Architectural Work Status: Challenges and Developmental Potential
A Case Study of three Finnish Business Enterprises

AISA Project Report

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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.

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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,

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		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

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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.

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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

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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.

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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.

References

Akella, J. and C. Barlow (2004). "Defining the Role of the Chief Architect." Enterprise Architect 2(1).

Al-Mashari, M. and M. Zairi (1999). "BPR implementation process: an analysis of key success and failure factors." Business Process Management Journal 5(1): 87-112.

Armour, F. J., S. H. Kaisler, et al. (1999a). "A Big-Picture Look at Enterprise Architectures." IT Professional(January-February): 35-42.

Armour, F. J., S. H. Kaisler, et al. (1999b). "Building an Enterprise Architecture Step by Step." IT Professional(July-August): 31-39.

Ashmore, P., J. Henson, et al. (2004) "Is Your Enterprise Architecture All It Can Be? Lessons From the Front-Line." Business Process Trends Volume, DOI:

Badri, M. A., D. Davis, et al. (1995). "A study of measuring the critical factors of quality management." International Journal of Quality & Reliability Management 12(2): 36-53.

Belout, A. and C. Gauvreau (2004). "Factors influencing project success the impact of human resource management." International Journal of Project Management 22(2004): 1-11.

Bernus, P., L. Nemes, et al., Eds. (2003). Handbook on Enterprise Architecture, Springer-Verlag.

Boehm, B. (1994). Software architectures: critical success factors and cost drivers. The 16th international conference on Software engineering. Sorrento, Italy, IEEE Computer Society Press: 365.

Boster, M., S. Liu, et al. (2000). "Getting the Most from Your Enterprise Architecture." IT Professional 2(4): 43-50.

Bredemeyer Consulting. (2000). "Software Architecting Success Factors and Pitfalls." from http://www.bredemeyer.com/CSFs_pitfalls.htm.

Buchanan, R. D. and R. M. Soley (2003) "Aligning Enterprise Architecture and IT Investments with Corporate Goals (an OMG whitepaper)." Business Process Trends Volume, DOI:

Carbone, J. (2004). "The Case for "Good Enough" Architecture." 18.8.2005, from http://www.harriskern.com/index.php?m=p&pid=377&authorid=&aid=157.

Carbone, J. (2005). "Ten Signs of Enterprise Architecture Maturity." 2005, from http://www.harriskern.com/index.php?m=p&pid=377&authorid=&aid=190.

Chrissis, M. B., M. Konrad, et al. (2003). Cmmi: Guidelines for process integration and product improvement, Addison-Wesley Professional.

CIO Council (2001). The Practical Guide to Federal Enterprise Architecture, version 1.0, Chief Information Officer Council.

COBIT. (2000). "Control Objectives for Information and related Technology (COBIT), 3rd Edition." from http://www.isaca.org/cobit.htm.

Coronado, R. B. and J. Antony (2002). "Critical Success Factors for the Successful Implementation of Six Sigma Projects in Organisations." The TQM Magazine 14(2): 92-99.

Curran, C. (2005). "Link IT Investments to Business Metrics." Enterprise Architect 3(1): 16-18.

Dale, B. G. (2003). Managing Quality, Blackwell Publishing.

de Boer, F. S., M. M. Bosanque, et al. (2005). Change Impact Analysis of Enterprise Architectures. Proceedings of the IEEE International Conference on Information Reuse and Integration (IRI -2005), IEEE: 177-181.

DoC (2003). IT Architecture Capability Maturity Model. Department of Commerce (DoC).

Erder, M. and P. Pureur (2003). "QFD in the Architecture Development Process." IT Professional 5(6): 44-52.

Information Technology Research Institute   Architectural Work Status   17
AISA Project
Eetu Niemi   30.8.2006

FEAF (1999). Federal Enterprise Architecture Framework, Version 1.1., September 1999, The Chief Information Officers Council (CIO).

GAO (2002). Enterprise Architecture Use across the Federal Government Can Be Improved. USA: Washington, D.C., United States General Accounting Office: 184.

GAO. (2003). "A Framework for Assessing and Improving Enterprise Architecture Management, v. 1.1."

Gustafsson, J., J. Paakki, et al. (2002). Architecture-Centric Software Evolution by Software Metrics and Design Patterns. Proceedings of the Sixth European Conference on Software Maintenance and Reengineering (CSMR'02). Budapest, IEEE Computer Society: 108-115.

