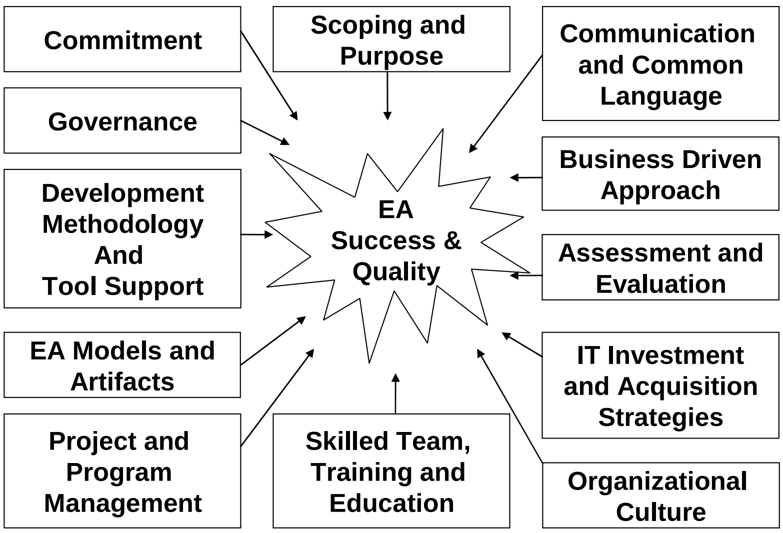

Figure 2. Potential Critical Success Factors for EA.

Table 1. Brief descriptions of the potential Critical Success Factors for EA.

CSF	Description/Content
Scoping and Purpose	Includes the definition of architecture (EA/SA) in the organization, the key stakeholder groups, the mission, goals and direction of EA, the purpose of EA and how wide organizationally, how deep and detailed, and how fast should the EA be developed in the organization.
Business Driven Approach	Includes the business linkage of architecture (EA) development, business-IT alignment, the business requirements, as well as the requirements set by the various stakeholders, and the equivalency between the requirements and architecture.
Communication and Common Language	Deals with the definition of architectural concepts (the common vocabulary), the definition of communications plan and strategy, and the success of architecture related communication.
Commitment	Refers to the commitment and involvement of the top-management in the architectural work, as well as the organizational buy-in.
Governance	Relates to issues such as governance (and guidance) structures, roles, responsibilities, processes and activities, change management processes (both the organizational and the architectural changes), and risk management processes.
IT Investment and Acquisition Strategies	Deals with the relationship (and dependency) between architectures or architectural work as well as with the IT investment and acquisition strategies of the organization.
Development Methodology and Tool Support	Deals with issues such as the definition and usage of the architecture frameworks, development methods and tools in architecture development and management.
EA Models and Artifacts	Deals with issues such as developing a documentation plan, collecting and analyzing the business requirements, ensuring that all necessary views are modeled providing a coherent and concise picture of the enterprise (current and future models), and developing a transition plan.
Assessment and Evaluation	Deals with the definition of issues, such as, architecture evaluation targets, architecture evaluation purposes and audience, architecture evaluation process and criteria (metrics), data gathering and analysis techniques.
Skilled Team, Training and Education	Refers to issues such as the capabilities and skills of the architecture team, the architecture/business training of architects, as well as other stakeholders.
Organizational Culture	Deals with issues such as the organization's readiness to develop and utilize EA, attitudes towards architecture approach, attitudes towards changes in general, and the organizational changes the architecture development may lead to.
Project Management	Deals with issues such as the coordination between various (architecture) projects, utilization of project milestones and checkpoints for architectural evaluation or guidance, taking advantage of lessons learned and best practices as well as being on budget and schedule.

3 Evaluation Components

Evaluation can be described as "a process of determining merit, worth, or significance" (Lopez 2000). ***Program evaluation*** refers to "the thoughtful process of focusing on questions and topics of concern, collecting appropriate information, and then analyzing and interpreting the information for a specific use and purpose" (Taylor-Powell, Steele et al. 1996). However, the evaluation discipline lacks a general theory, and in the different areas of knowledge different approaches are applied (Lopez 2000). An example of the categorization of these various approaches is briefly depicted in Table 2. The categories seem not to be exclusively distinguishable, especially, if the Consumer- and Participant-Oriented approaches are combined, the resulting approach can be regarded as the Stakeholder-oriented approach, because Consumer (or Customer) is one of the stakeholders to be kept on mind.

Table 2. An example of categorization of evaluation approaches (Fitzpatrick, Sanders et al. 2004).

Approach	Description
Objective-oriented	Focuses on making clear the goals and objectives and measuring how the project has done in reaching them. This approach is suitable if measuring outcomes is a major purpose of the evaluation.
Management-oriented	The aim is to identify and provide information needed by e.g. the project managers. This approach is suitable if a major purpose of the evaluation is program development.
Consumer-oriented	The aim is to provide information for users of products or services. This approach is suitable when either improving products or services or helping users to select among different products or services.
Expertise-oriented	The arguments for and against an action or proposal are laid out, as in a trial. This approach is suitable if the purpose of the evaluation is to determine whether or not to continue a project/program.
Adversary-oriented	Provides a balanced examination of all sides of controversial issues, highlighting both strengths and weaknesses.
Participant-oriented	Program participants and stakeholders are the key sources of both questions and the information to answer the questions. This approach is suitable for program improvement purposes.

Many other classifications exist, too (see e.g. Lopez 2000). Basically, evaluation focuses on products or processes. This viewpoint has been adopted particularly in the discipline of quality management aiming at improving the quality of products and processes (Juran and Godfrey 2000; Dale 2003). We share the similar viewpoint in this study: EA evaluation can roughly be divided into the evaluation of 1) EA models and artifacts (product view) and 2) the rest of the CSFs described in Figure 2 and Table 1 (process view). This report focuses on the evaluation needs for EA including also the EA models and artifacts on a general level. A more detailed analysis of the evaluation needs for the architecture models and artifacts is described in (Hämäläinen 2006).

A lot of literature exists on evaluation (Shadish, Cook et al. 1991; Taylor-Powell, Steele et al. 1996; Lopez 2000; Stufflebeam 2001; Fitzpatrick, Sanders et al. 2004; Chen 2005). In Table 3 the building blocks, the components, for evaluation are briefly described. All the components need to be addressed while planning the EA evaluation.

Table 3. The components of evaluation planning.

Component	Description	References
Purpose	The purpose of the evaluation: - Why are we doing the program? - Why are we doing the evaluation? - What's the point? What do we want to accomplish?	(Taylor-Powell, Steele et al. 1996), (Titcomb 2000)
Target	The object under evaluation (to delimit the factors to be considered): - What are we going to evaluate (the whole program, just a particular component, or some components)?	(Lopez 2000), (Taylor-Powell, Steele et al. 1996)
Audience	Potential users of the evaluation information/results: - Who will use the evaluation (results)? - How will they use it? - What they want to know? What questions will the evaluation seek to answer?	(Taylor-Powell, Steele et al. 1996; Grasso 2003)
Quality Attributes and Metrics	The characteristics of the target that are to be evaluated - What information will help answer the questions? - What information do you need to answer the questions?	(Taylor-Powell, Steele et al. 1996; Lopez 2000), (Titcomb 2000)
Yardstick or Standard	The ideal target against which the real target is to be compared.	(Lopez 2000; Titcomb 2000)
Data Gathering Techniques	The techniques needed to obtain data to analyze each criterion/indicator: - What sources of information will be used? - What data collection method(s) will be used? - What instruments (e.g. recording sheet, questionnaire, video or audio tape) will be used? - When will the data be collected (e.g. before and after the program, at one time, at various times, continuously, over time)? - Will a sample be used? - Who will collect the data? - What is the schedule for data collection?	(Taylor-Powell, Steele et al. 1996; Lopez 2000), (Titcomb 2000)
Synthesis Techniques (Data	Techniques used to judge each criterion and, in general, to judge the target, obtaining the results of evaluation: - How will the data be organized or tabulated?	(Taylor-Powell, Steele et al. 1996; Lopez 2000), see also (Grasso 2003)

Component	Description	References
Analysis Techniques)	- What, if any, statistical techniques will be used? - How will narrative data be analyzed? - Who will organize and analyze the data? - How will the information be interpreted and by whom? - How will the evaluation be communicated and shared? To whom?	
Evaluation Process	Series of activities and tasks by means of which an evaluation is performed: - What steps are needed? E.g. planning or preparation (evaluation design), examination (data gathering), decision making (synthesis, analysis, documentation) - When will the steps be conducted? - How long will it take to conduct each step, to collect the data needed? - Who conducts the steps? Who collects the data? - How will the results be documented, reported, communicated? - Who will receive the report? Will it answer their questions?	(Lopez 2000) (Taylor-Powell, Steele et al. 1996), (Titcomb 2000)
Manage the evaluation	Responsibilities, budget and timeline. Risks. - What resources do you need? - Whose time and how much of it is available to work on evaluation? - How much may the evaluation work cost? - What kind of expertise is needed to conduct the evaluation? - When is the evaluation (information) needed? (the flexibility is needed; evaluation should be adjusted so that it is completed when it will have the maximum impact) - What threats will damage the integrity of the data and the conclusions we want to draw? - Do you foresee any barriers or obstacles?	(Taylor-Powell, Steele et al. 1996) (Titcomb 2000) (Grasso 2003)

In the workshop discussion, it was brought up that also the objectivity of evaluation and evaluation information need to be addressed. To some extent, it must be accepted, that all evaluation information is not necessarily very objective, and different evaluators may come up with different results. To minimize the diversity of the results, both the evaluation process and the analysis techniques should be detailed enough to guide the evaluation work to ensure that the reliability of the evaluation results is on an acceptable level.

Relationships between the components are, to some extent, depicted in Figure 3. EA objectives are included in the figure because they affect both the purposes and the targets of EA evaluation by providing input for them.

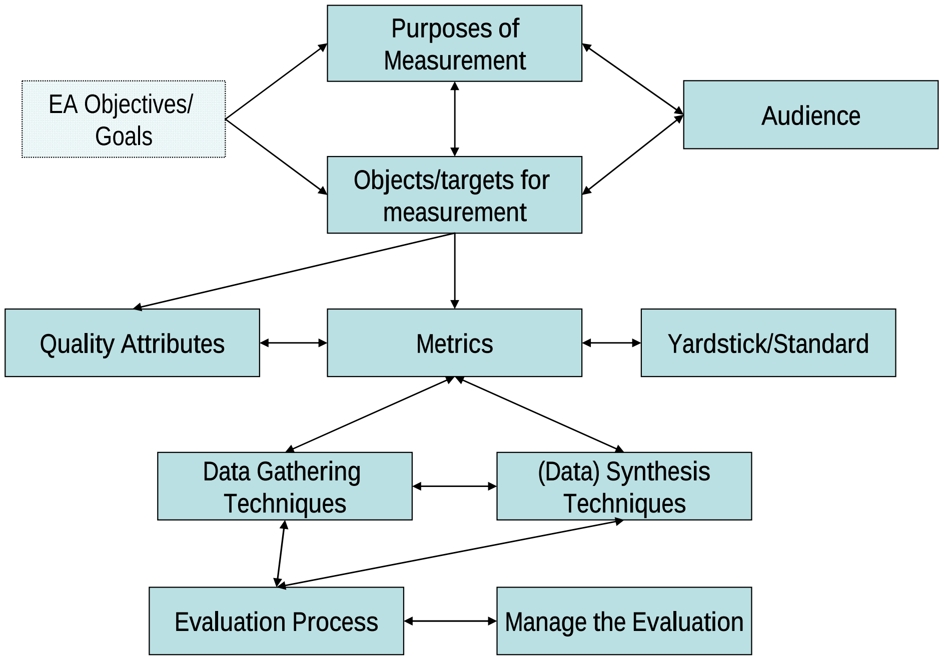

Figure 3. EA Evaluation components.

Since the aim of this step of the AISA project is to determine the EA evaluation needs, the rest of the report focuses on the following evaluation components: 1) EA objectives, 2) evaluation purposes, 3) audiences, and 4) evaluation targets.

After addressing these components, we are able to go on defining suitable evaluation criteria (quality attributes), and usable and simple metrics to evaluate each target.

4 EA Objectives

EA objectives define the goals for the EA approach in the organization; why it wants to apply the EA approach and what it wants to achieve through EA. Even though the EA objectives need to be defined in each organization based on, for instance, the business or IT strategy of the organization, some common features of these goals can be seen. Based on the literature review, several possible objectives were found to drive the EA work. The objectives are roughly categorized into 1) technology related, 2) strategic, 3) business, 4) financial and 5) miscellaneous objectives. Samples of EA objectives in each category are listed in Table 4, where, especially, the issues brought up in the workshop are referred to as (FGI 2006). More objectives are listed in the Appendix 1

In the workshop, one important trigger for EA work was brought up, namely the ever more complex and constantly changing environment the organizations have to deal with. There are complexities in the business environment, as well as in the existing information system environment (legacy systems). It has become ever more challenging to control this multifaceted environment – no one, nowhere, understands the "big picture", and difficulties arise especially in the decision making process. As a conclusion, there may be no way of seeing how a decision affects the different parts of the organization (processes, information systems, people, technology, and so forth). EA has been suggested to be one possible approach for putting some structure into the chaos as well as to manage the changes needed for improving the business and the organization.

Table 4. Some examples of EA objectives.

Category	Objective	Literature References
Technology	Increased interoperability and integration of e.g. - Information systems supporting the business - Data, business processes - Legacy, migration and new systems (FGI 2006) → aiming at simpler systems and lower costs (FGI 2006) Also the conformance of new technologies to EA and the effects of obsolete technologies should be taken into consideration (FGI 2006)	(Hjort-Madsen 2006) (The Open Group 2002) (OMB FEA Program Management Office 2004) (CIO Council 2001) (IAC 2005) (GAO 2003) (Anaya and Ortiz 2005)
Strategic	More strategic agility, e.g. - Business adaptability - Strategic adaptability - Increased organizational flexibility/agility	(Bhathena 2006) (Morganwalp and Sage 2004) (Kamokawa and Okada 2005) (Saha 2004) (Aziz, Obitz et al. 2005) (Guevara and Workman 2006)
	Better economies of scale	(Syntel 2005)

Category	Objective	Literature References
	Volume thinking (FGI 2006)	(CIO Council 2001)
Business	Business Process Excellence; Low cost provider, emphasizing efficient, reliable and predictable operations	(Ross and Weill 2005) (Van Grembergen and Saull 2001) (Kamokawa and Okada 2005)
	Improved Business-IT alignment	(Morganwalp and Sage 2004) (CIO Council 2001) (Aziz, Obitz et al. 2005; Malan and Bredemeyer 2005)
	Better management of IT investments, e.g. - To inform, guide, and constrain the decisions for the enterprise - Faster, simpler, and cheaper procurement - Reduced risks	(Van Grembergen and Saull 2001) (The Open Group 2002; Saha 2004) (CIO Council 2001)
	Reduced product/service time to market / time of delivery, leading to e.g. - More product leadership	(CIO Council 2001; Aziz, Obitz et al. 2005; Ross and Weill 2005) (Morganwalp and Sage 2004; IAC 2005),(GAO 2003), (Guevara and Workman 2006)
	More sophisticated asset management, e.g. - Predicting and controlling complex technical systems	(Morganwalp and Sage 2004), (Hjort-Madsen 2006)
Financial	Lower IT Costs - Lower IT operations costs - Improved IT operations efficiency - Lower support and maintenance costs - Reduced application development, implementation and maintenance cost - Lower acquisition costs - More efficient use of software licenses	(Ross and Weill 2005), (Morganwalp and Sage 2004; Aziz, Obitz et al. 2005) (The Open Group 2002) (Syntel 2005) (Van Grembergen and Saull 2001) (FGI 2006)
Miscellaneous	Improved Innovation, e.g. - Emerging technologies research - Supporting knowledge development and management	(The Open Group 2002) (Kamokawa and Okada 2005), (Van Grembergen and Saull 2001) (Morganwalp and Sage 2004)
	Improved change management, e.g. - EA "is the means to describe your business in terms of people, processes and IT in order to facilitate rapid and valuable impact analysis, thereby enabling performance-oriented change management" (MEGA 2006) - to support cultural and organizational changes, assist in implementing change - Life cycle thinking and change management (FGI 2006)	(CIO Council 2001) (OMB FEA Program Management Office 2004) (Schekkerman 2004b) (de Boer, Bosanque et al. 2005) (IAC 2005) (GAO 2003) (MEGA 2006) (Kluge, Dietzsch et al. 2006b) (Guevara and Workman 2006)

5 EA Evaluation Purposes

EA evaluation purposes provide the justification for doing the EA evaluation in the first place. They should answer questions like why are we doing the evaluation and what do we want to accomplish. EA evaluation purposes are, to a great deal, dependent on the objectives of EA. Additionally, as it was brought up in the workshop discussion, different audiences (stakeholders) have different needs for evaluation, and thus, different evaluation purposes are required. Especially the business management is mainly interested in financial measurement, while the IT organization may be more interested in technological aspects. Also, the time frame of evaluation affects the evaluation purposes; in the long run the organization is more likely to be able to evaluate the business value of EA (the business impacts) than in the early phases of the EA development cycle.

The EA evaluation purposes were planned to be organized according to the categories described in Table 2. However, this proved to be a non-trivial task because some evaluation purposes seemed to fit into several categories. Hence, we decided to define more informative categories to depict high-level purposes for EA evaluation. The categories used in organizing the EA evaluation purposes are the following: 1) Aiding decision making, 2) Describing results, 3) Assessing/Assuring results, 4) Analyzing results, 5) Describing process/product, and 6) Analyzing process/product. It should be noticed that this categorization is only a suggestion and other categorizations can be created. Samples of EA evaluation purposes in each category are listed in Table 5. The table also includes potential alternatives of the categorization described in Table 2. More EA evaluation purposes are listed in the Appendix 2.

Table 5. Some examples of EA evaluation purposes.

Category	Purpose	Literature References
Aiding decision making (Management-oriented/ Expertise-oriented)	To inform management decisions and actions to e.g. - Direct EA or EA program improvement - Inform EA policymaking - Support decision making about the EA program/project itself → to steer the program "To ensure that expected benefits from the EA are realized and to share this information with executive decision-makers, who can then take corrective action to address deviations from expectations" (GAO 2003)	(Basili, Caldiera et al. 1994) (ETS Office 2003) (Stufflebeam 2001) (GAO 2003)
Describing results (Objective-oriented)	To provide stakeholders with accurate accounting of EA program results, by e.g. - Demonstrating alignment with business strategy - Demonstrating the (business) value of EA, - Demonstrating the benefits of EA - Demonstrating the value of IT/IT investments - Evaluating the effectiveness of EA - Evaluating the quality of the (EA) processes and products	(Van Grembergen and Saull 2001; Aziz, Obitz et al. 2006) (Basili, Caldiera et al. 1994) (GAO 2003) (Department of Veterans Affairs 2001)

Category	Purpose	Literature References
Assessing / assuring results (Objective-oriented)	To determine if the objectives of EA or EA program are achieved, by e.g. - Demonstrating alignment with business strategy - Demonstrating the (business) value of EA, - Demonstrating the benefits of EA - Demonstrating the value of IT/IT investments - Evaluating the effectiveness of EA - Evaluating the quality of the (EA) processes and products - Performing cost-benefit analysis An important aspect of assuring results is also to evaluate different architecture solutions in order to choose the most suitable solution for the organization	(Aziz, Obitz et al. 2006) (Van Grembergen and Saull 2001); (Stufflebeam 2001) (Morganwalp and Sage 2004) (Basili, Caldiera et al. 1994; GAO 2003) (Department of Veterans Affairs 2001); (IEEE 1998)
Analyzing results (Objective-oriented)	To examine EA or EA program objective and benefit achievement trends (e.g. short or long term), by e.g. - Assessing the progress towards goals of the EA development/deployment - Assessing the progress towards target architecture	(Basili, Caldiera et al. 1994) (GAO 2003); (ETS Office 2003); (Stufflebeam 2001) (Department of Veterans Affairs 2001)
Describing process /product (Participant-oriented/ Consumer-oriented)	To determine cause and effect relationships in EA program or EA, e.g. - Assessing the impacts of changes - Evaluating the impact of corrective action - Evaluating the impact of decisions made (e.g. how they have affected the target architecture)	(The MITRE Corporation 2004; de Boer, Bosanque et al. 2005); (Basili, Caldiera et al. 1994; Stufflebeam 2001)
Analyzing process/ product (Management-oriented)	To explicate and illuminate EA or EA program, for e.g. - Identifying and assessing risks (operational, related to EA, related to business, related to different views of architecture (business, information, application, technology), to e.g. avoid over engineering (over engineering is a risk and may result in wasted resources) - Clarifying and prioritizing requirements - Understanding and documenting architecture - Organizational learning	(The MITRE Corporation 2004) (Rajput 2004) (Stufflebeam 2001; Jayashetty, Manjunatha et al. 2004) (Abowd, Bass et al. 1997)

6 EA Evaluation Audiences

EA Evaluation Audience refers to the potential users of the evaluation information and results. While planning EA evaluation, those EA stakeholder groups that may need or require evaluation results, need also be defined. Additionally, also the possible ways these stakeholder groups will use the information, should be discussed and determined.

In the beginning of the workshop, potential stakeholder groups of Enterprise Architecture were discussed and these are described in (Niemi 2006). In Figure 4, some potential stakeholders – audiences – of EA evaluation results are described. Audiences that were added based on the workshop discussion are: Business Process Management/ Process Developers, Business Users, Product Management, Projects/ Project Managers, and Research and Development (R&D).

However, each organization has to discuss and determine the relevant stakeholders for its EA approach, as well as for its EA evaluation results. Each audience may have different needs for evaluation because they are interested in different points of view (financial, strategic, efficiency, and so forth). A balance, or priority, between these various needs have to be addressed. In practice, one or two of the audiences are usually dominating, and therefore, their needs may be given first priority.

An important stakeholder group, that is not actually an evaluation information audience, but assists the EA evaluation team (either internal or external evaluators) to format the evaluation information using a language that is comprehensible for each audience, is Internal Communications.

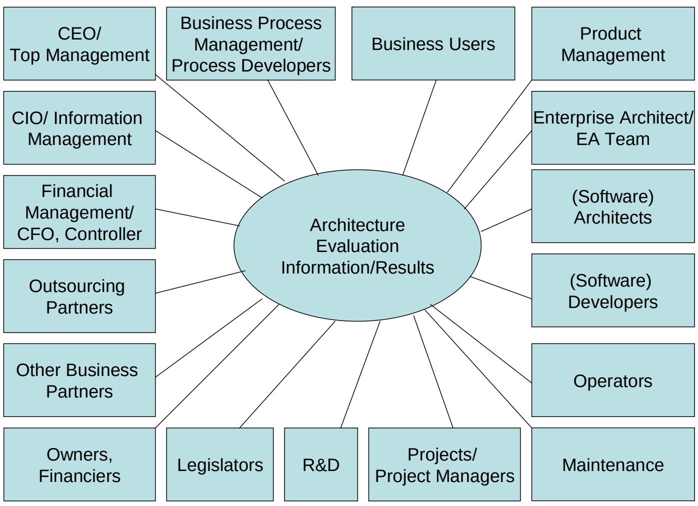

Figure 4. Some possible audiences for EA Evaluation results.

7 EA Evaluation Targets

CSFs for EA, which were briefly described in Table 1, provided a starting point for determining the EA evaluation targets. However, it should be remembered that the evaluation targets are also dependent on the objectives of EA, the purposes of EA evaluation, and the various audiences (stakeholders) that may require the evaluation results; therefore, the compatibility between these evaluation components should be assured.

The characteristics of the evaluation targets indicating the aspects or qualities of the targets that will be evaluated, are usually described with the help of quality attributes. Unfortunately, there is no consensus on what the quality attributes for EA are or should be. Some preliminary studies, suggesting quality attributes especially for EA, have been conducted (van den Bent 2006; Veltman-van Reekum 2006). At this point of the research project, an alphabetical list of possible attributes is provided (see Appendix 3) to stimulate the determination of the characteristics that are to be evaluated about each target.

EA evaluation targets are represented in Table 6. Some sample evaluation questions are related to each target. Especially, the issues addressed in the workshop discussion are referred to as (FGI 2006). Additionally, a more detailed analysis of the evaluation needs for architecture models and artifacts is represented in (Hämäläinen 2006).

While some of the evaluation needs (evaluation questions) cannot be incorporated into any specific CSF, also the entire EA program is considered as a separate evaluation target. Evaluation questions related to the entire EA program are, particularly, how is the program progressing, what is the business value of the EA (program), how mature is the EA (program), or how well does EA ensure, for instance, business process excellence, customer orientation, innovation or strategic adaptability.

Table 6. EA Evaluation targets and sample evaluation questions.

Evaluation Target and Sample Evaluation Questions	Literature References
Scoping and Purpose	
- To what extent are the objectives and benefits of the architecture approach identified, documented and approved in the organization? How clear or understandable are the objectives and benefits? - Are the objectives derived from the business or IT strategies of the organization (FGI 2006)? - To what extent are the stakeholders of EA and their concerns identified? - To what extent does the architectural work cover the organization? - What is the scope of the EA? How has it changed/expanded during the last quarter/year etc.? How controllable is the EA scope? (FGI 2006) - To what extent are the objectives and benefits of the architecture approach evaluated in order to ensure that they are met?	(Jayashetty, Manjunatha et al. 2004) (Ylimäki 2006) (Hilliard, Kurland et al. 1996; Hilliard, Kurland et al. 1997) (Morganwalp and Sage 2004) (IAC 2003) (NASCIO 2004) (Motola 2006)

Evaluation Target and Sample Evaluation Questions	Literature References
Business Driven Approach	
- To what extent are the business requirements taken into account in architectural planning? - To what extent are the business requirements identified and documented? - To what extent are the business requirements prioritized and how they are prioritized? To what extent are they conflicting or competing? To what extent is the architecture team aware of the changes in business requirements? Has the architecture team all necessary information related to the business? (FGI 2006) - To what extent do the requirements cover the concerns of stakeholders? To what extent are the requirements of different stakeholders in balance (FGI 2006)? - To what extent are the requirements relevant to e.g. business strategy? - To what extent is the equivalency between the requirements and architecture assured?	(Luftman 2000; ETS Office 2003) (Ylimäki 2006) (OMB FEA Program Management Office 2004; OMB 2005) (Curran 2005) (Hilliard, Kurland et al. 1996; Hilliard, Kurland et al. 1997; Burk 2005) (CIO Council 2000)
Communication and Common Language	
- To what extent are the architectural concepts defined, documented, approved and used in communication? - To what extent is the communication on architectures and architectural work established between different stakeholders? - To what extent are the architects/the architecture team capable of communicating with different stakeholders using the language these stakeholders can comprehend (FGI 2006)? - To what extent are the relevant stakeholders and their concerns identified? - To what extent is communication evaluated? How effective and successful is the communication? Has the architecture communication reached the key stakeholders? Has the communication been understandable? - Has the communication been on such a level (granularity) that it satisfies the needs of the stakeholders (FGI 2006)? - To what extent has the architects/architecture team been capable of communicating the top management whether the business requirements can be implemented in the schedule set by the business (FGI 2006)? - To what extent are the communication challenges identified and responded to?	(ETS Office 2003; Ylimäki 2006) (IAC 2003; OMB 2005) (NASCIO 2004; Tash 2006)
Commitment	
- To what extent is the (top) management aware of the architecture approach of the organization (FGI 2006)? - To what extent is the (top) management aware of the objects and benefits of EA? - To what extent is the (top) management committed to and involved in the architecture approach? Does the management sponsor the EA approach (FGI 2006)? - To what extent are the other stakeholders aware of the architecture approach of the organization (FGI 2006)? - To what extent are the other stakeholders committed to and involved in the architecture approach?	(ETS Office 2003) (Jayashetty, Manjunatha et al. 2004; Ylimäki 2006) (Kamokawa and Okada 2005) (GAO 2003; IAC 2003)

Evaluation Target and Sample Evaluation Questions	Literature References
- To what extent do the various stakeholder groups participate in the architecture development?	
Governance - To what extent is the governance structure defined, documented, approved and established? Are the roles, responsibilities and authorizations defined, documented and complied? Are the authorizations adequate enough (FGI 2006)? - To what extent are the governance processes and tasks defined, documented and implemented? - Does the governance have the necessary resources (time, money, etc.) (FGI 2006)? - How is the architecture work/governance positioned in the organization (e.g. in the information system management/CIO or elsewhere in the organization chart)? How successful has this solution been? Is there any need to reposition the architecture work/governance? (FGI 2006) - To what extent are architecture policies/ guiding principles defined, documented and approved? - To what extent does the governance assure e.g. the effectiveness of participation, presence of right processes, or the alignment with organization's strategic goals? - To what extent are both the architectural and organizational changes and risk management issues taken into account? - How effective are the EA governance processes, structures and practices? How helpful are they considered e.g. by the projects (FGI 2006)? Has there been a need to change these processes? How many changes have been needed? (FGI 2006) - To what extent do the governance processes provide feedback to the strategic or business planning processes (FGI 2006)? - To what extent is the EA governance process integrated into other business management processes (FGI 2006)? - Is there a formalized EA compliance process? How effective is it? - How effective is the planning, tracking and utilization of resources?	(Jayashetty, Manjunatha et al. 2004) (ETS Office 2003; Curran 2005; Ylimäki 2006) (GAO 2003) (Kamokawa and Okada 2005) (Ross 2004a) (Hilliard, Kurland et al. 1996; Hilliard, Kurland et al. 1997; Weill and Woodham 2002; Burk 2005) (OMB 2005) (CIO Council 2000; IAC 2003) {NASCIO, 2004 #729}
IT investment and Acquisition Strategies - To what extent does architectural work influence the IT investments and acquisition strategies of the organization? - How many investments comply with EA? How many do not comply with EA and why not? - How effective are the investment and acquisition strategies? - How effective/viable/practical is the investment decision making (process) (FGI 2006)	(DoC 2003); (ETS Office 2003); (GAO 2003); (Ylimäki 2006); (Burk 2005); (Hilliard, Kurland et al. 1996; Hilliard, Kurland et al. 1997); (Tash 2006); (CIO Council 2000)

