Lessons Learned

In this section, we summarize the AISA project by addressing the following topics:

- General Conclusions: Which conclusions can be drawn from the three-year research project?
- Implications for Practitioners: How can practitioners utilize the project results?
- Future Trends: How will the architecture work evolve in the future?
- Further Research: Which future research questions arouse?

General Conclusions

In the AISA project, we studied the quality management of both enterprise and software architectures, especially from the viewpoint of evaluation and measurement. From our study, we draw the following conclusions.

Both **EA and SA success factors** defined in the project (see the section on architecture work) present a wide view of factors that affect and should, therefore, be taken into consideration in architecture work. These factors can also be regarded as possible evaluation targets, for which criteria, metrics and methods can be developed. The potential critical success factors for EA also enabled us to construct an initial generic maturity model for EA and use it to evaluate the architectural work status of organizations. All of the test 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. Improvement needs were also detected (see Further Research).

Quality of EA is a concept that does not yet have an established definition (see the section on quality management). To put it simply, we suggest that 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. However, the quality management activities related to EA are still unclear and further research is, therefore, required.

Instead in the SA domain, quality management was clarified in this project and a **quality model for both the software architecture management process and the software architecture** was constructed (see the section on quality management in the EA and SA context). Furthermore, it seems that **architecture management** is spread out to many processes in organizations. The activities that aim to drive and control the architecture and architectural quality, may be included in several separate processes in organizations, such as investment planning, project management, process management or system development process. Because architecture management processes are not so clearly separate processes in organizations, the capability assessment of architecture management is rather difficult. Therefore, the different processes in organizations also affect the architectures and architectural quality. There also seems to be a need

- to shift from architectures that are driven by investment planning and system development towards architectures driven by architecture management
- for architecture management practices and process models that aim at high-quality architectures as well as a need to advance the maturity (and the quality) of

architecture management processes themselves
- for agility in architecture management and development. Architecture management and development processes cannot be too heavy (e.g. require a lot of time and resources), because the restricted time and quick changes in the environment of the organizations may require changes in them, too
- for metrics and metric programs for evaluating e.g. the architectural maturity, quality and performance.

Generally, **architectural work is currently under development or in initial state**. The results of the case studies (see the section on current status of architecture work) show a certain degree of similarity with other studies on EA maturity. According to GAO (2002), IFEAD (2005) and NASCIO (2005), EA has been widely adopted by organizations, but the **EA maturity** seems to be on a quite initial level:

- Organizations may have defined their architectural frameworks and principles, and also the architectural guidance to ICT development projects is established to some extent.
- The actual architectural models are still generally under construction as well as the transition plan. The current state and the target state architectural models may exist on specific domains or viewpoints but are typically inconsistent and the big picture of the organizations's EA may still be fuzzy.
- Tool support is mainly limited to basic office tools and ICT development tools already introduced in organizations.
- Architectural evaluation and measurement is seen as an important issue but architectural work is seldom on such a high maturity level that evaluation is considered a useful activity in the organizations. Also the lack of evaluation practices is a challenge.
- Architecture work seems to be more a project level activity than a systematic enterprise-level approach in organizations.

Architecture evaluation (see the section on evaluation of architecture work) is a multifaceted instrument in architecture work. It seems that

- architecture evaluation is still more trigger-based than stabilized work in companies. A trigger may be, for example, a problem, a question or a need for information relating to the business or ICT-environment of the organization.
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- architecture evaluation also has several meanings and roles in an organization and evaluations can be used for different purposes. The triggers revealed in our study (see the section on evaluation of architecture work) describe the role and meaning that architecture evaluation may have in an organization. In brief, architecture evaluations can be a tools for quality assurance, change management, architectural planning or IT cost management. Evaluations may also support the organizational planning and decision-making.
- different evaluation approaches are needed because architecture evaluation has different roles in different organizations.
- one challenge in architectural evaluations is the architectural documentation. Evaluation is typically based on documentation and descriptions. However, it is not clear or easy to decide what descriptions and documentation should be produced relating to architectures.
- there should be a relationship between architecture evaluations and organization's other measurement activities (such as balanced scorecards).

The **existing architecture evaluation methods** were also charted. The study

revealed that there seems to be a lack of methodologies evaluating EA. The most wide-spread approaches at the moment are maturity models and business-IT alignment assessment methods. Since no methods for the evaluation of the entire EA exist, techniques from the areas of business processes, data modelling, software architecture evaluation, benchmark testing, cost and benefits measurement of ICT investment were investigated (see the section on existing evaluation methods). 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. It seems that a combination of methods is necessary to improve the fulfilment of certain EA evaluation needs. However, the complexity of EA and the related variety of concerns complicates reaching an established overall evaluation approach. So far it is only possible to apply different techniques to only single architectural views of EA.

