Measuring Enterprise Architecture success: a tentative model for measuring success

Measuring Enterprise Architecture Success
A Tentative Model for Measuring Success

Nestori Syynimaa
Informatics Research Centre, Henley Business School, University of Reading, UK
School of Information Sciences, University of Tampere, Finland
Department of Computer Science, Faculty of Technology, University of Vaasa, Finland
CIO, Anvia Plc, Finland
nestori.syynimaa@gmail.com

Keywords: Enterprise Architecture, Success, Measuring

Abstract: Interest towards Enterprise Architecture (EA) has been increasing during the last few years. EA has been found to be a crucial aspect of business survival, and thus the importance of EA implementation success is also crucial. Current literature does not have a tool to be used to measure the success of EA implementation. In this paper, a tentative model for measuring success is presented and empirically validated in EA context. Results show that the success of EA implementation can be measured indirectly by measuring the achievement of the objectives set for the implementation. Results also imply that achieving individual's objectives do not necessarily mean that organisation's objectives are achieved. The presented Success Measurement Model can be used as basis for developing measurement metrics.

1. INTRODUCTION

Interest towards Enterprise Architecture (EA) has been increasing during the last few years among academics and practitioners. According to TOGAF (2009, p. 5), "*An effective enterprise architecture is critical to business survival and success and is the indispensable means to achieving competitive advantage through IT*". Implementation of EA requires also a tremendous amount of resources, in terms of money, time, and people. Therefore it is important that EA implementation would be successful. Current literature does not contain a tool to measure the success of EA implementation. Thus the research question of the paper is: *How to measure the success of EA implementation?*

Structure of the paper is following. First we introduce the key concepts used in the paper. Then we review the current literature of measuring success on Information Systems (IS) and related sciences, and form a model for measuring success. Thirdly we describe the methodology used. Next the data collection and analysis are described, and lastly the results and conclusions are presented.

EA has a number of definitions in the current literature (see for example: CIO Council, 2001; TOGAF, 2009; Zachman, 1997). On a conceptual level, two common concepts can be recognised (see Syynimaa, 2010). First of all, EA is *a formal description* of an organisation at a specific time. Usually there are descriptions at least for two temporally different states of the organisation; current and future. Secondly, EA is *a managed change* between the current and future states. As a description, EA is generally described using a four layer -model (Pulkkinen, 2006). These layers are Business Architecture (BA), Information Architecture (IA), Systems Architecture (SA), and Technology Architecture (TA). EA frameworks, such as TOGAF, usually contains methods and templates for creating and managing these descriptions of an organisation.

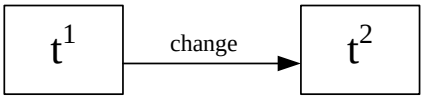

Figure 1: EA Implementation.

In this paper, by implementing EA, we mean the process of initial adoption of EA in an organisation on a certain scope. During this adoption, organisation will adopt some EA framework, and by using this framework, describes current and future states of the organisation, and conducts the managed change between the current and future states. Thus

the implementation can be understood as an instance of change, where the initial state of organisation is changed from the state without EA t^1, to the state where EA is adopted t^2 (see Figure 1).

2. MEASURING SUCCESS

In Oxford Dictionaries (2010), success is defined as "*the accomplishment of an aim or purpose*". Cale and Curley (1987, p. 246) defined success similarly on their research on measuring implementation outcome: "*To the extent that the outcome exceeds or falls short of expected or desired results, the user will consider the effort a success or failure*". They did not, however, test this empirically on their research, as they found the concept of success to be too subjective to be measured. Instead of that, they decided to focus on actual measurable post-implementation impacts. Same way, while studying successful change programs, Schaffer and Thomson (1992) recommended companies to focus on results, not activities.

The definition of success seems to be quite consistent in the current literature. Traditionally EA has been categorised as an Information Systems (IS) discipline (Gregor et al. 2007). To find out possible IS specific definitions of success or measurements, we next review the current literature of success in the field of IS.