Evaluation Target and Sample Evaluation Questions	Literature References
EA Development Methodology and Tool Support	
- To what extent is the architecture framework defined, documented, approved and used? - To what extent is architecture development controlled by an established process or methodology? - To what extent is the architecture development supported by (automated) tools? - To what extent are methodologies and methodology use evaluated? How effective are the methodologies (FGI 2006)? Do they provide sufficient guidance? Do they support reuse of models, patterns etc.? - To what extent are tools and tool use evaluated? How helpful are the tools, can the work be done faster with them (FGI 2006)? How well do they support the architecture development and management? How effectively are the tools used? - What are the costs of tool use? To what extent are verifiable benefits received from tool use? How does the tool use affect other features of system development, such as, its production costs, flexibility, adaptability or expandability (FGI 2006)? - To what extent is architecture process evaluated? How effective is the architecture process? To what extent does the architecture process meet its quality criteria? - What are the costs of methodology use? To what extent are verifiable benefits received from methodology use? - To what extent are verifiable benefits received from framework use?	(ETS Office 2003) (Ylimäki 2006) (GAO 2003; Burk 2005) (Hilliard, Kurland et al. 1996; Hilliard, Kurland et al. 1997) (Morganwalp and Sage 2004) (IAC 2003) {NASCIO, 2004 #729} (Motola 2006)
EA Models and Artifacts Notice that a more detailed analysis of the evaluation needs for architecture models and artifacts is represented in (Hämäläinen 2006)	
- To what extent are the document templates designed and how useful have those templates been (FGI 2006)? - To what extent are 1) the current and 2) objective states of EA and 3) the transition plan described, documented and approved? - How many decisions were made to develop e.g. the target architecture? How long did it take make these decisions? (FGI 2006) - How many components there are in the system (FGI 2006)? - To what extent are the models and documentation evaluated? To what extent do models and documentation meet the evaluation criteria (e.g. quality attributes)? - Are the models understandable and clear? Are they up-to-date? Are they complete enough? Are the concepts used in the models consistent? Are the models consistent enough providing a holistic view of the organization? (FGI 2006) - To what extent are the models and documentation used? How many stakeholders use models and documentation? (FGI 2006) - To what extent is model and documentation use measured? Are they useful to particular stakeholders? Do they provide the information needed by a particular stakeholder? (FGI 2006) - To what extent are the different views of EA aligned? Do they provide a coherent view of the organization? (FGI 2006) - How flexible is the architecture? To what extent does it consider the future (business) requirements that can be seen at present (FGI 2006)? - To what extent is the compliance of models and (the implemented) architecture evaluated? How compliant are they?	(Carbone 2004a; Ylimäki 2006) (GAO 2003) (Vasconcelos, Pereira et al. 2004) (Department of Veterans Affairs 2001; Burk 2005) (Hilliard, Kurland et al. 1996; Hilliard, Kurland et al. 1997) (Morganwalp and Sage 2004) (OMB 2005) {NASCIO, 2004 #729} (Guevara and Workman 2006)

Evaluation Target and Sample Evaluation Questions	Literature References
Assessment and Evaluation - To what extent are the needs for architecture evaluation identified and approved? To what extent do these needs correspond to the maturity of the organization's EA as well as to the organization's policies (ways of working)? (FGI 2006) - To what extent are the users of evaluation information identified (= stakeholders and their concerns)? - To what extent are the targets of evaluation identified? - To what extent are the evaluation criteria and metrics identified? - To what extent are the evaluation criteria and metrics aligned with the other evaluation metrics used in the organization (FGI 2006)? - To what extent are the evaluation points identified? What is the time-frame of evaluation (FGI 2006)? - To what extent are the evaluation practices identified? - To what extent are the costs and benefits of evaluation measured? - What are the costs of evaluation? To what extent are verifiable benefits received from evaluation? (Cost-benefit analysis) - Are evaluation techniques aligned with architecture maturity? - To what extent is the evaluation program assessed? Are we evaluating the right things? Does the evaluation provide right information for the right stakeholders at a right time? Is the evaluation process or techniques effective (e.g. in the sense of time and money)?	(Ylimäki 2006) (GAO 2003) (Burk 2005) (Hilliard, Kurland et al. 1996; Hilliard, Kurland et al. 1997) (CIO Council 2000; IAC 2003; Aziz, Obitz et al. 2006) (IEEE 1998)
Skilled Team, Training and Education - To what extent are the roles and responsibilities of the architecture team (architects) defined? - Does the team have the necessary resources (time, money, etc.) (FGI 2006)? - To what extent does the team has the necessary skills and knowledge needed in architectural work? How skillful and knowledgeable is the team? To what extent does the team has various skills and experience (in business, technology, system development, architecture, etc.) (FGI 2006)? - How have the necessary skills been acquired; through training, hiring, partners, consultants etc. (FGI 2006)? - To what extent is training and education available for the architects, for the other stakeholders? Is the training provided internally/externally? - To what extent are the training and education needs of other stakeholders taken into account? How skillful and knowledgeable are they? - To what extent has a training plan been developed and followed? - To what extent is training and education evaluated? How effective is training and education? How many persons have gained training/education? What kind of training/education? How much has it cost?	(Jayashetty, Manjunatha et al. 2004), (IT Governance Institute 2005) (ETS Office 2003) (Ylimäki 2006) (Kamokawa and Okada 2005) (GAO 2003) (OMB 2005) (IAC 2003)

Evaluation Target and Sample Evaluation Questions	Literature References
Organizational Culture - To what extent is the architecture approach approved by the organization? How aware are the organization members of the architecture approach and its objectives (FGI 2006)? How is the EA perceived by the organization (members)? - To what extent are the cultural challenges or constraints for architectural work been identified? - To what extent are the challenges or constraints responded to? - To what extent is the organization willing to change in general? To what extent are the employees resistant or willing to change in general? - How do the organization members response to architecture driven changes? - How has EA affected the organization, its structure and culture, after integrating or consolidating e.g. some of the financial and personnel management functions (FGI 2006)? - How long time has is taken to make the required changes in the organization? Has it taken longer or shorter time than earlier? (FGI 2006)	(Ylimäki 2006) (META Group Inc. 2000; Rudawitz 2003)
Project and Program Management - To what extent is the coordination between architecture development or implementation projects organized? - To what extent does the project methodology emphasize the importance of architecture? To what extent does the project methodology include architecture guidance (FGI 2006)? - To what extent has a project gained architecture guidance? How useful has the guidance been? (FGI 2006) - To what extent are the project milestones defined? To what extent is architectural evaluation done on the milestones (= architectural compliance review)? - To what extent are the lessons learned collected and transferred during or in the end of the project? - How successful have the project budgeting and scheduling been? How many projects have been successful in the sense of time and money? How many projects have had to refine budget, schedule or the project scope (FGI 2006)? Why? - Does the project deliver what was needed (what was planned) on schedule? If not, why not? - To what extent are the business objectives met? - To what extent are the architectural objectives met? - To what extent are the project objectives met? - To what extent are the EA-guiding principles followed in the project? - How is the architecture compliance of a project assured? To what extent do the projects fit to the EA? - How many projects have had difficulties in following the guiding principles or architectural constraints? How many projects have indicated a need to change or refine the architecture (plans, objectives etc.)? (FGI 2006) - What is the business value of (IT) projects?	(Carbone 2004a) (Ylimäki 2006) (Ross 2004a) (Van Grembergen and Saull 2001) (GAO 2003) (Hilliard, Kurland et al. 1996; Hilliard, Kurland et al. 1997; Department of Veterans Affairs 2001; Burk 2005) (ETS Office 2003) (Motola 2006)

Evaluation Target and Sample Evaluation Questions	Literature References
Entire EA Program	
- To what extent does EA meet the key stakeholders' concerns (i.e. captures the right information)? - What are the benefits of the EA approach to each stakeholder group (FGI 2006)? - To what extent does EA offer content to stakeholders in a satisfactory way in terms of 1) architecture effectiveness (doing the right things = product quality) and 2) architecture efficiency (doing the things right = process quality)? - How well EA ensures organizational alignment with business strategy? (Business Alignment) - To what extent is the progress towards the target architecture evaluated? How is the program progressing? - To what extent are the EA and business objectives and benefits met? If objectives are not met, why not, and how to assure that the same mistakes are not done again (FGI 2006)? - What kind of business impacts does EA provide? How have these impacts evolved/changed over time (quarter, year, 2-3 years, etc.)? (FGI 2006) - To what extent does EA provide the 'big picture" of the organization and assist business operations effectively in a situation where e.g. the market share is increasing, and the profitability is high (i.e. in a situation, where no radical changes are not necessary) (FGI 2006)? - How effective/viable/practical is the decision making (process) (FGI 2006) - How has EA affected the IT costs? Have they been decreasing or increasing? (FGI 2006) - What is the business value of EA? - What is the ROI/ROA of EA? - How well EA facilitates the management of change? - What business process/service improvements does EA provide? - What kind of support does EA provide for the business processes development and management (FGI 2006)? - How well EA ensures that interfaces, information, interoperation and connectivity are standardized (integration)? - How well EA integrates IT? (Convergence)? - How well EA ensures reuse of services and technologies? - How well EA ensures business process excellence? - How well EA ensures customer orientation? - How well EA ensures innovation? - How well EA ensures strategic adaptability? - How mature is the organization's EA (program)? How has the maturity evolved over time (quarter, year, 2-3 years etc.)? (FGI 2006)	(OMB FEA Program Management Office 2004; IT Governance Institute 2005; OMB 2005) (Kamokawa and Okada 2005) (Rico 2005) (Van Grembergen and Saull 2001) (Kluge, Dietzsch et al. 2006a) (Curran 2005) Gartner 2002; (Department of Veterans Affairs 2001) (NASCIO 2004; Burk 2005) (Guevara and Workman 2006)

8 Discussion

In this section, we discuss the implications of this research for the practitioners.

Usually, each organization has its own specific objectives for the architecture approach. The purposes for evaluating the organization's EA program can be defined based on these objectives, but other sources may exist as well, such as the most important audiences and their various requirements for evaluation information – top-management may want information to support the decision-making in a situation where the organization's role and position in its line of business is changing, while the architecture team likes to know how useful the projects have considered architecture guidance, or how many projects have effected the architecture. Once these aspects are clarified, the primary evaluation targets, that are compatible with the requirements set by different audiences, as well as with the evaluation purposes, can be defined.

If the organization has not yet clarified its objectives for the architecture approach, its EA program – or the objectives need to be revisited to ensure and maintain the unanimity about them – it can stimulate the discussion and definition of the EA objectives with the help of the sample objectives represented in this report (section 4). Similarly, discussion on the evaluation purposes, audiences and evaluation targets can be assisted and supported by the examples represented in sections 5, 6 and 7, respectively. Cross-tabulations can be used to depict the dependencies between the different evaluation components, such as, between

- the EA objectives and EA evaluation purposes,
- the audiences and EA evaluation purposes,
- the EA evaluation purposes and EA evaluation targets, and
- the audiences and EA evaluation targets.

In addition, it should be noticed that the maturity of the organization's EA affects the selection of evaluation targets, as well as the definition of evaluation criteria and metrics. In the workshop discussion, it was stressed that the EA maturity level of the organization, the evaluation targets and the evaluation criteria and metrics need to be compatible. In particular, a "young architecture organization" should start with defining simple metrics (such as on/off-metrics or quantitative metrics) indicating and demonstrating, for instance, the extent the stakeholders are aware of the EA approach and its objectives, or the support and guidance provided to projects implementing or changing the architecture. While the organization matures, more detailed business impacts can likely be measured. However, in this study, evaluation targets and evaluation questions were not mapped to the maturity levels.

Finally, in the workshop discussion, it was emphasized that no matter what the evaluation targets and metrics are, they must be compatible with, or integrated into, the other evaluation and measurement systems used in the organization (such as Balanced Scored Cards). Especially, if the business is striving for substantial growth (in the sense of market share, sales volume, and so forth), IT cost metrics are not likely to demonstrate lower costs at the same time.

9 Conclusions

In this report, we have presented the evaluation components that need to be addressed during EA evaluation planning. Since this step of the research project aimed at determining the evaluation needs for EA, the following evaluation components were addressed (see also Table 3): 1) evaluation purposes, 2) audiences and 3) evaluation targets. Additionally, because the EA objectives provide input for defining these components, they were also addressed in this study.

Literature review gave us examples of evaluation needs, which were reviewed and discussed in the workshop participated by seven representatives of the co-operating organizations.

As a conclusion, it seems that various evaluation purposes and various audiences may exist in an organization. Furthermore, EA evaluation targets depend, at least, on the EA objectives, the evaluation purposes, and the audience. Potential CSFs for EA, defined during the first year of the research project, provided a feasible starting point for determining the EA evaluation targets. Also the entire EA program was considered as a separate evaluation target.

The importance of the scope and purpose of EA was emphasized in the focus group discussion: it should be written down, why the architecture approach is applied in the first place. Usually, the objectives of EA are derived from the strategies of the organization, either from the business or IT strategies. These strategies should explicitly convey the purpose of the IT organization, or the information systems management organization, and its objectives followed by a clear purpose and objectives for the architecture work.

Other evaluation targets that arose during the workshop discussion, and that seem to be salient – especially in the organizations taking their early steps in the EA development – were communication and common language, commitment, models and artifacts, and the evaluation of the business impacts of the EA program. The last target – evaluating the business impacts of EA, was considered to be the most difficult task: How to evaluate whether the EA process and, especially, the results (models, new information systems, new processes, new ways of doing business, and so forth), have benefited the various stakeholders? How to evaluate those benefits? An additional challenge is to prove that the business impacts are actually – or at least partially – consequences of EA efforts.

One possible solution to this problem is presented by (Guevara and Workman 2006); they state that IT projects can impact business value only by five ways, namely, by 1) increasing revenue, 2) reducing costs, 3) improving process efficiency, 4) mitigating risks, and 5) preserving capabilities.

Finally, even though the discussion in the workshop mainly focused on the enterprise architecture level, the evaluation needs (evaluation purposes, audiences, and targets) presented in this report are, to some extent, applicable to software architecture level as well.

The next steps of the project will proceed with selecting some of the architecture evaluation targets described in this report for further scrutiny. Following this, quality attributes will be refined and simple and usable metrics will be defined for each of these evaluation targets.

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APPENDIX 1. Objectives for EA.

Category	Objective	References
Technology	Standardization, e.g. - Sharing common system development methods - Ensure standard IT portfolio (convergence)	(Riland and Paterson 2006) (CIO Council 2001; OMB FEA Program Management Office 2004)
Technology	Increased interoperability and integration of e.g. - Information systems supporting the business - Data, business processes - Legacy, migration and new systems (FGI 2006) → aiming at simpler systems and lower costs (FGI 2006) “realizing that the business rules are consistent across the organization, that the data and its use are immutable, interfaces and information flow are standardized, and the connectivity and interoperability are managed across the enterprise” (CIO Council 2001)	(Hjort-Madsen 2006) (The Open Group 2002) (OMB FEA Program Management Office 2004); (CIO Council 2001) (GAO 2003; IAC 2005) (Anaya and Ortiz 2005)
Strategic	More strategic agility, e.g. - Business adaptability - Strategic adaptability - Increased organizational flexibility/agility	(Bhathena 2006) (Morganwalp and Sage 2004) (Saha 2004; Kamokawa and Okada 2005); (Aziz, Obitz et al. 2005) (Guevara and Workman 2006)
Strategic	Tighter alignment to business strategy	(OMB FEA Program Management Office 2004) (Morganwalp and Sage 2004)
Strategic	Increased market value	(IT Governance Institute 2005)
Strategic	Increased quality (of processes, products and resources), by e.g. - Simplification and consistency at every level - Integrity and dependability of aggregated data	(GAO 2003; IAC 2005; Syntel 2005)
Strategic	Better economies of scale Volume thinking (FGI 2006)	(Syntel 2005) (CIO Council 2001)
Business	Improved customer orientation, e.g. - Improved customer intimacy EA is the transformation mechanism to create one company/organization focused on its clients	(Ross and Weill 2005) (Van Grembergen and Saull 2001) (Kamokawa and Okada 2005) (IAC 2005) (GAO 2003)
Business	Business Process Excellence; Low cost provider, emphasizing efficient, reliable and predictable operations	(Ross and Weill 2005) (Van Grembergen and Saull 2001) (Kamokawa and Okada 2005)
Business	Increased (asset) productivity	(Saha 2004); (GAO 2003)
Business	Increased strategic and tight alignment with partners, e.g. - Flexible sourcing of value chain components	(Morganwalp and Sage 2004) (Aziz, Obitz et al. 2005)
Business	Improved Business-IT alignment	{Crumps, 2006 #128} (Morganwalp and Sage 2004) (Kluge, Dietzsch et al. 2006b) (CIO Council 2001) (Aziz, Obitz et al. 2005; Malan and Bredemeyer 2005)
Business	Synergy Achievement	(Van Grenbergen & Saull 2001)

Category	Objective	References
Business	Better management of IT investments, e.g. - To inform, guide, and constrain the decisions for the enterprise - Faster, simpler, and cheaper procurement - Reduced risks	(Van Grembergen and Saull 2001; The Open Group 2002; Saha 2004) (CIO Council 2001)
Business	Managerial Satisfaction - More senior management satisfaction with IT - More business unit leader satisfaction with IT	(Ross and Weill 2005)

Business	Better IT Responsiveness
	- Reduced application development, implementation and maintenance time
	- Faster acquisition/procurement process of IT
	- Technical Adaptability:
	  - IT effectively responds to ever-changing business needs
	  - To design more agile and responsive enterprise systems that provide value to the business partners' demands
		(Ross and Weill 2005)
		(Syntel 2005)
		(Van Grembergen and Saull 2001)
		(The Open Group 2002)
		(Morganwalp and Sage 2004)
		(Aziz, Obitz et al. 2005)
		(Guevara and Workman 2006)

Business	Improved and consistent communication, e.g. - Greater data sharing - Integrated process standards - Supporting knowledge development and management	(Ross and Weill 2005) (CIO Council 2001) (Schekkerman 2004b) (de Boer, Bosanque et al. 2005) (Aziz, Obitz et al. 2005) (Morganwalp and Sage 2004)
Business	Reduced product/service time to market / time of delivery, leading to e.g. - More product leadership	(Ross and Weill 2005) (CIO Council 2001; Aziz, Obitz et al. 2005) (Morganwalp and Sage 2004) (IAC 2005) (GAO 2003) (Kluge, Dietzsch et al. 2006b) (Guevara and Workman 2006)
Business	More sophisticated asset management, e.g. - Predicting and controlling complex technical systems	(Morganwalp and Sage 2004) (Hjort-Madsen 2006)
Business	Risk Management, e.g. - Reduced business risk - Improved legal and regulatory compliance - Increased disaster tolerance - Reduced security breaches - Reduced decision risks - Reduced risks of investments	(Aziz, Obitz et al. 2005; Ross and Weill 2005) (The Open Group 2002; Morganwalp and Sage 2004; IT Governance Institute 2005) (CIO Council 2001)
Business	Supported decision making (strategic and operational), leading to e.g. - More efficient program management	(CIO Council 2001) (Malan and Bredemeyer 2005) (IAC 2005) (Schekkerman 2004b) (Morganwalp and Sage 2004; de Boer, Bosanque et al. 2005)
Business	Evolutionary and adaptive development and governance of architecture	(Morganwalp and Sage 2004)
Financial	Cost-effectiveness, from e.g. - Cost savings - Increased productivity - Increased quality	(Syntel 2005) (Rico 2005) (Kamokawa and Okada 2005) (Tash 2006)

Category	Objective	References
Financial	Reusability of e.g. - Models - Code - Software and hardware components - Services - Processes	(Aziz, Obitz et al. 2005) (Morganwalp and Sage 2004) (Riland and Paterson 2006)
Financial	Lower IT Costs - Lower IT operations costs - Improved IT operations efficiency - Lower support and maintenance costs - Reduced application development, implementation and maintenance cost - Lower acquisition costs - More efficient use of software licenses	(Aziz, Obitz et al. 2005; Ross and Weill 2005) (Morganwalp and Sage 2004) (The Open Group 2002) Hite 2003; (Van Grembergen and Saull 2001) (Syntel 2005) (FGI 2006)
Miscellaneous	Improved Innovation, e.g. - Emerging technologies research - Supporting knowledge development and management	(The Open Group 2002) (Kamokawa and Okada 2005) (Van Grembergen and Saull 2001; Morganwalp and Sage 2004)
Miscellaneous	Improved change management - EA “is the means to describe your business in terms of people, processes and IT in order to facilitate rapid and valuable impact analysis, thereby enabling performance-oriented change management” (MEGA 2006) - To support cultural and organizational changes, assist in implementing change - Life cycle thinking and change management (FGI 2006)	(CIO Council 2001) (OMB FEA Program Management Office 2004); (Schekkerman 2004b); (de Boer, Bosanque et al. 2005) (IAC 2005), (GAO 2003), (MEGA 2006) (Kluge, Dietzsch et al. 2006b) (Guevara and Workman 2006)
Miscellaneous	Staff management excellence, e.g. - Reduced skill set requirements (Reduce the variety of skills required by IT professionals within the enterprise) → Increased flexibility of staffing	(Van Grembergen and Saull 2001) (Syntel 2005) (Aziz, Obitz et al. 2005)

APPENDIX 2. EA Evaluation Purposes.

Category	Purpose	References

Aiding decision making
 	
(Management-oriented / Expertise-oriented)
	To inform management decisions and actions to e.g.
	- Direct EA or EA program improvement
	- Inform EA policymaking
	- Support decision making about the EA program/project itself
	  - About program planning and installation
	  - About program continuation, expansion or "certification"
	  - About program modification
	  → to steer the program
	
	"helps surface additional factors that may inhibit EA development or implementation, focuses or redirects available resources, generates support for follow-on architectures, and provides a scorecard on overall processes" (ETS Office 2003)
	
	"to ensure that expected benefits from the EA are realized and to share this information with executive decision-makers, who can then take corrective action to address deviations from expectations" (GAO 2003)
		(Basili, Caldiera et al. 1994)
		(ETS Office 2003)
		(Stufflebeam 2001)
		(GAO 2003)

Aiding decision making (Management-oriented)	To assess investments and payoffs, for e.g. providing a rationale to adopt or refine new techniques, methods etc.	(Basili, Caldiera et al. 1994); (Stufflebeam 2001)
Describing results (Adversary-oriented)	To provide balanced information on strengths and weaknesses of e.g. - EA, EA program, organization and current processes/products - Organization's EA readiness/EA capability	(Basili, Caldiera et al. 1994) (Stufflebeam 2001) (META Group Inc. 2000) (Syntel 2005) (ETS Office 2003)
Describing results (Objective-oriented)	To provide stakeholders with accurate accounting of EA program results, by e.g. - Demonstrating alignment with business strategy - Demonstrating the (business) value of EA, - Demonstrating the benefits of EA - Demonstrating the value of IT/IT investments - Evaluating the effectiveness of EA - Evaluating the quality of the (EA) processes and products	(Van Grembergen and Saull 2001; Aziz, Obitz et al. 2006) (Basili, Caldiera et al. 1994) (GAO 2003) (Department of Veterans Affairs 2001)
Assessing / assuring results (Objective-oriented)	To determine if the objectives of EA or EA program are achieved, by e.g. - Demonstrating alignment with business strategy - Demonstrating the (business) value of EA, - Demonstrating the benefits of EA - Demonstrating the value of IT/IT investments - Evaluating the effectiveness of EA - Evaluating the quality of the (EA) processes and products - Performing cost-benefit analysis	(Aziz, Obitz et al. 2006) (Van Grembergen and Saull 2001); (Stufflebeam 2001) (Morganwalp and Sage 2004) (Basili, Caldiera et al. 1994; GAO 2003) (Department of Veterans Affairs 2001); (IEEE 1998)

Category	Purpose	References
Assessing / assuring results (Objective-oriented / Expertise-oriented)	To assure that the results of EA or EA program are positive, by e.g. - Demonstrating alignment with business strategy - Demonstrating the (business) value of EA, - Demonstrating the benefits of EA - Demonstrating the value of IT/IT investments - Demonstrating the improved business-IT alignment - Evaluating the effectiveness of EA - Evaluating the quality of the (EA) processes and products - Performing cost-benefit analysis	(Aziz, Obitz et al. 2006) (Van Grembergen and Saull 2001) (Stufflebeam 2001; Morganwalp and Sage 2004) (Basili, Caldiera et al. 1994) (GAO 2003) (Department of Veterans Affairs 2001) (IEEE 1998)
Assessing / assuring results (Objective-oriented)	To assess benefits and gains of EA or EA program, by e.g. - Demonstrating the (business) value of EA, - Demonstrating the benefits of EA - Demonstrating the value of IT/IT investments - Evaluating the effectiveness of EA - Performing cost-benefit analysis	(Aziz, Obitz et al. 2006; Cumps, Viaene et al. 2006) (Van Grembergen and Saull 2001); (Stufflebeam 2001; Morganwalp and Sage 2004) (IEEE 1998)
Analyzing results (Expertise-oriented)	To pinpoint responsibility of good and bad EA or EA program outcomes, for e.g. determining incentives	(Stufflebeam 2001)
Analyzing results (Participant-oriented)	To diagnose EA or EA program shortcomings, for e.g. Detection of problems -> directs EA or EA program improvement	(Stufflebeam 2001) (Abowd, Bass et al. 1997)
Analyzing results (Objective-oriented)	To examine EA or EA program objective and benefit achievement trends (e.g. short or long term), by e.g. - Assessing the progress towards goals of the EA development/deployment - Assessing the progress towards target architecture	(Basili, Caldiera et al. 1994) (GAO 2003) (ETS Office 2003) (Stufflebeam 2001) (Department of Veterans Affairs 2001)
Analyzing Results (Participant-oriented/ Expertise-oriented)	To compare results and benefits of EA or EA program to norms and standards (if available) or to compare performance of competing EA programs, by e.g. - Evaluating EA, EA program, organization and current processes/products - Evaluating organization's EA readiness/EA capability - Demonstrating the (business) value of EA, - Demonstrating the benefits of EA - Demonstrating the value of IT/IT investments - Demonstrating the improved business-IT alignment - Evaluating the effectiveness of EA - Evaluating the quality of the (EA) processes and products	(Aziz, Obitz et al. 2006) (Van Grembergen and Saull 2001) (Stufflebeam 2001) (Morganwalp and Sage 2004) (Basili, Caldiera et al. 1994; GAO 2003)
Describing process /product (Participant-oriented / Consumer-oriented)	To determine cause and effect relationships in EA program or EA, for e.g. - Assessing the impacts of changes - Evaluating the impact of corrective action	(The MITRE Corporation 2004; de Boer, Bosanque et al. 2005) (Basili, Caldiera et al. 1994; Stufflebeam 2001)

Category	Purpose	References
Describing process/ product (Objective-oriented/ Expertise-oriented)	To describe and critically appraise EA or EA program, for e.g. - Organizational learning - Gaining stakeholder support	(Stufflebeam 2001) (Abowd, Bass et al. 1997)
Analyzing process/ product (Management-oriented)	To explicate and illuminate EA or EA program, for e.g. - Identifying and assessing risks (operational, related to EA, related to business, related to different views of architecture (business, information, application, technology), to e.g. avoid over engineering (over engineering is a risk and may result in wasted resources) - Clarifying and prioritizing requirements - Understanding and documenting architecture - Organizational learning	(The MITRE Corporation 2004) (Rajput 2004) (Stufflebeam 2001; Jayashetty, Manjunatha et al. 2004) (Abowd, Bass et al. 1997)
Analyzing process/ product (Expertise-oriented)	To assess EA's or EA program's theoretical soundness, by e.g. - analyzing EA's or EA program's compliance with theories and standards	(Stufflebeam 2001); (ISO 2001); (Satpathy, Harrison et al. 2000/2001); (Jenssen and Sage 2000); (May 2005)

APPENDIX 3. Some Quality Attributes Relatable to Architectures (not categorized, in an alphabetical order).

