# A Synthesis of Enterprise Architecture Effectiveness Constructs

Siyanda Nkundla-Mgudlwa and Jan C. Mentz
*School of Computing, University of South Africa, Private Bag X6, Florida Park, Johannesburg, 1710, South Africa*

Keywords: Enterprise Architecture, Effectiveness Measurement, Enterprise Architecture Implementation, Design Science Research, Critical Success Factors, Measurement Constructs.

Abstract: Companies throughout the world use Enterprise Architecture (EA) because of benefits such as the alignment of business to Information Technology (IT), centralisation of decision making and cost reductions due to standardisation of business processes and business systems. Even though EA offers organisational benefits, EA projects are reported as being costly, time consuming and require tremendous effort. Companies therefore seek to ascertain ways to measure the effectiveness of EA implementation because of the money and time being spent on EA projects. EA Effectiveness refers to the degree in which EA helps to achieve the collective goals of the organisation and its measurement depends on a list of constructs that can be used to measure the effectiveness of EA implementation. Currently, there exist no comprehensive list of constructs that are suitable to measure the effectiveness of EA implementation. The paper reports on the results of a study that explored the development of a comprehensive list of constructs suitable for measuring the effectiveness of EA implementation. The artefact developed in this research study is called Enterprise Architecture Effectiveness Constructs (EAEC). The EAEC consists of 6 constructs namely: - alignment; communication; governance; scope; top leadership commitment and skilled teams, training and education. To achieve the purpose of this research study, a design science research (DSR) strategy was followed. The EAEC was evaluated in two rounds by EA experts from industry and academia.



## 1 INTRODUCTION

Enterprise Architecture is implemented by companies worldwide because of the benefits and the value it promises. The EA benefits stated in the literature are, *improved business-Information Technology (IT) alignment, better decision making, increased business performance, reduced IT costs and improved interoperability (Ross et al., 2006, Wan et al., 2013)*. Even though the use and implementation of EA may lead to a company experiencing these benefits, an EA implementation requires time, money and effort. An organization's ability to quantify the value of an EA implementation is therefore very important. The challenge, though, that organisations face is to understand how the effectiveness of an EA implementation can be measured (Lankhorst, 2005, Schelp and Stutz, 2007). Furthermore, EA teams are under pressure to demonstrate the value and benefits of EA to the organisation in terms of the cost and time spent on EA (Weiss, 2006, Rodrigues and Amaral, 2013).

Regardless of this need there seems to be no unified list of constructs suitable for measuring effectiveness of EA implementation reported in the literature. This paper aims to fill this gap by creating an integrated list of measurement constructs. The list is derived from the various existing published critical success factors as well as EA effectiveness models and frameworks.

Since the research approach followed in this paper is Design Science Research the paper is structured accordingly. The problem awareness and solution proposal is presented in Section 2 followed by a description of the research design in Section 3. The design of the artefact is discussed in Section 4 followed by the evaluation of the artefact in Section 5. The paper concludes with suggestions for further research in Section 6. Please note that due to the nature of the EA topic, the terms business, organization and enterprise are used interchangeably in this paper.



Nkundla-Mgudlwa, S. and Mentz, J.
A Synthesis of Enterprise Architecture Effectiveness Constructs.
DOI: 10.5220/0006321002820293
In *Proceedings of the 19th International Conference on Enterprise Information Systems (ICEIS 2017) - Volume 3*, pages 282-293
ISBN: 978-989-758-249-3

## 2 ENTERPRISE ARCHITECTURE BACKGROUND

Enterprise Architecture is known by many definitions (Saint-Louis and Lapalme, 2016). Zachman, widely regarded as the originator of the discipline of EA (Mentz et al., 2012), describes EA as the ontology of the enterprise (Zachman, 2008). This ontology consists of a set of descriptive representations, known as primitive and composite models, that describes an enterprise in such a way that it can be used to produce systems to management's requirements. In a more standardised tone EA is defined as the fundamental organisation of a system, embodied in its components, their relationships to each other and the environment, and the principles governing its design and evolution (IEEE, 2011).

The creation of an enterprise's architecture is achieved by an Enterprise Architecture Framework (EAF). According to (Cameron and McMillan, 2013) an EAF is used to implement an EA in terms of a set of models, method and principles. The Open Group Architecture Framework (TOGAF Ver 9.1) (The Open Group, 2011) is a popular EAF currently in use (Zhang, 2012, Sobczak, 2013, Schmidt et al., 2014). More specifically, TOGAF Ver 9.1 (The Open Group, 2011) describes itself as creating business capability via the use of an architecture development capability. Despite TOGAF's popularity as an EAF there are other EAF's such as for example the Zachman Framework (Zachman, 2008) and the Department of Defense Architecture Framework (DoDAF V2.0) (Department of Defense, 2010).

The successful implementation of an EA holds potential benefits to the business. These benefits are varied and has been researched and proposed by EA practitioner and researcher alike (Foorthuis et al., 2015). Niemi (2008) summarizes EA benefits as *improved business to IT alignment, enhanced communication and collaboration among stakeholders, improved decision making and reduced IT costs*. Despite these promised benefits, the implementation of EA in an organization remains a challenge (Löhe and Legner, 2014) especially considering that the expected benefits takes some time to manifest (Schmidt and Buxmann, 2011) after the implementation of an EA practice.

