

# Quality Evaluation Question Framework for Assessing the Quality of Architecture Documentation

Niina Hämäläinen<sup>1</sup>, Jouni Markkula<sup>2</sup>

<sup>1</sup>Information Technology Research Institute, University of Jyväskylä,  
P.O. Box 35, FIN-40014 University of Jyväskylä, Finland  
Niina.Hamalainen@titu.jyu.fi

<sup>2</sup>Department of Information Processing Science, University of Oulu,  
P.O. Box 3000, 90014 University of Oulu, Finland  
Jouni.Markkula@oulu.fi

## 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.

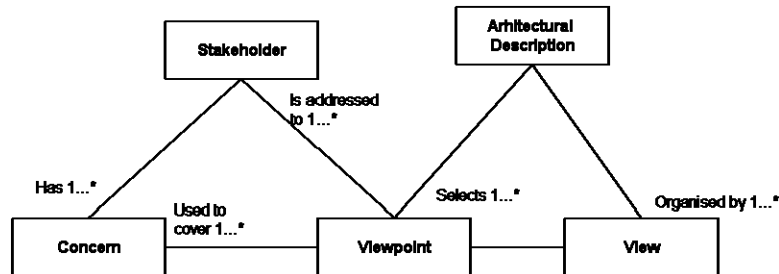


Figure 1: Architectural description related concepts (IEEE 1471 [2])

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 exist 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.

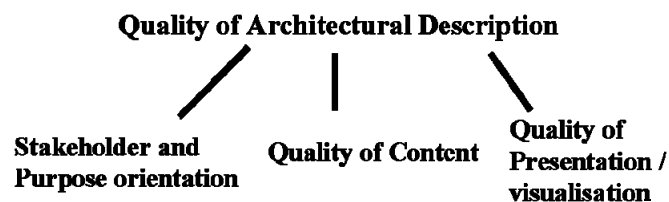


Figure 2: Main aspects of quality of architectural description

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

<b>Criteria</b>	<b>Questions/metrics</b>	<b>Importance</b>
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/respond 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.	
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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

<b>Criteria</b>	<b>Questions/metrics</b>	<b>Importance</b>
Scope and focus	Scope: Is it defined what part of reality will be described in the description (e.g. only primary processes)?	1
	Aspects: Is it defined what aspects will be described?	1.25
	The level of detail: Is it defined what level of detail will be described?	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 inaccurate or untrue reasoning?	2
Correctness of EA	“Substantive” errors / deficiencies after the EA description has been released: Is there found “substantive” errors/	2.25

	<p>deficiencies?                      The number of “substantive” errors / deficiencies found (e.g. the number and type of change request applied to EA principles)?</p>	
Correctness of SA	<p>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?</p>	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).	2
	<p>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?</p>	1.5
	Sufficient level of detail: Has each topic has just the detail that stakeholder needs?	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

<b>Criteria</b>	<b>Questions/metrics</b>	<b>Importance</b>
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

	<p>(This increases readability of models and reduces the perceived complexity.)</p> <p>Similarity: Are similar objects presented in the similar way?</p> <p>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.)</p>	
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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	<p>Ownership:</p> <p>Is staff responsible for the documentation clearly identified and supported?</p>	1
	<p>Maintenance practice:</p> <p>Is it known how the documentation will be maintained once it has been accepted?</p> <p>Is defined how often and when documentation is updated?</p> <p>Frequency of updates (number of updates / year or project).</p> <p>Needs for updates (number of architecture changes made in a year, in projects that require documentation update).</p>	2
	<p>Maintainability of documentation:</p> <p>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.</p>	2.5
Cost effectiveness	<p>Costs:</p> <p>Time and resources needed to produce or update architecture documentation (required man-days).</p>	2.25
	<p>Amount of documentation:</p> <p>Number of documents/models.</p>	3
	<p>Frequency of documentation updates:</p>	2.5

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

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

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.

## **6.0 Acknowledgement**

This paper is based on the work carried out in the AISA project (Quality Management of Enterprise and Software Architectures) financed by the Finnish Funding Agency for Technology and Innovation (Tekes) and participating companies: Elisa Oyj, OP Bank Group, IBM Finland, S Group, Tieturi, and A-Ware Oy. We wish to thank the participating companies for their co-operation. In addition, Tanja Ylimäki and Eetu Niemi participated in the validation of these results.

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