2.1 Success in IS

Shannon and Weaver (1949) have found three levels of success of *information*, the output of Information System. These levels are *Technical*, *Semantic*, and *Effectiveness*. Technical level refers to the accuracy and efficiency of the information system. Semantic level refers to the extend information conveys the intended meaning, and effectiveness to how the information effects the receiver.

DeLone and McLean (1992) reviewed 180 research articles to explore how the success on Information Systems is defined and used as a dependent variable. They found out that there are plenty of dependent variables to choose from, which is not a good thing for the IS as a science. According to them, this is due to the fact it is hard to compare results between different researches when the number of used dependent variables is high. They found six major success categories, which are *System Quality*, *Information Quality*, *Use*, *User Satisfaction*, *Individual Impact*, and *Organisational Impact*.

In 2003 DeLone and McLean updated their Success model. In this updated model, they included for instance *Net benefits* as a new concept. As the feedback loop is valid even in the situation where net benefits are negative, DeLone and McLean reminds that researcher should clearly define the stakeholders and context where net benefits are to be measured (DeLone & McLean, 2003). Updated IS Success Model can be seen in Figure 2.

Wateridge (1998) studied the success criteria of IT projects. His research was based on a survey having 132 responses. As a result, the six most important criterion for IT project success were found. These criteria are: *Meets User Requirements*, *Achieves Purpose*, *Meets Timescale*, *Meets Budget*, *Happy Users*, and *Meets Quality*. A major conclusion was that as projects are individual and independent, the success criteria needs to be defined on the outset of each project. "*Only when the success criteria has been defined can project managers consider the appropriate factors to deliver that criteria.*"

Markus and Tanis (2000) have suggested a

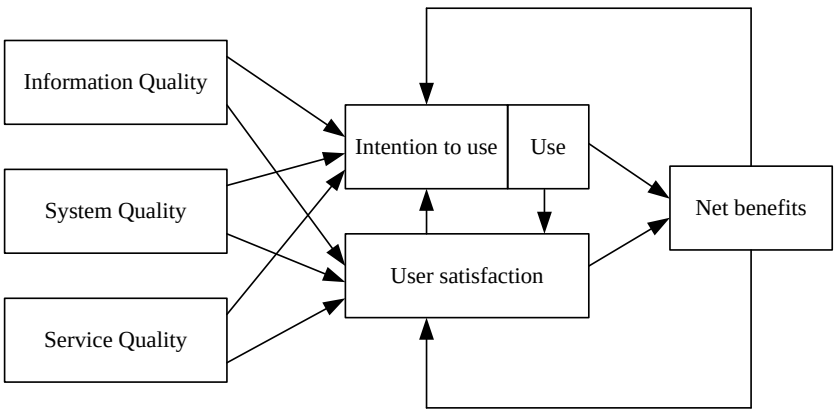

Figure 2: Updated IS Success Model (DeLone & McLean, 2003).

minimum set of success metrics on Enterprise System Success. These are *Project Metrics*, *Early Operational Metrics*, and *Longer-Term Business Results*.

Thomas and Fernández (2008) conducted an exploratory study on IT project success. Their findings imply that when success criteria are formally defined and measured, it leads to improved outcomes of IT projects. They found that "*Success was more than just meeting the requirements detailed in the business case*" (Thomas & Fernández, 2008, p. 736). In their research, 36 companies were analysed by interviewing and by reading sample documents. Companies were measuring success in three categories; *Project Management*, *Technical*, and *Business*. Examples for success criteria are, respectively, *on-time and on-budget*, *customer/user satisfaction*, and *meeting business objectives*. They found that success on one category did not necessary lead to success on other categories. For instance, if users were satisfied in the project, it did not necessary mean that business objectives were met.

Lyytinen and Hirschheim (1987) identified three failure aspects for information system. These aspects are *Failure for a system to meet its objectives*, *Outcome failures*, and *Failures in use*.