EA implementation refers to the process of establishing an EA practice in an organization based on a specified scope (Syynimaa, 2013). An EA practice produces various EA artefacts such as models, standards, principles and other descriptive documentation used to describe the enterprise as comprehensively as possible (Niemi and Pekkola, 2015). The complex nature of the task of representing the enterprise in artefactual terms lead to several implementation issues. Seppanen et al. (2009), for example, highlights 3 sets of interrelated challenges facing EA implementation in public administration. These challenges are *the lack of properly established EA governance, insufficient support for the development of EA, and inadequate resources to do EA governance and development*. Furthermore, the implementation of an EA practice requires project management expertise along with an IT portfolio management process (Seppanen et al., 2009). Bonnet (2009) states that EA implementation is of interest to staff that are responsible for managing change projects and implementing operational changes. These members of staff are also referred to as stakeholders (The Open Group, 2011, Lankhorst, 2005). Stakeholders are either directly involved in implementing an EA or has a need that is satisfied by the implemented EA.

The degree to which a stakeholder is satisfied with an EA implementation depends on the effectiveness of an EA practice. In an EA implementation, the term effectiveness refers to the outputs of an EA implementation that completely meet the defined goals of an EA project (Rouhani et al., 2014). As such EA effectiveness is a measure of the degree to which organizational objectives are attained through the outputs of the EA practice (Van der Raadt et al., 2010) as well as the ability of the EA practice to aid the achievement of the collective goals of the organization (Rouhani et al., 2015). According to Rouhani et al. (2015) enterprise architects find it challenging to determine the effectiveness of an EA implementation.

Given the challenging nature of measuring EA effectiveness (Ylimäki, 2008, Espinosa et al., 2011, Morganwalp and Sage, 2004, Rodrigues and Amaral, 2013) efforts have been made to determine the quality of EA implementations. Since an EA implementation of EA can be costly as well as time consuming, it is important to investigate and identify critical success factors (CSF) that contribute to EA success. Nikpay et al. (2013) define critical success factors as the things that must go well to ensure the overall success of the project.

Bricknall et al. (2006) identified 3 groupings of CSFs that impacts the modelling and management of EA, namely, *IT and business management buy-in, manageable EA project scope and relevant EA artefacts as the contents of the EA*. According to

Ylimäki (2008) the EA CSFs that is important to organisations are:

- Scoping and purpose
- Communication and common language
- Top management commitment
- Development methodology and tool support
- Business driven approach
- EA models and artefacts
- EA governance
- IT investment and acquisition strategies
- Skilled team, training and education
- Project and Program management
- Assessment and evaluation
- Organizational culture

Aier and Schelp (2010) identified a more comprehensive list of CSFs to describe EA implementation success (see Table 1) in terms of 4 factors groups and nineteen individual factors.

Table 1: EA implementation Critical Success Factors (Aier and Schelp, 2010).

| Factor Group | Individual Factor | Description |
|---|---|---|
| Contextual Factors | Size of Company/architecture | Size of company impacts the number and size of resulting architecture models used |
| | Market orientation | cost center or profit center |
| | economic pressure | Are there cost cutting exercises? |
| | budget | Is there a dedicated (E)A budget? |
| | strategic alignment | What kind of business/IT alignment exists? |
| | culture | How does the corporate culture influence change? |
| Structure | governance | Is there an EA governance and how is it anchored? |
| | architectural power | How strong are formal and informal architectural power and the resulting impact? |
| | skills of architects | What skills do architects have? |
| | skills of non-architects | What are the architectural knowledge and architectural skills Of non-architects? |
| | EA visibility outside the EA department | Are any architectural efforts visible Outside the architecture department? |
| | tools | Is there any EA tool support? |
| | coverage | What is covered by EA? |
| Process | project support | How are architects involved in projects in general? |
| | impact in projects | How do they contribute to projects? |
| | rules and EA processes | What are the instruments to enact architecture within projects? |
| EA over Time | training of architects | frequency and amount of architectural training and further education |
| | training of non—architects | frequency and amount of architectural training and further education |
| | EA marketing | "marketing" measures to raise architecture attention and architecture sensibilization |

Finally, Wan et al. (2014) categorizes EA CSFs according to the following 4 categories:

- *EA readiness and preparation* addresses the organizational understanding of EA in terms of introducing the concept of EA to the organization as well as the management of change that results from EA implementation.
- *Top Commitment and leadership* is critical in order to have a successful EA implementation due to the need for top leadership commitment and support.
- *EA domain techniques* refers to the professional EA related techniques or the skills that enterprise architects should acquire to do EA work.
- *EA governance and program management* concern mainly management-control issues in relation to incremental EA implementation and EA lifecycle maintenance.

As can be seen from the preceding summary the selection and determination of CSFs for successful or effective EA implementation can lead to complex results. A preliminary analysis can lead to a potential set of essential CSFs namely, *top leadership commitment, EA governance, EA scope and skilled EA teams and training*.

The precise measurement of an effective EA implementation according to CSFs is a challenging task (Kaisler et al., 2005). There are, however, approaches reported in the academic literature that address the measurement of the effectiveness of EA implementation problem. What follows is a brief overview of 5 notable examples in support of the research problem addressed by this paper. Table 2 lists the frameworks and models in question.