Acceptability
Accessibility
Accountability
Accuracy
Acquirability
Adaptability
Affordability
Analyzability
Applicability
Authority / user acceptance
Automatic checks and feedback
Availability
Awareness
Believability / credibility
Breadth (Completeness / coverage)
Budget compliance
Buildability
Business case attainment
Cache performance
Changeability
Clarity
Coherency (Strategic alignment)
Communicativeness
Completeness
Complexity
Compliance
Compliance / standardization
Comprehensibility
Comprehensiveness
Conceptual integrity
Conciseness
Confidentiality
Conformance
Consistency
Content presentation
Controllability
Correctness
Cost/effort estimation
Cost-effectiveness / economy
Coverage
Currency / maturity
Cycle Time / time behavior
Defect Trend
Delivery
Denial of service
Dependability
Depth
Ease of development
Error-free
Effectiveness
Efficiency & estimation
Error avoidance
Error handling
Ethicalness
Evolution, Evolvability
Expandability/ Extension
Explicitness
Expressiveness
Extensiveness of use of legacy systems
Failure, Failure Frequency / Mean time to failure
Fault Tolerance
Feasibility
Flexibility / resilience
Formal Verifiability
Formality (formal specifications)
Functionality
Generality
Genericity
Hazard
Hierarchy / structure
Implementability
Improvement measures
Informal Verifiability
Initial implementation time
Installability
Integrability
Integrity
Interface facility
Interoperability
Interpretability
Lateness
Learnability
Maintainability / serviceability
Management Context
Measurability
Memorability
Modifiability
Modularity
Objectivity
Openness
Operability
Operational flexibility
Performance
Perspicuity
Physical characteristics
Portability
Privacy
Process Maturity
Progress Monitoring
Provides both current status and trend measures
Purpose/goal relevance/appropriateness
Readability

Recoverability / Survivability
Relevance
Reliability
Repeatability
Replaceability
Resource Usage / resource behavior
Reusability
Robustness
Rollout schedule
Safety / Risk Avoidance
Satisfaction (client satisfaction)
Scalability
Schedule/Priority Estimation
Security
Similarity
Simplicity, Simplicity of use
Size
Space
Stability
Standardization
Steerability
Subsetability
Suitability
Support
Supportability
Targeted market
Testability
Time to market
Timeliness / responsiveness
Traceability
Training/trainability
Transferability
Understandability
Usability
Usefulness
Validity
Variability
Verifiability
Visibility and Control

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Measurement in Enterprise Architecture Work – the Enterprise Architecture Team Viewpoint

AISA Project Report

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Author:	Status: Final
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Summary

Currently, many organizations develop their enterprise architecture (EA) processes. One aspect in this development work is the planning of the EA work related measurement work and the definition of the EA team's responsibilities in the measurement. However, it currently seems that it lacks a holistic view of measurement work that could or should be carried out relating to EA work.

This study contributes to this question by identifying EA work related measurement aspects and activities. The responsibilities of EA team in measurement are also discussed.

Contents

1 Introduction

Enterprise Architecture (EA) is a holistic view of an organization [5, 9, 11]. It is defined as a coherent whole of principles, methods and models that are used in the design and realisation of an enterprise's organisational structure, business processes, information systems, and infrastructure [13].

Because of expectations to yield multiple business and IT-related benefits to organizations, EA has recently become highly interesting approach for both practitioners and academic researchers. Expected benefits of EA approach are, for example, that EA delivers insight and overview of business and IT, it is helpful by mergers and acquisitions, it supports (out/in) sourcing and systems development as well as it manages IT portfolio and delivers roadmaps for change [17]. In addition, EA is expected to be helpful in decision making and managing complexity, as well as in business and IT budget prioritization [17]. Because of these sought benefits, many public and private sector organisations develop currently their EA processes and activities.

Measurements and evaluations are common part of organisations' work and those are carried out including in many different processes and activities (e.g. in process development, performance measurement and quality assurance). Enterprise architecture processes are not exception. Thus, it has to be decided what measurement and evaluation work and tasks will be carried out in enterprise architecture work and how this work will be performed. EA team take quite often partly or totally the responsibilities of this planning work.

However, it seems to that it currently lacks a holistic view of measurement that should or could be carried out in EA work. Even though quite extensive research has been carried out in EA modelling and development frameworks, methods and tools (e.g.[3, 6, 7, 12, 13, 18, 21]), academic research has almost disregarded the area of EA work related evaluation and measurement thus far. The few contributions in this area include EA maturity models (e.g. [14, 16]) and evaluation methods, but the planning aspects of evaluation, including e.g. the definition of evaluation aims, activities and evaluators, seem to be omitted. In addition, roles of the EA team in measurement seem to be addressed very rarely.

This study contributes to the research on EA work planning by defining EA work related measurement aspects and activities. In addition, responsibilities of EA team in measurement are considered. This study aims especially to assist practitioners in their EA measurement planning.

This report is organized as follows. In the next section, the research method is described. Section 3 and 4 discusses measurement and enterprise architecture work in general. Section 6 presents the results of this study. These are analysed in section 7. Finally, section 8 concludes the report by including a discussion of the study's contribution and agenda for further research.

2 Research Method

Constructive study was chosen as the research method since the area of research lacks existing definitions of the measurement and evaluation aspects in EA work. In the study, the following steps were conducted.

Pre Study phases

Firstly, literature review and the identification of measurement needs were carried out to form a basis for identifying measurement work relevant for EA work and for identifying areas where the EA team could participate in this work.

1. *Needs for EA evaluations and measurements*. Before this study, we carried out studies in which we identified needs for architecture evaluations and measurements ([22],[8]). These studies included for example focus group interview on the EA evaluation and measurement needs in practitioners from collaborating companies in august 2006.

2. *Literature review*. Literature on evaluation and measurement was charted to identify why, how and where measurement and evaluation is carried out in organisations in general. In addition, the existing knowledge and views of EA related measurement work were gathered.

Construction phases

Secondly, the phases of the definition of EA work measurement aspects and activities were carried out.

3. *Definition of EA work measurement aspects and activities*. The findings of literature review and studies on evaluation needs were used as a basis to define the EA work measurement aspects and activities. A description of aspects and activities was produced.

4. *Focus group interview of practitioners*. A focus group interview of five practitioners from four collaborating Finnish or international organizations was organized in December 2006. The organizations represented different industries and employed from 14 to several thousand people. Interviewees are presented in the table 1. All of the organizations were initiating EA work and employed architecture specialists who could contribute to the study. The objectives of the interview were 1) to review the results of the preceding phases, and 2) to collect additional, experience-based information. The interview was moderated by one researcher, while the other took notes. In addition, the interview was audio-recorded.

Table 1. Interviewees in the focus group interview.

Companies	Number of interviewees	Viewpoints of interviewees
Architecture consultation company Number of personnel 10 (year 2005)	1	enterprise and software architecture consultation
Banking, finance and insurance company Number of personnel 11 974 (year 2005)	1	enterprise architecture

Telecommunication company Number of personnel 4989 (year 2005)	1	enterprise architecture
Business & IT consulting and development organization A part of a large international company having 329 373 employees (year 2005) in total	2	software architecture, enterprise architecture, marketing, business

5. *Updating the description of EA work aspects and activities*. The findings from the focus group interview were analyzed and the description of EA measurement aspects and activities was modified and updated according to the experiences disclosed by the focus group.

3 Measurement in General

This section describes measurement in general. Measurement is carried out for many different purposes in companies. Purposes of measurement are especially the followings [2].

- Evaluate (how well is the organization/unit/team/people performing?)
- Control (how to ensure that the subordinates are doing the right thing?)
- Budget (on what programs, people or projects should resources be allocated?)
- Motivate (how to motivate e.g. line staff, middle managers, stakeholders?)
- Promote (marketing/public relations aspect; how to convince stakeholders that the organization/unit/team is doing a good job?)
- Celebrate (what accomplishments are worthy of the important organizational ritual of celebrating success?)
- Learn (why is what working or not working?)
- Improve (what exactly should who do differently to improve performance?)

Measurement has several application areas (e.g. company and project management, improvement of products and services). Therefore, many different evaluation aspects, practices and methods exist in companies. These exist for example relating to the:

- Performance measurement
- Operational/operations measurement
- Program evaluation
- Service quality evaluation
- Process measurement and capability assessment
- Product solution evaluation
- Project evaluation / measurement
- Software / system measurement
- Quality evaluation / measurement

- Impact evaluation
- Cost-Benefit, Cost-effectiveness analyses
- Benchmarking

Therefore, the responsibilities of measurement work are quite often spread out in companies. It lacks quite often a holistic view of measurement work carried out in an organisation.

The activities of measurement process are described, for example, by Juran and Godfray. These activities are described in the figure 1.

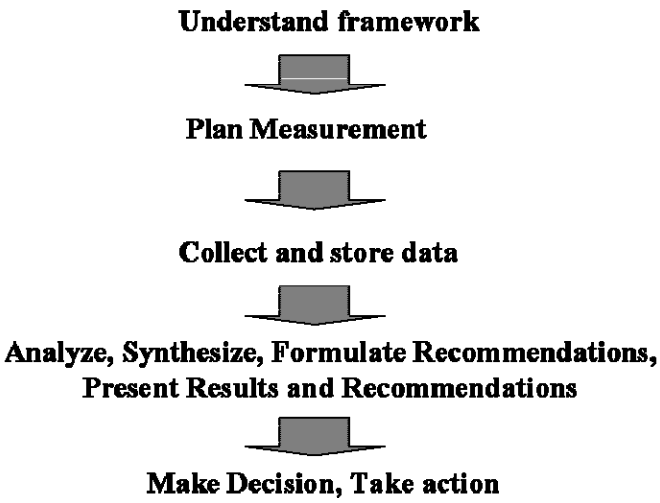

Figure 1. Measurement process acts [10].

In the development of new process in company, it has to decide and define, what kind of measurement work will be performed relating to it or included in it: what the purposes of measurement are, what measurement activities will be carried out and who the responsibility of measurement have. EA processes are currently developed in many organisations. Measurement in EA work is thus also needed to be defined in this development work.

4 Enterprise Architecture Work and Team

Enterprise architecture is typically used as an instrument in managing a company's daily operations and future development [13]. According to Lankhorst [13] management areas relevant to EA are strategic management, strategy execution, quality management, IT governance, IT delivery and support and IT implementation.

Organisations developing their EA activities establish quite commonly EA teams that are mainly responsible of EA work. Few definitions of EA team/group exist in literature, suggesting that the characteristics of the team – such as its role, composition, organization and tasks – are organization-specific to at least some extent. Briefly, the team is stated to be the stakeholder that creates, develops and maintains EA according to policies set by an architectural board of senior executives

[19]. As the skill set required in EA work is extensive, one suggestion is that the team could be virtual [15]. According to Paras [15], the virtual EA team consists of

- *Core EA Team* of no more than ten full-time enterprise architects with possible domain specialities (e.g. business, systems and technology architecture), led by a chief enterprise architect. The core team coordinates the EA effort through the extended EA team.
- *Extended EA Team* produces EA documentation and models. The members of this team work in the line of business and use only a small part of their time to EA work.
- *EA Community* includes persons who are not members of the core or extended EA teams, but use EA documentation and models.

Aziz et al. [1] and Syntel [19] have also presented similar views on EA team.

The responsibility of EA team is quite often to plan what measurement or evaluation work is carried out in EA work. EA team may carry out part of this work and part of this work can be carried out other staff or partners. However, we think that EA team should have the whole picture of measurement work carried out relating EA work and aims of it.

5 Measurement in Enterprise Architecture Work

This study identified what kind of measurement work may exist relating EA work. We identified that there exist

1) organisation's (general) measurement work,
    a. which is needed to be carried out also in EA work and
    b. of which planning and development EA team may participate.
2) EA work specific measurement and evaluation work.

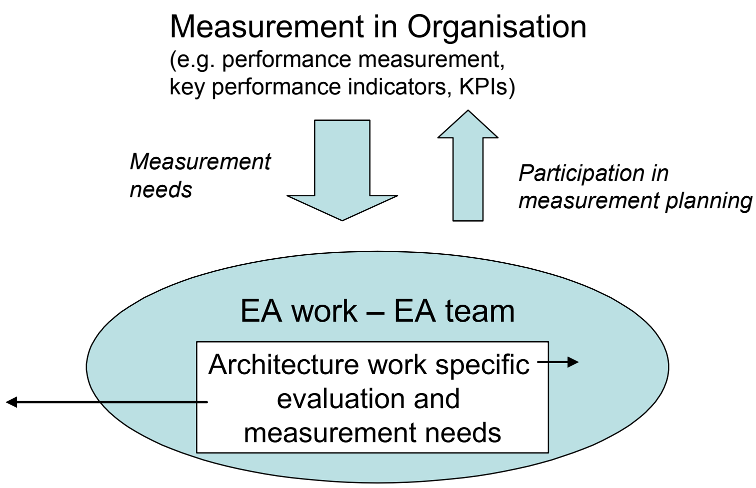

Figure 2. Measurement Needs affecting EA work

5.1 Organisation's general measurement work

In organisations, it exist general measurement needs which need to be taken account also in EA work (e.g. quality management, performance measurement etc.). EA team has thus to carry out measurement that is planned to be carried out in the company in general and report the measurement results. On the other hand, EA team may participate in the development of companies' general measurement practices and metrics.

Especially, performance measurement related key performance indicators KPIs are used in EA work. For example, Christiansen and Gotze have identified in their study that the forty-five percent of the governments with national EA program have and use key performance indicators in their work with the national EA programs [4]. The performance measurement needs were presented also by practitioners in the focus group interview.

The following performance measurement activities seemed to be relevant for EA work. Questions behind these measurement activities are also presented.

Performance measurement reporting

- To what extent have the company objectives been attained?
- Company Level Performance Measurement: Deriving EA team level metrics from company-level metrics, collecting data and reporting to company level

Company Performance Measurement Planning/Consulting

- How to improve the performance measurement system?
- Participating/consulting in the planning and definition of company's performance measures from EA perspective.

5.2 Enterprise Architecture Work Specific Measurement Work

In organisations, it exist evaluation and measurement needs also which relate especially to the EA work. These measurement aspects are followings.

EA work impact evaluation

- What impacts have been realized by EA work?
- Planning and carrying out the measurement and evaluation of the impacts of EA work in the company.

EA approach use evaluation

- To what extent is the EA approach used in the company?
- Evaluating the extent of the EA approach use in the company

EA Team operations evaluation

- How is EA work progressing toward pre-established goals?
- Ongoing operational monitoring and reporting of the EA team's and architects' accomplishments, particularly progress toward pre-established goals of the team.

Evaluation of EA work

- What is the quality of EA work and its results?
- Evaluating the quality of EA work, and its benchmarking

Evaluation of Architecture and Architectural Solutions

- Is the architectural solution suitable to the organization and situation?
- Planning criteria for architectures and architectural solutions, evaluating architectural solutions against criteria, and presenting results.

5.3 Measurement Aims and Activities

In Tables 2 and 3, enterprise architecture measurement aspects and activities relating to these aspects are presented. Each activity is defined in the terms of 1) its main aims and 2) the main tasks conducted in the activity.

Table 2. Performance Measurement Aims and Activities in Enterprise Architecture Work.

Measurement Aspect	Aims	Activities
Performance Measurement Reporting	▪ To evaluate the performance of the EA work against company level objectives ▪ To report performance measurement results to company level	▪ To interpret and align company level business performance goals to the EA work ▪ To develop EA work level measures ▪ To define data collection and reporting methods ▪ To collect and store data ▪ To report results

Company Performance Measurement Planning/ Consulting	▪ To participate (or consult) in the definition of company level performance metrics
	▪ To demonstrate how well the company has achieved its (EA) objectives
	(EA provides overall structural view of the company and thus provides a basis for structural improvement)
		▪ To develop company level performance metrics related to the EA approach
		▪ Potential solutions:
		  ▪ To integrate EA work evaluation and measurement into the company level performance metrics
		  ▪ To take the EA approach and EA work into account on the company level

Table 2. Measurement Aspects, Aims and Activities in Enterprise Architecture Work.

Measurement Aspect	Aims	Activities
Evaluating of EA Work Impacts	▪ To evaluate the impacts caused by EA work ▪ To demonstrate the impacts and possible benefits to company level ▪ To aid decision making about e.g. the future and resources of EA work ▪ To improve EA work practices	▪ To evaluate the extent to which EA work causes changes in the company. ▪ Two methods exist 1) To evaluate the difference between a target (e.g. organizational function/units or whole company) where EA work has been carried out (treatment group), and a target where it has not (control/comparison group). 2) To evaluate the difference between the situation before and after carrying out EA work (reflexive comparison) ▪ To define data collection and reporting methods ▪ To collect and store data ▪ To analyze data, report results and formulate improvement recommendations
Evaluating of EA Approach Use	▪ To evaluate the extent of EA approach use/adoption in the company	▪ To develop criteria and metrics for EA approach use ▪ To define data collection and reporting methods ▪ To collect and store data ▪ To analyze data, report results and formulate improvement recommendations
Evaluating of EA Team Operations	▪ To support the management of the EA team ▪ To monitor and report the EA team's and architects' accomplishments, particularly progress toward pre-established goals	▪ To understand the company's needs and pressures and goals of EA work ▪ To develop evaluation criteria and metrics for the EA team and individual architects (e.g. process, product and impact criteria and metrics) ▪ To define data collection and reporting methods ▪ To collect and store data ▪ To analyze data, report results and make decisions
Evaluating of EA Work	▪ To evaluate and monitor the quality of EA work and the artefacts produced ▪ To identify improvement needs of EA work ▪ To measure EA work against other companies (e.g. toughest competitors or industry leaders)	▪ To define criteria and metrics for EA work (e.g. process and product quality metrics and criteria) ▪ To define data collection and reporting methods ▪ To collect and store data ▪ To analyze data and formulate improvement recommendations for EA work AND/OR ▪ To benchmark EA work practices against other companies
Evaluating of Architectures and Architectural Solutions	▪ To evaluate architectures and architectural solutions produced in projects	▪ To understand business needs and requirements for architectures and architectural solutions ▪ To develop criteria and metrics for architectures and architectural solutions (e.g. quality and financial criteria) ▪ To define architecture evaluation methods and practices ▪ To collect and store data ▪ To analyze data and report results and formulate architecture improvement recommendations

6 Discussion

In this section, the results of this study and the findings of focus group interview are summarized and discussed. In addition, limitations of the study are discussed. The focus group provided views on the responsibilities of the EA team, the measurement concerns, and the roles of the EA team in measurement and evaluation.

Generally, the focus group considered that the defined measurement aspects covered sufficiently the aspects and activities in practice. The focus group also provided a number of ideas on the basis of practical experiences. These are taken into account in the description of measurement aspects and activities.

Affect of Responsibilities and Status of the EA Team and EA work to the Measurement

Practitioners in focus group view discussed how EA team's responsibilities and objectives affect on the EA related measurement. According to the focus group, the following observations were made.

In summary, factors affecting EA measurement are:

- how clear the role and responsibilities of EA work and EA team are,
- does it exist also long-term goals for EA work and,
- what the status and maturity of EA process and practices are.

Enterprise architecture team's responsibilities and authority are not necessarily clearly defined in practice. Thus EA team may not have a clear role in the organisation. Moreover, EA team may not have clear objectives. In addition, EA team may not have direct authority or even resources budgeted to EA work in the early phases of EA development.

As practitioners' in interview brought out, the lack of clear role, responsibilities, objectives and authority means, that enterprise architecture work may be very difficult to evaluate or it cannot be evaluated reliable at all. In addition, these factors may cause that the organisation and planning of EA measurement may be challenging.

Role and responsibilities of EA team have an affect also for the role of EA team in measurement and measurement carried out relating EA work. It can be said that defining the role of EA team is one prerequisite for the defining its role in measurement.

A prerequisite for the measurement is also that EA team should have long-term objectives. However, short-term goals may also be needed to show quickly the achievement of the benefits of the EA work.

Status and maturity of organisation's EA work and practices also affect on what kind of measurement is useful to perform. For example, the impacts of EA work are not sensible to evaluate if EA process initialization is just started.

EA team's roles in measurement.

The EA work related measurement aspects and activities relating were presented in the previous section. In different measurement aspects, EA team may have different role. The role of EA team may be in measurement, for example:

- gathering information for pre-planned measurements and reporting the results (e.g. company's performance measurement),
- carrying out the whole measurement process from the planning the measurement work to the analysis of results (e.g. quality evaluation of architecture work results)
- supporting and consultation the measurement planning (e.g. supporting the planning of company's general measurement activities),

This study do not restrict that all evaluation aspects and activities identified by this study should be only carried out by EA team. For example, Syntel [20] presents that EA evaluation should not be carried out by the architects themselves, because of objectivity. If the problems in objectivity are expected, we recommend the using employees outside of EA team or reviewers from outsiders.

As the characteristics of the EA team, such as its organizational position, aims and resources differ in various organizations, measurement work carried out by EA team may differ.

Practices and challenges of EA measurement

The goals of measurement should be defined. As the practitioners in the focus group interview emphasized, measurement and evaluation without clear objectives should be avoided.

Moreover, frequencies for carrying out the evaluation and measurement tasks should be defined as suggested by the focus group. In practice, it is typically carried out annually and is focused on receiving feedback on the work carried out by the team, and using it for improvement.

According to the group, it should be remembered that measurement is quite often part of the management system and thus affects the behavior of individuals, units and entire companies. Therefore, the aims of measurement should be identified well as well as used measures and evaluation targets should be correct. The planning of measurement is thus a critical phase for the success of measurement.

Limits of this study

Measurement concerns and needs for enterprise architecture work are organization-specific to at least some extent. Therefore, the presented measurement aspects and activities are suggestive on what kind of EA measurement could or should carried out in companies.

The focus group included practitioners from organizations initiating and supporting the initiating EA work, which may have affected the results.

7 Conclusion

In this report, EA work measurement aspects and activities were defined by constructive research, including a literature review and a focus group interview of practitioners. EA team's roles in measurement were also considered.

This study identified that means of EA measurement are the supporting the management of EA work, the improvement of EA work practices and products and the evaluation of impacts and benefits of EA work. In addition, the measurement may be executed as a part of architecture work. For example, evaluations of architecture alternatives can be used to support architecture planning and decision making. In addition, organisation's common measurement programs affect also on EA work. Measurement needs of those are also needed to taken into account in EA work. The EA team may act in various roles in both EA measurement planning and the actual measurement in the company. EA team may perform measurement work and support the data gathering and planning of measurement work.

Contributions to Research

The presented EA measurement aspects and activities contribute to the literature on EA evaluation. They can be used as a basis for further research on measurement methods, metrics and criteria suitable for these measurement aspects.

Contributions to Practice

Practitioners may use the results of this study to assure that all relevant evaluation aspects and related activities have been considered in the planning of EA measurement, and thus make sure that the most important evaluation concerns are addressed. Moreover, the experiences of the focus group may help practitioners in initiating the EA evaluation.

Agenda for Further Research

The results of this study can be used as a basis for further research in for example in the following ways. Firstly, evaluation and measurement methods, criteria and metrics could be developed relating to these measurement aspects and activities. Secondly, the role of EA team in measurement could be studied.

Future of EA measurement

Currently, a limited effort is done to measure for example EA progress and value in organisations [4]. For example, evaluation and measurement is only a small part of EA teams' work in the companies represented by the focus group members in this study.

Being able to measure, in the meaning of having the skills and capability to measure, is essential at all stages of the EA adoption [4]. As soon as the maturity of EA processes will be increased and the role of EA work in companies will be stabilized, more and more EA measurement efforts can be expected to be carried out. Thus, significance of EA measurement will increase in the future and it will be actual part of daily enterprise architecture work.

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QUALITY MANAGEMENT ACTIVITIES FOR ENTERPRISE ARCHITECTURE

AISA Project Report

Version: 1.0	Date: 4.5.2006
Author: Tanja Ylimäki	Status: Final

Summary

During the past few years enterprise architectures (EA) have gained much attention of ICT people. EA is suggested to be the approach for controlling the complexity and constant changes of the business environment of an organization, enabling a true alignment between the business vision, business requirements and information systems.

EA studies have mainly focused on the development and modeling of EA, whereas the quality and assessment aspects of EA have only recently gained attention. AISA project aims at scrutinizing the field of quality management of architectures (both at the enterprise and software level).

This report describes the work done in the second phase of the AISA project. The aim of the phase was to determine quality management (QM) activities needed in enterprise architecting. They were derived from general quality management, EA management and EA development literature and discussed and reviewed in a workshop participated by the representatives of the co-operating organizations of the research project.

Based on the literature review and the workshop results QM activities for EA are suggested to be divided into activities related to 1) the EA governance process, and 2) the EA development life cycle. QM activities within the EA governance process deal with e.g. the definition of quality policy, quality objectives, EA mission, vision and objectives, establishment of EA governance structure, definition of communication and documentation policies, quality measurement planning, and quality control and assurance, as well as definition of the actual EA development methodology. QM activities within the EA development life cycle deal with e.g. definition of the EA stakeholders and EA requirements, actual EA modeling (from different points of view), migration planning, implementation (through system development or other types of projects), quality control and assurance in different phases of the life cycle, and using the EA as a guide and a mentor, or as a tool for ICT related decision making.

These activities describe a “vision” or the big picture of what activities could and should be included in the EA governance and development processes in order to enable gaining an EA of high quality rather than offering a ready-made practice-oriented package for quality management of EA to be put into action. Depending on the organization’s needs and its EA capability and maturity, relevant or priority QM activities can be determined. Finally, the following conclusions were drawn:

- There is a need to shift from investment decisions driven EA development to EA governance driven development.
- There is a need to increase the maturity of the EA governance and EA development processes. The set of QM activities presented in the report can be regarded as the highest level of EA maturity; if all the appropriate activities are planned and conducted, the organization should have a more mature EA.
- There is a need to develop metrics for controlling, assessing, and evaluating e.g. quality, maturity and performance of EA.

Contents

1 Introduction

During the past few years enterprise architectures (EA) have gained much attention of ICT people. EA is suggested to be the approach for controlling the complexity and constant changes of the business environment of an organization, enabling a true alignment between the business vision, business requirements and information systems.

EA studies have mainly focused on the development and modeling of EA, whereas the quality and assessment aspects of EA have only recently gained attention. AISA project aims at scrutinizing the field of quality management of architectures (both at the enterprise and software level).

This report presents the results of the second phase of the AISA project's first year. The phase aimed at determining the quality management (QM) activities for EA. The phase consisted of the following steps:

1. Identification of the activities related to quality management.
2. Identification of the activities related to enterprise architecture governance.
3. Integrating the quality management activities into the enterprise architecture governance.
4. Workshop/focus group interview of the representatives of the user and service provider organizations (Krueger and Casey 2000) to review, discuss, and validate the QM activities for EA.
5. Analysis, consolidation and reporting of the results of the workshop/focus group interview and the literature review.

The QM activities for software architecture were studied with the help of a similar process, and the results are reported in a separate document (Hämäläinen 2005).

The remainder of this report is organized as follows. In the next section, we represent the basic ideas of quality management both in general and in the field of EAs. The sections three and four describe the results of the literature review and workshop, and the last section concludes the report.

2 Quality Thinking

In this section the main concepts for quality and quality management both in general and in the field of EA are briefly described.

2.1 Quality and Quality Management

Quality (of a product, service, etc.) has, for example, the following characteristics (Lecklin 2002; Dale 2003):

- conformance to agreed and fully understood requirements,
- fitness for purpose or use, and
- customer satisfaction: the product or service satisfies customer expectations and understands their needs and future requirements in a cost-effective way.

Why we should care about quality? Dale (2003) presents various points why quality is perceived to be important. Examples of these are as follows:

- quality is a primary buying argument for the ultimate customer
- quality is a major means of reducing costs
- quality is a major means for improving flexibility and responsiveness
- quality is a major means for reducing throughput time.

Juran (Juran and Godfrey 2000) introduces his "**Trilogy of Quality Management"**, which defines that managing for quality makes extensive use of three managerial processes: 1) quality planning, 2) quality control, and 3) quality improvement.

They are similar to the parallel processes long used to manage for finance:

- Financial planning which prepares the annual budget.
- Financial control which consists of evaluating actual financial performance.
- Financial improvement which aims to improve financial results; e.g. cost-reduction projects, new facilities to improve productivity, new product development to increase sales, acquisitions, or joint ventures.

Quality planning can be defined as a "structured process for developing products (both goods and services) that ensures that customer needs are met by the final result. The tools and methods of quality planning are incorporated along with the technological tools for the particular product being developed and delivered" (Juran and Godfrey 2000).

Quality planning has to deal with the quality gaps depicted in Figure 1 by providing processes, methods, tools and techniques for closing each of the component gaps and thereby ensuring that the final quality gap is at a minimum.

The quality control process is "a universal managerial process for conducting operations so as to provide stability – to prevent adverse change and to maintain the status quo" (Juran and Godfrey 2000). To maintain stability, the quality control process evaluates actual performance, compares actual performance to goals, and takes action on the difference. According Juran quality control's relation to **quality assurance** can be described as follows: "Each evaluates performance, each compares performance to goals, each acts on the difference. However, quality control has as its primary purpose *to maintain control* (or stability), performance is evaluated *during operations.* Quality assurance's main purpose is to verify that *control is being maintained,* performance is evaluated *after operations.*"

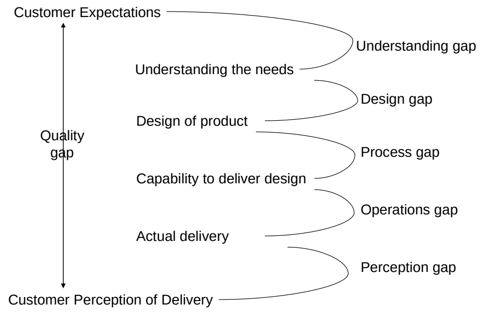

Figure 1. The quality planning deals with the quality gaps (Juran and Godfrey 2000).

Quality improvement process is clarified with the definition of the term improvement. It can be seen as an "organized creation of beneficial change; the attainment of unprecedented levels of performance" (Juran and Godfrey 2000). Furthermore, improvement usually takes place project by project and step by step.

Total Quality Management (TQM) is a "management philosophy embracing all activities through which the needs and expectations of the customer and the community, and the objectives of the organization are satisfied in the most efficient and cost effective way by maximizing the potential of all employees in a continuing drive for improvement" (Dale 1994), or "the vast collection of philosophies, concepts, methods, and tools now being used throughout the world to manage quality" (Juran and Godfrey 2000).