While **architecture evaluation methods, metrics and criteria** are more established on the level of SA than EA, there was an attempt to clarify this area. EA evaluation is typically done as maturity evaluations and most of the existing methods and metrics support these activities. However, maturity evaluation is a quite superficial way to evaluate EA and may not be sufficient after the initial stages of EA development have passed. There is a definite need for more accurate and objective measures for different aspects of architecture and architecture work. We charted a vast amount of both qualitative and quantitative metrics for different areas of architectures and architecture work from literature, but the challenge of selecting the most suitable and useful for an organization remains (see the section on metrics and criteria).

In the complex and demanding business, IS development and software engineering context, the significance of well designed architectures and **high quality documentation** has been continually increasing. The challenges related to the architecture documentation in the organizations seems to be influenced by at least the following:

- multiple stakeholders of architecture work
- definition of the architecture framework and views used
- decisions concerning the documents to be 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 enable more efficient architectural communication and enhance the understanding of the architecture. While the understanding of architecture can be seen as a prerequisite for the realization of architecture, the quality of architecture documents have, therefore, an effect on the realization of architectures. 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 while producing them. We also suggest that the quality check of architecture documents should be included in architecture reviews and quality evaluation checklists should be developed.

For the most part, at least in Finland 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, or commitment, is not considered to have the first priority. 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. Also the evaluation of the benefits of the EA work is considered a challenging task.

In general, it seems that **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. Additionally, 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.

In addition to several evaluation metrics defined for the above mentioned evaluation targets, we also studied the risks and decision-making in architecture work. An **overview of generic risks** that can potentially be related to EA in organizations was provided (see the section on architectural risks). EA risks were conceptualized both as factors that may lead to negative outcomes in the EA program, and as negative outcomes resulting from these factors. The risks were categorized using the work system framework. The results can be used 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. Additionally, we suggest that EA risk management supports the attainment of EA objectives, or EA can even be exploited to facilitate organizational risk management.

Architecture decisions are high level decisions that, in the EA domain, can involve (see the section on decision-making)

- 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. The baseline architecture is constantly monitored and improvements planned but the big picture is not necessarily taken into account. The target architecture state are not necessarily officially approved, and the architecture transition plans may be working papers and the transitions are not necessarily systematic. Architectural decision making is dependent on the organization in question and

- 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
- 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).

Finally, 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. The generic evaluation model for EA could be improved to be one possible tool to support organizations in launching the EA program. Similarly, the quality models developed in the project (see the section on quality management in the EA and SA context and the dissertation) provide a support for enhancing the software architecture work in organizations.

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Implications for Practitioners

Especially from the viewpoint of practitioners, the lessons learned are as follows.

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** (see the section on architecture work). However, these factors can be used as a checklist by which practitioners both in the ICT user and service provider organizations undertaking, or planning to undertake, EA or SA efforts can ensure that the efforts are comprehensive, well-implemented, and have the minimum chance of failure. Additionally, the factors - the possible evaluation targets of architecture work - provide one usable starting point for the development of architecture evaluation criteria, metrics and methods.

Stakeholder identification is still difficult in practice for various reasons. Particularly, the EA stakeholders, their concerns and viewpoints are organization-specific at least to some extent, a certain stakeholder may fill several roles, and be a member of various stakeholder teams, groups or organizations, and the stakeholder viewpoints could be classified differently depending on the enterprise. To overcome these obstacles, the extensive framework including EA stakeholder roles, teams and organizations, and addressing their EA-related concerns and viewpoints, can be used in organizations to support identification of the stakeholders of EA and their concerns (see the section on stakeholders of architecture work).

Architects are dependent on the input and support of the various stakeholders. Therefore, architectural work involves **communication** to a great extent. Architects need to act as translators between stakeholders and constantly communicate the progress of the architecture program. The best way to communicate seems to be face-to-face. Information in a repository or in the corporate intranet supports communication but is not sufficient on its own.

The possible benefits of architecture work can be used as a basis for defining the objectives of architectural work in an enterprise. Additionally, 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. Benefits and their related metrics and evaluation criteria (see the section on evaluating the benefits of architecture work) can also be used as a basis for developing a measurement system for quantifying the value of architectural work.

The components of evaluation planning can be used 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, the given examples of EA objectives, evaluation purposes, audiences and evaluation targets can stimulate the discussion in organizations.

The results of the study on the evaluation of architecture documentation 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.

In addition, the wide selection of evaluation questions, criteria and metrics presented

related to communication, commitment, business-IT alignment and EA compliance (see the section on metrics) can be useful for organizations helping them define the few specific metrics for their needs.

Architectural risks are not necessarily taken into account in organizations. The overview and categorization of generic risks related to EA provided by the project (see the section on architectural risks) can be used 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.

Architectural decisions (see the section on architectural decision-making) should

- 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 into account possible change needs to the architecture
- be enforceable and enforced
- be communicated with their rationale.

Architectural decision making is dependent on the organization in question; decision makers involve various roles including architects, project roles and business management roles and decision-making may be fragmented to various decision making points in the organizations. 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). However, the following tips may support tackling the architectural decision-making in organizations:

- Plan architecture decision making and management:
    - define necessary decisions to enforce organizational strategies
    - define decision criteria
    - define how detailed should decisions be
    - define what kind of decisions should be officially approved
    - define where the decisions should be made and by whom
    - define who should gather the information required for decisions
    - define how are the decisions documented and communicated
    - define 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.