Table 2: EA Effectiveness Measurement Papers.

| Title | Author (s) |
|---|---|
| A framework for Enterprise Architecture effectiveness | Kamogawa and Okada (2005) |
| Experience report: Assessing a global financial services company on its Enterprise Architecture effectiveness using NAOMI | Van Der Raadt et al. (2007) |
| Measuring the Effectiveness of Enterprise Architecture Implementation | Bonnet (2009) |
| Measuring Enterprise Architecture Effectiveness - A focus on Key Performance Indicators | Van der Raadt et al. (2010) |
| An Effectiveness Model for Enterprise Architecture Methodologies | Günther (2014) |

The selection in Table 2 was based on a systematic keyword search of the EA literature on EA implementation, these keywords were:

- EA effectiveness
- EA success
- Measuring EA effectiveness
- Measuring EA success.

The keyword search targeted the paper's abstract, research findings and conclusion. The databases used to search literature were:

- Google Scholar
- ACM Digital Library
- IEEE Xplore
- Science Direct
- Elsevier
- Springer Link
- Taylor and Francis

Kamogawa and Okada (2005) developed a framework that assesses EA effectiveness in the context of e-business. The critical elements mentioned in their EA effectiveness framework are namely; EA development power, governance and EA cognition. Van Der Raadt et al. (2007) developed the Normalized Architecture Organization Maturity Index (NAOMI). NAOMI has three variables to assess EA effectiveness, these are: *architecture awareness, architecture maturity and architecture alignment*. Measuring the Effectiveness of Enterprise Architecture Implementation by Bonnet (2009) and Van der Raadt et al. (2010) provides two organisational objectives to measure the effectiveness of EA implementation. The two organizational objectives are namely; agility and alignment. Focus Framework for Enterprise Architecture Measurements (FFEAM) is developed by Günther (2014) and it considers four areas namely, *the decision-making process, the decision-making results, programme implementation, and programme results*. Rouhani et al. (2015) explore the factors that affect effectiveness of EA Implementation Methodology (EAIM) and propose the effectiveness model for EAIMs. There are five factors that affect effectiveness of EAIM, these are:

- Alignment
- Adaptiveness
- Support

- Binding
- innovation.

These 5 effectiveness approaches reveal three common effectiveness elements namely:

- Communication skills
- EA scope
- Alignment

The above discussion shows the varied approaches and indicators of effective EA implementation. The increased use of EA introduces a problem with regards to selecting an appropriate set of EA CSFs to measure EA effectiveness. This problem can be addressed by a synthesis of existing approaches to construct an integrated CSF list.

This paper report on the results of a research study that applied Design Science Research (DSR) to the development of an artefact that represents a comprehensive list of constructs suitable for measuring effectiveness of EA implementation.

## 3 RESEARCH APPROACH

The research approach followed in this research is Design Science Research (DSR) as described by Vaishnavi and Kuechler (2011). Figure 1 shows the

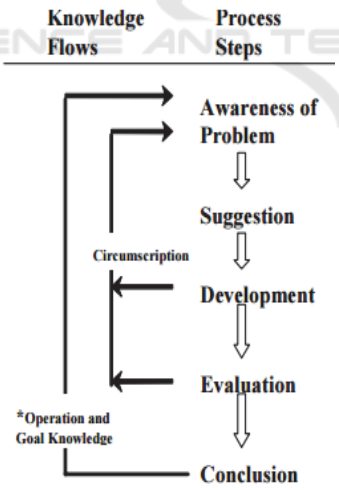


Figure 1: Design Science Research steps, adapted from (Vaishnavi and Kuechler, 2011).

5 main steps of the DSR method.

These steps entail the following:

- **Awareness of a Problem** – an awareness of the problem may be supported by multiple sources including new developments in industry or in a reference discipline. The problem addressed in this paper is the absence of an integrated list of constructs suitable to measure the effectiveness of EA implementation. EA is costly, time consuming and requires effort to implement and it is therefore important to quantify its value.
- **Suggestion** – the solution suggestion phase follows an awareness of the problem has been established. During the suggestion phase an artefact is proposed as a solution to the problem. The solution proposed in this paper is an artefact that represents an integrated list of EA effectiveness constructs. The name of the artefact is Enterprise Architecture Effectiveness Constructs (EAEC).
- **Development** – the proposed solution is designed and implemented in this phase. The inputs to this phase can be existing artefacts or theories that is relevant to the problem space. The EAEC is based on a synthesis of existing EA measurement frameworks, models as well as EA CSFs. The first step in the design phase is to select these EA measurement artefacts by using a literature review approach. After the artefacts were identified they were compared to find commonality in terms of measurement constructs.
- **Evaluation** – in this phase the newly developed artefact is used to demonstrate that the problem has been addressed. Vaishnavi and Kuechler (2011) state that an artefact is evaluated according to criteria that that are always implicit and frequently made explicit in the awareness of the problem phase. An appropriate evaluation method needs to be selected according to the type of the artefact being developed.
- **Conclusion –** conclusion is the final phase of the DSR process and in this step the results of the process are communicated to all relevant stakeholders namely; Information Technology (IT) stakeholders, business stakeholders and external stakeholders (suppliers).