Dale (1994, 21) describes the TQM to evolve through four stages:

- *Inspection:* Activities such as measuring, examining, testing, gauging one or more characteristics of a product or service and comparing these with specified requirements to determine conformity.
- *Quality control:* The operational techniques and activities that are used to fulfill requirements for quality.
- *Quality assurance:* All those planned and systematic actions necessary to provide adequate confidence that a product or service will satisfy given requirements for quality.
- *Total quality management* is the fourth and the highest level and it involves the application of quality management principles to all aspects of the business, including customers and suppliers.

Quality management is not a separate part of the organization, it is more or less integrated into the management system of an organization to enable systematic deployment of the management's strategies and declarations of will throughout the organization (Lecklin 2002). Quality management also includes and deals with the organizational parts, responsibilities, procedures, processes and resources needed to improve quality (Lillrank 1998).

2.2 Managing the Quality of Enterprise Architecture

In this section we will briefly discuss the quality management of enterprise architecture. We start by revising the definitions for EA and the quality of EA.

An Enterprise Architecture, EA, is generally seen as a blueprint which identifies the focal parts of the organization (such as people, business processes, technology, information, financial and other resources) and its information systems, as well as the means how these different parts collaborate to achieve the desired business objectives (Hoogervorst 2004; Kaisler, Armour et al. 2005). An ideal EA provides a holistic, enterprise-wide and consistent view of the organization instead of a looking at it from the single application or system point of view (Kaisler, Armour et al. 2005; Lankhorst 2005).

During the previous step of the AISA project we defined the following preliminary definition for the **quality of EA** (based on Lecklin 2002; Dale 2003): an Enterprise Architecture has a good quality if it conforms to the agreed and fully understood business requirements, fits for the purpose (which is to gain business value through EA), and satisfies the various stakeholder groups' (e.g. the top management, IT management, architects, developers) expectations in a cost-effective way and understands their current needs as well as their future requirements. Cost-effectiveness is a multifaceted issue, though. It may refer, for example, to the investment costs or the life cycle costs of information systems, depending on the decision that is usually made by the top management.

The quality of EA is, however, more than merely the quality of the implemented EA indicating that it is successfully used (e.g. EA conformant information systems are being developed and used to support the business operations). It may also refer to the quality of EA artifacts and documentation, the quality of the EA development process, or the quality of EA governance (process).

Why we should strive for an EA of high quality? Generally, EA provides e.g. a means of reducing information systems investment costs, life-cycle costs or throughput time, or a means of eliminating redundancy of, for example, systems and information. It also is an important means for improving flexibility and responsiveness of the business providing tools to manage the complexity of the business, as well as the complexity of the systems. More specifically, if the EA has also high quality these benefits are more likely to be reached.

2.2.1 EA Maturity vs. EA Quality

In EA efforts – conducted both by the practitioners and the academia – different (capability) maturity models and maturity assessments (GAO 2003; NASCIO 2003) have gained more attention than "traditional" quality thinking, possibly because they provide rather simple tools to assess the stage of the EA programs and to enhance its maturity, and thus, quality. The maturity models also have their roots in the field of quality management (Fraser, Moultrie et al. 2002). One of the earliest maturity models is the Crosby's Quality Management Maturity Grid (QMMG) which indicates that an organization's quality management evolves through five levels of maturity:

uncertainty, awakening, enlightenment, wisdom, and certainty (Fraser, Moultrie et al. 2002). The Capability Maturity Model (CMM) for software – and especially its improved version, the Capability Maturity Model Integrated (CMMI) for systems and software engineering (Chrissis, Konrad et al. 2003) – is one of the best known. The software process maturity can be defined as "the extent to which a specific process is explicitly defined, managed, measured, controlled, and effective" (Paulk, Curtis et al. 1993).

Maturity as a word means "ripeness" and it conveys the notion of development from some initial state to some more advanced state (Fraser, Moultrie et al. 2002). It also indicates that there may be several intermediate states on the way to the maturity. Similarly, quality improvement evolves step by step. In this report, the maturity models are considered as one means or approach of advancing the quality of EA, while the EA quality management may encompass a wider range of activities. Quality models also provide at least initial quality measurement systems for EA.

2.2.2 Quality Management of EA

Quality management of EA is about defining and conducting all those activities that are needed to reach an EA of high quality and, thus, it relates to the same perspectives than the quality of EA. There is a need to manage e.g. the quality of EA governance process, EA development process, EA artifacts or specification, and the implemented EA that is used.

How to piece together these different perspectives of EA quality management? We started with a rough depiction of the relation between the different management activities in an organization. EA as a holistic view to the enterprise co-operates with, and to some extent integrates into, the different management activities, such as business management, IT governance, systems development and quality management (see Figure 2), that are all needed in order to run the business successfully.

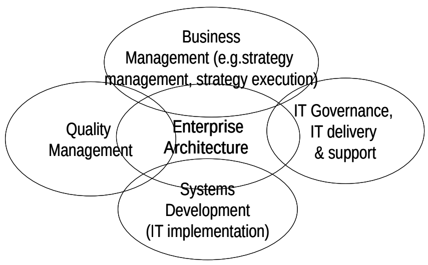

Figure 2. EA co-operates with other management activities in an organization.

Another view is presented in Figure 3. The ultimate aim of the TQM is to integrate quality management into the business management, the every day operations of the enterprise. The degree of this integration is dependent e.g. on the line of business or the size of the organization. In the manufacturing organizations there may be a separate department or team responsible for the quality management whereas in the information-centric businesses quality issues may be more integrated with the business management. The EA governance also aims at being integrated into the business management, as well as into the quality management to ensure reaching an EA of high quality which is effectively utilized in an organization.

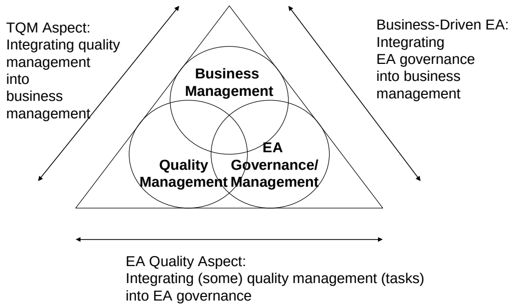

Figure 3. The management triangle: integration is needed e.g. between the quality management, enterprise architecture and business management.

Next, the relationship between the EA governance process and EA development process needed to be clarified. **EA governance** (sometimes also called as EA management or EA program management) can be defined as "the practice and orientation by which enterprise architectures and other architectures are managed and controlled at an enterprise-wide level" (The Open Group 2002). Architecture governance also refers to "how an organization makes decisions, set priorities, allocates resources, designates accountability, and manages its architectural processes" (Baker and Janiszewski 2005). As depicted in Figure 4, EA governance is seen as a continuous process controlling and guiding the actual EA development work that is suggested to be conducted incrementally and iteratively in several development cycles (see e.g. Perera 2005).

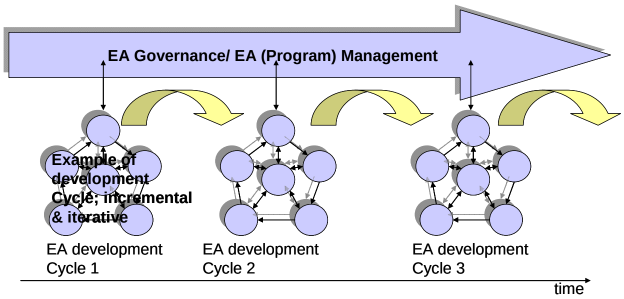

Figure 4. EA governance controls and guides the EA development cycles.

Because we did not want to restrict ourselves to any particular EA development methodology, we identified the main **generic EA development life cycle** steps to depict the EA development process. The generic EA development life cycle includes the steps of initialization, development/planning, realization, using/maintaining, and improving the EA (Grossman and Sargent 1999; CIO Council 2001; The Open Group 2002). Depending on the actual methodology used to develop an EA the precise content (phases, activities, tasks and outputs) of these generic steps will vary. In Figure 5 the generic steps within a single EA development life cycle are depicted together with EA governance process that should initiate before the first EA development cycle.

Within this context we suggest that the QM activities for EA are integrated into

1. the EA governance process, and
2. the EA development life cycle.

Quality management of the EA artifacts is included in the QM activities that are integrated into the EA development life cycle. In the next sections we will discuss the two levels of EA quality management in more detail.

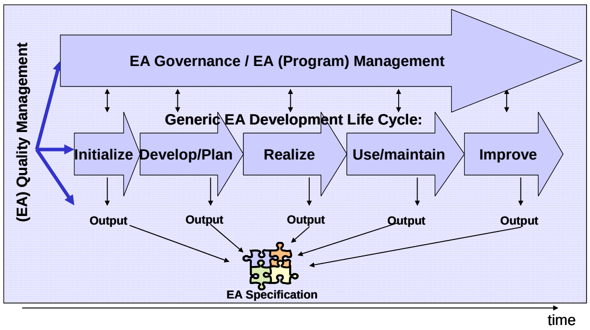

Figure 5. EA quality management is integrated into the EA governance process and the EA development life cycle.

3 Quality Management Activities within the EA Governance Process

In this section we will describe the quality management activities that are integrated into the EA governance process.

3.1 Quality Policy and Quality Objectives

Quality policy can be defined as the principles guiding the everyday business functions derived from the values of the organization, indicating for example the significance of the quality for the enterprise and how this can be seen in customer relationships or in the actions of both the staff and the management (Lecklin 2002).

Quality objectives can be defined as the measurable goals for quality efforts (Lecklin 2002). For example, the share of the satisfied customer to be over 70 %, or the total time spent on orders (from receiving an order to the delivery of goods or service) not exceeding 7 days are strategic quality objectives (Lecklin 2002).

Quality management tasks related to the quality policy and quality objectives are as follows:

- Define the quality policy (Lecklin 2002; Kartha 2004) for EA or follow the existing quality policy of the organization and its guidelines.
- Define the measurable quality objectives (Lecklin 2002; Kartha 2004) for EA based on e.g. the business objectives (Chrissis, Konrad et al. 2003) or strategic quality objectives of an organization (Lecklin 2002). The quality objectives may relate e.g. to
    - the EA governance process,
    - the EA development process and the actual method used,
    - the EA specification consisting of the artifacts produced during the development process, and
    - the implemented EA, the EA conformant information systems supporting the business operations that are used in the organization.

3.2 Definition of Architectural Starting Points

Architectural starting points are the essential issues that need to be considered, communicated and agreed upon in the beginning of the EA journey. Quality management activities related to the architectural starting points are as follows:

- Identify the key EA stakeholders (adapted from Juran and Godfrey 2000; Kartha 2004) to be able to involve them in the EA approach and development as early as possible in order to reach their commitment (see e.g. IAC 2005). It should be considered whether also their primary needs should be charted on a rough level at this point.
- Define vision, mission, objectives, principles and scope for EA (Grossman and Sargent 1999; The Open Group 2002; IAC 2005). EA objectives can be divided into long, middle-long, and short term objectives (van der Raadt, Hoorn et al. 2005). An example of a short term goal is communicating the added value of

architecture to senior and middle management. Improving the quality and structure of information systems and infrastructure is typically a long-term goal. It should be noticed that when the short-term goals are emphasized, middle-long and long term goals will be influenced negatively (van der Raadt, Hoorn et al. 2005). Furthermore, the problem of prioritization has to be dealt with. As van der Raadt et al. (2005) put it: "Clearly assigning priority to either the quality of architecture products or the availability of resources, such as time and money, may prevent many problems. Architects prioritize quality because they are responsible for the quality of a design. Management, however, is more likely to prioritize the use of resources because they are responsible for finishing projects within time and budget. In practice this difference in responsibilities and prioritizing often results in tension between the two groups. The choice of prioritizing quality has a negative correlation with the use of time and money, and vice versa."

It is also important to determine the intended use of the architecture, which can be business process reengineering, systems acquisition, system-of-systems migration or integration, user training, interoperability evaluation, or any other intent (CIO Council 2001). In the AISA Workshop it was brought up that architecture may also be the tool to reveal issues the organization is skating around, issues that are ignored or unable to be discussed and solved. Hence, the purpose of the architecture, as well as, vision, mission, scope etc. are closely tied to the organization's strategic plans, and they should be compliant with the business vision, mission, strategies and objectives. Architecture principles can be defined as the rules that govern the architecture process, affecting the development, maintenance and use of the EA (The Open Group 2002). Additionally, in the AISA Workshop it was pointed out that architecture visions describe the characteristics of an ideal architecture. In practice, however, many constraints (time, money, skills etc.) exist and the ideal architecture turns out to be "the realistic architecture", the best one developed with the restricted resources.

- Define the architecture approach or framework to provide a formal structure for representing the EA (CIO Council 2001; The Open Group 2002; GAO 2003; IAC 2005). An organization may choose an existing EA framework, such as the Zachman framework (Zachman 1987), TOGAF (The Open Group 2002), or FEAF (FEAF 1999), and apply it as such or modify it to better fit to the organization's needs, or totally define an organization specific framework.
- Define architecture terms and concepts to form the common terminology and language used in architectural discussion in the organization, or at least within the architecture team (see e.g. Ylimäki and Halttunen 2005).

3.3 Establishing the EA Governance Structure

In order to be able to manage the EA development efficiently governance structures need to be defined. Establishment of EA and its governance require a lot of co-operation between the actual EA team (see Section 3.8 Resource Management), the business management, and other key stakeholders (maybe even entire organization). The quality management activities related to the establishment of the EA governance structure are as follows:

- Establish and maintain the organizational policy for planning and performing the EA governance process (adapted from Chrissis, Konrad et al. 2003). This activity can be integrated into the definition of the architecture principles described above.

- Define and establish the EA governance structure (CIO Council 2001; The Open Group 2002; Curran 2005; IAC 2005; van der Raadt, Hoorn et al. 2005) including at least the processes, activities, tasks, roles, responsibilities, and authorizations needed. Organizational structure may consist of e.g. a governance board, an architecture board or a program management office.

In the next subsections we suggest some of the processes or activities that are needed in successful EA governance.

3.4 Definition of Communication, Documentation and Review Policies

Quality management activities related to communication, documentation and review issues are as follows:

- Define and establish the communication strategy
    - Develop a marketing strategy and the communications plan in order to keep the senior executives and business units continually informed and to disseminate EA information to stakeholders (CIO Council 2001; IAC 2005).
    - Provide for feedback and discussion (The Open Group 2002; IAC 2005). Feedback channels from different stakeholder groups were seen as an important part of the communication also in the AISA Workshop discussion. They enable e.g. the architecture to take the technological constraints into consideration as early as possible or the collection of lessons learned about the effectiveness of both the EA governance and development processes.
    - Communicate, communicate, communicate in order to gain and maintain top-management commitment and organizational buy-in.
- Define and establish the documentation policy
    - Develop a documentation plan (Kartha 2004), which should include e.g. what and how will be documented about the EA governance process, and the EA specification.
    - Ensure that the documentation policy is followed (e.g. through quality control).
    - Provide for reports of EA progress (The Open Group 2002; GAO 2003).

- Define and establish the review policy
  - Define how the outcome of the EA governance and development processes is reviewed, validated, or approved. Develop a review plan.
  - Review, validate and approve the outcome of the EA governance and development processes to determine EA product accuracy and completeness in e.g. 1) internal reviews conducted by the EA core team, 2) subject matter experts' or the domain owners' assessments of the EA products for accuracy and completeness (CIO Council 2001; GAO 2003). Notice that reviewing occurs at several points in the development process.

3.5 Definition of Risk and Change Management Strategies

Quality management activities related to the risk and change management strategies are as follows:

- Define the risk management strategies (OMB FEA Program Management Office 2005). In the AISA Workshop it was suggested that risk management is needed at least at the level of how to deal with technological risks or the ever changing business environment. The following steps may be utilized (Rajput 2004): 1) Understand and define the risks (and e.g. the extent, likelihood, significance of each risk), 2) assess risks, and 3) manage risks utilizing one or more of the possible strategies, such as avoidance, monitoring, improved response, transferring (reducing impact), or assumption (acceptance).
- Define the change management strategies (OMB FEA Program Management Office 2005). This includes at least the following two levels:
  - Plans to deal with the cultural change (Dale 2003).The adaptability of an organization's culture is an important determinant of business success (Hermansen and Caron 2003). Typically, an organizational culture has formed through shared group dynamics over years, and these cultural patterns are difficult to change. It may even become a constraint on business strategy (Hermansen and Caron 2003).
  - Definition of the maintenance policy to enable governance of the evolution of the EA (The Open Group 2002), i.e. definition of how to deal with change requests related to e.g. the EA specification, or the EA governance and development processes.

3.6 Quality Measurement Planning

Before any evaluation, assessment, or measurement can be conducted measurement planning must be done or at least initialized (Juran and Godfrey 2000; Kartha 2004):

- Identify controls needed (Juran and Godfrey 2000):
  - Define what are the things that will be measured e.g. about the EA governance, the EA development process, the EA artifacts, the implemented EA/the EA in use, or the customer satisfaction.
  - Define why measurement is needed and conducted, where, how and by whom will the measurement results be used.
  - Define when measurement will be conducted (the milestones).
  - Define how the measurement will be conducted and by whom.

  - Define the metrics for e.g. the EA quality, EA maturity, and EA objectives, such as business value added by the EA, EA program maturity metrics, EA program impact metrics, EA usage, EA completeness (IAC 2005). In the AISA Workshop it came up that metrics for EA measurement are difficult to determine, because the time frame for measurement is longer – years rather than months – than in the system development projects. The effects of the EA program will be seen, say, after five years. Within this time the business environment may have totally changed (e.g. through mergers and acquisitions), and it is very difficult to analyze the actual benefits or defects of the EA efforts.

- Set standards for control (Juran and Godfrey 2000), set levels at which the processes are out of control and define actions needed in such cases. This was seen essential also in the AISA Workshop discussion. It is necessary for an organization to determine the minimum acceptable level for EA processes and artifacts etc. There is no need to reach an EA that is 100 % perfect, it just needs to be good enough (see also Ambler 2005). It was also brought up that the minimum acceptable level of e.g. EA processes may be different at different EA maturity levels. A slogan of “just in time, just enough” was suggested to represent the ability of doing things well enough indicating maturity, at least to some extent. Furthermore, it came up in the AISA Workshop that the organization should encourage the architecture team as well as other stakeholders to exceed this minimum level, possibly through some kind of a rewarding system. On the other hand, it is important to discuss what the risks of not even reaching the minimum level of EA processes and artifacts are.
- Optimize self-control (Juran and Godfrey 2000), measure workers’ output, and give feedback on their performance. In the AISA Workshop it was considered important that EA should not dictate the system development team how to implement the systems needed, but rather to guide and motivate the system development team by providing them e.g. design patterns or piloted solutions that ease their work, but do not harness their creativity.

Finally, the above issues of the measurement planning are documented into an (initial) evaluation plan.

3.7 Quality Control and Quality Assurance of EA Processes

After the quality control and assurance is planned, the plans need to be put into action. The following activities are needed in conducting quality control and assurance of EA processes – both the EA governance process and the EA development process (the method):

- Refine or update the evaluation plan (e.g. what, when, how, who, and metrics) if needed.
- See that the quality policies and objectives are met by conducting the steps defined the evaluation plan. The following general steps of quality control and assurance can be exploited (adapted from Juran and Godfrey 2000; Chrissis, Konrad et al. 2003):

- Evaluate the performance of EA governance or EA development processes, related artifacts, customer satisfaction (are the stakeholders' requirements met etc.) using the defined metrics.
- Compare the performance with the (quality) goals or requirements defined for EA governance, EA development processes, related artifacts, or customer satisfaction.
- Take appropriate actions on the difference, e.g. adjust the processes, or the artifacts (GAO 2003).
- Provide constructive feedback to facilitate continuous improvement (Stylianou and Kumar 2000).
- Document the evaluation and the actions taken in an evaluation report.

3.8 Resource Management

Resource management deals with issues like assignment of personnel, training, awareness and competency. Activities needed in resource management are as follows:

- Establish the initial EA team
    - Assign the chief architect to take responsibility for leading the development of the EA work products and support environment (CIO Council 2001; GAO 2003). She/he will serve as the technology and business leader for the development organization, ensuring the integrity of the architectural development processes and the content of the EA products. She/he should also be friend and liaison to the business line units and ensure that business unit processes are emphasized in the EA. Furthermore, the chief architect is responsible for ensuring that the EA provides the best possible information and guidance to IT projects and stakeholders, and that systems development efforts are properly aligned with business unit requirements. (CIO Council 2001)
    - Architecture team should also include IT experts (such as systems, data, infrastructure and security systems architects), business line experts, and technologists (CIO Council 2001; GAO 2003). Participants should have an understanding of the current business and technical environment and the strategic business objectives envisioned in the EA (CIO Council 2001).
    - Assign responsibility and authority for the team (CIO Council 2001). The EA core team is responsible for all activities involving the development, implementation, maintenance, and management of the architecture.
    - Identify the thought-leader, which may be e.g. the CIO, or organizational head, project manager, technical team lead, or the chief architect on the project. "The thought leader is someone who is respected throughout the organization for their leadership abilities, and who becomes the "go-to" person for explanations or problems" (IAC 2005). Thought leader is the one to explain the vision and purpose of EA to the stakeholders and even sell the concept.
- Assign, or at least try to estimate other resources (like funding/budget, schedule, rooms, tools etc.) needed for the EA program or for a development cycle (IAC

2005). In the AISA Workshop scheduling issues were considered almost more important than budgeting issues. It is necessary that the “right people have enough time to do the right things”. On the other hand, EA budgeting was regarded as a difficult task. It is easier to estimate the ICT expenses than the EA expenses, because it is still somewhat unclear what EA is all about and which issues can be regarded as “pure” EA issues. Usually, there is no historical evidence to rely on while making the EA budgets. Therefore, they are mainly based on rough estimates or good guesses.

- Train people performing or supporting the EA management and development processes (adapted from Chrissis, Konrad et al. 2003): Discover their needs, develop a training plan (including e.g. the content, audience, resources, staffing, and curriculum design), deliver the training content to the audience and evaluate the effects of training (Juran and Godfrey 2000).

3.9 Development of EA Methodology

A defined EA methodology will be needed to provide a common set of procedures for developing an EA, and to help ensure consistency in the procedures used across the organization for developing and maintaining the EA (GAO 2003). Some more or less detailed EA development processes or methods exist (e.g. CIO Council 2001; Popkin Software 2002; The Open Group 2002), but it is typical that organization specific methods are defined and used. Activities needed in the EA method development are as follows:

- Develop the process (Juran and Godfrey 2000): Define, document and establish the EA development process; its phases, activities, inputs, and outputs (CIO Council 2001; GAO 2003). The method also needs to be documented, understood and consistently applied by the EA team (GAO 2003). It should be noticed that the QM activities within the EA development life cycle (presented in the next section) are actually activities that need to be considered while defining or applying the EA method. These activities should be integrated into appropriate steps of the method.
- Select appropriate modeling language(s), techniques (can be done as part of the EA development process definition) to enable e.g. standardized EA output and consistent EA views.
- Select appropriate (automated) tools to develop and manage EA (CIO Council 2001; GAO 2003; IAC 2005). The choice of tools is based on the organization’s needs and the size and complexity of the architecture (see e.g. Rudawitz 2003).
- Provide appropriate training related to the EA methodology, modeling languages and tools to ease the method adoption in the architecture team (for example as part of resource management activity as described above).

4 Quality Management Activities within the EA Development Life Cycle

In this section we describe the QM activities that are integrated into the EA development life cycle. While we did not want to restrict ourselves to any particular EA development method, we used the generic EA development life cycle steps to depict the EA development process. When the actual EA development methodology will be defined, the activities presented in this section, are integrated into appropriate phases of the method.

4.1 QM Activities for EA Initialization – Scope, Stakeholders and Requirements

In the EA initialization step the scope, stakeholders and EA requirements need to be clarified. The following activities are needed:

- Define or refine the scope, mission, vision, objectives, and principles of EA (Grossman and Sargent 1999; The Open Group 2002; IAC 2005).
- Define the depth of the EA. "Care should be taken to judge the appropriate level of detail to be captured based on the intended use and scope of the EA and executive decisions to be made using the EA. It is important that a consistent and equal level of depth be completed in each view and perspective. […] It is equally important to predict the future uses of the architecture so that, within resource limitations, the architecture can be structured to accommodate future tailoring, extension, or reuse" (CIO Council 2001). Importance of predicting the future changes was considered essential also in the AISA Workshop. This is where the business management's perspectives may collide with the architecture team's perspectives; business management may want a low-cost "quick and dirty" solution for a particular problem at hand, while the architecture team is trying to develop a long-range EA plans to be able to respond to the future changes.
- Identify both the internal and external stakeholders for EA, as well as all relevant standards, regulations, and policies that may affect the EA (adapted from Juran and Godfrey 2000).
- Discover the stakeholders' needs (adapted from Juran and Godfrey 2000):
    - Plan to collect the business' needs and other stakeholders' needs.
    - Collect architectural requirements, stakeholder needs, expectations, and constraints. Some requirements can also be rather implicit; such requirements are known, but seldom documented, and hence, easily ignored. In the AISA Workshop a best-practice was suggested; an architect goes through all the requirements gathered and marks those that are architecturally significant. Definition of the architectural requirements is very much based on the expertise of the architect or any other person conducting the EA requirements gathering and analysis.
    - Analyze and prioritize the needs, requirements, and constraints. Requirements may be conflicting or ambiguous. In the AISA Workshop it

was pointed out that architecture can also be seen as a tool to discover and reveal these inconsistencies.

  - o Translate the needs into EA requirements or into the language of the EA team and finally, document the EA requirements. In the AISA Workshop it was pointed out that the time frame of the (business) requirements can be rather short. The architecture team should be mature enough to be able to translate these short-term requirements into long-term architectural requirements.

- Communicate in a continuous manner in order to gain and maintain the top-management commitment and organizational buy-in. Take the characteristics of the organization culture into account in a way the communication is conducted (e.g. the language and communication means used).

4.2 QM Activities for EA Development

Activities needed in the EA development step of the life cycle relate to EA modeling, migration planning, and quality control and assurance.

4.2.1 EA Modeling

EA modeling deals with the following activities:

- Model the current architecture (the as-is architecture) describing the current state of an enterprise's architecture (Armour, Kaisler et al. 1999b; CIO Council 2001; GAO 2003). Model the perspectives defined in the architecture framework, e.g. business architecture, information architecture, systems architecture and technology architecture (see e.g. The Open Group 2002).
- Develop the future architectures (the to-be architecture) describing the future state or the "to be built" state of the enterprise's architecture within the context of the strategic direction (Armour, Kaisler et al. 1999b; CIO Council 2001; GAO 2003).
- Ensure traceability between the as-is and the to-be state. "The process of tracing differences between the current and the future states is maybe the most difficult steps in the entire EA life-cycle process" (IAC 2005).
- Document the architectural decisions including justifications of the decisions made.

While modeling the EA, all the defined documentation and communications policies and strategies should be followed in order to enable reaching a consensus on the EA, as well as an EA specification of high quality, or at least of acceptable quality.

4.2.2 Migration Planning

Migration or transition planning is about to develop "an incremental strategy for transitioning the baseline to the target" (CIO Council 2001), to design how to get from the current situation to the future situation (Armour and Kaisler 2001; CIO Council 2001; GAO 2003). The following activities are needed while planning the migration:

- Identify and define the steps or projects needed. Define scopes and mission statements for each project and prioritize the projects (adapted from Juran and

Godfrey 2000). Document these definitions and decisions in a migration or transition plan.

- Do architecture implementation planning (Armour and Kaisler 2001); map resources (budgets, schedule, people etc.) to the choices made in the migration planning.

4.2.3 Quality Control and Quality Assurance

Quality control and quality assurance within the EA development step may relate e.g. to the

- the current EA measuring how aligned or misaligned it is with the organizational goals,
- the EA artifacts or the EA specification measuring the conformance to the documentation policy or standards, or
- the "customer" satisfaction measuring the extent to which the stakeholders' requirements are met.

Issues to evaluate and assess depend on what is defined in the evaluation plan. The tasks needed in quality control and assurance are as follows:

- Refine or update the evaluation plan (e.g. what, when, how, who, and metrics) if needed.
- See that the quality policies and objectives are met by conducting the steps defined in the evaluation plan. The following general steps of quality control and assurance may be exploited (adapted from Juran and Godfrey 2000; Chrissis, Konrad et al. 2003)
    - Evaluate the performance of the current EA, the EA artifacts, the customer satisfaction etc. using the defined metrics.
    - Compare performance with the (quality) goals or requirements defined for EA artifacts, customer satisfaction etc.
    - Take action on the difference, e.g. modify the artifacts.
    - Provide constructive feedback to facilitate continuous improvement (Stylianou and Kumar 2000).
    - Document the evaluation and the actions taken in an evaluation report.

4.3 QM Activities for EA Realization

EA realization is about to implement the EA as defined in the migration plan. This is usually conducted in several projects (that may or may not involve information systems development), and hence, project management activities are needed. In the AISA Workshop discussion it was underlined that in practice EA mainly focuses on providing guidance and policies for the individual IT projects that implement the EA conformant information systems.