Summary of success and failure metrics can be seen in Table 1. As it can be seen, most of the IS success metrics are subjective and on conceptual level, besides easily measurable on-time and on-budget kind of metrics. This implies that there are no success metrics in IS to be used to measure EA success as-is. However, findings do reveal that some success criteria are on different organisational levels. For instance user satisfaction is an individual criterion, whereas meeting business objectives is an organisational criterion.

Table 1: Summary of success and failure metrics.

Article	*Success and failure metrics*
Shannon & Weaver 1949	Technical, Semantic, and Effectiveness
DeLone & McLean 1992	System Quality, Information Quality, Use, User Satisfaction, Individual Impact, and Organisational Impact
DeLone & McLean 2003	System Quality, Information Quality, Service Quality, Use, Intention to use, User Satisfaction, and Net benefits
Wateridge 1998	Meets User Requirements, Achieves Purpose, Meets Timescale, Meets Budget, Happy Users, and Meets Quality
Markus & Tanis 2000	Project Metrics, Early Operational Metrics, and Longer-Term Business Results
Thomas & Fernández 2008	three categories: Project Management, Technical, and Business
Lyytinen & Hirschheim 1987	Failure for a system to meet its objectives, Outcome failures, and Failures in use

2.2 EA implementation success

Niemi and Pekkola (2009) adapted Delone's and McLean's success model to describe EA's benefits realisation process. As they stated, success of IS equals realisation of benefits, or value of, IS. Similarly, they propose that the success of EA equals realisation of EA's benefits. They presented a model, where they added EA benefits to each of the seven success categories of IS Success Model in terms of *process*, *product*, *outcome*, and *impact* (see Table 2). They also presented an example how to utilise the model using a case.

In the same way as the original IS Success Model, Niemi's and Pekkola's model does not provide with metrics for measuring EA success. However, their model suggests *benefits* of EA process, product, and outcome (see Net Benefits row in Table 2). Also these benefits are *instances of objectives*. For example, if the reason for EA implementation is some expected direct benefits of EA implementation, objective of EA implementation is to achieve these benefits. Thus EA implementation success can be measured by checking whether these benefits are achieved.

2.3 Success Measurement Model

Current literature does not contain a success *measurement* model at the time of writing this article. Success models presented earlier in this section can be used as a theoretical foundation for our proposed measurement model. This Success Measurement Model is presented in Figure 3. The logical reasoning is following. As the success of the change is the extend how change meets intended objectives o^n set in t^1, the success of the change can be measured by measuring whether objectives are met in t^2. Theoretically the proposed Success Measurement Model is not limited to EA or IS field.

As mentioned earlier, success can be different on different "layers" of the organisation. The model presented above captures the success regardless of the organisational layer. If for instance objective(s) of an individual are met on a certain change (in this

case EA implementation), the change was a success. If in the same change organisation's objectives were not met, the change was a failure. Thus the change can be a success and a failure at the same time, depending on whose viewpoint is taken.

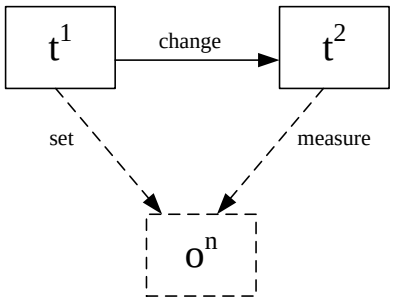

Figure 3: Success Measurement Model.

3. METHODOLOGY

According to Tashakkori and Teddlie (1998), researcher should use a philosophical approach that suits best for the research problem. Basically, research paradigm applied in this research is *positivistic* on Burrell's and Morgan's (1979) model. To get an answer to the research question, we first need to empirically validate the model presented in Figure 3 in an EA context. In this paper, we are using a real-life EA implementation pilot. In practice, it is not possible to arrange EA implementation in a controlled laboratory-like environment. Therefore the empirical data has been acquired from an actual EA implementation. Moreover, there is no controlled way to find out whether the implementation was successful or whether the goals were met. Thus the only way to find this out, is to ask it from individuals participating in the implementation.