The sections that follow provide more detail with regards to the design and evaluation of the EAEC. The awareness of the problem as well as the solution proposal phases were addressed in Section 2 of this paper.

# 4 THE EAEC DESIGN PROCESS

In this section the development of the EAEC is discussed. The EAEC consists of a comprehensive list of constructs suitable for measuring effectiveness of EA implementation. Existing artefacts and measurement frameworks used in this phase (see Table 2) produced various lists of effectiveness constructs. The EAEC was developed by synthesizing these lists as well as the EA CSFs derived from existing effectiveness approaches.

The list of existing EA CSFs is called the EA CSF list and contains three elements namely, *top management support or commitment, scope, governance and skilled teams, training and education*. The list derived from the EA effectiveness approaches is called the EA effectiveness elements list and consist of: *communication skills, scope and alignment*.

## 4.1 The Synthesis of EA CSFs and EA Effectiveness Elements

The EA CSF list and EA effectiveness elements are synthesized to produce a list of integrated constructs. This synthesis yields 6 constructs namely, *top leadership commitment; governance; scope and skilled teams, training and education; communication skills and alignment*. To ease the task of reference these 6 elements will be referred to as measurement constructs in this paper. The detailed meaning of each constructs are as follows:

- **Top management commitment** is described by Wan et al. (2014) as a facet that deals with commitment from top executives and provides sufficient power to perform organisational changes. Bricknall et al. (2006) are of the view that top IT and business stakeholders buy-in are critical because without their support EA programmes can easily fail. Ylimäki (2008) confirms the involvement of top management in an EA effort.
- **Governance** deals with the roles and responsibilities among different stakeholders in business, IT and suppliers. Issues that are covered under EA governance are *governance structure, effective governance processes and activities, effective change management environment, effective risk management and business management process integration* (Ylimäki, 2008). Governance is mentioned by Aier and Schelp (2010) as an important factor for EA implementation success. EA governance and program management involves management-control issues in relation to incremental EA implementation and continuous improvement (Wan et al., 2014).
- **Scope** refers to the parts of the organisation such as IS and IT that should be included in the initial EA project in order to create an EA (Bricknall et al., 2006). The scope of EA must be clear and the benefits of EA should also be included in the scope documentation. Furthermore, there must be "as-is" documentation that shows the current status of the architecture, an IT strategy, target architecture ('to be' architecture) and a plan of how to reach the targeted architecture (which is a "to-be" architecture) (Bricknall et al., 2006). Ylimäki (2008) states that **s**coping and purpose refers to how an organisation addresses issues such as *holistic EA, a clear mission, goals and direction; value and benefits of EA and a clearly defined EA*. Holistic EA addresses issues such as the definition of EA in the organisation and the documentation of key EA stakeholder groups (Lankhorst, 2005, Ylimäki, 2008). Scoping in Wan et al. (2014) study falls under the EA readiness and purpose facet. One of the success factors in the EA readiness and purpose facet is an understanding of the high-level business formal structure such as *strategy, vision, mission, objective*.
- **Skilled teams, training and education**, this CSF addresses the establishment of skills required for architecture team and key stakeholder in terms of architecture work. The architecture teams need to have both business and architecture skills (Boster et al., 2000, Ylimäki, 2008). The skills of architects and non-architects are also mentioned as critical by (Aier and Schelp, 2010). Aier and Schelp (2010) state that communication and regular training or education are CSFs for the long-term success of EA. The training and education of non-architects fosters the acceptance of architectural issues and reduces barriers (Aier and Schelp, 2010). According to Wan et al. (2014) training is covered under the EA domain techniques facet. This facet refers to EA skills and business skills that enterprise architecture should acquire (Wan et al., 2014).
- Business and IT **alignment** (B-IT) is defined as the degree to which the IT missions, objectives, and plans support and are supported by the business mission, objectives,

and plans (Reich and Benbasat, 1996). An organisation needs to be aligned internally to be agile externally (Bonnet, 2009). Alignment refers to IT supply meeting organisation demands (Lindström et al., 2006). Günther (2014) refers to B-IT alignment during the decision-making process as a subjective alignment of business and IT stakeholders. The B-IT alignment in this context refers to understanding of business by IT and understanding of IT by business Günther (2014). Alignment is one of the 5 critical factors that affect the effectiveness of EA implementation because of the positive relationship between alignment and effectiveness of EA implementation (Rouhani et al., 2014).

- **Communication skills** refers to the process of communicating with stakeholders in terms of EA projects. Kamogawa and Okada (2005) state that EA should reflect communication in which all stakeholders are involved. According to Van Der Raadt et al. (2007), communication involves architecture descriptions and models. Further, the level in which an architecture function can communicate with its stakeholders is essential in determining its ability to be effective (Van Der Raadt et al., 2007, Lange et al., 2012). Bonnet (2009) mention communication and understanding as one of the dimension under alignment. Communication and understanding refers to common understanding of business and IT through knowledge sharing, and insight in consequences of decision-making. The latter requires that enterprise architects communicate to business effectively. Effective engagement ensures that all key stakeholders share the risks and responsibilities (Ross et al., 2006).