Future Trends

In the past, architecture has been considered more a technical approach but a change is evident. Architecture is quickly becoming an even more important **strategic management tool** for organizations in the future, as they seek to rationalize their operations and ICT portfolios as well as alignment between business and ICT. Even now EA development and governance are moving from the ICT department towards the

business. Similarly, the scope of EA will transform from the project level towards the enterprise level. Business planners and managers will apply EA for planning organizational improvements and gaining competitive advantage. Also enterprise architects will become more involved in the strategy and decision making processes in the organizations as they are they are able to understand both IT and business.

However, for EA to become such an extensively utilized management tool, there is a **need for better tool support**. EA stakeholders have different needs, different competencies, and use EA in different ways. EA tools should be able to present EA content in different ways to different stakeholders, and automatically support the consistency and completeness of architectural models. Such tools exist even now but they are not yet extensively spread. Organizations do not want to adopt a single tool, because it may not support the in-house frameworks and models, or may limit future improvements.

The **quality of architecture descriptions and documents** will also become a more important aspect. Descriptions, models and documents are essential in supporting architecture related communication and gaining a mutual understanding of the architecture visions, objectives, target states, and so forth. Therefore, for example, the modeling languages used in architecture modeling should be simple enough to be understandable and readable by the various stakeholder groups of the architecture work.

EA evaluation seems to be becoming an even more important activity for EA teams in the future (c.f. Liimatainen and Koskinen 2007; Rosen et al. 2007). As EA becomes a more mature, established practice in organizations, evaluation is required to assess the current status of EA, and to manage and improve it. In the future, especially the following evaluation targets will presumably become important:

- **EA benefits and value**: Displaying the realized value or benefits of EA will be important to enable EA teams to justify investments in EA. Even though it currently seems to be possible to justify EA investments with little solid evidence in many organizations (c.f. Aziz and Obitz 2007), this may not be the case in the future. Eventually, as the hype-value of EA diminishes and EA becomes a more established practice in organizations, the organizational management will probably require solid business cases for EA investments.

- **EA acceptance and utilization**: Evaluation of EA acceptance and use are important predictors of the success of the EA program – it is highly likely that no benefits are realized from EA if it is not actually applied in the organization. To become the stated strategic management tool, EA needs to be adopted as a tool in the day-to-day management decision-making. Property oriented EA evaluation techniques (see Winter et al. 2007) need to be applied to extract useful information from EA.

Also the evaluation practices will evolve and become more established. Evaluation and measurement of architecture work (process view) and architectures (product view) will become an integral part of architecture development and management. Especially in the SA domain, the importance of business requirements and needs will grow in the development and management of architectures.

All the above mentioned trends imply that the role and the profession of an enterprise architect will become perharps even more challenging. As Allen Brown puts it in the Architecture & Governance Magazine:

> " ... enterprise architects are now rated more highly than developers, when

> measured by the value they can deliver to their companies... It's worth noting that as the enterprise architecture profession continues to evolve and mature, there remains a shortage of qualified architects. Consequently, this demand is fueling the trend for hiring professionally certified enterprise architects." (Brown 2008)

Further Research

Which are the aspects or areas of EA and SA quality management and evaluation that were not considered during the research project? Which are the aspects or areas that still need to be scrutinized? To conclude this section, we provide the following suggestions for further research:

- Improving the **generic evaluation model for enterprise architecture**
    - Simplifying the model by combining areas (success factors) and modifying questions
    - Finding the most important areas for each level of maturity or in general
    - Finding the most important issues in each area
    - Defining simple and usable evaluation criteria and metrics to evaluate each area
    - Charting for new important issues not included in the model
    - Establishing distinct steps for moving to the next level of maturity
    - Studying the relationships or dependencies between the areas
- Constructing **evaluation methods and metrics for architecture benefits**
    - Defining the constructs that interact in the benefit realization process
    - Establishing causalities between constructs relating to architecture, architecture work and benefits
    - Displaying empirical evidence on architecture benefits
- Creating a **systematic, consistent architecture evaluation methodology**
    - Selecting and combining metrics and evaluation criteria
    - Selecting the most feasible metrics for each maturity level
    - Developing usable and effective processes or methods for evaluation
- Clarifying the **initialization phase of architecture work**
    - Creating agile or lightweight architecture development and management processes and practices for supporting systematic start-up of architecture work
    - Charting the available tool support for architecture work; how effective the tools are; can they really assist and ease the architecture work
    - Charting for best practices for establishing architecture work in an organization
- Studying the **implementation and utilization of architectures**
    - Charting for use cases of architecture and related practices
    - Finding ways to enhance architecture usage by stakeholders

- Charting for best practices for making architecture utilization and implementation a systematic, continuous process

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