

A SYSTEMATIC REVIEW OF ENTERPRISE ARCHITECTURE ESTABLISHMENT PROCESS

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ABSTRACT. Enterprise Architecture (EA) is gaining its importance and has become significant agenda in any Information Technology reform in most organisations. Despite many claimed benefits, establishment of EA can be challenging due to by many different EA views, methodologies and frameworks that exist at present. Therefore this study provides a systematic review of Enterprise Architecture (EA) establishment process with the aim to review the EA establishment process from the existing EA frameworks. 16 papers were selected in the synthesis process and finally only six EA frameworks were chosen for further analysis. The result shows there are 43 processes related to EA establishment and each EA framework has their own limitation and additional features. Results also indicate that these processes can be grouped into seven common EA processes across all frameworks which are used by all frameworks

Keywords: enterprise architecture framework, enterprise architecture process, systematic review

INTRODUCTION

Enterprise Architecture (EA) is introduced with the purpose to align the business and IT together in order to support the organisation vision and mission. It has become significant agenda in any IT reform in most organisations. Enterprise Architecture (EA) is a hierarchical approach for aligning business and IT and it describes how the information systems, processes, organisational units and people in an organisation function as a whole (Fernández, 2013; Hjort-Madsen, 2009; Wan, Johansson, Luo, & Carlsson, 2013). EA analyses an organisation all the way from its generic strategic components to its detailed IT infrastructure. As EA is becoming an increasingly mature field of work, many organisations having difficulties with implementing an effective EA function due to inflexibility and complexity of the business and IT structures (van der Raadt & van Vliet, 2008). EA practitioners are in uncertainty due to by many different EA views, methodologies and frameworks exist at present (Magoulas, Hadzic, Saarikko, & Pessi, 2012; Schöenherr, 2009; Sessions, 2007). In addition, study by Roeleven and Broer (2009) reveal that more than 66 per cent of EA program in Netherlands did not fulfil expectation due to longer time spend during EA establishment process itself.

EA establishment process describes a set of the processes that involve in establishing an EA initiative. As a prerequisite to the development of every EA program, every organisation should establish a development plan and strategy that includes the definition of a vision, objectives, and principles (Rouhani, Mahrin, Nikpay, & Nikfard, 2013). Therefore, the purpose of this study is to identify what are the processes in EA establishment defined by the existing

EA frameworks. In this systematic review, the contextual limitation is set to research that focus on the EA establishment process from the existing EA frameworks only. We utilise research of verified quality, which means that only articles in peer-review journals and from reputable conferences shall be addressed. The remaining discussions are as follows, next section we explain the review method applied and the findings, followed by result analysis and discussion. Finally in a conclusion, we also outline some possible future works.

REVIEW METHOD

This section explain the processes of Systematic Literature Review (SLR) based on the guidelines by Kitchenham and Charters (2007), and Okoli and Schabram (2010). It comprises of five subsections which are; SLR questions, data sources, search strategy, study selection, and inclusion and exclusion criteria. The SLR guideline consists of three main phases which are planning the review, conducting the review and reporting the review phase. Figure 1 describes the phases in detail.

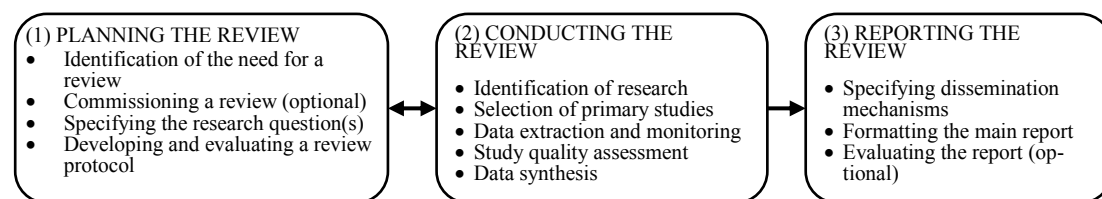


Figure 1. Systematic literature review phases and stages

SLR QUESTIONS

To design the SLR questions, the researcher follows the criteria by Petticrew and Roberts (2008). Table 1 shows the criteria and scope of research question structure.