## 4.2 The Relationship between Constructs

Figure 2 shows an illustration of the 6 measurement constructs as well as the relationships between them. The Alignment and Communication constructs are shaded in a different colour than the other four constructs because they either have a direct or indirect relationship with the other four measurement constructs. Therefore, Alignment and Communication are 2 measurement constructs that are common among the measurement constructs. This means that the other 4 measurement constructs either have a direct or indirect relationship with Alignment or Communication or both. The relationships are labelled as bidirectional arrows in the diagram. These relationships are discussed next:

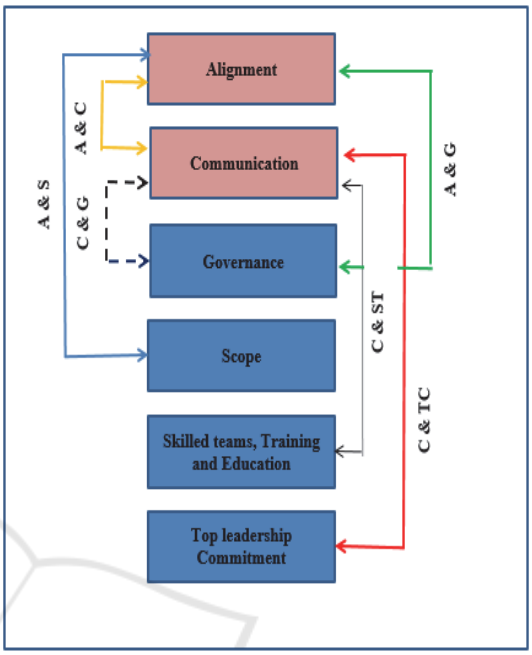


Figure 2: Measurement Constructs and Relationships.

- **Alignment and Scope (A & S)**
  Alignment refers to the strategic fit between strategy and operations, functional integration of business and IT, external suppliers or other lines of business within the organisation (Henderson and Venkatraman, 1993, Bonnet, 2009). Bonnet (2009) is of the view that alignment is achieved when all components of an organisation are interrelated coherently. The organisational scope of architecture indicates which part of an organisation is involved in the EA program (Van Der Raadt et al., 2007). As such Scope is an intrinsic variable that links with Alignment that means business strategy and IT strategy must be aligned for an EA implementation to be regarded as effective.
- **Alignment and Communication (A & C)**
  Communication refers to the ability of the architecture function to communicate EA relevant information to the organisation (Van der Raadt et al., 2010). For communication to be effective, architecture alignment needs to be in place as well. Communication within the alignment dimension refers to a common understanding of business and IT through

knowledge sharing, and insight of the consequences of decision making (Bonnet, 2009, Van der Raadt et al., 2010). The relation between alignment and communication means business to IT alignment needs to be communicated to all the stakeholders for an EA implementation to be regarded as effective.

- **Alignment and Governance (A & G)**
  Governance within the alignment dimension refers to formal decision making, monitoring, and control of priorities and budget for both business and IT (Van der Raadt et al., 2010, Bonnet, 2009). The governance relation indicates that an effective EA implementation requires governance of the alignment produced by EA.
- **Communication and governance (C & G)**
  Ylimäki (2008) states that effective communication is critical to share knowledge, achieving a common understanding, agreement and a shared view of EA scope, vision and objectives. The linkage of communication and scope is also shared by Wan et al. (2014) and Bricknall et al. (2006) in that organisational understanding of EA is important therefore effective communication plays a critical role in ensuring that an organisation understands the EA scope. The link between communication and governance is stated by Ylimäki (2008). There is indirect communication between communication and governance according to Van Der Raadt et al. (2007) in terms of architecture awareness. This relation means that the roles and responsibilities of the EA implementation need to be clearly communicated to all stakeholders for the EA implementation to be regarded as effective.
- **Communication and skilled teams (C & ST)**
  Teams need to have good communication skills to effectively communicate with different stakeholders and to provide training effectively. It is critical for EA architects to have good communication skills to translate business requirements into EA. The people that matter in terms of determining the relevance and effectiveness of EA is the business not necessarily the technical staff. Enterprise architects must communicate with the business in relevant terms (i.e. non-technical) so that engagement can be fostered. This relationship is critical to an effective EA implementation due to the importance of the business as a key stakeholder and recipient of the benefit of EA.
- **Communication and Top leadership commitment (C & TC)**
  Effectiveness and top leadership commitment is important for effective EA implementation. This relationship was identified by Ylimäki (2008). Communication between stakeholders and Support & commitment from top executives are factors that are mentioned under top commitment and leadership facet, therefore there is a correlation between these two factors (Wan et al., 2014).

# 5 EVALUATING THE EAEC

During the evaluation phase the EAEC was demonstrated to eleven EA experts from industry and academia (in the South African context). The objective of evaluating EAEC was to assess whether problem of a lack of an integrated EA effectiveness measurement list was adequately addressed (see Section 2 for problem awareness discussion). The eleven EA experts were identified based on their LinkedIn profiles as well as referrals from the power utility.

The evaluation was conducted in two rounds that followed a presentation of the EAEC. During the first round each expert was required to provide general information about their experience in EA and to answer 3 open ended questions about the EAEC. During the second round the EA experts were asked to review the responses from the other experts (presented to each expert without revealing any identities) to indicate their view in terms of whether they agree, in neutral or disagree with claims made during the first round. The evaluation was done under the protection of an ethical clearance certificate that guaranteed the anonymity as well as the right to choose to participate in the research.