The empirical data is acquired from an EA pilot among Finnish Higher Education Institutions (HEIs). In the pilot, an EA framework for HEI field called KARTTURI (see CSC, 2011) was developed, and descriptions of the organisations were produced by utilising this framework. The pilot started in February 2010 and ended in February 2011. There were 12 participating institutions in the pilot. The pilot was funded by the Finnish government and participating institutions. The pilot was structured on three levels (see Figure 4), and each level had their own goals (objectives) for the pilot. The highest level was *the pilot level*, which aimed for instance to

Table 2: EA Success Model (Niemi & Pekkola, 2009, p.8)

	Process	*Product*	*Outcome*	*Impact*
Information Quality	Quality of information used in EA processes	Quality of EA artifacts	Quality of information produced by implemented EA	No direct equivalent
System Quality	Quality of EA processes	No direct equivalent	Quality of implemented EA	No direct equivalent
Service Quality	Quality of support services to the EA function	Quality of EA services	Quality of organizational services constructed according to EA	No direct equivalent
Intention to Use	No direct equivalent	Potential alternative to the Use construct	Potential alternative to the Use construct	No direct equivalent
Use	Functioning of the processes according to specifications	Consumption of EA products by stakeholders	Consumption of the output of implemented EA by stakeholders	No direct equivalent
User Satisfaction	Stakeholder's response to the functioning of EA processes	Stakeholder's response to the use of EA products	Stakeholder's response to the use of implemented EA	Stakeholder's response to the consumption of EA impacts
Net Benefits	Direct benefits from EA processes	Direct benefits from EA products	Direct benefits from implemented EA	No direct equivalent

improve EA-framework to be more suitable for the whole higher education field in Finland. The second level was *the sub-project level*, on which participating institutions formed sub-projects on a certain problem domain, aiming for instance to enable better co-operation on study programmes. Third level was *the HEI level*, on which each HEI had their own goals.

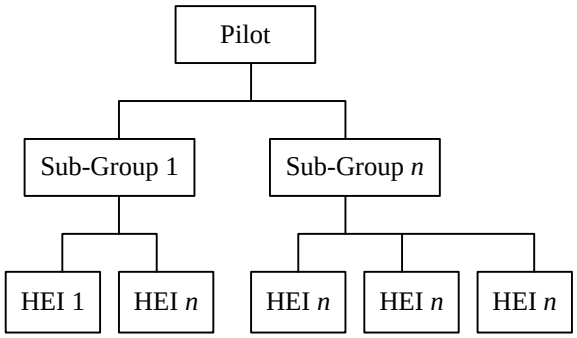

Figure 4: Pilot Structure.

The first step in developing a measurement scale is to develop a conceptual definition of the construct to be measured (MacKenzie, Podsakoff, & Podsakoff, 2011). As already noted, success is subjective and hard to measure. Therefore it is difficult, even impossible, to describe it as a construct of concepts. To overcome this, we have adopted the strategy to simply ask respondents opinion on the success of the implementation. Measuring the achievement of the goals is not any easier, as there is no as-is scale to be used, nor variables to be measured. Thus we adopted the strategy to ask respondents opinion on achievement of goals in one question, and actual goals on another. This way the model can be used also in a situation where goals are not known.

DeLone & McLean's success model suggests that meeting the personal goals (individual impact) is positively associated with meeting organisational goals (organisational impact). Therefore the level of *individual's goals* is also included. This also leads to assumption, that meeting goals on lower levels are positively associated on meeting goals on higher levels. Research hypotheses are based on these assumptions and are as follows:

- H1: Meeting goals is positively associated with individual's perception of success
- H2: Meeting individual's goals is positively associated with individual's perception of success
- H3: Meeting individual's goals is positively associated with meeting organisation's goals
- H4: Meeting organisation's goals is positively associated with individual's perception of success
- H5: Meeting organisation's goals is positively associated with meeting sub-project's goals
- H6: Meeting sub-project's goals is positively associated with individual's perception of success
- H7: Meeting sub-project's goals is positively associated with meeting pilot's goals
- H8: Meeting pilot's goals is positively associated with individual's perception of success