Table 1. Criteria and scope of research question structure

Criteria	Scope
Population	EA frameworks
Intervention	The differences of establishment process from the existing EA frameworks
Comparison	List of EA establishment process
Outcomes	A common list of EA establishment process
Context	Review of any studies on EA establishment process

Based on the research question structure as shown in Table 1, the primary question is: *What are the processes in EA establishment defined by the existing EA frameworks?*

This is followed by these sub questions:

1. *What are the existing EA frameworks that clearly define its EA establishment process?*
2. *What are the differences and limitation of the EA establishment processes defined from the selected EA frameworks?*
3. *Which EA processes can be configured based on Configurable Process Model (CPM)?*

Study Selection and Resources

Based on the identified research questions, a study selection criterion must be identified to support the direct evidence to reduced likelihood of bias. The sources of papers are from the highest to lowest priority: journals, conferences or proceedings, technical reports, thesis reports, books and magazine articles. The selection of online databases were based on databases that indexed “Enterprise Architecture” or “Information Technology Architecture” stud-

ies from the available online databases subscribed by the University Teknologi Malaysia's library. The research involved ten online databases as data sources which are ACM Digital Library, Australian Digital Thesis (ADT), Emerald, EthOS (UK Thesis), IEEEExplore Digital Library, ProQuest (USA Thesis), SpringerLink, Taylor & Francis, Web of Knowledge and Google Scholar. The initial search strings are (*enterprise architecture*), (*information technology architecture*), (*process*), (*steps*), (*phases*), (*frameworks*) and (*methodologies*). The search strings are then constructed using Boolean "AND" and Boolean "OR" to allow synonyms and word class variants of each keyword. The search strings were executed in the digital libraries based on titles, abstracts and metadata, assuming that these provide a concise summary of the work.

Inclusion and Exclusion Criteria

The main inclusion criterion for this study is to include are the processes in EA establishment defined by the existing EA frameworks. This review targeted peer reviewed articles and only articles in English were included. The search included articles that meet the research questions stated. The detail inclusion criteria included are: 1) Studies that originally propose own EA framework, 2) Studies that clearly defines EA framework with establishment process, and 3) Studies that provide the evidence on the usage of those EA establishment process in the organisation. Meanwhile, the articles that are excluded from our research criteria are 1) Studies that are claiming another author that has no supporting evidence, 2) Studies that propose a hybrid EA establishment process based on existing EA frameworks, 3) Studies that only describe the concept of EA establishment process and 4) Studies that are not written in English.

Data Extraction and Study Quality Assessment

To ensure the data extraction process meets the quality criteria, a quality criteria checklist from Salleh, Mendes, & Grundy (2011) has been used in this process. Study quality checklists as shown in Table 2 are the items checklist for the study identified. Our study checklist uses three scale which are coded and given a score which are; Yes=1; Partially = 0.5; No= 0. From the item checklist, each paper will be given a summing on each of the items. Possible scores range from 0.5 to 5 is the highest score.

Table 2. Item Study Checklist

Item	Answer
Was the article referred?	Yes/No
Was aim of the study is clearly stated?	Yes/No/Partially
Were the data collection were carried out well?	Yes/No/Partially
Were the study participants were described?	Yes/No/Partially
How generalizable are the findings of this study to the target population with respect to the size and representativeness of sample.	Yes/No/Partially

FINDINGS

Figure 2 shows the summary of the stages of study selection in this SLR guidelines according to Kitchenham & Charters (2007). The initial phase of the search process identified 966 studies using the search term defined. Of these, only 45 were potentially relevant based on the screening of contents of the frameworks. Each of these results was filtered according to the inclusion and exclusion criteria before being accepted for the synthesis of evidence. All possible duplicates and similarity of the frameworks are excluded too. Finally, only 16 studies were accepted for the synthesis of evidence after a detailed assessment.

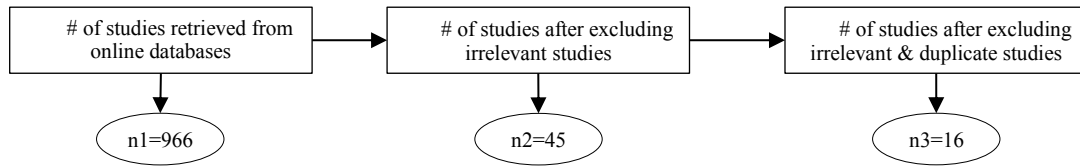


Figure 2. Stages of study selection

Quality Factors

Table 3 shows the quality scores for all 16 studies. Four (25%) and two (13%) studies are in good and very good quality. Six studies are rated as fair, three are poor and only one study in very poor quality as it did not provide a detailed result and methodology conducted in the study. Therefore since this study only emphasise on the original, pragmatic and clearly defined EA establishment process, all ten studies that with very poor, poor and fair ratings are removed. Finally, only six studies were included for the purpose of analysis of evidence.

Table 3. Result of quality checklist

Quality Scale	Very Poor (=1)	Poor (=2)	Fair (=3)	Good (=4)	Very Good (=5)	Total
Number of Studies	1	3	6	4	2	16
Percentage (%)	6%	19%	37%	25%	13%	100

DISCUSSIONS

In this section, we discuss our result based on the research question developed. We present the synthesis of evidence of our SLR, with the aim to identify common EA processes that can cater across most of EA frameworks.