## 5.1 Analysis of Evaluation

The objective of evaluation was determining the degree of common understanding of EAEC and in so doing to establish that the EAEC addressed the problem (Section 2) it was designed to solve.

### 5.1.1 Round 1 Results

During the first round all eleven EA acknowledged that there is a need to have a tool that will enable

organisations to measure the effectiveness of EA implementation. The 6 constructs were confirmed by all eleven EA experts as being critical and comprehensive to measure the effectiveness of EA implementation. 6 out of eleven (55%) EA experts stated that the EAEC has the potential of being a useful tool once measuring units are determined for the six constructs. All eleven EA experts expressed their concerns regarding the EA definition and their role as enterprise architects. The EA experts stated that the EA definition is not fully understood and the role of the enterprise architects is often confused with the role of an IT architect.

### 5.1.2 Round 2 Results

In round 2, the EA experts were asked to review their collective opinions and to indicate their view in terms of whether they agree, in neutral or disagree with claims derived in round 1. Table 3 to 5 shows an overview of the opinions from round 1. A total number of 9 EA experts participated in round 2.

The EA experts were asked to confirm or change their original opinions. In terms of question 1 (Table 3) 5 EA experts agreed with the claims, 3 disagreed and 1 was in neutral. The confirmation of the claims for question 1 indicate that 56% of the EA experts support the claims.

Table 3: Question 1 responses.

| Question | Responses |
|---|---|
| Reason for using EAEC | The artefact pinpoints the pain points we have in business in terms of EA project implementation |
| | It covers all critical elements that one can use to measure the effectiveness of EA implementation |
| | That artefact has potential |
| | In its current form, it can be used as guiding artefact |
| | The artefact can be used as a practice framework to establish EA |

With regards to question 2 (Table 4) 8 EA experts agreed with the four claims and 1 EA expert disagreed with the claims.

Table 4: Question 2 responses.

| | |
|---|---|
| Reason for not using EAEC | Artefact is too generic, it is not detailed enough, expand the artefact |
| | I would not know how to use the artefact. Where do I start and how? |
| | The artefact does not have measuring units, it does not have tools or methods to measure EA effectiveness |
| | Does not take organisational or stakeholder view into account |

For question 3, 6 EA experts agreed with the claims, 2 disagreed and 1 was neutral. Of the total, 67% EA experts stated that the artefact needs to have measuring units to be effectively evaluated. 1 out of the 9 EA experts stated that the 6 measurement constructs can be measured at different levels in the organisation depending on the maturity level of the EA. 2 of the 9 EA architects are of the view that the correlations between the measurement constructs must be represented based on strength and the order of importance.

Table 5: Question 3 responses.

| | |
|---|---|
| Suggested changes | Add tools or methods to measuring all 6 measurement constructs |
| | Add architecture standards and recipes |
| | Include direction setting - this is a strategic guidance and should not be confused with governance |
| | Add reference models |
| | Make a relation between skilled teams and alignment because architects are assigned to projects based on their skills |
| | Order the constructs according to their importance in measuring EA effectiveness |
| | Indicate the impact of relations on EA effectiveness |
| | Indicate a timeline for each construct in terms of a measurement at different maturity level |

### 5.1.3 Discussion

As per the problem discussed in the first stage of the DSR process (see Section 2) there is a lack of an integrated set of constructs to effectively establish the quality of an EA implementation. The proposed approach was to synthesise the existing CSFs as well as measurement frameworks and models to establish a comprehensive list of measurements contained in an Enterprise Architecture Effectiveness Constructs (EAEC) (see discussion in Section 4).

The evaluation of the EAEC set out to learn whether the task of creating a comprehensive measurement list was achieved. The feedback and opinions of the interviewed EA experts was most instructive. On the one hand the acceptance of the set of constructs and their relations where well received and in that respect the problem was solved. On the other hand, though, the experts pointed out the inherent limitations of addressing the measurement of effective EA implementation by way of constructs alone. What is needed is a detailed process as well. In conclusion, the problem as formulated in Section 2 seems to have been solved but as an artefact by itself only solves a part of the problem of measuring EA implementation. This necessitate further exploration on the topic in terms of addressing the issue of specific metrics as well as a measurement method. That task is left for further iterations of the DSR method.

# 6 CONCLUSION AND FURTHER WORK

This paper reported on a research study that aimed at designing and evaluating an artefact that entailed a comprehensive list of constructs suitable for measuring the effectiveness of EA implementation. The intention of the evaluation was to establish whether the artefact is doing what it is supposed to be doing and then to identify areas of improvements (see Section 5.1.3). The proposed artefact was evaluated by 11 EA experts that were selected from industry and academia.

The research objectives achieved at the end of the research project was as follows:

1. To identify existing EA critical success factors and EA effectiveness approaches.
2. To find commonalities in the identified EA critical success factors and EA effectiveness approaches.
3. To synthesize the EA critical success factors and EA effectiveness approaches to produce an artefact that consists of a comprehensive list of constructs suitable for measuring effectiveness of EA implementation.
4. To evaluate a synthesized EA effectiveness Constructs (EAEC).