4.3.1 Implementing the Plans

Activities needed in implementation are as follows:

- Implement the plans and validate transfer to operations (adapted from Juran and Godfrey 2000):
    - Follow the migration plan and take appropriate actions.
    - Refine or update the migration plan if needed.
    - Conduct (system) development project(s) to move closer to the to-be architecture (CIO Council 2001).
    - Ensure the compliance of an individual development project to the EA (The Open Group 2002). This was highlighted also in the AISA Workshop discussion. Furthermore, CIO Council (2001) suggests that an enforcement policy may be defined to provide the standards and process for determining the compliance of systems or projects with the EA and procedures for resolving the issues of non-compliance. A project's technical and schedule compliance is typically assessed in terms of how it conforms to the content, intent, and direction set by the EA (CIO Council 2001).
- Provide support for the project team(s) (adapted from Juran and Godfrey 2000), including e.g. the following tasks:
    - Review the team progress,
    - Identify and help any problems,
    - Coordinate the related projects, and
    - Communicate the project results to the appropriate stakeholders.

4.3.2 Quality Control and Quality Assurance

In the realization phase quality control and quality assurance is needed in order to ensure that the implementation of the information systems supporting the business operations is conformant to the EA. The following activities are similar to the quality control and quality assurance activities for the EA development phase:

- Refine or update the evaluation plan if needed.
- See that the quality policies and objectives are met by conducting the steps defined in the evaluation plan. The following general steps of quality control and assurance are suggested (adapted from Juran and Godfrey 2000; Chrissis, Konrad et al. 2003)
    - Evaluate e.g. the customer satisfaction (are the stakeholders' requirements met), or the conformance of the system development project to the EA specification (The Open Group 2002). Conformance was regarded as important issue also in the AISA Workshop discussion.
    - Compare performance with the (quality) goals or requirements defined for EA, customer satisfaction etc.
    - Take action on the difference and steer the project to the right direction.
    - Provide constructive feedback to facilitate continuous improvement (Stylianou and Kumar 2000).
    - Document the evaluation and the actions taken in an evaluation report.

4.4 QM Activities for EA Usage

EA usage is about 1) using the EA specifications for the purposes it was designed in the first place; to inform, guide, mentor and constrain the business decisions, especially those related to IT investments (CIO Council 2001), as well as 2) utilizing the EA conformant information systems to support the business operations.

4.4.1 Continuous Tracking for Changes

When part or the whole EA has been implemented and introduced within an organization, it is still important to track for changes that may affect the architecture. Activities related to tracking for changes are as follows:

- Refine or update the EA models and artifacts if required. These adjustments and minor amendments do not indicate substantial changes to the EA.
- Continuously track for new business requirements (The Open Group 2002). The change requests should be handled according to the maintenance policy.
- Continuously track for new stakeholder requirements (adapted from The Open Group 2002). This kind of change requests should also be handled according to the maintenance policy.
- Continuously track for new technology opportunities.
- Continuously track for new products or services provided by the vendors and partners.

4.4.2 Quality Control and Quality Assurance

Assessment is needed in order to evaluate the effects the EA has on the organization and the business success. The following activities are similar to the quality control and quality assurance activities for both the EA development and realization phase:

- Refine or update the evaluation plan (e.g. what, when, how, who, and metrics) if needed.
- See that the quality policies and objectives are met by conducting the steps defined in the evaluation plan. The following general steps of quality control and assurance are suggested (adapted from Juran and Godfrey 2000; Chrissis, Konrad et al. 2003)
    - Evaluate e.g. the usage of the implemented EA; how widely or deeply it is used in the organization, the business success (the value gained through EA), or the customer satisfaction to ensure whether all the stakeholders' requirements are met.
    - Compare performance with the (quality) goals or requirements defined for EA usage, business success, customer satisfaction etc.
    - Take action on the difference e.g. through training and communication.
    - Provide constructive feedback to facilitate continuous improvement (Stylianou and Kumar 2000).
    - Document the evaluation and the actions taken in an evaluation report.

4.5 QM Activities for EA Improvement

From the quality management point of view the EA improvement phase aims at providing plans for continual improvement (Chrissis, Konrad et al. 2003; Kartha 2004) to enable reaching the defined or new business objectives. Improvement may focus on e.g. the EA governance process, the EA development process (the methodology), EA artifacts, or EA usage. Activities suggested in this phase are as follows:

- Plan for continual improvement, plan preventive or corrective actions.
- Evaluate the maturity or the quality of the current EA (program), for example,
    - to clarify the current situation, what EA activities have been carried out, what EA activities should still be considered,
    - to find out if there is a need to modify or refine the migration plan,
    - to assess the possible inefficiencies in the EA governance and development processes, EA artifacts, or in the EA usage and utilization (NASCIO 2003), and
    - to assess the effects of change requests, such as the effects of new business requirements, as well as the necessity of a change. Change impact analysis applied to EA models can be used to see what would happen if a change occurs, before the change really takes place (de Boer, Bosanque et al. 2005).
- The EA (governance) team or the top management makes the decision to start a new EA development cycle or iteration based e.g. on the evaluation results or new (business) requirements.
- Update or refine the migration plan if needed.
- Plan a new EA development cycle or project taking the changed and new business and other requirements into account ensuring the compliance of a single project to the EA.
- Provide the appropriate resources through resource management activity.
- Deal with the cultural change (Dale 2003).
- Train people developing and using the EA (adapted from Juran and Godfrey 2000).
- Communicate, communicate, communicate to reach and maintain both top-management support and commitment and the organizational buy-in.

As a conclusion, the improvement phase can be regarded as a kick-off for a new EA development cycle.

5 Conclusions

In this report we presented a wide range of theoretical quality management activities for enterprise architecture. They were derived from general quality management, EA management and development literature and discussed and reviewed in a workshop participated by the representatives of the co-operating organizations of the project.

EA quality management activities were integrated into the EA governance process and into the generic phases of the EA development life cycle. This report aimed at describing a “vision” or the big picture of what activities could or should be included in the EA governance and development processes in order to enable gaining an EA of high quality rather than offering a ready-made practice-oriented package for QM of EA to be put into action. Depending, for example, on the organization’s needs, resources, and maturity level, relevant or priority QM activities can be determined. On the other hand this big picture of QM activities for EA represents the focal elements of the AISA research project the way we see them at the moment, but it is likely that the picture may change and clarify in the course of the research project as the understanding of the problem area increases.

Even though the study is preliminary and the results should be generalized with care, some conclusions can be drawn:

There is a need to shift from investment decisions driven EA development to EA governance driven development. Quarter based economies impede the long-term thinking that EA requires; it is sometimes difficult to justify the top management that the investment that seems expensive at the moment will save money in the future. Thus, it is typical that short-term investment decisions drive the EA development efforts. While the companies have to deal with these limited resources, both in the sense of time and money, there is the need to select the most important quality management activities to start with. In the AISA Workshop the topic of EA assessment and measurement was emphasized. It can provide one possible starting point for EA quality improvement. Evaluation of the current state of the organization’s architecture and its EA capability provides input for the definition of the organization’s “declaration of will”, as well as to the definition of the top priority QM activities the organization should start with.

Another point made in the AISA Workshop was the fact that extensive QM processes can be developed which guide or even force to an ideal output and performance, but which do not work in practice. Therefore, the QM processes need to be streamlined and optimized to be as light as possible and easy to be adopted by an organization. Only then the activities can be conducted effectively and the top management’s acceptance and commitment as well as the organizational buy-in can be gained.

There is a need to increase the maturity of the EA governance and development processes. One way to enable the shift from the investment decisions driving the EA development efforts to more systemized and controlled EA approach is to determine, deploy and improve the processes for EA governance and development, and, thus, increase the maturity of EA, as well as the maturity of the organization, its EA capability. The set of QM activities presented in this report can be regarded as the highest level of EA maturity; if all these activities are carefully planned and conducted, the organization should have a more mature EA.

In the previous phase of the AISA project the potential critical success factors (CSF) for EA were studied (Ylimäki 2005). It can be noticed that the EA quality management activities focus to the same issues than the CSFs for EA (Figure 6). Hence, the QM activities presented in this report together with the CSFs for EA could be integrated into an EA maturity model for business organizations.

Figure 6. Potential critical success factors for EA.

There is a need to develop metrics for controlling, assessing and evaluating e.g. the quality, maturity and performance of EA. Development of appropriate metrics and best practices for evaluation and assessment has to deal with the questions like what the issues that will be measured and evaluated are, how the evaluation results are used and by whom. In the AISA Workshop it was suggested that descriptive metrics should be developed. The problem of descriptive metrics is that different interpretations of the evaluation results may exist. Typically, also the business management expects to have numeric metrics to base their decisions on. Therefore, both metrics will be needed.

Furthermore, there is the problem of justifying the architecture’s benefits for an organization. Issues to resolve are e.g. how to ensure that the business success, or the decrease in ICT costs is reached because of the EA approach adopted, or how to justify the need for EA approach to the business management in the first place. One possible solution to the latter problem was presented in the AISA Workshop: a pre-EA project can be set up with defined objectives, schedules, milestones, budget and staffing. Such a project aims at introducing and selling the EA approach to the organization, especially gaining the top management commitment, possibly determining the current state of the organization’s architecture – explicit or implicit – pointing out the most acute problems and defining initial objectives or the future state, and, therefore, enabling easier rollout of the EA governance and development processes.

These issues will be clarified in the following steps of the AISA Project starting with the further description of the current state and the development needs of the architecture quality management in the participating organizations.

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Quality Management Activities in Software Architecture Process

AISA Project Report

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Abstract

Architecture processes are considerably new parts of organisations' processes. These processes have the responsibility to aim at high quality and financially successful architectures. However, the architecture management activities which promote this aim are not clearly defined yet. This study reviews literature and practitioners' experiences on quality management activities that could be suggested to promote the achievement of high quality architectures. These activities are proposed to be taken into account in the software architecture management process design, development and capability assessment.

Contents

1 Introduction

Product and process quality management practices as well as process maturity and capability assessment practices are widely adopted and introduced in ICT industry. These practices include, among others, quality standards (e.g. ISO 9000 standards), frameworks for assessment the process maturity of an organization or a project (e.g. CMMI, Software Productivity Research (SPR)) and quality award programs (e.g. Malcolm Baldrige, European Quality Award).

Relatively new parts of organizations' processes are enterprise and software architecture management processes and their quality management. Software architecture management (SAM) consists of the activities of capturing the architectural requirements of software-intensive systems and understanding them. Moreover, the process also includes design, analysis/evaluation, implementation, maintenance, improvement, and certification of the architecture as well as its documentation (Bass et al. 1998; IEEE 2000).

It is quite generally known that software architecture and its management process have an impact on the quality of the system. Academia and practitioners have come to realize that a critical success factor for system design and development is finding a high quality and financial successful architecture. An organisation's architecture management processes has the responsibility to aim at the quality and financial success of architectures. Other processes within an organisation, such as those for investment planning and system development, do not have this responsibility if not this responsibility is clearly included in these processes. This means that the success of architectures is not necessarily considered in decision making in these other processes. Therefore, the status and capability of the architecture management processes in organisations should be considered carefully if the architectural success is the aim of the organisation.

Although the idea of a successful architecture is not clearly defined, practitioners and academia have become increasingly interested in how successful software architecture can be achieved. The aim of this study is to identify and describe such quality management activities relating to software architecture management (SAM) which could be suggested to promote the achievement of a high-quality successful software architecture. In the following, these activities are called SAM-related quality management (QM) activities. By identifying these QM activities, this study aims to help an organisation's processes developers, quality managers and architects to design and develop architecture management processes that aim at high-quality architectures.

Development work and research on SAM related QM practices have already been conducted in the recent years. A variety of methods and best practices, which could be utilized in the quality management of software architectures, are being developed and studied. Process models and approaches for the architectural design have been developed (e.g. by de Bruin and van Vliet (de Bruin and van Vliet 2003) and Chung et al (Chung et al. 1995)). Architecture evaluation methods (e.g. ATAM (Kazman et al.

1998), ARID (Clements 2000), ALMA (Bengtsson et al. 2004)) and principles (e.g. by Barbacci (Barbacci et al. 1997)) are being developed and studied for the assessment of architectures. Architecture review practices are also discussed, for example, by Maranzano et al. (Maranzano et al. 2005) and Kazman and Bass (Kazman and Bass 2002) and quality assessment criteria and metrics have been investigated, for example, by Hilliard et al. (Hilliard et al. 1996), Losavio et al. (Losavio et al. 2003) (Losavio et al. 2004) and Dias et al (Dias et al. 1999). However, architecture management processes and process activities which promote the achievement of high-quality software architectures have only been briefly discussed or completely ignored in previous research.

This research involved reviewing the quality management literature on QM activities that are relevant for architectural design and development. These activities, presented in sections 3 and 4, were distilled from various quality standards (e.g. ISO standards) and process maturity models (e.g. CMMI) plus articles and books on quality management implementation (e.g. (Juran and Godfrey 2000)). Moreover, in order to collect empirical data for the present study, a group interview was organised for a focus group of practitioners from four ICT service providers and user organizations. As a result, this study presents a number of quality management activities relating to SAM.

This study consists of the following sections. Firstly, section 2 presents the research method used in this study. Secondly, sections 3 and 4 present the results of this study: the quality management activities relating to software architecture management. Section 5 compares the results with the current state of architecture management in ICT service provider and user organisations. Finally, section 6 summarizes the study and presents areas for further examination.

2 Research Method

In order to identify and analyse the quality management activities relating to software architecture management, a series of the following research phases was used in this study.

Phase 1. The study of quality management literature, standards and maturity models

Firstly, a list of general product and process quality management activities, mentioned in previous research, standards and process maturity models, was produced. ISO standards and CMMI were especially considered. The list of activities was analysed and the objectives and activities were organised into groups.

Phase 2. Applying the QM activities to SAM

The phases of software architecture management were analysed against the identified QM activities. A proposal was produced in which it was described which QM activities could be executed in a certain phase of software architecture management.

Phase 3. Empirical research: A focus group interview (Krueger and Casey 2000) of practitioners

A semi-structured group interview for a focus group of practitioners from four ICT user and service provider organisations was organised. The practitioners were specialists of the management of software and enterprise architectures. The goal of the interview was to collect activities from the practitioners. A proposal of SAM-related QM activities was presented in the interview, and the interview was thus structured according to them. The practitioners reviewed the proposal based on their own practical experiences. Moreover, they were also asked to add new activities to the results on the basis of their practical experiences. The interview was tape-recorded and notes were written during the interview session. Based on this data a list of QM activities for software architecture management was produced.

Phase 4. Consolidation and analysis of results

The results from the empirical study and previous research were combined. These results are presented in chapters 3 and 4.

3 Quality Management of SAM Process

In this study attention was paid to both process and product quality aspects. Moreover, it was established that the quality management activities of software architecture management can be divided as follows:

1) *Activities that relate to the quality management of SAM process*. These activities are included in the organization's processes and project management and concentrate on the quality of SAM-process (process quality aspect).

and

2) *Activities that relate to the quality management of SA*. These activities are included in the SAM-process phases and concentrate on the achievement of software architecture of good quality (product quality aspect).

In this chapter the QM activities that relate to the quality management of the SAM-process are presented. The QM activities included in the SAM-process are presented in chapter 4.

The quality of architecture is influenced by the process used to acquire, develop, and maintain it. The process capability and quality management activities presented in table 1 were identified as being related to the QM of SAM process.

Table 1. Quality management activities of the software architecture management process.

Activity	Adapted from	Description
Organisational Policy		
Establishing and maintaining an organisational policy for planning and performing the software architecture management (SAM) process.	(Chrissis et al. 2003), [FGI] = according to focus group interview	
Development of SAM Process		
Planning and developing a process which is able to produce and manage the software architecture in the operating conditions.	(Chrissis et al. 2003), (Juran and Godfrey 2000), [FGI]	Paying attention especially to: • the change management of requirements and architectural designs and • the document management of architectural documents.

Activity	Adapted from	Description
Proving then that the process can produce, develop and manage software architectures under operating conditions.	(Juran and Godfrey 2000), [FGI]	
Optimizing the process features and goals.	(Juran and Godfrey 2000), [FGI]	
Maintaining the plan for performing the SAM process.	(Chrissis et al. 2003)	
Establishing and maintaining the description of the SAM-process.	(Chrissis et al. 2003)	
Transferring the SAM-process to operations.	(Juran and Godfrey 2000)	Implementing the plan for transfer and validating transfer.
Process management		
Providing resources (e.g. staff, time, funding) and assigning responsibility and authority for performing the SAM-process, developing the architecture related work products, and providing the services of the SAM-process.	(Chrissis et al. 2003)	
Identifying and involving the relevant stakeholders of the SAM-process as planned.	(Chrissis et al. 2003)	
Training and advising the people performing or supporting the SAM-process as needed.	(Chrissis et al. 2003), [FGI]	
Quality Objectives / Goals		
Establishing and maintaining quantitative quality objectives for the SAM-process that address quality and process performance based on customer and stakeholder needs and business objectives.	(Chrissis et al. 2003), [FGI]	
Establishing general (no project-specific) optimal quality goals for the SAs that are produced by SAM-process.	(Juran and Godfrey 2000), [FGI]	
Quality Measurement and Metrics		
Planning process measurements.	(Juran and Godfrey 2000), [FGI]	Deciding what aspects of the SAM-process to measure and choosing the metrics.
Planning software architecture evaluation.	(Juran and Godfrey 2000), [FGI]	Deciding what aspects of the software architectures to evaluate and choosing the metrics.
Evaluation of Process Performance		
Evaluating the actual performance of the SAM-process, comparing the actual performance of the process with quality goals and acting on difference.	(Chrissis et al. 2003), (Juran and Godfrey 2000)	

Activity	Adapted from	Description
Monitoring and controlling the SAM process against the plan for performing the process and taking appropriate corrective action.	(Chrissis et al. 2003)	
Objectively evaluating adherence of the SAM-process against its process description, standards, and procedures, and addressing non-compliance.	(Chrissis et al. 2003)	
Reviewing the activities, status, and results of the SAM-process with higher level management and resolving issues.	(Chrissis et al. 2003)	
Process Improvement		
Ensuring continuous improvement of the SAM process in fulfilling the relevant business objectives of the organisation.	(Chrissis et al. 2003)	
Collecting work products, measures, measurement results and improvement information derived from planning and performing the SAM process and from architectures produced by the SAM process.	(Chrissis et al. 2003), [FGI]	Information can be used to support the future use and improvement of the organization's processes, process assets and architectures.
Identifying and correcting the root causes of defects and other problems in the SAM process.	(Chrissis et al. 2003)	

4 Quality Management of Software Architecture

In this study we identified the following list of quality activities that can be executed and included in the software architecture management process.

4.1 Capturing Architectural Requirements and Understanding Them

Architectural requirements capturing related QM activities are as follows.

Requirements Collection

- Planning the collection of requirements. Planning to collect customer and stakeholder needs ("af = adapted from (Juran and Godfrey 2000)).
- Identifying customers and stakeholders. Identifying both internal and external customers and stakeholders (af (Juran and Godfrey 2000)).
- Identifying what requirements and boundaries organisation's strategy and ICT strategies set for the system [FGI].
- Identifying all relevant standards, regulations, and policies (af (Juran and Godfrey 2000)).

- Describing the existing environment and identifying boundaries that the existing environment sets for the system [FGI].

- Identifying the possible change situations. Identifying how the company's environment and the system operation environment may change. [FGI]

- Identifying also the long term requirements for architecture [FGI].

- Finally, collecting the requirements. Collecting a list of customers' and stakeholders' needs, expectations, constraints, and interfaces in their language (af (Juran and Godfrey 2000; Chrissis et al. 2003)).

Analysis of Requirements

- Analyzing, validating and prioritizing customers' and stakeholders' requirements and needs (af (Juran and Godfrey 2000)). Grouping together related requirements and needs (af (Juran and Godfrey 2000)).

- Developing a definition of required functionality and quality attributes for the system (af (Chrissis et al. 2003)).

- Identifying architecturally significant needs/requirements by identifying architecturally significant functionality and architecturally significant quality attributes of the requirements definition [FGI].

- Executing language transfer. Translating architecturally significant needs and requirements into the language of a software architecture development team (af (Juran and Godfrey 2000)).

4.2 Designing Architecture

QM activities related to the architectural design are as follows.

Preparation for architectural design

- Identifying what is needed so that the architectural designs can be delivered without deficiencies (af (Juran and Godfrey 2000)). Defining design process and other practices.

- Determining methods for identifying architectural features (af (Juran and Godfrey 2000)).

Architectural design

Designing and developing a software architecture that can respond to the needs and suit the environment (af (Juran and Godfrey 2000)).

- Firstly, determining which architectural features and goals will provide the optimal benefit for the customer/stakeholders (af (Juran and Godfrey 2000)).

- Selecting main structures of architecture by selecting high-level architectural features and goals (af (Juran and Godfrey 2000), [FGI]).

- Selecting and designing detailed structures of architecture. Developing detailed architectural features and goals (af (Juran and Godfrey 2000), [FGI]).

- Addressing all relevant standards, regulations, and policies (af (Juran and Godfrey 2000)) in the design process.

- Optimising architectural features and goals. Optimising the software architecture features so as to meet stakeholder needs as well as customer needs (af (Juran and Godfrey 2000)).

- Finally, setting and publishing the final architectural design.

4.3 Analyzing / Evaluating and Certification of Architecture

QM activities related to architecture evaluation/analysis are as follows.

- Establishing project-specific optimal quality objectives for software architecture (af (Juran and Godfrey 2000), [FGI]).

- Deciding the evaluation criteria and metrics by creating project-specific measurements of quality for software architecture (af (Juran and Godfrey 2000), [FGI]) and identifying the unit of measurement for each customer need (Juran and Godfrey 2000).

- Deciding the explicit criteria to be used in evaluating alternative architectural designs and design features.

- Executing the evaluations. Evaluating and measuring architectural features in the suitable phases of the system life cycle (af (Juran and Godfrey 2000), [FGI]).

- Executing the certification of architecture. Architecture certification can be seen as an act of attesting that the system will meet a certain standard or, generally, as an act of verifying conformance with certain requirements.

4.4 Architecture Implementation

QM activities related to architecture realization / implementation are as follows.

- Before the implementation, proofing and testing the architectural concept by implementing the main structures of the architecture [FGI].

- Producing an implementation plan.
- During the implementation, organising the architecture advisor who gives advices on how to conduct the implementation of the architecture [FGI].
- Collecting feedback from the architecture implementation (e.g. problems occurring in the architecture implementation) [FGI].

4.5 Maintaining and Improving Architecture

QM activities related to architecture maintenance and improvement are the following update and evolution activities.

- During the system maintenance, identifying and correcting the causes of defects and other problems in the architecture (af (Chrissis et al. 2003)).
- Making other minor changes for the architecture (e.g. construction of a new interface to the system in the integration situation) [FGI].
- Identifying the development needs of the architecture.
- Proving the development or improvement needs of the architecture (af (Juran and Godfrey 2000)).
- Establishing the infrastructure for improvement (af (Juran and Godfrey 2000)). Identifying the improvement project(s) and establishing project team(s) (af (Juran and Godfrey 2000)). Providing the teams with resources, training, and motivation to 1) diagnose the causes and 2) stimulate remedies (af (Juran and Godfrey 2000)).
- Conducting a diagnostic journey from symptom to cause. This includes analyzing the symptoms, theorizing as to the causes, testing the theories and establishing the causes (af (Juran and Godfrey 2000)).
- Conducting a remedial journey from cause to remedy. This includes developing the remedies, testing and proving the remedies under the operating conditions, dealing with resistance to change, and establishing controls to hold the gains (af (Juran and Godfrey 2000)).
- Finally, implementing remedies and controls (af (Juran and Godfrey 2000)).

4.6 Documenting Architecture

QM activities related to architecture documentation are the following.

- Documenting at least the following aspects: 1) input information for architectural design and development, 2) architectural plans including architectural decisions, 3) reviewing results by management, and 4) results from architectural evaluations/assessments and the measures taken because of the results (af (Curran 2005)). Taking the users of the documentation into account in documentation process.

- Updating and maintaining architectural documentation [FGI].

- Controlling architectural documents to ascertain that they correspond to the organisation's standards.

5 Discussion

Quality management activities relating to software architecture management were identified and analysed. The identified activities were categorised to activities that concentrated on the quality of the SAM-process and to activities that concentrated on the quality of software architecture. These identified quality management activities are suggested to promote the achievement of high-quality software architectures.

During the process of defining these activities, the following observations were made. These observations focus on the current state of architecture management and how the results of this study could be applied in organisations.

Architecture management is spread out to many processes in organisations

As mentioned at the beginning of this paper, software architecture management (SAM) consists of the activities of capturing and understanding the architectural requirements of software-intensive systems. Moreover, it includes designing, analyzing/evaluating, realizing, maintaining, improving, and certifying the architecture as well as documenting it (Bass et al. 1998; IEEE 2000). In this study the more detailed activities were also identified. In the focus group interview the idea was raised that these activities, which aim to drive and control the architecture and architectural quality, may be included in several separate processes in organisations. Parts of these activities may be included in, for example, in investment planning, project management, the organisation’s processes management and system development process.

Currently, architecture management processes are not so clearly separate processes in organisations. This situation makes the capability assessment of architecture management difficult. In addition, this situation means that the organisations’ different processes and the related tasks currently affect on the organisations’ architectures and architectural quality.

A need to move from architectures driven by investment planning and system development towards architectures driven by architecture management

Practitioners in the focus group interview described how investment decisions made in the investment planning process and system development choices affected on the organisation’s architectures. It seems that single investments on software or a system (e.g. ERP investments) and single system development projects in organisations may drive the organisations’ architectures and architectural quality more than organisations’ architectural designs and visions (e.g. enterprise architecture). This means that other processes than architecture management processes drive the architectures. This may affect on the quality of an organisation’s architectures. A challenge is to change this situation so that architecture management processes start to drive architectures.

A need of architecture management practices and process models that aim at high-quality architectures

Currently, it is not clear what activities architecture management process should include, in which order these activities should be executed, and what results should be produced relating to the activities. In addition, it is not entirely clear how the system development and architecture management processes should co-operate. For example, it is not clear in which phases of the system development process architecture evaluations should be executed. This study gives answers to the question what activities should or could be executed in architecture management that would focus on the architectural quality. The development work of process models and of the best practices for architecture management which include these identified activities and describe the execution order should be continued.

A need to advance the maturity of architecture management processes

As mentioned previously, the architecture management activities may be spread out to be parts of many processes in organisations, and other processes may drive architectures more than an architecture management processes. This means that there is a need, firstly, to establish the status of architecture management processes in organisations, and secondly, to increase their maturity. This work is already on-going in many organisations. The results of this study aim to help this work by defining such architecture management activities that promote the achievement of high-quality architectures. The results of this study can be used to support this work of establishing of a SAM-process.

A need for agility in architecture management and development

It came up in the focus group interview that it is hard to execute all these QM activities identified in this study in a very quick-moving industrial environment. Restricted time and quick changes in organisations' structures and operations (e.g. companies' mergers) often change organisations' architectures and architecture management processes. In addition, architecture management processes cannot be too heavy (e.g. require a lot of time and resources) although those processes could produce ideal architectures. However, it was also suggested that the maturity of an organisation's architecture management could be higher when more of these QM activities (identified, for example, in this study) are executed in the organisation's architecture management processes. In summary, agile architecture management should be considered in further research.

A need for metrics and metric programs for architectural maturity and quality

In the focus group interview, it was also mentioned that metrics and metric programs for architectural quality should also be developed. Metric programs have traditionally been primarily developed for the measurement of software and software development quality (e.g. Motorola's, IBM Rochester, and Hewlett-Packard's metrics programs (Kan 2005)). As mentioned at the beginning of this paper, the metrics for the assessment of architectures and their management processes have been developed for example, by Hilliard et al. (Hilliard et al. 1996) and Losavio et. al. (Losavio et al. 2003) (Losavio et al. 2004). Research and development work must be continued in order to detail and establish evaluation criteria and metrics for architectural quality. Metric programs for architectural quality can then be developed in organisations.

Restrictions and limitations in this study

There are some limitations in this study. Corresponding quality management activities were combined from different sources. Limited number of quality management activities of software architecture management was considered in this study. However, the results give an image of the QM activities in SAM.

6 Conclusion

Architectural quality is one aim of the architecture management process. Evaluation practices for architectural quality and architectural design patterns that support specific quality attributes have been developed and extensively discussed in the previous research. However, the architecture management process activities aiming at architectural quality have only briefly been discussed so far.

This study identified activities that are suggested to promote the achievement of high-quality architectures. The criticality and execution of these SAM related quality management activities in system development need to be assessed based on surveys directed to ICT service providers and user organisations. This question is being addressed in our on-going research.

In addition, a further research question, raised in this study, is how the existing quality standards (e.g. ISO standards) and maturity models (e.g. CMMI) could be applied to the quality management of software architectures.

7 Acknowledgements

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Quality Evaluation of Architectural Documentation and Models

AISA Project Report

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Author: Niina Hämäläinen	Status: Final

Summary

Architecture documents have more and more central role in the company management, IT governance and system development. For example, enterprise architecture core diagrams are suggested be used in the company management. Architecture documents are used especially to support communication. Examples of use situations of architectural documentation are business planning for transition from a legacy business or ICT structure to a new structure and communication between acquirers and developers as a part of contract negotiations.

The quality of architectural documents is crucial for the value of documents: how useful those are for the company's business and ICT development work. This study contributes to the quality assessment of architectural documentation by identifying and defining a group of questions, criteria and metrics that can be used in the quality assessment of architectural documentation and models. Questions, criteria and metrics relate to the stakeholder and purpose –orientation and the quality of content and visualization as well as to the architecture documentation management. These evaluation factors were validated by practitioners. The results of this study aim to help enterprise and software architects to produce architectural descriptions and models of good quality.