Halttunen, V. (2002). Architectural Planning of Information Systems: A Structure for Coping with Diversified Architectures. Larkki project report, 8.2.2002.

Hermansen, E. and J.-P. Caron (2003). Organizational Agility: Kicking the Culture "Crutch". Engineering Management Conference, IEMC '03. Managing Technologically Driven Organizations: The Human Side of Innovation and Change, IEEE: 181-185.

Hämäläinen, N. (2005). Quality Management Activities in Software Architecture Management (manuscript).

Hämäläinen, N., J. Markkula, et al. (2006). Success and Failure Factors for Software Architecture. Proceedings of the International Business Information Management Conference (6th IBIMA), Bonn, Germany.

IAC. (2003). "Advancing Enterprise Architecture Maturity." 2003.

IAC. (2005). "Advancing Enterprise Architecture Maturity, version 2.0." from http://www.actgov.org/actiac/documents/sigs/easig/EAMaturityWP013105.pdf.

IFEAD (2005). Trends in Enterprise Architecture 2005 - How are Organizations Progressing? Web-form Based Survey 2005. The Netherlands: Amersfoort, Institute For Enterprise Architecture Developments: 33.

Juran, J. M. and A. B. Godfrey (2000). Juran's Quality Handbook, McGraw-Hill Companies.

Kaisler, S. H., F. Armour, et al. (2005). Enterprise Architecting: Critical Problems. Proceedings of the 38th Hawaii International Conference on System Sciences (HICSS'05). Hawaii, IEEE Computer Society.

Kartha, C. P. (2004). "A Comparison of ISO 9000:2000 quality system standards, QS9000, ISO/TS 16949 and Baldridge criteria." The TQM Magazine 16(5): 331-340.

Kim, i.-W., Y.-G. Kim, et al. (2005). An enterprise architecture framework based on a common information technology domain (EAFIT) for improving interoperability among heterogeneous information systems. Third ACIS International Conference on Software Engineering Research, Management and Applications, IEEE Computer Society.

Krueger, I. H. (2004). Evaluating Software Architectures: Stakeholders, Metrics, Results, Migration Strategies. Department of Computer Science & Engineering. San Diego, University of California.

Lankhorst, M. (2005). Enterprise Architecture at Work. Modelling, Communication, and Analysis, Springer-Verlag.

Lindvall, M., R. T. Tvedt, et al. (2003). "An Empirically-Based Process for Software Architecture Evaluation." Empirical Software Engineering 8(1): 83-108.

Lopez, M. (2000). An Evaluation Theory Perspective of the Architecture Tradeoff Analysis Method (ATAM), The Software Engineering Institute, Carnegie Mellon University.

Losavio, F., L. Chirinos, et al. (2003). "Quality Characteristics for Software Architecture." Journal of Object Technology 2(2): 133-150.

META Group Inc. (2000). "Architecture Capability Assessment." META Practice 4(7).

META Group Inc. (2004). "Architecture Program Maturity Assessment: Findings and Trends." Enterprise Planning & Architecture Strategies, Teleconference 2118, 23 September 2004, from http://www.metagroup.com/us/displayArticle.do?oid=49449.

NASCIO. (2003). "NASCIO Enterprise Architecture Maturity Model, v. 1.3." 2004, from https://www.nascio.org/publications/index.cfm.

NASCIO. (2004). "NASCIO Enterprise Architecture Maturity Model, v. 3.1 Self-Assessment (Draft)." 2004, from https://www.nascio.org/publications/index.cfm.

NASCIO (2005). The States and Enterprise Architecture: How far have we come? Findings from the NASCIO 2005 EA Assessment. Lexington, National Association of State Chief Information Officers (NASCIO): 45.

OMB (2005). OMB Enterprise Architecture Assessment Framework Version 1.5, OMB FEA Program Management Office, The Executive Office of the President, USA.

OMB (2005a). Federal Enterprise Architecture Program EA Assessment Framework 2.0, OMB FEA Program Management Office, The Executive Office of the President, USA.

OMB (2005b). OMB Enterprise Architecture Assessment Framework Version 1.5, OMB FEA Program Management Office, The Executive Office of the President, USA.

Passori, A. and M. Schafer. (2004). "Architecting the Architecture: Chief Enterprise Architect to the Rescue." EA Community Articles Retrieved October 4, 2004, from http://www.eacommunity.com/articles/openarticle.asp?ID=2032.