4. DATA COLLECTION

A web based questionnaire was selected as a tool to acquire empirical data from the EA pilot. Basic strategy in the questionnaire was to measure individuals' opinions to the presented statements. The scale used was a five level Likert scale. Example of a question and the scale used is presented in Figure 5. There is a debate on whether the Likert scale variable could be used as an interval scale variable. By definition, Likert scale variables are ordinal scale variables. However, there are some techniques to use to treat it as interval scale variable. In this case, a five level scale is used ranging from 1 (disagree) to 5 (agree). Also a neutral position (3) is given, so a respondent should understand both ends to be on equal distance from a neutral position.

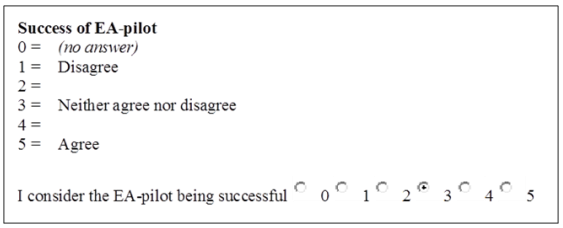

Figure 5: Example of a questionnaire question.

The questionnaire was sent to the pilot level steering group's and project group's members. Project group members were also asked to forward the questionnaire to individuals participating on institution's internal project group. The questionnaire was sent initially in April 2011 and reminder in May 2011.

5. ANALYSIS

Questionnaire was anonymous, so responses can't be linked to the actual respondents. The number of pilot level steering and project group's members are known, so the response percentage can be calculated. Steering group had 15 members, from which 2 responses were received. Project group had 20 members, from which 11 responded. The number of institutions' internal project group members were not known but was estimated to be around 100. From this group, 9 responses were received. A total number of responses were 24.

The number of responses is too low to make statistically definitive conclusions. Thus all conclusions drawn here should be considered as tentative. For statistical analysis, SPSS (PASW Statics 18) package was used, and for tabular data, Excel 2007.

From participating institutions, all but one had at least one response. Five had three or more responses. Pilot's and HEI's groups had most answers, 11 and 9, respectively. Steering group and others had only two responses. One of the other's indicated to be a management's representative and the other one was participating in the pilot as an external specialist. As there are responses from all groups, and almost from all institutions, it can be argued that there is enough data to make analysis.

Table 3: Variable names and explanations.

Variable	*Explanation*
OG	Individual's own goals
HG	HEI level goals
SG	Sub-group level goals
PG	Pilot level goals
HB	Pilot met the budget
HC	Pilot met the schedule
GM	Median (OG,HG,SG,PG,HB,HC)
SU	Respondent's perception of the success of the pilot

Variables used in the analysis can be seen in Table 3. Independent variables used are OG, HG, SG, PG, and GM. Even though the variables could be considered to be on interval scale, for statistical validity, variables were treated as ordinal scale variables. Correlation matrix can be seen in Table 4. Correlations are calculated using Spearman's rank correlation. Significance is calculated as 2-tailed.

Table 4: Correlation matrix.

		OG	*HG*	*SG*	*PG*	*GM*
HG	Cor.	.409				
	Sig.	.059				
	N.	22				
SG	Cor.	.626**	.642**			
	Sig.	.002	.002			
	N.	22	21			
PG	Cor.	.586**	.643**	.644**		
	Sig.	.004	.002	.002		
	N.	22	21	21		
GM	Cor.	.748**	.725**	.908**	.812**	
	Sig.	.000	.000	.000	.000	
	N.	23	22	22	23	
SU	Cor.	.628**	.547**	.626**	.836**	.798**
	Sig.	.001	.008	.002	.000	.000
	N.	23	22	22	23	24

Regressions of the models can be seen in Table 5. While looking in to regressions, it can be seen that models do explain well the variance of perceived success.

Table 5: Regressions.