Contents

1 Introduction

Currently, companies commonly utilize architectural documents and models in their management, business and ICT development work. These documents and models relate to enterprise and software architectures. Lankhorst et. al represents that describing architectures is all about communication [1]. If an architecture description is not used as a means of communication in some shape or form, this description should not have been created in the first place.

The models are essential elements of architectural descriptions [2]. Models act as a medium for communication, helping to explain thinking to others. Models reduce the amount of information the reader needs to understand, and their structure guides the reader through the information [2]. In addition, models help to understand the situations it is modelling and to analyze situations by allowing the isolating key elements and understanding their relationships. Models also help to organize processes, teams, and deliverables as a result of the structures they reveal in the situation being modelled [2].

Use situations for architecture descriptions are described for example by the IEEE 1471 standard [3]. These are, for example, business planning for transition from a legacy architecture to a new architecture; communications between acquirers and developers as a part of contract negotiations and preparation of acquisition documents; planning and budget support; communications among organisations involved in the development, production, fielding, operation, and maintenance of a system as well as expression of the system and its (potential) evolution and analysis of alternative architectures.

Quality problems relating models are, for example, crowded diagrams, inconsistent notation, over emphasis of one aspect and the overlooking of individual stakeholder concern [4]. In addition model can be irrelevant, too complex, not sufficiently complete and contain superfluous elements [1]. These problems may affect the communication about topics presented in the model. The communication may thus be funnelled to the discussion about visualisation issues, neither than discussion about the questions to be solved.

The documentation is not the main aim of architecture development. However, the quality of documents and models affect on how well architectural documents and models are understood and used. The quality of them may thus affect on the value and usefulness of this documentation.

So for the assuring that architecture document can be understood and used correctly, architects should have practices to evaluate the quality of documents. However, it is not clear how to carry out the quality evaluation of architecture documentation. It seems that quality evaluation criteria and metrics for architectural documentation are thus not yet identified and analyzed yet enough.

Previous studies have studied and considered the quality evaluation of conceptual models [5, 6] [7] and technical documentation [8] [9]. Quality dimensions for conceptual models (syntactic, semantic and pragmatic quality) [5, 6] and for technical information (easy to use, to understand and to find) [9] are defined. In addition, quality properties for conceptual models [6] and for technical information [9] are also defined.

Some studies, books and guidelines relating to documentation of architectures are also published. These are presented, for example, relating enterprise architecture descriptions (e.g.[10], [1], [11], [12], [13]) and relating software architecture descriptions (e.g. [2], [14], [15], [16], [17]). Qualities of an effective architectural description (e.g. correctness, sufficiency, conciseness, clarity, currency and precision) is also introduced, for example, by Rozanski and Woods [2].

This study contributes the quality assessment of architectural documentation by presenting a group of quality evaluation questions, criteria and metrics for architectural documentation. These evaluation factors are validated by a group of practitioners.

This study consists of the following sections. Firstly, architecture documentation related concepts are considered in chapters 1. Secondly, research method used in this study is introduced in chapter 2. Evaluation questions and criteria identified by this study for architectural documentations are presented in chapter 3. Finally, identified metrics and the practitioners' validation results of them are discussed and analysed.

2 Architecture Documentation

2.1 Enterprise and Software Architecture Definitions

Enterprise architecture is typically used as an instrument in managing a company's daily operations and future development [1]. It can be seen both as a strategic tool for company management and as a tool for the IT governance. According to Lankhorst [1] management areas relevant to EA are strategic management, strategy execution, quality management, IT governance, IT delivery and support and IT implementation.

Enterprise architecture and enterprise models are usually produced and used at the organisation level. The enterprise architecture is defined for example by Kaisler et al. [18] that enterprise architecture is " *the main components of the organization, its information systems, the ways in which these components work together in order to achieve defined business objectives, and the way in which the information systems support the business processes of the organization*". These components include staff, business processes, technology, information, financial and other resources, etc.

Other definition for EA is presented in [1]: *enterprise architecture is a coherent whole of principles, methods and models that are used in the design and realisation of an enterprise's organisational structure, business processes, information systems, and infrastructure.*

Software architecture descriptions are usually produced in the projects in their system or software development work. A definition of software architecture is provided by Bass et. al [19]: "*The software architecture of a program or computing system is the structure or structures of the system, which comprise software elements, the externally visible properties of those elements, and the relationships among them.*"

2.2 Architecture documentation standards

The concept of an architectural description / documentation is formalized and standardized in IEEE 1471 Standard: *Recommended Practice for Architectural Description* [3]. In addition standards for architecture descriptions are also developed and defined by companies. For example, IBM has presented architecture description standards ([20], [21]).

Main architecture documentation concepts defined by IEEE 1471 Standard [3] are especially the followings:

- *Stakeholder*: An individual, group or organization that has at least one concern relating system.
- *Architectural description*: A set of views (which consist of architectural models) and additional architectural information.
- *View*: A set of model representing enterprise or system from the perspective of a related set of concerns.
- *Model*: A particular diagram and description constructed following the method defined in a viewpoint.

- *Viewpoint*: The conventions for creating, depicting and analyzing a view.

Relationships between these concepts are presented in figure 1.

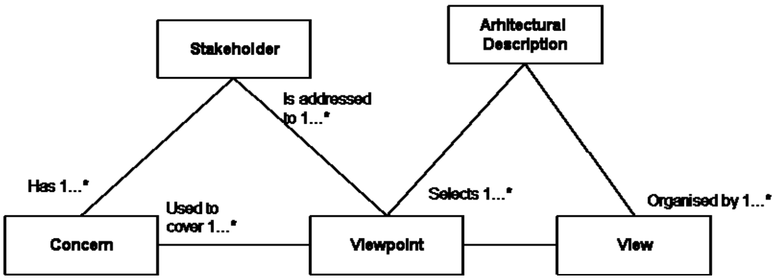

Figure 1. Architectural description related concepts (IEEE 1471 [3]).

2.3 Architecture document and model types

Various documents may relate to architecture documentation. Different document types are needed because use purposes and users of architecture documents vary a lot. A categorisation of enterprise architecture models is the following [10]:

- Ad hoc models: models that serve basic goals of communication and documentation and that are usually developed using simple drawing or presentation tools
- Standardized models: models adopting a standard or framework-based approach and using case tools
- Formal models: models that are based on reference architectures
- Federated models: models that aggregate across diverse sources and using EA tools interoperating with diverse repositories of information
- Executable models: active knowledge models that can be consulted by applications as well as humans.

Rozanski and Woods classify software architecture models to formal qualitative or quantitative models or informal qualitative models (sketches) [2]. These are defined as follows:

- *Qualitative models* illustrate the key structural or behavioral elements, features, or attributes of the architecture being modelled.
- *Quantitative models* make statements about the measurable properties of an architecture, such as performance, resilience, and capacity.
- A *sketch* is a deliberately informal graphical model, created in order to communicate the most important aspects of an architecture to non-technical audience. It may combine elements of a number of modeling notations as well as pictures and icons.

2.4 Architecture Frameworks

Architectural frameworks have a central role in architectural documentation. These frameworks provide structure to the architectural descriptions by identifying and sometimes relating different architectural domains and the modelling techniques associated with them [22]. They typically define a number of conceptual domains or aspects to be described [22].

Enterprise architecture frameworks are for example Zachman's Framework for Enterprise Architecture [23], The Open Group Architecture Framework (TOGAF) [24], Archimate framework, ISO Reference Model of Open Distributed Processing (RM-ODP) [25]. Software architecture frameworks are for example Kruchten "4+1" View Model [26], Software Engineering Institute (SEI) set of views [14], Siemens Four View Model [27] and Rational Architecture Description Specification (ADS).

As discovered by May [4], viewpoints defined for example by different SA frameworks do not completely correspond to each other. The similar situation seems to be relating to EA framewoks. It is thus currently no commonly accepted set of architectural viewpoints [4, 28]. As Smolander [28] bring out architectural viewpoints chosen by companies are rather agreements between people depending on the organizational and project environment. In the practice, the selection of architectural viewpoints is thus based on the prevalent situation and characteristics in a company and in the project at hand.

2.5 Core Architecture Documents

Many different kind of documents may relate in architecture documentation. EA core artifacts are identified, for example, by Winter and Fischer [29]. EA core artifacts are mentioned especially to include documents relating to:

- Strategy specification
- Organisation/process specification
- Application specification
- Software specification
- Technical infrastructure specification
- Specification of dependencies between different layers.

2.6 Architecture documentation practices

Company's architecture documentation practices are affected by architects' own practices as well as by company level practices.

Organisation level aspect

A maturity model for enterprise architecture representations and capabilities is introduced by Polikoff and Coyne [10]. This maturity model consists of the following levels:

Level 1 Ad hoc: No common reference framework, possible use of case tools, little commonality between descriptions produced by different people or groups.

Level 2 Standardized: Established methodology for describing architectures, use of industry standard/custom framework, methodology not fully supported and enforced by tools.

Level 3 Formal: Methodology enforced by tools; Reference architectures; Multiple tools in use but from different vendors with low level of interoperability; Reference framework and architectural models cannot be readily queried.

Level 4 Federated: Connections between different systems and tools established.

Level 5 Executable: Models are consultable by applications at run time. Knowledge about enterprise activities, systems and capabilities becomes a real time resource.

Architect-aspect

In addition, architect's decisions and choices affect on architecture documentation. Architect decides what to describe in architecture documentation. Given a specific goal and focus, an architect decides which aspects of an enterprise or a system are relevant and should be represented in the model [1]. Examples of aspects that are frequently included in enterprise architecture models are: products, business processes, applications and IT-infrastructure elements, as well as their relations [1].

2.7 Challenges and Questions Relating to Architecture Documentation

Several discussions between AISA project researchers and company practitioners have been carried out before this study. In these discussions came up frequently following architecture documentation related challenges and questions:

- *Architectural documents do not exist in company.*
- *What documents and models should be produced? Framework and viewpoints that should be chosen?*
- *Many kinds of stakeholders and use purposes for architecture documentation exist. What kind of architecture documents should be produced in company?*

Different purposes and different target audiences may thus require fundamentally different models: while an IT manager may wish to have an overview of the system software, the devices it runs on, and the communication paths between these devices, the manager of a company may wish to have an overview of the products the company produces and the services they depend on [1]. The need for the fundamentally different kind of models is one key challenge in architecture documentation work.

3 Research method

In order to define, categorize and validate quality criteria and metrics for architectural descriptions and models, a series of the following research phases was carried out in this study.

3.1 Sources for the evaluation questions, criteria and metrics

Specific quality dimensions of documents can be measured by asking probing questions [8]. The evaluation questions provide thus the direction and foundation for the evaluation. Such as presented in [30] a several sources can be used for the identification and construction evaluation questions, criteria and metrics. The sources selected to be used in the identification and construction criteria and metrics for architecture documentation in this study were:

- Models, findings, or salient issues raised in the literature in the enterprise and software architecture field
- Questions, concerns, and values of practitioners
- General evaluation and quality models for documentation (e.g. technical documentation)
- Views and knowledge of expert consultants: Consultants comments and recommendations in articles published in internet.
- The researcher's own professional judgment

The first version of the list of the quality metrics, criteria and questions was produced on based these sources.

3.2 Validation of results

A semi-structured group interview with a focus group of practitioners from five ICT user and service provider organisations was organised for the validation of the results. Practitioners were managers and specialists of the management of enterprise and software architectures in their organisations. The companies and interviewees are described in the next table.

Table 1. Interviewees in the focus group interview

Companies	Number of personnel (year 2005)	Number of interviewees	Viewpoints of interviewees
Architecture consultation company	10	2	business consultation and software architecture consultation
Banking, finance and insurance company	11 974	1	enterprise architecture
Telecommunication company	4989	1	enterprise architecture
Business & IT consulting and development organization	a part of a large international company having 329 373 employees in total	2	enterprise architecture, software architecture, marketing, business
Retail and service company	28 092	1	IT governance, enterprise architecture

The participants from these companies were interviewed as one group in order for group members to influence each other by responding to ideas and comments of others [31]. This group influence came up and new aspects were brought out.

However, some aspects may not have been brought out by interviewees due to confidentiality reasons.

Metrics, evaluation criteria and their definitions presented in the following chapter paper were presented to the participants. Based on practitioners' own practical experiences, practitioners were asked to evaluate value and usefulness of these evaluation criteria and metrics. The interview was tape-recorded. Notes were written during the interview session. In addition, the query for evaluation of usefulness of evaluation criteria and metrics was organised. Workshop participants answered to this query. The question form and results of this query are presented in the appendix 1.

4 Quality Evaluation of Architecture Documentation

On based literature, it was identified that the quality of architectural descriptions can be evaluated from the following aspects:

1) stakeholder and purpose orientation: evaluation of how well documents are focused on purpose and on the stakeholder that use these documents..

2) content quality: evaluation of quality of information included in the models

3) presentation/visualisation quality: evaluation how well information is presented in documents.

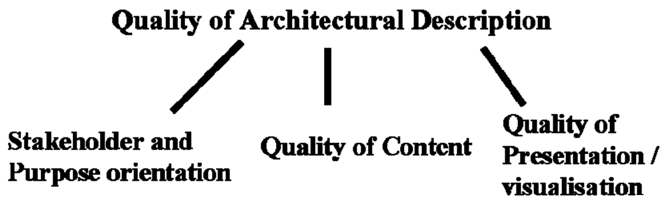

Figure 2. Aspects on quality of architecture description.

A group of evaluation criteria and questions to be used for the evaluation of each of these aspects was identified. In addition, it was identified a group of evaluation factors for the management of architecture documentation.

4.1 Stakeholder and Purpose Orientation

Stakeholder and purpose orientation evaluation questions are presented in the table below.

Table 2. Evaluation questions and metrics for the content quality of architectural description.

Criteria	**Questions/metrics**	**Sources**
Stakeholders	Are the stakeholders of a model / AD defined and who are them?	[1]
Purpose	Is it the purpose of a model / AD in relation to these stakeholders defined and what it is?	[1]
Model's/ AD's suitability for the stakeholders	- Does model provide the stakeholder with the desired knowledge? - Do model answer/correspond to the objective of stakeholder? - Do model relate to problem? - Is a practical reason for the information evident? - Is the information presented from the stakeholders' point of view?	[1]
The use of AD/models – value of AD/model (degree the AD or model is being read, understood, and effectively used)	- Frequency of Use: This characteristic describes how frequently the documentation is used or referenced. - Number of Users: This characteristic describes the approximate number of personnel who will likely want or need to use this documentation. - Variety of Users: This characteristic describes the variety of different functional areas or skill levels of personnel who will likely use this documentation. - Impact of Nonuse: This characteristic describes the level of adverse impact that is likely to occur if the documentation is not used properly.	[32]

4.2 Quality of Content

Aspects for the AD's content quality of evaluation are presented in the figure below and evaluation questions relating to these aspects are presented in next table.

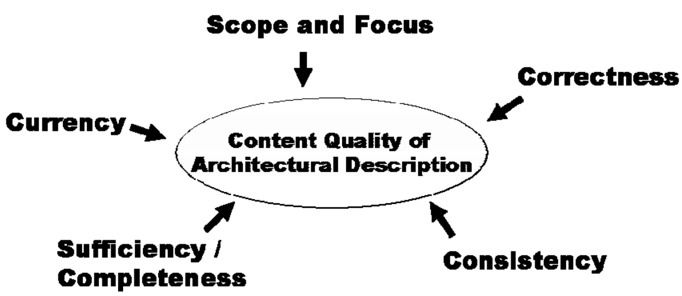

Figure 3. Aspects on the architecture description's content quality.

Table 3. Evaluation questions and metrics for the content quality of architectural description.

Criteria	**Questions/metrics**	**Source**
Scope and focus	– Scope: Is it defined what part of reality will be described in the model/AD (e.g. only primary processes)? – Aspects: Is it defined what aspects will be described? – The level of detail: Is it defined what level of detail will be described?	[1]

Currency of EA description	– Does information reflect the current enterprise?
	    – degree with which the current version of the documentation is up to date (Percents, subjective evaluation)
	    – Number of architectural effects having projects carried out after EA description has been produced
	    – Number of architecture changes made after EA description has been produced.
	– Frequency with which AD is kept current
	    – Number of updates / year
		[32]
		own contribution

Currency of SA description	Does information reflect a system? – Frequency with which AD is kept current – *Number of updates / project*	[9], own contribution
Correctness	Verification of information: – Is the information included in an AD/model verified? – Is there any incorrect arguments, or in-accurate or untrue reasoning?	[9], [1]
Correctness of EA	The number of ”subtantive” errors / deficiences found after EA has been released: *the number and type of change request applied to EA principles*	[33]

Correctness of SA	– Correctness for stakeholders:
	    – Does model/AD present correctly needs and concerns of stakeholders?
	– Correctness of solution:
	    – Does model define correctly architecture that will meet stakeholder's needs?
		[2]

EA Completeness	EA's coverage of business areas – The degree to which EA addresses needs of each business area (e.g. subjective evaluation score 1-10)	[33]

Sufficiency / Completeness	AD's coverage of required viewpoints – The degree to which AD addresses each required architectural viewpoint (e.g. subjective evaluation score 1-10) Sufficient amount of information: – Is the all required information included in the model? Are all topics relating stakeholder's objectives and concerns covered, and only those topics? – Is information repeated only when needed? – Do model contain irrelevant or superfluous elements? Sufficient level of detail: – Has each topic has just the detail that stakeholder needs?	[33],[9], [1]
Consistency	Are models presenting different viewpoints consistent with each other?	[2]

4.3 Quality of Presentation/Visualization

Quality aspects for the AD's presentation/visualization are presented in the figure below.

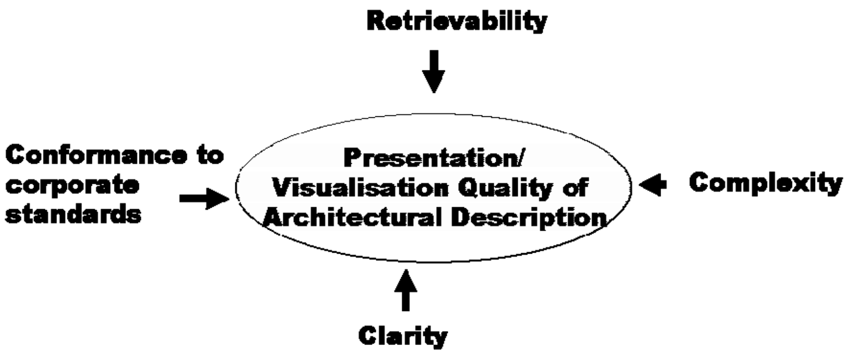

Figure 4. Aspects on the presentation/visualization quality of architecture description.

Evaluation questions and metrics for these criteria are presented in next table.

Table 4. Evaluation questions and metrics for presentation/visualisation quality of architectural description.

Criteria	**Questions/metrics**	**Source**
Conformance to corporate standards	Does the presentation of the AD/model conform to the corporate standards (if any) for such documents?	[2]
Retrievability: Presentation way familiar to stakeholder	– Does model have intuitive structure for the stakeholder? – What is the intuitive structure of stakeholder? – Do model correspond to it? Are used structures to which the receiver is used to?	[1]
Retrievability: Notation and structures	– Do model use a defined notation? – Is the notation/structure of model explained ? – Is stakeholder familiar with notation?	[1]
Clarity: Vocabularity and concepts	– Is the vocabularity and concepts stakeholders' concepts? Are the terms and concepts used known by stakeholder? – Are the terms used defined? Are the (new) concepts defined and explained? – Are the names of elements descriptive? Are the all of model's elements defined so that their meanings, roles, and mapping to the real world are all clear and not open to different interpretations?	[1] [2]
Complexity Information amount	Is there too much information included in the model? - The number of elements in the model (Humans are only good at working with models that do not include more than 30 elements) - The number of types of elements in the model - The number of relations depicted in the model - The number and types of concepts - The number of architectural viewpoints (Viewpoints reduce complexity)	[1]
Complexity Visual complexity	– Proximity**:** Are the related objects placed near to each other in a model? – Continuity**:** Is there any right angles positioned next to each other? (Right angles should not be positioned next to each other in a model.) – Closure: Are objects symmetry and regular? (This increases readability of models and reduces the perceived complexity.) – Similarity: Are similar objects presented in the similar way? – Common fate: Are similar object presented to move or function a similar manner? (People have a tendency to perceive different objects that move or function in a similar manner as a unit.)	Gestald principles, referred in [1]

4.4 Architecture documentation management

Criteria for the architecture documentation management evaluation are presented in the figure below.

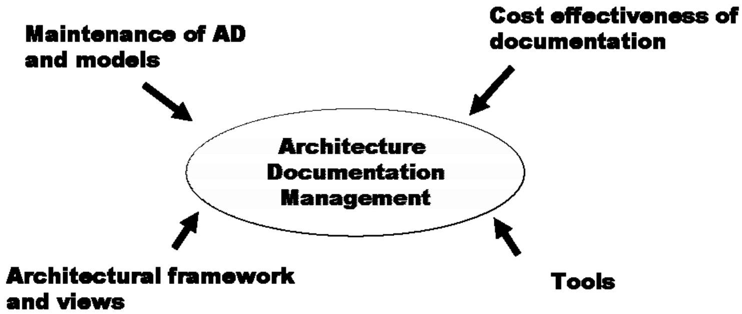

Figure 5. Criteria for the architecture document management evaluation.

Table 5. Evaluation criteria for architecture documentation management.

Criteria	Questions / metrics	Sources
Maintenance of AD and models	Ownership: Is staff responsible for AD clearly identified and supported? Maintenance practice: - Is it know how the AD will be maintained once it has been accepted? – Frequency of updates*: Number of updates / year or project* – Needs for updates: *Number of architecture changes made (in a year, in projects) that require documentation update* Maintainability of models – Ease of update: the relative ease or difficulty with which the documentation can be updated, including revision dates and distribution of new versions and the relative ease or difficulty with which the consistency between descriptions can be checked.	[32], [2]
Cost effectiveness of EA documentation	– Costs: Time and resources needed to produce or update EA descriptions or models: *Man-days needed* – Amount of documentation*: Number of documents/models* – Frequency of EA documentation updates: *Updates / project or updates / year* – Needs for updates: *Number of architecture changes made (in a year, in projects) that require documentation update*	own contribution
Cost effectivness of project architecture documentation	– Costs: Time and resources needed to produce or update project related architecture description or models o *Man-days needed* o Amount of architectural documentation*: Number of documents/models/project* o Frequency of updates: *Updates / project*Needs for updates: *Number of architecture changes made (in a year, in projects) that require documentation update*	own contribution

Architectural Framework and Views	Architecture Framework
	
	EA Framework
	– Do there exist architectural framework for EA?
	– Is EA framework accepted in organisation?
	– Is EA framework used in the EA documentation work?
	
	SA Framework
	– Do there exist architectural framework for SA?
	– Is SA framework accepted in organisation?
	– Is SA framework used in the SA documentation work?
	
	Architectural views:
	– Are the suitable architectural views chosen for the company or for the project?
	– Relating to each viewpoint is it defined:
	    – A Viewpoint name?
	    – The stakeholders the viewpoint is aimed at?
	    – The concerns the viewpoint addresses?
	    – The language, modelling techniques, or analytical methods to be used in constructing a view based upon the viewpoint?
		[34], [22], [2], [3]

Tools for AD and models	– Support for organisation's framework and viewpoints
	    – Does design tools support the framework and viewpoints that organisation has chosen to use?
	    – Does design tools support production of the deliverables required?
	– Suitability for Stakeholders: Is there ability to represent architecture models and views in a way meaningful to stakeholders (e.g. to non-technical stakeholders)?
	– Repository for architectural documentation: Is there an EA repository for storage and dissemination of the captured EA information?
		[34], [24]

5 Discussion

Architecture descriptions are used as communication tool. Architecture documents of bad quality may funnel the communication to irrelevant aspects. The documents of good quality support and advance communication. Therefore, the quality of architectural documentation is suggested to be considered by architects when they produce these documents. Quality evaluation criteria, questions and metrics for architectural descriptions and models were identified and categorised in this study. These were presented in previous chapter. In the following, practitioners views for these criteria are presented. In addition, it is discussed realities relating architecture documentation.

5.1 Practitioners' Comments for Evaluation Aspects

Practitioners mostly brought out that evaluation aspects and criteria seem to be useful and those help in evaluation of quality of architecture documents. In addition, practitioners accepted the evaluation aspects (stakeholder and purpose –orientation, quality of presentation and quality of content).

According to query results (see appendix 1), quality criteria that should at least to be evaluated seem to be especially:

- Stakeholder and Purpose-orientation:
  - *Stakeholders*: Are stakeholders of description defined?
  - *Purpose*: Are purpose of description in relation to stakeholders defined?
  - *Models/descriptions suitability for the stakeholder*: Is description suitable for stakeholders and purpose?
- Quality of content:
  - *Scope*: Is it defined what part of reality will be described in the description?
  - *Aspects*: Is it defined what aspects will be described?
  - *The level of detail*: Is it defined what level of detail will be described?
  - *Sufficient amount of information*: Is the all required information included in the description? Does description contain irrelevant or superfluous elements? Has each topic just the detail that stakeholder needs?
  - *Currency of SA descriptions*: Does information of system architecture description reflect a system?
- Quality of presentation:
  - *Vocabularity and concepts*: Are vocabularity and concepts stakeholders concepts and are new concepts defined and explained?

- Documentation management:
    - Ownership: Is staff responsible for description identified and support?
    - Architecture views: Are views defined, accepted and used?
    - Architecture design tools: Are design tools suitable for the documentation needs?

It was received a little number of replies for the query so more answers may have produced a little bit different result. However, author of this report suggest that these criteria could be seen as central evaluation criteria that should at least focused in the quality evaluation of architecture documents.

In focus group interview of practitioners, some comments came also up in which it was seen that it is not essential to evaluate the quality of architecture documents. In these comments, it was seen that the architecture documentation is not central issue in architecture design and management. So focusing on the quality of documentation was not seen relevant in this point of view.

5.2 Architecture Documentation Work Realities

Company's situation affects the possibilities for architecture documentation work. It is needed to know [14]:

- what people you will have: which skills are available,
- what budget is on hand, and
- what the schedule is.

In addition, some other realities relate to architecture documentation work. Some of these are presented in the following.

Resources and time limits: Architects often do not have much time to architectural design and analysis [2]. The process of architecture definition is not usually allocated much time – and the situation architect are trying to model may be complex, difficult, or new to architect and architect's stakeholders. It is not thus reasonable to produce beautiful exemplary documents that will never be used because e.g. the project will have run out of money at implementation time. The reality is that all projects and work make cost/benefit trade-offs to pack all the work to be done into the time and the resources allocated for that work. Architecture documentation is no different [14].

Requirements and needs for architecture documents: A rough-and-ready model that is produced early and becomes established and familiar to the team over time may be more useful than something considered more fully that appears too late [2]. Simple models are more useful in presentations to non-technical stakeholders or early in the architectural analysis to bring out some key features, while sophisticated models are more useful as analysis, communication, and comprehension tools for technical stakeholders, such as software developers [2]. Same model can thus be complete or even too complex in one situation, and in other situation same model can be not sufficiently complete.

Notation and tools: The range of phenomena addressed by enterprise and system modelling stretches multiple disciplines. Several modelling languages and practices are used, and one cannot always find a single person/profession that can guarantee the consistency of all models involved.

5.3 Restrictions

A limited number of sources for identification evaluation criteria, questions and metrics were investigated in this study. All possible criteria and metrics may not thus have been identified. However, the results give an image of the evaluation aspects for architecture documents.

In this study, mainly EA and SA design and development specialists were interviewed. Their perspectives might reveal much more than the companies' other business and ICT stakeholders' perspectives. Points of views of documentation users were thus not gathered in the interview.

6 Conclusion

Architecture documents seem to have more and more central role in the company management, IT governance and system development. For example, enterprise architecture core diagrams are suggested be used in the company management ([35]). These documents are thus more and more produced in companies.

This study identified the quality evaluation aspects, questions and metrics for architecture documentation. These are suggested to be used by enterprise and software architects in their architecture design and documentation work as well as by reviewers in reviews of architectural documentation. These questions, criteria and metrics relate to the stakeholder and purpose –orientation and the quality of content and visualization as well as to the architecture documentation management.

Future research question is following: how architecture documents can be produced and managed efficiently when reality is that different stakeholders needs documents that contain information on different levels and that present information in different ways.

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Appendix 1. Query Results

Evaluation of the quality of architectural documentation

Respondents:
- 2 persons from ICT service provider companies
- 2 persons from ICT user companies

Crosses indicate the number of responses to the evaluation questions. If multiple responses for a specific question from the same respondent were received, their average was used.

Instructions for evaluation

Either

1) Recall situations that have involved architectural documentation evaluation in your company. These evaluations could be related to either documentation produced in your company or documentation produced by other parties.

Or

2) If evaluations have not been carried out, create mental images from situations where architectural documentation quality is evaluated. What kind of situations would these be and what would be the aspects of relevance in these situations?

In the following, a number of architectural documentation quality criteria, questions and metrics are presented. Please evaluate the usability and relevance of these quality criteria, questions and metrics.