Perkins, A. (2003). "Critical Success Factors for Enterprise Architecture Engineering (Visible Solutions Whitepaper)." from www.visible.com.

Pinto, J. K. and S. J. Mantel, Jr (1990). "The Causes of Project Failure." IEEE Transactions on Engineering Management 37(4): 269-276.

Pulkkinen, M. (2006). Systemic Management of Architectural Decisions in Enterprise Architecture Planning. Four Dimensions and Three Abstraction Levels. Proceedings of the 39th Annual Hawaii International Conference on System Sciences (HICSS '06). Kauai, Hawaii, IEEE Computer Society.

Pulkkinen, M. and A. Hirvonen (2005). EA Planning, Development and Management Process for Agile Enterprise Development. Proceedings of the 38th Annual Hawaii International Conference on System Sciences (HICSS '05), IEEE COmputer Society.

Quazi, H. A., J. Jemangin, et al. (1998). "Critical factors in quality management and guidelines for self-assessment: The case of Singapore." Total Quality Management 9(1): 35-55.

Rehkopf, T. W. and N. Wybolt (2003). "Top 10 Architecture Land Mines." IT Professional 5(6): 36-43.

Rico, D. F. (2005). "A Framework for Measuring the ROI of Enterprise Architecture."

Rudawitz, D. (2003). "Selecting an Enterprise Architecture Tool - A primer for how and why."

Rutledge, S. (2000). The Requirements Gathering Process, Quaero, LLC.

Schekkerman, J. (2004a). Enterprise Architecture Validation - Achieving Business-Aligned and Validated Enterprise Architectures, Institute For Enterprise Architecture Developments, URL: http://www.enterprise-architecture.info/: 27.

Schekkerman, J. (2004b). How to survive in the jungle of Enterprise Architecture Frameworks - Creating or choosing an Enterprise Architecture Framework. Canada, Trafford.

Shereshevsky, M., H. Ammari, et al. (2001). Information Theoretic Metrics for Software Architectures. Proceedings of the 25th Annual International Computer Software and Applications Conference (COMPSAC 2001). Chicago, IL, USA, IEEE Computer Society: 151-157.

Stake, R. E. (2000). Case Studies. Handbook of Qualitative Research. N. K. Denzin and Y. S. Lincoln. Thousand Oaks, Sage Publications: 435-454.

Svahnberg, M. and C. Wohlin (2005). "An Investigation of a Method for Identifying a Software Architecture Candidate with Respect to Quality Attributes." Empirical Software Engineering 10: 149-181.

Taylor-Powell, E., S. Steele, et al. (1996). Planning a Program Evaluation (Report: G3658-1), University of Wisconsin-Extension.

The Office of Enterprise Technology Strategies (2003). Maturity Review Plan (Version 1.0.0), Office of Enterprise Technology Strategies, State of North Carolina.

The Open Group. (2002, the edition 8.1 has been published in December 2003). "TOGAF 8, The Open Group Architecture Framework "Enterprise Edition"." from http://www.opengroup.org/architecture/togaf/.

Tvedt, R. T., M. Lindvall, et al. (2002). A Process for Software Architecture Evaluation Using Metrics. Proceedings of the 27th Annual NASA Goddard/IEEE Software Engineering Workshop (SEW-27'02): 191-196.

van der Raadt, B., J. Hoorn, F., et al. (2005). Alignment and Maturity are Siblings in Architecture Assessment. Proceedings of the 17th Conference on Advanced Information Systems Engineering, CAiSE 2005. Porto, Portugal, Springer.

van der Raadt, B., J. Soetendal, et al. (2004). Polyphony in Architecture. Proceedings of the 26th International Conference on Software Engineering (ICSE 2004), IEEE Computer Society: 533-542.

Van Eck, P., H. Blanken, et al. (2004). "Project GRAAL: Towards Operational Architecture Alignment." International Journal of Cooperative Information Systems 13(3): 235-255.

Woody, C. (2005). Eliciting and Analyzing Quality Requirements: Management Influences on Software Quality Requirements, The Software Engineering Institute, Carnegie Mellon University.

Yin, R. K. (1989). Case Study Research Design and Methods. Newbury Park, Sage Publications.

Ylimäki, T. (2005). Towards Critical Success Factors for Enterprise Architecture. AISA Project report, Information Technology Research Institute, University of Jyväskylä.

Zachman, J. A. (1987). "A Framework for Information Systems Architecture." IBM Systems Journal 26(3): 276-292.