The design science research (DSR) (see Section 3) method was applied to this research. The proposed solution can be deemed effective when it achieves what it was intended for which means that it solves (to some degree at least) the identified problem.

This research results contributes to the knowledge in the field of Information systems (IS) as it relates to EA implementation measurement. The EAEC consists of six measurement constructs namely: *communication, alignment, governance, top leadership commitment, scope, skilled teams, training and education*. Good communication skills and business to IT alignment are considered the common measurement constructs among other measurement constructs because they either have a direct relationship or indirect relationship with other measurement construct. Measuring the effectiveness of EA implementation requires that the 6 measurement constructs be present.

In terms of further research the following problems emerged and should be considered for further study:

- The performance of the EAEC in an operational context
- Enhancing the EAEC with detailed performance metrics in support of the measurement constructs
- The establishment of a measurement method to expand the EAEC

Finally, the research results have confirmed the essential difficulty and inherent complexity involved in determining how effective an EA implementation really is. The need and resultant problem will continue to impact on the total value of EA to the enterprise and must therefore be addressed an ultimately solved.

# REFERENCES

Aier, S. & Schelp, J. A reassessment of enterprise architecture implementation. Service-Oriented Computing. ICSOC/ServiceWave 2009 Workshops, 2010. Springer, 35-47.

Bonnet, M. 2009. *Measuring the effectiveness of Enterprise Architecture implementation.* Master of Science in Systems Engineering,

Policy Analysis and Management – Information Architecture, TU Delft, Delft University of Technology.

Boster, M., Liu, S. & Thomas, R. 2000. Getting the most from your enterprise architecture. *IT Professional,* 2**,** 43-51.

Bricknall, R., Darrell, G., Nilsson, H. & Pessi, K. Enterprise architecture: critical factors affecting modelling and management. ECIS, 2006. 2349-2361.

Cameron, B. H. & Mcmillan, E. 2013. Analyzing the current trends in enterprise architecture frameworks. *Journal of Enterprise Architecture,* 9**,** 60-71.

Department Of Defense 2010. Version Description Document for The DoD Architecture Framework (DoDAF) and DoDAF Meta Model (DM2) Version 2.02. Office of the Assistant Secretary of Defense (OASD) for Network Infrastructure and Integration (NII): United States of America Department of Defense.

Espinosa, J. A., Boh, W. F. & Delone, W. The organizational impact of enterprise architecture: a research framework. System Sciences (HICSS), 2011 44th Hawaii International Conference on, 2011. IEEE, 1-10.

Foorthuis, R., Van Steenbergen, M., Brinkkemper, S. & Bruls, W. A. 2015. A theory building study of enterprise architecture practices and benefits. *Information Systems Frontiers***,** 1-24.

Günther, W. A. 2014. *Measuring Enterprise Architecture Effectiveness: A Focus on Key Performance Indicators.* Master of Science (M.Sc.) of ICT in Business Leiden University.

Henderson, J. C. & Venkatraman, H. 1993. Strategic alignment: Leveraging information technology for transforming organizations. *IBM systems journal,* 32**,** 472-484.

IEEE 2011. ISO/IEC/IEEE 42010:2011, Systems and software engineering — Architecture description. http://www.iso-architecture.org/ieee-1471/index.html.

Kaisler, S. H., Armour, F. & Valivullah, M. 2005. Enterprise architecting: critical problems. *38th Hawaii International Conference on System Sciences.* Hawaii: IEEE.

Kamogawa, T. & Okada, H. A framework for enterprise architecture effectiveness. Proceedings of ICSSSM'05. 2005 International Conference on Services Systems and Services Management, 2005., 2005. IEEE, 740-745.

Lange, M., Mendling, J. & Recker, J. A comprehensive EA benefit realization model--An exploratory study. System Science (HICSS), 2012 45th Hawaii International Conference on, 2012. IEEE, 4230-4239.

Lankhorst, M. 2005. Enterprise Architecture at Work: Modelling, Communication and Analysis. 1 ed.: Springer, Berlin, Germany, EU. ISBN 3540243712.

Lindström, Å., Cegrell, T. & Grandell, M. The Top IT Concerns for Chief Information Officers in European Electric Power Industries. 41st International Conference on Large High Voltage Electric Systems 2006, CIGRE 2006; Paris; France; 27 August 2006 through 1 September 2006, 2006.

Löhe, J. & Legner, C. 2014. Overcoming implementation challenges in enterprise architecture management: a design theory for architecture-driven IT Management (ADRIMA). *Information Systems and e-Business Management,* 12**,** 101-137.

Mentz, J., Kotzé, P. & Van Der Merwe, A. 2012. A comparison of practitioner and researcher definitions of enterprise architecture using an interpretation method. *Advances in Enterprise Information Systems II***,** 11-26.

Morganwalp, J. M. & Sage, A. P. 2004. Enterprise architecture measures of effectiveness. *International Journal of Technology, Policy and Management,* 4**,** 81-94.