Abbreviations:
AD – architecture description
EA – enterprise architecture
SA – system / software architecture

STAKEHOLDER AND PURPOSE ORIENTATION	**1** Important to evaluate (primary evaluation target)	**2** Useful to evaluate (evaluated if enough time)	**3** Not necessary to evaluate	4 Useless to evaluate
Stakeholders: Are the stakeholders of a model / architecture description (AD) defined and who are them?	xxx	x		
Purpose: Is it the purpose of a model / AD in relation to these stakeholders defined and what it is ?	xxxx			
Model's/ AD's suitability for the stakeholders: • Does model provide the stakeholder with the desired knowledge? • Do model answer/correspond to the objective of stakeholder? • Do model relate to problem? • Is a practical reason for the information evident? • Is the information presented from the stakeholders's point of view?	xxx	x		
The use of AD/models – value of AD/model degree the AD or model is being read, understood, and effectively used (www-source), – ***Frequency of Use***: This characteristic describes how frequently the documentation is used or referenced. – ***Number of Users***: This characteristic describes the approximate number of personnel who will likely want or need to use this documentation. – ***Variety of Users***: This characteristic describes the variety of different functional areas or skill levels of personnel who will likely use this documentation. – ***Impact of Nonuse***: This characteristic describes the level of adverse impact that is likely to occur if the documentation is not used properly.		xxxx		

CONTENT QUALITY	**1** Important to evaluate (primary evaluation target)	**2** Useful to evaluate (evaluated if enough time)	**3** Not necessary to evaluate	4 Useless to evaluate
Scope: Is it defined what part of reality will be described in the model/AD (e.g. only primary processes)?	xxxx			
Aspects: Is it defined what aspects will be described?	xxx	x		
The level of detail Is it defined what level of detail will be described	xxx		x	
Currency of EA description: • Does information reflect the current enterprise? – *degree with which the current version of the documentation is up to date* (Percents, subjective evaluation) – *Number of architectural effects having projects carried out after EA description has been produced* – *Number of architecture changes made after EA description has been produced.* • Frequency with which AD is kept current – *Number of updates / year*		xxxx		
Currency of SA description • Does information reflect a system? • Frequency with which AD is kept current *Number of updates / project*	xx	xx		
Verification of information: • Is the information included in an AD/model verified? • Is there any incorrect arguments, or in-accurate or untrue reasoning?	x	xx	x	
Correctness of the EA • The number of "subtantive" errors / deficiences found after EA has been released: – *the number and type of change request applied to EA*	x	x	xx	

Correctness of SA • Correctness for stakeholders: – Does model/AD present correctly needs and concerns of stakeholders? • Correctness of solution: – Does model define correctly architecture that will meet stakeholder's needs?	xx	x	x	
EA completeness EA's coverage of business areas: The degree to which EA addresses needs of each business area (e.g. subjective evaluation score 1-10)	x	xxx		
AD's coverage of required viewpoints The degree to which AD addresses each required architectural viewpoint (e.g. subjective evaluation score 1-10)	x	xx	x	
Sufficient amount of information: • Is the all required information included in the model? Are all topics relating stakeholder's objectives and concerns covered, and only those topics? • Is information repeated only when needed? • Do model contain irrelevant or superfluous elements?	xx	xx		
Sufficient level of detail: Has each topic has just the detail that stakeholder needs?	xx	x		x
Consistency: Are models presenting different viewpoints consistent with each other?	xx	x	x	

PRESENTATION / VISUALIZATION QUALITY	**1** Important to evaluate (primary evaluation target)	**2** Useful to evaluate (evaluated if enough time)	**3** Not necessary to evaluate	4 Useless to evaluate
Conformance to corporate standards: • Does the presentation of the AD/model conform to the corporate standards (if any) for such documents?	x	x	xx	
Presentation way familiar to stakeholder: • Does model have intuitive structure for the stakeholder? • What is the intuitive structure of stakeholder? • Do model correspond to it? Are used structures to which the receiver is used to?	xx		xx	
Notation and structures: • Do model use a defined notation? • Is the notation/structure of model explained ? • Is stakeholder familiar with notation?	xx	x	x	
Vocabularity and concepts: • Is the vocabularity and concepts stakeholders' concepts? Are the terms and concepts used known by stakeholder? • Are the terms used defined? Are the (new) concepts defined and explained? • Are the names of elements descriptive? Are the all of model's elements defined so that their meanings, roles, and mapping to the real world are all clear and not open to different interpretations?	xx	xx		

Information amount: Is there too much information included in the model? – *The number of **elements** in the model* – *The number of **types** of elements in the model* – *The number of **relations** depicted in the model* – *The number and types of **concepts*** – *The number of architectural **viewpoints** (Viewpoints reduce complexity)*		xxxx		
Visual complexity: – **Proximity:** Are the related objects placed near to each other in a model? – **Continuity:** Is there any right angles positioned next to each other? (Right angles should not be positioned next to each other in a model.) – **Closure**: Are objects symmetry and regular? (This increases readability of models and reduces the perceived complexity.) – **Similarity**: Are similar objects presented in the similar way? – **Common fate**: Are similar object presented to move or function a similar manner? (People have a tendency to perceive different objects that move or function in a similar manner as a unit.)	x	xx	x	

ARCHITECTURE DOCUMENTATION MANAGEMENT	**1** Important to evaluate (primary evaluation target)	**2** Useful to evaluate (evaluated if enough time)	**3** Not necessary to evaluate	4 Useless to evaluate
Ownership: • Is staff responsible for AD clearly identified, understood, and supported	xxxx			
Maintenance practice: • Is it know how the AD will be maintained once it has been accepted? • Frequency of updates*: Number of updates / year or project* • Needs for updates: *Number of architecture changes made (in a year, in projects) that require documentation update*		xxxx		
Maintainability of models Ease of update: the relative ease or difficulty with which the documentation can be updated, including revision dates and distribution of new versions.		xx	xx	
Costs: Time and resources needed to produce or update AD or models *Man-days needed*		xxx	x	
Amount of documentation *Number of documents/models*		x	xx	x
Frequency of updates – *Updates / project or updates / year* – Needs for updates: *Number of architecture changes made (in a year, in projects) that require documentation update*		xx	xx	

Architecture Framework • Do there exist architectural framework? • Is framework accepted in organisation? • Is framework used in the documentation work?	xx	x	x	
Architectural views: • Are the suitable architectural views chosen for the company or for the project? • Relating to each viewpoint is it defined: – A Viewpoint name? – The stakeholders the viewpoint is aimed at? – The concerns the viewpoint addresses? – The language, modelling techniques, or analytical methods to be used in constructing a view based upon the viewpoint?	xx	xx		
Architecture Design Tools • **Support for organisation's framework and viewpoints** – Does design tools support the framework and viewpoints that organisation has chosen to use? – Does design tools support production of the deliverables required? • **Suitability for Stakeholders** – Is there ability to represent architecture models and views in a way meaningful to stakeholders (e.g. to non-technical stakeholders)?	xxx		x	
Repository for architectural documentation • Is there an EA repository for storage and dissemination of the captured EA information?	xx	x	x	

The Role of Architecture Evaluations in ICT-companies

AISA Project Report

UNIVERSITY OF JYVÄSKYLÄ
INFORMATION TECHNOLOGY
RESEARCH INSTITUTE

Version: 1.0	Date: 1.11.2006
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Abstract

Architecture evaluation is a way to get answers to organisation's information needs and problems relating to its business and ICT. Companies' needs to move towards business value driven ICT-development and pressures to improve the cost-effectiveness of ICT are some of the reasons for the increasing interest in the evaluations and measurements of architectures. However, the role and the meaning which architecture evaluation may have in companies is not clearly identified or defined. For example, needs and triggers for architectural evaluations do not seem to be identified in previous studies. The aim of this study is to gain understanding of roles and meanings, which architecture evaluation and measurement may have in companies. Triggers for evaluations and measurements were identified and analyzed. Practitioners from five ICT user and service provider organisations were interviewed in this study. This study reveals that the role of architecture evaluation may be to enhance the understanding of company's business and ICT-environments from financial and structural viewpoints. In addition, it can be used as a tool in change management, quality assurance, process planning, IT cost management and architectural choice making.

Contents

1 Introduction

Companies' needs to move towards business value driven ICT-development and to improve the cost-effectiveness of ICT are illustrative of contemporary development pressures. These, among others, pressures drive companies to improve the understanding of their business- and ICT-environments. Architectures and architectural descriptions (enterprise and software architectures) are used to enhance understanding of the company's environments. However, architectural descriptions and documents do not directly answer all business and ICT related questions and information needs.

Stakeholders in a company have various information needs, questions and topics of concern relating to the company's business and ICT. One way to seek answers to these questions and information needs is the execution of architecture evaluations. Lately, interest in carrying out such evaluations of architectures has increased in companies. In addition, experts also highlight the importance of evaluations of architectures and architecture processes (e.g. (META Group Inc. 2000a; META Group Inc. 2000b)). The methods and practices for architecture evaluations and measurement are studied and developed by many organisations as well. However, the role of architecture evaluation in companies and its meaning for them is not yet clearly defined or identified, suggesting that real evaluation needs or triggers for evaluations are not identified and gathered from practitioners and specialist in ICT companies.

The aim of this study is to gain understanding of the meanings and roles, which architecture evaluation and measurement may have in companies. This study identifies and analyses companies' triggers for architecture evaluations. Our research involved reviewing five ICT-companies' practitioners' experiences on and conceptions of triggers for enterprise and software architecture evaluations. Triggers for architecture evaluations are problems, questions, topics of concerns and information needs which initiate the evaluation work.

This study consists of the following sections. Firstly, general evaluation concepts and architecture evaluation related concepts and architectural viewpoints are considered. Secondly, the research method used in this study is presented. Thirdly, the triggers for architecture evaluations identified and categorised in this study are presented. Finally, these triggers are analysed and suggestions for roles and meanings of architecture evaluations are given. The areas for further examination are also presented.

2 Architecture Evaluation Concepts

It seems that there is no commonly accepted evaluation and measurement theory. Nevertheless, many sources and research areas in several domains define evaluation and measurement concepts as well as present methods and practices for it. For example, evaluation and measurement concepts are defined in the domains of program evaluation (e.g. (Worthen 1990; Shadish et al. 1991; Taylor-Powell et al. 1996; Worthen 1997; Chen 2005)), quality management (e.g. (ISO 2003a), (ISO 2003b)) and software engineering (e.g. (Kan 2005), (IEEE 1998), (Bache 1994)). Research and development work on evaluation methods and practices is ongoing in the context of enterprise and software architecture management (e.g. relating EA (GAO 2003; META Group Inc. 2004)). However, evaluation theory (e.g. concepts and practices) does not yet seem to be established in this context.

2.1 Enterprise and Software Architecture Definitions

IEEE 1471 Standard (IEEE 2000) defines architecture as the fundamental organization of a system embodied in its components, their relationships to each other and to the environment, and the principles guiding its design and evolution. In one instance enterprise architecture is defined by Kaisler et al. (Kaisler et al. 2005) as "*the main components of the organization, its information systems, the ways in which these components work together in order to achieve defined business objectives, and the way in which the information systems support the business processes of the organization*". These components include staff, business processes, technology, information, financial and other resources, etc. A definition of software architecture is provided by Bass et. al (Bass et al. 2003): "*The software architecture of a program or computing system is the structure or structures of the system, which comprise software elements, the externally visible properties of those elements, and the relationships among them.*"

2.2 Stakeholders

Architecture work has a group of stakeholders. These stakeholders have varying topics of concern, information needs and questions relating to company's business and ICT. These stakeholders have thus different perspectives on architectures. Therefore, they have different questions and concerns relating to architectures. On one hand, enterprise architecture related stakeholders may include the ICT and the business organisations, management, the architecture group, the investment board, ICT maintenance and security groups (e.g. (Armour et al. 1999b; Syntel 2005)). On the other hand, software architecture related stakeholders may include acquirers, developers, architects, users, maintainers, suppliers, testers, assessors, communicators, system administrators and support staff (Rozanski and Woods 2005).

2.3 Evaluation perspectives

Due to this variety of stakeholders and their information needs, different evaluation approaches are needed. A classification of evaluation approaches is proposed by

Worthen et. al (Worthen 1997) in the context of program evaluation. The adaptation of this classification to the architecture context is presented in the next table.

Table 1. Evaluation approaches
(adapted to the architecture evaluation context from Worthen et al. (Worthen 1997))

Evaluation approach	**General purpose of evaluation**
objective-oriented evaluation	determining the extent to which goals are achieved
management-oriented evaluation	providing useful information to aid in making decisions
consumer-oriented evaluation	providing information about products to aid in making decisions about purchases or adoptions
expertise-oriented evaluation	providing professional judgments of quality
adversary-oriented evaluation	providing a balanced examination of all sides of controversial issues, highlighting both strengths and weaknesses
participant-oriented evaluation	understanding and portraying the complexities of a architecture, responding to an audience's requirements for information

2.4 Architecture evaluation concepts

Fundamental evaluation concepts are described, for example, by Marta Lopez in the examination of one architecture evaluation method (ATAM) (Lopez 2000). These concepts are:

- *target*: the object under evaluation
- *criteria*: the characteristics of the target that are to be evaluated
- *yardstick or standard*: the ideal target against with the real target is to be compared
- *data-gathering techniques*: the techniques needed to obtain data to analyze each criterion
- *synthesis techniques*: techniques used to judge each criterion and, in general, to judge the target, obtaining the results of the evaluation
- *evaluation process*: series of activities and tasks by means of which an evaluation is performed.

Assessment targets of architecture evaluation, presented in previous studies, vary significantly. Architecture evaluations may examine the EA or SA description represented in the EA or SA products, the processes used to produce and manage the EA or SA, and the other processes such as capital planning and investment management or systems development that use the EA or SA and the EA or SA resources (Hagan 2004).

Data gathering and synthesis techniques and evaluation process for architectures are largely not defined separately. Rather, these are defined by and included in the architecture evaluation methods. In addition, evaluation methods support different evaluation approaches. Some enterprise architecture evaluation methods are, for example, the following enterprise architecture maturity models:

- *OMB Enterprise Architecture Assessment Framework* (US FEAPMO 2004) (Federal Enterprise Architecture Program Management Office, US FEAPMO),

- *The Enterprise Architecture Maturity Model*, EAMM (NASCIO 2003) (National Association of State Chief Information Officers , NASCIO)

- *The Extended Enterprise Architecture Maturity Model*, E2AMM (IFEAD 2004) (Institute for Enterprise Architecture Developments, IFEAD).

- *A Framework for Assessing and Improving Enterprise Architecture Management*, EAMFF (GAO 2003) (US General Accounting Office, GAO)

- The *COSM (Component Oriented Software Manufacturing) Maturity Model* (Herzum Software).

- *IT Architecture Capability Maturity Model*, ACMM (US Department of Commerce, Doc).

An array of methods is also being developed for evaluation of software architectures. These methods are evaluated and compared in some studies (e.g. (Dobrica and Niemelä 2002), (Babar et al. 2004) (Ionita et al. 2002)). Software architecture evaluation methods may include the following:

- Scenario-based Architecture Analysis Method, SAAM (Kazman et al. 1994)

- Architecture Trade-off Analysis Method, ATAM (Kazman et al. 1998)

- Active Reviews for Intermediate Design, ARID (Clements 2000),

- SAAM for Evolution and Reusability, (Lung et al. 1997),

- Architecture-Level Modifiability Analysis, ALMA (Bengtsson et al. 2004),

- Architecture-Level Prediction of Software Maintenance,

- Scenario-Based Architecture Reengineering,

- SAAM for Complex Scenarios,

- MITRE's Architecture Quality Assessment (Hilliard et al. 1996; Hilliard et al. 1997).

3 Architectural Viewpoints

This study focuses on examining architecture evaluations which are based on information included partly or totally in architecture descriptions and documents. Architectural descriptions related concepts are considered in this chapter.

3.1 Architectural Descriptions

Both enterprise and software architectures are described by architectural descriptions. The architectural descriptions may be baseline and/or target architecture descriptions. IEEE 1471 defines a couple of concepts relating to architecture descriptions. IEEE 1471 concepts seem to be accepted both in the SA and in the EA domain (EA domain adaptations for example relating to Togaf Framework (Hilliard 2000) and by Steen et. al. (Steen et al. 2004)). Concepts defined by IEEE 1471 (IEEE 2000) are especially the following:

- *Architectural description*: A set of views (which consist of architectural models) and additional architectural information.
- *View*: A set of model representing enterprise or system from the perspective of a related set of concerns.
- *Model*: A particular diagram and description constructed following the method defined in a viewpoint.
- *Viewpoint*: The conventions for creating, depicting and analyzing a view.

Relationships between these concepts are presented in Figure 1.

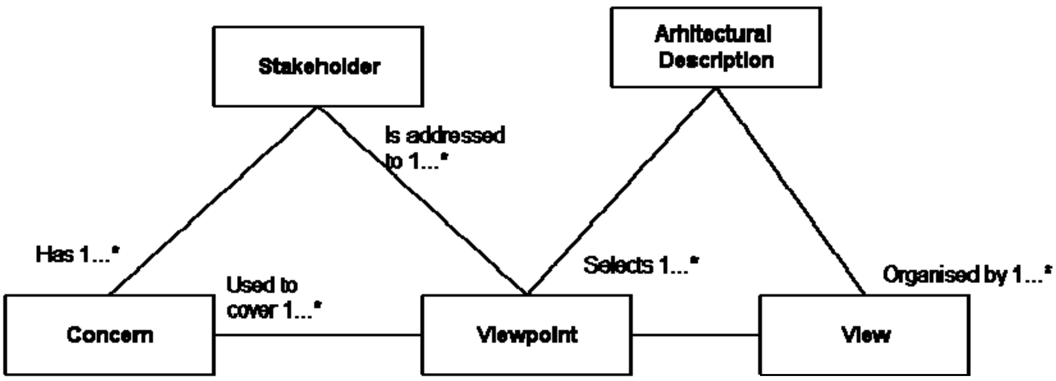

Figure 1. Architectural description related concepts (IEEE 1471 (IEEE 2000)).

3.2 Viewpoints

Viewpoints delineate the architectural information that is presented to the stakeholders (Koning and Vliet 2006). Viewpoints, on the one hand, prescribe the content and “models” to be used, and, on the other hand, indicate their intended “stakeholders” and their concerns (Koning and Vliet 2006).

Architecture frameworks both in enterprise architecture and in software architecture domain define a couple of viewpoints. For example, EA viewpoints are defined by Zachman's Framework for Enterprise Architecture (Zachman 1987), The Open Group Architecture Framework (TOGAF) (The Open Group 2002), Archimate framework, ISO Reference Model of Open Distributed Processing (RM-ODP) (ISO 1994). SA viewpoints are defined, for example, by viewpoint models such as Kruchten "4+1" View Model (Kruchten 1995), Software Engineering Institute (SEI) set of views (Clements et al. 2002), Siemens Four View Model (Soni et al. 1995) and Rational Architecture Description Specification (ADS).

As discovered by May (May 2005), viewpoints defined such as defined by different Viewpoint models do not completely correspond to each other. Enterprise architecture viewpoint models seem to be similar situation. A commonly accepted set of architectural viewpoints does not thus currently exist (Smolander et al. 2002; May 2005). As Smolander (Smolander et al. 2002) reveals the architectural viewpoints chosen by companies are rather agreements between people depending on the organizational and project environment. In practice, the selection of architectural viewpoints is, thus, based on the prevalent situation and characteristics in the company and in the project at hand.

However, different viewpoint models have similarities in the viewpoints defined by them. In the following, viewpoints that seem to be accepted on some level in the EA domain are presented firstly; secondly, viewpoints that seem to be on some level accepted in the SA domain are introduced.

3.3 Enterprise architecture viewpoints

Enterprise architecture viewpoints define abstractions on the set of models representing the enterprise architecture, each aimed at a particular type of stakeholder and addressing particular concerns (Steen et al. 2004). Enterprise architecture viewpoints which are generally mentioned include: *business architecture, information and data architecture*, a*pplication (systems) architecture* and *technical (technology, infrastructure) architecture* (e.g. (The Open Group 2002; IT Governance Institute 2005; Whittle and Myrick 2005)). Roles these viewpoints have and examples of targets suggested to be described relating to each viewpoint are described in the following table.

Table 2. Enterprise architecture viewpoints.

Business architecture	
Role	Defines what the enterprise must produce to satisfy its customers, compete in a market, deal with its suppliers, sustain operations, and care for its employees (Whittle and Myrick 2005). An enterprise view of what the business must do today as well as in the future to accomplish particular business requirements (Whittle and Myrick 2005).
Content examples	Key business operations and value streams for the organization (IT Governance Institute 2005; Kaisler et al. 2005; Whittle and Myrick 2005), Business processes (Kaisler et al. 2005), Organisational structure: Organisations, units and functions and responsibilities of them, Roles/Skills (Kaisler et al. 2005; Whittle and Myrick 2005), Enterprise operating environment (Whittle and Myrick 2005)
Information / Data architecture	
Role	*Information architecture* The informational needs of the enterprise in the context of core business processes and strategic goals of the enterprise (Whittle and Myrick 2005). Major information entities needed to operate the business, their relationships, and how they map to business processes, units, and locations (Armour et al. 1999a). *Data architecture* Identifies how data are maintained, accessed and utilized (IT Governance Institute 2005).
Content examples	*Information architecture* The information and data management framework and precepts (Whittle and Myrick 2005). Operational and decision support systems needed to support the core processes and strategic goals, where the information for those systems is located, and how this information will be management (Whittle and Myrick 2005). *Data architecture* Data, at the element level, its associated relationships, in what processes they are used and in what form, and how they flow between processes (Whittle and Myrick 2005).
Application / Systems architecture	
Role	To provide a logical portfolio of applications for supporting the various business processes of an enterprise (Whittle and Myrick 2005).
Content examples	The application software portfolio and integration relationships; Interface specifications, tools, utilities, and in some cases approved products for applications; Application inputs and outputs; Application geographical deployment requirements; Guiding principles, standards, and design characteristics for the acquisition and the development (Whittle and Myrick 2005).
Technical / Technology / Infrastructure architecture	
Role	To describe the technology needed to meet the business requirements, helps ground the other architecture views by making it clear that the technology exists to implement them (Armour et al. 1999a).
Content examples	Supporting services, computing platforms, and internal and external interfaces the information systems need to run (Armour et al. 1999a).

3.4 Software architecture viewpoints

May (May 2005) has analyzed five different software architecture viewpoint models: the Kruchten "4+1" View Model, the Software Engineering Institute (SEI) set of views, the ISO Reference Model of Open Distributed Processing (RM-ODP), the Siemens Four View Model and the Rational Architecture Description Specification). The result was that the commonly accepted SA viewpoints (that these viewpoint models seem to define one way or another) are *functional*, *behavioural*, *external* and *deployment viewpoint*. In addition to these, Rozanski and Woods (Rozanski and Woods 2005) define *information* and *operational viewpoints*. Roles of these viewpoints and examples of their content are described in the next table.

Table 3. Software architecture viewpoints.

Functional viewpoint	
Role	Business aspects of the system. Description of the system's functional/structural elements and their responsibilities, interfaces and primary interactions (May 2005; Rozanski and Woods 2005)
Content	Functional capabilities, decomposition, uses, layered, abstraction, external interfaces, internal structure, design philosophy (May 2005; Rozanski and Woods 2005)
Information viewpoint	
Role	Description of the way the system stores, manipulates, manages, and distributes information (Rozanski and Woods 2005)
Content	Information structure and content, information flow, data ownership, transaction management and recovery, timeliness, latency, and age, references and mappings, data volumes, archives and data retention, regulation (Rozanski and Woods 2005)
Behavioral / Concurrency	
Role	Description of the system's dynamic aspects (May 2005) Description of the concurrency structure of the system, mapping functional elements to concurrency units to clearly identify the parts of the system that can execute concurrently, and showing how this is coordinated and controlled (Rozanski and Woods 2005)
Content	Process, concurrency (task structure, mapping of functional elements to tasks, interprocess communication, state management, etc.) etc.
Development / External viewpoint	
Role	Description of system's implementation structures
Content	Code structure and dependencies, system-wide design constraints, system-wide standards to ensure technical integrity, work assignment (May 2005; Rozanski and Woods 2005)
Deployment viewpoint	
Role	Description of the physical environment into which the system will be deployed, including the dependencies the system has on its runtime (Rozanski and Woods 2005)
Content	Hardware, third-party software, network, physical constraints etc.

Operational viewpoint	
Role	Describes how the system will be operated, administrated, and supported when it is running in its production environment (Rozanski and Woods 2005)
Content	Installation and upgrade, functional migration, data migration, operational monitoring and control, configuration management, performance monitoring, support, backup and restore (Rozanski and Woods 2005)

4 Research Method

In order to gain understanding of meanings and roles that architecture evaluation and measurement have in companies, a series of research phases was used in this study. A semi-structured group interview with a focus group of practitioners from five ICT user and service provider organisations was organised.

4.1 Interviewees

Practitioners were managers and specialists of the management of enterprise and software architectures in their organisations. The companies and interviewees are described in the next table.

Table 4. Interviewees in the focus group interview

Companies	**Number of personnel (year 2005)**	**Number of interviewees**	**Viewpoints of interviewees**
Architecture consultation company	10	2	enterprise and software architecture consultation
Banking, finance and insurance company	11 974	1	enterprise architecture
Telecommunication company	4989	1	enterprise architecture
Business & IT consulting and development organization	a part of a large international company with 329 373 employees in total	2	enterprise architecture, software architecture, marketing, business
Retail and service company	28 092	1	IT governance, enterprise architecture

4.2 The arrangements for the interview

The participants from these companies were interviewed as one group in order for group members to influence each other by responding to ideas and comments of others (Krueger and Casey 2000). This use of group did have an impact, bringing out new aspects. However, some aspects may not have been brought out by the interviewees due to confidentiality reasons.

4.3 Interview

Architectural viewpoints and their definitions discussed at the beginning of this paper were presented to the participants. In addition, the main evaluation concepts and perspectives were presented. Based on practitioners' own practical experiences, practitioners were asked to name evaluation or measurement needs that relate to each architectural viewpoint. In addition, they were asked to name evaluation needs that exist relating to relationships between these viewpoints.

4.4 Data collection and analysis

The interview was tape-recorded. Notes were written during the interview session. Based on this data, a list of questions, information needs and topics of concern which may be triggers for architectural evaluations was produced. This list was reviewed by practitioners and the list was completed with comments. This list is presented in the next chapter.

5 Triggers for Architecture Evaluations

In the focus group interview, it came up that from the practitioner's point of view it was difficult to directly specify evaluation needs that relate to each architectural view. Practitioners suggested that company's business and ICT related problems, questions, topics of concern and information needs may be triggers for architecture evaluations. A group of triggers which came up in the focus group interview are presented in the table below. In addition, evaluation needs which arise due to these triggers are presented.

Table 4. Triggers for architecture evaluations.

Triggers for architecture evaluations	**Evaluation needs**	**Evaluation Targets**
A need for the documentation of good quality		
A need to produce architectural models and documentations that • can be quickly communicated and • are understandable by many different stakeholders • are cost-effectively kept up to date.	The evaluation the quality of architectural documentation. A need to evaluate: - Policy: do policies (e.g architectural framework) exist for documentation and are they followed? - Intelligibility and usability: are documents easy to understand and use? - Accuracy: are documents truthful and factual? - Cost effectiveness of maintenance: how much effort is needed to keep models and documentation up to date? - Traceability between architectural documents: is there traceability between architectural documents?	Architecture documen-tation (EA / SA)
A need to have organisation's business environment descriptions of good quality	The evaluation existence and quality of business descriptions (goals, strategy, company's operations) : • existence of business descriptions (e.g. goals, strategy, company's operations) • Accuracy: are the descriptions up to date?	Business architecture document-tation
A need to have information / data models of good quality	The evaluation of the quality the information / data models	Information / Data architecture
Change pressures in organisation		
A change need in the business or ICT (e.g. a need to move from one solution to another)	The evaluation and identification of the places affected by a change and effects in each architectural viewpoint.	EA viewpoints
An observation that ICT-architecture do not correspond to company's business's requirements	The evaluation how the enterprise architecture should be changed by identifying what chances should be carried out in each architectural viewpoint.	EA viewpoints

Triggers for architecture evaluations	**Evaluation needs**	**Evaluation Targets**
The understanding of business and ICT environments		
A need to enhance the understanding of company's business/ICT	The evaluation of enterprise architecture from different aspects or against different factors e.g. the identification of overlaps.	EA viewpoints
A goal that ICT supports business	The evaluation of how business architecture is supported by other viewpoints (information, applications, infrastructure).	EA viewpoints
A need to enhance the understanding of responsibilities in the company	Identification and evaluation of responsibilities in company (for example who is responsible for customer informations).	Business architecture
A need to understand the state of the company's product portfolio and processes	The description and evaluation of business architecture related aspects.	Business architecture
A need to understand information managed in company	The description of major information entities and responsibilities in information management.	Information / Data architecture
A need to understand the state of the company's application portfolio	The description and evaluation of structures and components of application architecture.	Application architecture
A need to understand quality aspects relating to the company's application portfolio	The evaluation the application architecture against quality aspects and attributes e.g. the identification of overlaps.	Application architecture
A need to understand the current state of technical infrastructure	The description and evaluation of structures and components of technical infrastructure.	Technology architecture
Company management and process planning		
A need to make sure that organisational choices are suitable	The evaluation of organisational structures and operations: are those suitable or should those be changed.	Business architecture
The distribution of work	The evaluation of processes: identification of which tasks will be carried out by the company and which are dealt out to partners.	Business architecture
Business process planning	The evaluation of functionality of business processes: e.g. do processes correspond to company's strategy?	Business architecture
Management of architectures		
An observation that ICT-architecture does not correspond to ICT-development projects' needs	The evaluation of how architectural principles or architecture descriptions should be changed.	EA viewpoints

Triggers for architecture evaluations	**Evaluation needs**	**Evaluation Targets**
An effort to drive investments to follow up architectural principles	The evaluation of if the investment corresponds and is suitable to the existing architecture and architectural principles.	EA viewpoints
A need to drive technical infrastructure investments to follow the architectural principles	The evaluation of if investments correspond to the principles.	Technology architecture principles
IT cost management		
A need to understand and manage costs relating to the company's application portfolio	The evaluation of financial aspects and factors relating to application architecture	Application architecture
A need to understand and manage costs relating to technical infrastructure	The evaluation of financial aspects and factors relating to technical infrastructure	Technology architecture
Architectural choices		
A need to find the best possible system solution and a need to understand the aspects relating the solution	The evaluation of the architectural solution: e.g. evaluation of • quality aspects (evaluation against quality attributes), • flexibility of solution, • the life cycle of solution, • suitability for the situation in question (e.g is solution possible within available time, money and resources).	SA viewpoints (EA viewpoints)
An effort towards long-term technical solutions and need to argue for the long-term technical solutions	The comparison of a long-term and short-term solution.	EA / SA viewpoints

6 Discussion

Architecture evaluation triggers and needs were identified and analysed in this study. During this study, the following observations were made.