Model	*R*	*R2*	*AR*	*SE*
(OG,HG,SG,PG) → SU	.989	.978	.972	.615
OG → HG	.973	.947	.944	.866
HG → SG	.984	.969	.967	.698
SG → PG	.984	.968	.966	.752
GM → SU	.826	.682	.667	.562

R2 = R Square, AR = Adjusted R Square, SE = Standard Error of the Estimate

6. RESULTS AND DISCUSSION

Based on the analysis, it can be argued that there is enough evidence to accept the hypothesis H1. Thus it can be argued, that the success of the EA implementation can be measured as our model in Figure 3. suggest.

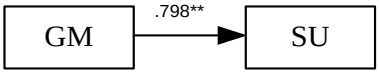

Figure 6: Achievement of goals are related to perceived success.

Analysis also provides support for accepting all hypotheses except H3. Thus achieving goals on all levels are positively related to the perceived success. This implies that achieving goals on all levels do

contribute towards success. What is interesting though, is that achieving personal goals are not significantly related to achieving organisation's goals (see Figure 7). However, achievement of organisation's goals is positively related to achieving sub-project's goals and that to achieving pilot's goals. It can also be noted, that achieving pilot level goals has the strongest influence to the perceived success.

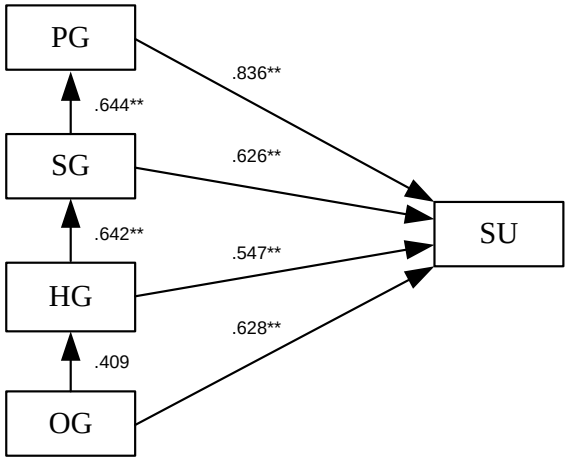

Figure 7: Results.

The research has following contributions. First of all, it contributes to the theory of success. It has been empirically demonstrated that the success of change can be measured indirectly by measuring the achievement of its objectives. Secondly, it contributes to the EA research by demonstrating the importance of setting objectives. Objectives of individuals participating to EA implementation are not necessary same than organisation's objectives, or other individuals'. Earlier it has been found that it is hard to satisfy all stakeholders, and that their objectives might be conflicting (van der Raadt, Schouten, & van Vliet, 2008). Our results supports these findings. Moreover, results shows that achieving individual's objectives is not related to achieving organisation's objectives. Interestingly, this contradicts with the original DeLone & McLean's model. According to their model, even though individuals' and organisation's objectives could be different, they should be positively related. A novel finding is that objectives on the levels outside the organisation has same or stronger influence to the perceived success than those inside the organisation.

All research, including this one, has limitations. As already stated, the number of responses (24) is not big enough to draw definite statistical conclusions. Moreover, no sampling were used but the whole population of the pilot participants were used as a sample. There were responses from almost all participating organisations and from all roles, so it can be argued that results are representing the pilot. However, it cannot be argued that results are generalisable outside the pilot. Therefore results should be regarded as tentative.

7. CONCLUSIONS

As a conclusion, the success of Enterprise Architecture implementation can be measured indirectly by measuring the achievement of the goals. However, achievement of goals should not be measured only from individual's or organisation's point of view, but from both. The model presented in this paper can be used as basis for future research on EA implementation success. More research on which goals are typical, important, and crucial in EA implementations needs to be conducted. Also the relation between objectives on different organisational levels needs further research.

The Success Measurement Model presented can be used as a basis when developing success measurement metrics. Even though the need for success measurement arise from a practical problem in EA context, the model should be utilisable in other contexts too as it is based on general literature. In this paper the model is empirically validated only in EA context and therefore requires further validation before using it in other contexts. The model is difficult to use in any context for measuring success as-is, so there is a need for further development.