Niemi, E. 2008. Enterprise architecture benefits: Perceptions from literature and practice. *Evaluation of enterprise and software architectures: critical issues, metrics and practices:[AISA Project 2005-2008]/Eetu Niemi, Tanja Ylimäki & Niina Hämäläinen (eds.). Jyväskylä: University of Jyväskylä, Information Technology Research Institute, 2008.-(Tietotekniikan tutkimusinstituutin julkaisuja, ISSN 1236-1615; 18). ISBN 978-951-39-3108-7 (CD-ROM).*

Niemi, E. & Pekkola, S. 2015. Using enterprise architecture artefacts in an organisation. *Enterprise Information Systems***,** 1-26.

Nikpay, F., Selamat, H., Rouhani, B. D. & Nikfard, P. A Review of Critical Success Factors of Enterprise Architecture Implementation. Informatics and Creative Multimedia (ICICM), 2013 International Conference on, 2013. IEEE, 38-42.

Reich, B. H. & Benbasat, I. 1996. Measuring the linkage between business and information technology objectives. *MIS quarterly***,** 55-81.

Rodrigues, L. S. & Amaral, L. Key Enterprise Architecture Value Drivers: Results of a Delphi Study. Proceedings of the 21th IBIMA Conference, 2013 Vienna, Austria.

Ross, J. W., Weill, P. & Robertson, D. 2006. *Enterprise architecture as strategy: Creating a foundation for business execution*, Harvard Business Press.

Rouhani, B. D., Mahrin, M. N., Nikpay, F. & Rouhani, B. D. 2014. Current issues on enterprise architecture implementation methodology. *New Perspectives in Information Systems and Technologies, Volume 2.* Springer.

Rouhani, B. D., Mahrin, M. N. R., Nikpay, F., Ahmad, R. B. & Nikfard, P. 2015. A systematic literature review on Enterprise Architecture Implementation Methodologies. *Information and Software Technology,* 62**,** 1-20.

Saint-Louis, P. & Lapalme, J. Investigation of the lack of common understanding in the discipline of enterprise architecture: A systematic mapping study. Enterprise Distributed Object Computing Workshop (EDOCW), 2016 IEEE 20th International, 2016. IEEE, 1-9.

Schelp, J. & Stutz, M. 2007. A balanced scorecard approach to measure the value of enterprise architecture.

Schmidt, C. & Buxmann, P. 2011. Outcomes and success factors of enterprise IT architecture management: empirical insight from the international financial services industry. *European Journal of Information Systems,* 20**,** 168-185.

Schmidt, R., Zimmermann, A., Möhring, M., Jugel, D., Bär, F. & Schweda, C. M. Social-software-based support for enterprise architecture management processes. International Conference on Business Process Management, 2014. Springer, 452-462.

Seppanen, V., Heikkila, J. & Liimatainen, K. Key issues in EA-implementation: case study of two Finnish government agencies. 2009 IEEE Conference on Commerce and Enterprise Computing, 2009. IEEE, 114-120.

Sobczak, A. Methods of the Assessment of Enterprise Architecture Practice Maturity in an Organization. International Conference on Business Informatics Research, 2013. Springer, 104-111.

Syynimaa, N. Measuring Enterprise Architecture success: a tentative model for measuring success. 14th International Conference on Informatics and Semiotics in Organisations, ICISO 2013, 2013 Stockholm, Sweden.

The Open Group 2011. *TOGAF Version 9.1*, Van Haren Publishing.

Vaishnavi, V. & Kuechler, B. 2011. *Design Science Research in Information Systems* [Online]. [Accessed 9 May 2012 2012].

Van Der Raadt, B., Bonnet, M., Schouten, S. & Van Vliet, H. 2010. The relation between EA effectiveness and stakeholder satisfaction. *Journal of Systems and Software,* 83**,** 1954-1969.

Van Der Raadt, B., Slot, R. & Van Vliet, H. Experience report: assessing a global financial services company on its enterprise architecture effectiveness using NAOMI. System Sciences, 2007. HICSS 2007. 40th Annual Hawaii International Conference on, 2007. IEEE, 218b-218b.

Wan, H., Johansson, B., Luo, X. & Carlsson, S. Realization of enterprise architecture (EA) benefits. Working Conference on Practice-Driven Research on Enterprise Transformation, 2013. Springer, 92-105.

Wan, H., Luo, A. & Luo, X. How Enterprise Architecture Formative Critical Success Facets Might Affect Enterprise Architecture Success: A Literature Analysis. International Conference on Informatics and Semiotics in Organisations, 2014. Springer, 197-209.

Weiss, D. 2006. Enterprise Architecture Measurement Program, Part 1: Scoping. ID.

Ylimäki, T. 2008. Potential critical success factors for enterprise architecture. *Evaluation of enterprise and software architectures: critical issues, metrics and practices:[AISA Project 2005-2008]/Eetu Niemi, Tanja Ylimäki & Niina Hämäläinen (eds.). Jyväskylä: University of Jyväskylä, Information Technology Research Institute, 2008.-(Tietotekniikan tutkimusinstituutin julkaisuja, ISSN 1236-1615; 18). ISBN 978-951-39-3108-7 (CD-ROM).*

Zachman, J. A. 2008. The Zachman Framework: the official concise definition. http://www.zachman.com/about-the-zachman-framework [Online].

Zhang, L.-J. 2012. Editorial: Big services era: Global trends of cloud computing and big data. *IEEE Transactions on Services Computing,* 5**,** 467-468.