Architecture evaluation is more trigger-based than stabilized work in companies.

This study revealed that architecture evaluations do not at least yet have a stabilized role in companies unlike, for example, requirements engineering and architecture design have. Evaluations seem not to have a fixed status in the architecture processes or in other processes in companies. Therefore, evaluations are not executed regularly.

In this study, it came up that some kind of trigger must exist before the evaluation is executed. This trigger may be, for example, a problem, a question or a need for information relating to company's business or ICT-environment. In the figure below, the first steps before the architecture evaluation, identified in this study, are summarized.

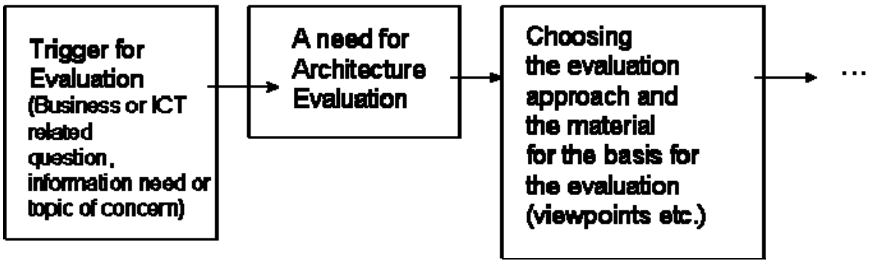

Figure 2. Starting steps for the architecture evaluation.

Architecture evaluation has several meanings and roles in companies and evaluations can thus be used for different purposes.

This study revealed a couple of triggers for architecture evaluations. These triggers can be categorised to the following categories:

- Company and business management: Support needs for organisation's structural design (e.g. business process design) and for the distribution of the work (e.g for out-sourcing).

- Holistic view: Understanding needs relating to the current status of organisation's business and ICT-environment.

- IT cost management: Financial information needs relating to company's ICT (applications and technical infrastructure).

- Change management: Change pressures relating to architectures and architectural principles – identification of probability and nature of changes that should be made and decision making about changes.

- Quality management: Quality questions relating architectural documentation, the company's information/data structures, application and technical infrastructure, as well as systems solutions.

- Architecture management: Confirming that architecture related work meets expectations e.g. investments correspond to the architectural principles.

- Architectural choices: evaluation of architectural alternatives against quality, cost and other aspects.

We suggest that these evaluation triggers describe role and meaning that architecture evaluation may have in companies. Architecture evaluations can hence be one of the tools of quality assurance, change management, architectural planning and IT cost management. In addition, evaluations may support the organisational planning and decision making. Different evaluation approaches are needed because architecture evaluation's role varies remarkably.

A motivation for the evaluation defines the material and architectural viewpoints to be viewed.

The nature of a trigger for the evaluation drives the choosing of architectural documentation and viewpoints to be viewed in the evaluation. Sometimes it can be concentrate only on one viewpoint, but sometimes many viewpoints and their relationships can be analyzed.

The nature of evaluation and its challenges differ between areas.

In the interview, practitioners brought out that business architecture seems to be the most difficult area to evaluate. The challenge relating to evaluation of information / data architectures is the lack of information and data models in companies. Currently, companies are not accustomed to actively producing information and data models. Practitioners felt that application and technical architecture are the most understandable areas and these areas are typically evaluated in companies. The evaluation of these areas is numerical (e.g. amounts of components, cost).

One challenge in architectural evaluations is the architectural documentation.

Evaluations are based on the architectural documentation and descriptions that the company has. In the interview, practitioners brought out some challenges that relate to architectural documentation. It is not clear and easy to decide what descriptions and documentation should be produced relating to architectures. In addition, the amount of documentation produced should be limited. The quality and amount of architectural documentation may have an effect on the possibilities to execute evaluations for a company's architectures. However, the descriptions are needed for analysing and understanding architectures.

The relationship between architecture evaluations and organisation's other measurement activities

Companies already have measurement practices and metric programs (e.g. enterprise performance measurement, balanced scorecard). In the interview, it came up that a link between an organisation's existing measurement practices and architectural evaluations and measurements should be specified.

Restrictions

In this study, the EA and SA design and development specialists were interviewed. Their perspectives might reveal much more than the companies' other business and ICT stakeholders' perspectives. In addition, all the possible triggers for evaluations may not have been identified in this study. However, the results give an image of the role and meaning of architecture evaluations in companies.

7 Conclusion

This study revealed that currently architectural evaluations seem not to have a stabilized role and meaning in companies. This situation is reflected, for instance, in architecture evaluations not having stabilized place in organisations' architecture process models. It came up that a trigger for evaluation must exist. However, the reason for this may be that architecture evaluation practices are still immature in general and, therefore, we might expect to see changes in the future.

In this study, triggers for architecture evaluations in companies were identified and analysed. This study aims to enhance the definition of the role for architectural evaluation in organisations.

The future research questions, raised in this study, include the questions of what kind of stabilized role architecture evaluation could have in organisations and how architecture evaluations and measurements could be linked to an organisation's other measurement and evaluation programs and practices.

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Success and Failure Factors for Software Architecture

AISA Project Report

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Abstract

This paper provides a view of the software architecture development and management process. It reviews the literature and practitioners' experiences relating to the factors that cause success and failure for software architecture and classifies these factors into subgroups. This study demonstrates that the success of software architecture depends on multiple factors. Project management, organisational culture and communication, the skills of architects and architectural know-how, architecture methods and practices, the quality of system requirements and, finally, architecture solutions seem to affect the achievement of successful architecture.

Contents

1 Introduction

Currently, a concern of many ICT-service providers and user organisations in their system development work is software architecture. Another central issue in this development work is the quality of the system. Software architecture is a critical factor in the design and construction of any complex software-intensive systems. Software architecture has an impact on the quality of the system. On one hand, a good architecture can help ensure that a system will satisfy key requirements in such areas as performance, reliability, portability, scalability, and interoperability (Garlan 2000). On the other hand, a bad architecture can be disastrous. It may prevent the achievement of goals that are set for the system.

Architecture evaluation is a way to increase the understanding of the quality of architecture. A variety of methods is being developed for the evaluation of software architectures. Evaluation methods developed during the last decade are, for example, SAAM (Kazman et al. 1994), ATAM (Kazman et al. 1998), ARID (Clements 2000) and ALMA (Bengtsson et al. 2004). Evaluation objectives, criteria, as well as evaluation targets, examined by the software architecture evaluation methods, differ markedly. Evaluation objectives and use cases are discussed in some method comparisons (e.g. (Dobrica and Niemelä 2002; Babar et al. 2004)) and other studies (e.g.(Hämäläinen et al. 2005)). In spite of this discussion in various papers, evaluation criteria and metrics are presently neither established nor detailed yet. Nevertheless several evaluation criteria and metrics descriptions exist. Software architecture evaluation criteria are discussed for example by Hilliard et al.

(Hilliard et al. 1996; Hilliard et al. 1997) and Losavio et al. (Losavio et al. 2003; Losavio et al. 2004). One reason for the non-establishment of architecture evaluation criteria and metrics may be that common views on what is successful software architecture and what factors have an effect on achieving it do not exist. It is not clear what targets and factors should be evaluated and measured. However, successful architecture is a widely used concept.

Academia and practitioners have come to realize that a critical success factor for system design and development is finding a successful architecture. Although the idea of a successful architecture is not clearly defined, practitioners and academia have become increasingly interested in what makes software architectures succeed or fail. The identified success and failure factors help system development managers and architects make a number of critical decisions. These decisions relate, for example, to the selection of evaluation criteria and metrics for the quality assessment of architectures and architecture management processes.

It is generally known that the success of software architecture is typically influenced by factors at various levels. However, these factors are mainly discussed only by a few studies and reports organised and produced by some research institutes and the ICT industry (e.g. (van der Raadt et al. 2004), (Avritzer and Weyuker 1999), (Boehm

1994)). Thus, these factors are, as yet, far from having been fully investigated in detail.

Our study contributes to this field with an identification and analysis of success and failure factors of software architecture. Our research involved reviewing the relevant literature and practitioners' experiences on factors that cause the success or failure of software architecture efforts. The factors listed in the following section were distilled from various articles and empirical research on software architecture implementation. Moreover, in order to collect empirical data for the present study, we organised an interview for a focus group of practitioners from three ICT service provider and user organisations. Success and failure factors were then categorised into a number of subgroups representing various dimensions of change related to the development and management of software architecture. As a result, this study presents a number of factors related to software architecture success and failure.

This study consists of the following sections. Firstly, section 2 presents the research method used in this study. Secondly, sections 3 and 4 present the results of this study: success and failure factors for software architecture. Finally, section 5 summaries the findings and presents areas for further examination.

2 Research Method

In order to identify and analyse the success and failure factors for software architecture a series of the following research phases was used in this study.

Phase 1. The study of previous research and reports

Firstly, a list of success and failure factors mentioned in previous research and ICT-industry reports was produced. Secondly, the list of factors was analysed and the similar factors were organised into groups. Finally, the preliminary system development areas to which similar factors were related were identified.

Phase 2. Empirical research: A focus group interview (Krueger and Casey 2000) of practitioners.

A semi-structured group interview with a focus group of practitioners from three ICT user and service provider organisations was organised. Practitioners were specialists of the management of software and enterprise architectures. The goal of the interview was to collect success and failure factors from the practitioners. We presented previous research results in the interview and in turn structured the interview according to them. The practitioners reviewed the previous study results based on their own practical experiences. In addition they were asked to add new factors to the results on basis of their practical experiences. The interview was tape-recorded and videotaped. Notes were written during the interview session. Based on this data a list of system development areas affecting the success of software architecture and success and failure factors relating to these areas was produced.

Phase 3. Consolidation and analysis of results.

The results from empirical study and previous research were combined. These results are presented in chapters 3 and 4.

3 Software Architecture Success Factors

In this study, we identified six system development areas that seem to affect the success/failure of software architecture. These areas are presented in figure 1. The success and failure factors, identified in this study, relate to these areas. In the following sections, we describe the success factors included in these areas. The failure factors related to these areas are presented in chapter 4.

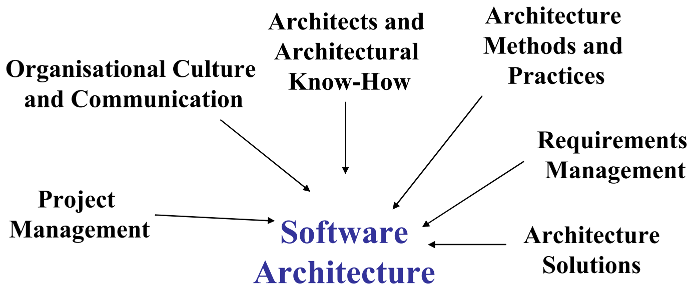

Figure 1. System development areas affecting the success and failure of software architecture.

3.1 Success and Failure Factors within Project Management

Project management offers time, staff and resources for architectural work. Software architecture success factors relating to the project management can be divided into factors relating to staffing, scheduling, planning and funding. In this study, we identified the project management factors that promote the success of software architecture, which are displayed in Table 1.

Problems in staffing, scheduling, project planning and project funding complicate the architectural work. These kinds of problems are presented in the following section. In the interview of practitioners, we also noticed that some of these problems are more relevant for the service provider organisations than for the user organisations. For example, the lack of clear statement of the problem is more critical problem for the service providers than for the user organisations.

Table 1. Success and Failure Factors related to project management

Success Factor	Adapted from	Failure Factor
Clear aim of project The aim of the project is clear and reasonable.	[FGI = based on Focus Group Interview]	***Not a clear statement of the problem*** The project lacks a clear problem statement or the project team has not provided a clear statement of the problem. The organisation does not have time or willingness to define clearly the aim of the project. [FGI = based on Focus Group Interview], (Avritzer and Weyuker 1999)

Success Factor	Adapted from	Failure Factor
Strong management sponsorship The project and architecture work have strong management sponsorship. Management offers time and funding for the project.	(Bredemeyer Consulting 2000), [FGI]	
Clear milestones in the project Predetermined milestones are set in the planning stage to track the direction of the project.	[FGI]	***The lack of clear milestones in the project*** The direction of the project is not checked during the project. The only milestone is the end of the project. [FGI]
Strong leadership Strong leadership specifically for the project.	(Bredemeyer Consulting 2000)	***Poor leadership*** No project manager/leader has been identified (Avritzer and Weyuker 1999). Poor leadership (Bredemeyer Consulting 2000) Lack of control/authority (Bredemeyer Consulting 2000).
Clearly defined teams and roles Project management teams are clearly defined. A good lead architect with a well-defined role and style.	(Bredemeyer Consulting 2000)	

Success Factor	**Adapted from**	**Failure Factor**
Available knowledge / staff Market / business understanding is available.	(Bredemeyer Consulting 2000)	***Lack of resources/talent*** The needed resource does not exist or project management is not able to offer it [FGI]. *Lack of domain expertise*: No domain experts have been committed to the project team (Avritzer and Weyuker 1999). *Lack of architect*: No architect exists (Clements et al. 2002) or failure to select software architects. Each layer has an architect assigned; however, a chief architect with responsibility for the overall architecture has not been selected (Avritzer and Weyuker 1999). *Lack of other resources*: For example the lack of points of view of end users or of administrator [FGI].
Teamwork	(Bredemeyer Consulting 2000)	
		The project scope too broad The project scope is too broad. The capability to divide the project into smaller entities/units may also be lacking. (Avritzer and Weyuker 1999), [FGI]

Success Factor	Adapted from	Failure Factor
		No project, system or testing planning
		A project plan has not been put in place. The project team has not written an overall architecture plan and has not developed a system test plan. No contingency plan has been provided. No plan for moving to OO technology has been established. (Avritzer and Weyuker 1999)
		Stakeholders unclear
		The stakeholders are not clearly identified (Avritzer and Weyuker 1999) or they are difficult identify (Clements et al. 2002).
		Lack of a quality assurance organization
		A quality assurance organization has not been selected (Avritzer and Weyuker 1999).
		Lack of requirement team
		An independent requirement team has not been selected (Avritzer and Weyuker 1999).
		Funding not formalized
		Project funding has not been formalized (Avritzer and Weyuker 1999)

Success Factor	Adapted from	Failure Factor
		Insufficient resources Insufficient resources have been allocated for building tasks. (Avritzer and Weyuker 1999)
		No measures of success Measures of success have not been identified. (Avritzer and Weyuker 1999)
		No scheduling or unrealistic scheduling No project schedule is in place.(Avritzer and Weyuker 1999) The deployment date is unrealistic (Avritzer and Weyuker 1999) [FGI]. The focus is too much on getting positive results in the short term (van der Raadt et al. 2004). The project team has not put a hardware and installation schedule in place (Avritzer and Weyuker 1999). The project team has not allocated sufficient time for testing (Avritzer and Weyuker 1999).

3.2 Success and Failure Factors Related to the Organisational Culture and Communication

Organisational culture refers to the values, beliefs and customs of an organisation. Whereas organisational structure is relatively easy to draw and describe, organisational culture is less tangible. Organisational culture has an impact, for example, on how well the architecture will be adopted and followed. The success factors related to organisational culture are:

Table 2. Success Factors related to the organisational culture and communication

Success Factor	**Adapted from**	**Description**
Status and role of architecture	[17], [FGI]	Architecture is woven into the organisational culture. The role of the architecture and of the architectural descriptions is more instructive than supervisory.
Ownership	(Bredemeyer Consulting 2000), [FGI]	Willingness to take ownership of architecture
Approving attitude towards architecture	(Bredemeyer Consulting 2000)	The project organisation is willing to follow architecture
Training, teambuilding	(Boehm 1994)[FGI]	The training of staff to design and manage architectures.
An effective and constructive communication culture relating to architectural issues		Successful communication between different groups can be seen as an effective exchange of information. Interpersonal and team communication (Bredemeyer Consulting 2000). The communication culture in an organisation is based on an open exchange of well-argued, even critical, opinions [FGI].

The following aspects and factors relating to organisational culture and communication complicate architectural work:

Table 3. Failure Factors related to the organisational culture and communication

Failure Factor	**Adapted from**	**Description**
Profit-centre and project culture		Consideration of architectural issues only from the point of view of one's own profit centre or project [FGI]. Thinking too narrowly or short-sightedly [FGI].
Quarterly thinking		Far-sighted architectural decisions are difficult to justify in the quarterly thinking [FGI].
"Turf" thinking		Architectural decisions are formulated so that the decisions complicate the work of the decision maker as little as possible [FGI].
Organisational Politics		Organisational politics drive the architectural decision making (Bredemeyer Consulting 2000)
Negative Attitude towards Architecture and Architects		The product team believes "we can solve it better ourselves" (Bredemeyer Consulting 2000). The designed architecture is not implemented. The product team implements its own ad hoc solutions [FGI].
Poor communication		Poor communication inside/outside the architecture team (Bredemeyer Consulting 2000). The architecture team loses touch with the product team's problems (Bredemeyer Consulting 2000).

Failure Factor	Adapted from	Description
Disparity in the perception of the architecture		There are, for example differences in the perceptions between developers and architects (Clements et al. 2002).

3.3 Success and Failure Factors Related to the Architects and Architectural Know-How

The personal skills of architects have an effect on the fluency of the architectural design process in collaboration with the stakeholders. Personal skills may also have an impact on architectural decision making. We identified the following skills of architects affecting the success of software architecture:

Table 4. Success Factors related to the architects and architectural know-how

Success Factor	Adapted from	Description
Practical experience	(van der Raadt et al. 2004), [FGI]	Architects have practical experience on system development or architects have the humility to discuss architectural solutions with the development team.
Domain knowledge	(Bredemeyer Consulting 2000; van der Raadt et al. 2004) [FGI]	Architects have at least a minimal knowledge on the problem domain.
System development knowledge	[FGI]	Architects have knowledge on the system development method used and on how the architectural work is related to the method.
Capability to create architectural vision	(Bredemeyer Consulting 2000), [FGI]	Architects have a capability to create a clear and compelling vision that suits the organisation
Conceptual thinking	[FGI]	Architects are able to think conceptually and analytically.

Success Factor	**Adapted from**	**Description**
Capability to argue rationally	[FGI]	Architects are able to reason rationally, be critical of their own ideas, and put this rationality to use.
The ability to outline large entities	[FGI]	
Communicative and social skills		Architects can understand and combine views of the stakeholders [FGI]. Architects have communicative and social skills (van der Raadt et al. 2004). They are good communicators and listeners as well as good persuaders (Bredemeyer Consulting 2000). Moreover, they provides constructive feedback when it is needed (Bredemeyer Consulting 2000). They are also effective in selling and marketing architectural ideas [FGI]. These skills are important in spreading architectural knowledge, and explaining the urgency of architecture within an organization and a project team (van der Raadt et al. 2004)
Project management skills	(Bredemeyer Consulting 2000), [FGI]	Architects have good project management skills. However, the project management skills needed depend on the scope of the project.
Humility	[FGI]	The progress of architectural work is more important for the architect than personal merits.

Failure factors relating to the architects and architectural know-how are identified only briefly in previous research. However, the following factors are mentioned by previous studies and practitioners:

- *Unconvincing leadership by architects*: Architect or architecture team does not "sell" (lead) architecture enough (Bredemeyer Consulting 2000).
- *Incapability to create an architectural vision* (Bredemeyer Consulting 2000) [FGI].

3.4 Success and Failure Factors Related to the Architecture Methods and Practices

The software architecture management process contributes to the activities of capturing architectural requirements and understanding them, designing, analyzing/evaluating, realizing, maintaining, improving, and certifying the architecture as well as documenting it (Bass et al. 1998; IEEE 2000). The process model together with the methods and tools chosen to carry out architectural work, in turn have influence on this work. In addition, the standardization of the architectural concepts and of the descriptions in an organisation has an effect on the architectural practices. We identified the following factors relating to the architecture management process model, architectural methods and tools that affect the success of software architecture.

Architecture Management Process model:

- *Incremental and iterative development*: Deployed in phases / incrementally (Bredemeyer Consulting 2000) [FGI].
- *Validation of requirements:* Validation of requirements during each step of the process (Bredemeyer Consulting 2000).
- *The evaluation of architecture:* The evaluation of the architecture before it is implemented [FGI].
- *Life-cycle thinking in the architectural design*. The needs for change are taken into account in the architectural design [FGI].

Methods, tools and practices:

- *Suitable and effective methods and tools:* Architects should have effective tools at hand: methods that fit the specific requirements and situation of a company (van der Raadt et al. 2004). The methods should not constrain the architect in his work nor his creativity.
- *Well-defined limits for architects:* A well-defined field in which the architect is allowed to use his creativity in the architectural design and work [FGI].

- *Clear rules in the architectural decision making:* Clear rules on which architectural decisions can be made in the project and which decisions are made outside the project. Furthermore, clear definitions on which architectural decisions are made by architect and which are only prepared by him and which have to be decided by the project management. [FGI]

- *Change management* [FGI].

Standardization of architectural practices:

- *Standardization of architectural practices:* Standardisation architecture methods, descriptions, and terminology within the organisation [FGI].

Architectural specifications:

- *Clear and understandable architectural specifications*: Clear specifications including dependencies (Bredemeyer Consulting 2000) Architecture is understandable by all. That is, the architectural models and descriptions an architect produces, should be understandable and unambiguously interpretable by all stakeholders (Bredemeyer Consulting 2000; IEEE 2000). Architectural models and descriptions are practical, easily translatable to the practice of software development and implementation. Otherwise the architecture will exclusively be used by the architects (van der Raadt et al. 2004).

Enterprise architecture:

- *Defined and described enterprise architecture* [FGI]. Enterprise architecture is important in improving the adjustment of different projects to each other, and making sure information systems fit together, and into the entire architecture (van der Raadt et al. 2004).

The following factors related to the architecture management complicate the architectural design.

Architecture management process, methods, tools and practices:

- *Attention focus on methods and tools, not on architecture*: Much time is spent on finding the best methods and modelling languages, which takes the attention away from the real purpose of architecture (van der Raadt et al. 2004).

- *No architecture selection decision criteria*: The project lacks decision criteria to choose the software architecture (Avritzer and Weyuker 1999).

- *No change management*: No modification (MR) tracking system in place (Avritzer and Weyuker 1999) [FGI].

- *No iterative design*: The first version of the architectural design is implemented. The time is not used on architectural evaluations or on assessments of architectural alternatives [FGI].

- *The cutting down of the architectural design*: The time is focused on the coding rather than on the architectural design and evaluations [FGI].

- *Outputs not identified*: The expected outputs of the architectural work have not been identified (Avritzer and Weyuker 1999) [FGI].

- *Outdated architectural documentation* (Clements et al. 2002).

Architectural specifications:

- *Essential architectural views / aspects not documented* [FGI].

- *Architectural descriptions are at too low a level or are not detailed enough* (Bredemeyer Consulting 2000) [FGI]. Architectural specifications are class diagrams (Clements et al. 2002).

- *Architectural descriptions are at too high a level.* The architecture can not be carried out based on descriptions [FGI].

Enterprise architecture:

- *Enterprise architecture is not defined or described* [FGI].

- *A very heterogeneous enterprise architecture* [FGI].

3.5 Success and Failure Factors Related to the Requirements Management

Architectural design and decision making is founded on identified requirements. Previous studies do not clearly highlight which factors in the requirements management advance the success of software architecture. However, the problems in requirements quality cause failure for software architecture like as described in the next chapter. Therefore, it is evident that the quality of the requirements and of the requirements management process advances the success of software architecture.

Three basic quality characteristics for the requirements of good quality are (Pohl 1994):

Table 5. Success and Failure Factors related to the requirements management.

Success factor	Failure Factor
Complete requirements	***Incomplete requirements*** Requirements are missing for a feature (Avritzer and Weyuker 1999). The existing environment (e.g. legacy systems) of system is not considered. or described. An assessment of the size of the expected user community has not been done (Avritzer and Weyuker 1999) Project lacks a clear statement of its data storage requirements. (Avritzer and Weyuker 1999) Anticipated usage of the system was not clearly characterized. (Avritzer and Weyuker 1999) *Unbalanced set of requirements* (Clements et al. 2002).
Agreed Requirements The requirements are correct, consistent, feasible, prioritized [FGI] and necessary.	***Requirements not prioritized*** The project team has not prioritized the requirements (Avritzer and Weyuker 1999).

Success factor	Failure Factor
Well-represented requirements The requirements specifications are unambiguous, concise, traceable, non-redundant, organised [FGI], conformant to standards and verifiable.	***Requirements unclear*** Requirements not well-defined, not signed off, changing (Bredemeyer Consulting 2000). The team has not clarified some requirements. Requirements need to be clarified.(Avritzer and Weyuker 1999)
	Requirements not documented No requirements documentation exists (Avritzer and Weyuker 1999).
	Insufficient resources to support a new requirement have been allocated (Avritzer and Weyuker 1999).

3.6 Success and Failure Factors Related to the Architecture Solutions

Architectural choices and decisions are made in architectural design. Based on these decisions, the architectural specifications are produced. The following high-level success and failure factors relating to architecture solutions are mentioned:

Table 6. Success and Failure Factors related to the architecture solutions.

Success Factor	Failure Factor
Simple architecture (Bredemeyer Consulting 2000)	***Complex*** Too many components on every hierarchical level (Clements et al. 2002).
Architecture solve the problem Solve at least the current (Bredemeyer Consulting 2000) and impending [FGI] problems as well as change needs.	***Architecture does not correspond to the requirements*** Does not solve the project teams problems (Bredemeyer Consulting 2000)

Success Factor	Failure Factor
	Architectural decisions are based on the wrong interpretation of requirements The wrong interpretations of the regulations may lead, for example, to unnecessary complex architectural solutions [FGI].
	Bad design / idea (Bredemeyer Consulting 2000).
	Standards and standard components neglected (Clements et al. 2002)
	External structures drive the architecture
	Architecture follows customer's organizational structure (Clements et al. 2002). Architecture depends on specifics of an operating system (Clements et al. 2002). Architecture follows hardware design (Clements et al. 2002).
	Exceptions drive architecture (Clements et al. 2002).

4 Discussion

In this study, we identified and analysed success and failure factors for software architecture in system development work. This study demonstrates that the success of software architecture depends on multiple factors. Project management, organisational culture and communication, the skills of architects and architectural know-how, architecture methods and practices, the quality of system requirements and, finally, architecture solutions seem to affect the achievement of successful architecture.

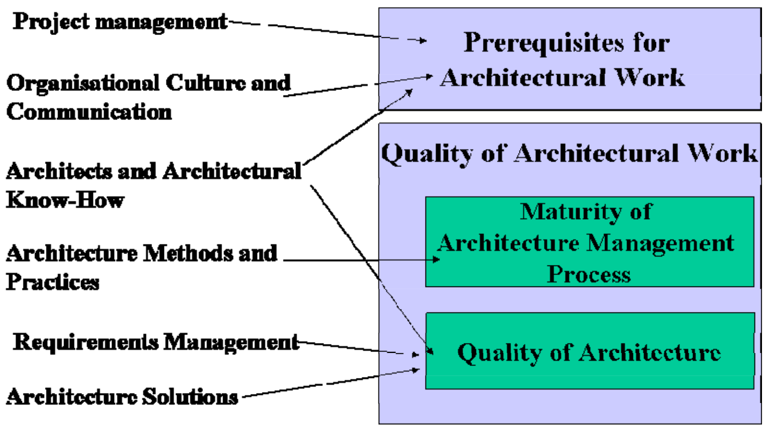

Figure 2. The main areas affecting architectural success.

Restrictions and limitations in this study

There are some limitations in this study. Corresponding success and failure factors were combined from different sources. Limited number of success and failure factors was considered in this study. However, the results give an image of the factors affecting architectural success.

5 Conclusion

The results of this study can be used as a checklist by which practitioners in ICT service providers and user organisations undertaking, or planning to undertake, software architecture efforts can ensure that their software architecture–related efforts are comprehensive, well-implemented, and have the minimum chance of failure.

A further outcome of this study is the development of software architecture quality management methods and process models such as software architecture evaluation practices. This study shows for which targets architecture management evaluation criteria, metrics and methods could be developed and utilized.

Further research questions, raised in this study, include the question of which evaluation criteria and metrics are suitable for each success factor. In addition, the criticality of these software architecture success and failure factors in system development need to be assessed based on surveys directed to ICT service providers and user organisations. We are addressing this last question in our on-going research.

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