For instance in EA context, one could developed metrics based on Niemi's and Pekkola's model to measure achievement of benefits of EA processes and products. Processes and products are quite well standardised in existing EA frameworks, such as TOGAF, whereas outcomes are purely context related and thus hard to standardise.

REFERENCES

Burrell, G., & Morgan, G. (1979). *Sociological Paradigms and Organizational Analysis*. London: Heinemann Books.

Cale, E. G., & Curley, K. F. (1987). Measuring Implementation Outcome: Beyond Success and Failure. *Information & Management, 13*(5), 245-253.

CIO Council. (2001). A Practical Guide to Federal Enterprise Architecture. *Available at http://www.cio.gov/documents/bpeaguide.pdf*.

CSC. (2011). *KARTTURI - Korkeakoulujen kokonaisarkkitehtuurin menetelmäopas*. Helsinki: CSC Tieteen tietotekniikan keskus Oy.

DeLone, W. H., & McLean, E. R. (1992). Information Systems Success: The Quest for the Dependent Variable. *Information Systems Research, 3*(1), 60-95.

DeLone, W. H., & McLean, E. R. (2003). The DeLone and McLean model of information systems success: A ten-year update. *Journal of management information systems, 19*(4), 9-30.

Lyytinen, K., & Hirschheim, R. (1987). Information systems failures: a survey and classification of the empirical literature. *Oxford Surveys in Information Technology*(4), 257-309.

MacKenzie, S. B., Podsakoff, P. M., & Podsakoff, N. P. (2011). Construct Measurement and Validation Procedures in MIS and Behavioral Research: Integrating New and Existing Techniques. *Management Information Systems Quarterly, 35*(2), 293-334.

Markus, M. L., & Tanis, C. (2000). The Enterprise Systems Experience-From Adoption to Success. In R. W. Zmud (Ed.), *Framing the Domains of IT Research: Glimpsing the Future Through the Past* (pp. 173-207). Cincinnati, OH, USA: Pinnaflex Educational Resources Inc.

Niemi, E., & Pekkola, S. (2009, 5-8 Jan. 2009). *Adapting the DeLone and McLean Model for the Enterprise Architecture Benefit Realization Process.* Paper presented at the HICSS '09, Hawaii.

Oxford Dictionaries. (2010). "success". Oxford Dictionaries. April 2010. from Oxford University Press: http://oxforddictionaries.com/definition/success

Pulkkinen, M. (2006). *Systemic Management of Architectural Decisions in Enterprise Architecture Planning. Four Dimensions and Three Abstraction Levels.* . Paper presented at the HICSS'06, Hawaii.

Schaffer, R. H., & Thomson, H. A. (1992). Successful Change Programs Begin with Results. *Harvard Business Review, 70*(1), 80-89.

Shannon, C. E., & Weaver, W. (1949). *The Mathematical Theory of Communication*. Urbana, IL, USA: University of Illinois Press.

Syynimaa, N. (2010). *Taxonomy of purpose of Enterprise Architecture* Paper presented at the 12th International Conference on Informatics and Semiotics in Organisations, ICISO 2010.

Tashakkori, A., & Teddlie, C. (1998). *Mixed methodology: Combining qualitative and quantitative approaches*. London: Sage Publications, Inc.

Thomas, G., & Fernández, W. (2008). Success in IT projects: A matter of definition? *International Journal of Project Management, 26*(7), 733-742.

TOGAF. (2009). *TOGAF Version 9*: Van Haren Publishing.

van der Raadt, B., Schouten, S., & van Vliet, H. (2008, September 29 - October 1). *Stakeholder perception of enterprise architecture.* Paper presented at the ECSA 2008, Second European Conference on Software Architecture, Paphos, Cyprus.

Wateridge, J. (1998). How can IS/IT projects be measured for success? *International Journal of Project Management, 16*(1), 59-63.

Zachman, J. A. (1997). Enterprise architecture: The issue of the century. *Database Programming and Design, 10*(3), 44-53.