What are the existing EA frameworks that clearly define its EA establishment process?

The final list of six EA frameworks is shown on Table 4.

Table 4. List of EA frameworks with EA establishment process

No	Developer (Year)	Framework
1	Spewak (1992)	Enterprise Architecture Planning (EAP)
2	The Open Group (1995)	The Open Group Architecture Framework (TOGAF)
3	US OMB (1999)	Federal Enterprise Architecture Framework (FEA)
4	Schekkerman (2001)	Extended Enterprise Architecture Framework (E2AF)
5	Sandeen (2003)	The State of Arizona's Enterprise Architecture
6	Steenkamp et al.(2013)	Enterprise Architecture Process Model

ENTERPRISE ARCHITECTURE PLANNING (EAP)

Enterprise Architecture Planning (EAP) was introduced by Spewak in 1992. EAP focuses on business mission as the primary driver, followed by the data required to satisfy the mission, the applications that are built using that data and finally the technology to implement the applications. In summary, the processes involved in EAP can be divided into four levels with activities as stated in Figure 3.

The Federal Enterprise Architecture (FEA). The U.S. Federal Enterprise Architecture (FEA) is an initiative of the U.S. Office of Management and Budget, Office of E-Government and IT (Council, 1999, 2001). FEA became a recognised strategic and management best practice in U.S. Federal Government with the passage of the Clinger-Cohen Act in 1996. It provides a common approach for IT acquisition in the U.S federal government, and ease sharing of information and resources across federal agencies. In FEA there are four steps as stated in Figure 3

The TOGAF Architecture Development Method. The Open Group Architecture Framework (TOGAF) is an EA framework that provides a comprehensive approach for designing, planning, implementing, and governing an enterprise information architecture. TOGAF was initiated early 1990s as methodology for the development of technical architecture and has been developed by The Open Group into an extensive EA framework (Lankhorst, 2013). The EA processes in TOGAF can be divided into four main steps as stated in Figure 3

Extended Enterprise Architecture (E2A). E2A approach and framework was created by Jaap Schekkerman in 2001. E2AF assumes a holistic approach to architecture, stating that an enterprise must be designed as a whole (Schekkerman, 2006). The focus is on the awareness of threats and opportunities in the environment. Figure 3 shows the phases and activities in E2A.

Enterprise Architecture Process Model (EAPM). Steenkamp et al. (2013) has proposed an agile development of EA. Like other life cycle process models, an EAPM depict the interrelated tasks of architects and developers who will plan, manage, develop, evaluate and maintain the enterprise architecture. Figure 3 shows the stages of architecture development processes and the relationship between the enterprise strategy and IT strategy.

The State of Arizona's Enterprise Architecture. The State of Arizona's Enterprise Architecture (EA) describes a comprehensive framework for IT and business that supports the Arizona State government strategic plan. This is done by describing a direction for current and future activities, supported by underlying EA principles, standards, and best practices (Sandeem, 2003). The process involves in Arizona Enterprise Architecture Implementation Process is stated as per Figure 3

What are the differences and limitation of the EA establishment processes defined from the selected EA frameworks?

Based on the SLR conducted, every EA frameworks have their own ways to establish the EA. In general, the common processes involved are plan, analyse, design, develop, implement. These processes occur in all six EA frameworks studied. Spewak (1993) propose additional process such as initiation process by but do not include the maintenance process. Meanwhile Steenkamp (2013) did not mention the analysis process but directly go for development after planning process. In addition, FEA, TOGAF and E2A provide extra processes (determine investment strategy, determine opportunities, and educate and train people) to assist the EA establishment process. Whereas for State of Arizona's EA, lack of focus is given to early establishment phase but it provide a complete guideline on the EA project management area. Therefore based on the identified differences and limitation, next step is to identify which EA processes can be optimised and generalised regardless of the EA framework adopted by the organisation.

Which EA processes can be configured based on Configurable Process Model (CPM)?

Current EA frameworks are lacking of common ground, language and methodology for its establishment process (Magoulas et al., 2012; Schöenherr, 2009; Sessions, 2007). To resolve this issue we proposing a Configurable Process Model (CPM) approach. CPM is a model origin from Business Process Modelling (BPM) concept. Its combines a family of similar process models together to be configured in order to fit the requirements of specific organisations or projects. CPM is designed to merge redundant processes; therefore it can solve the issues of multiple EA frameworks. Figure 3 shows all EA processes for the six frameworks selected in this study.

Using CPM, all processes involved in EA establishment are mapped properly regardless of the original EA frameworks. All the common process of the existing EA framework are

shown in a sequence of thick arrow (Figure 4) meanwhile the process variability's are shown on the right side of the forth process. This shall provide the flexibility to the organisation to adopt this assessment model because it has taken into consideration most of EA framework.

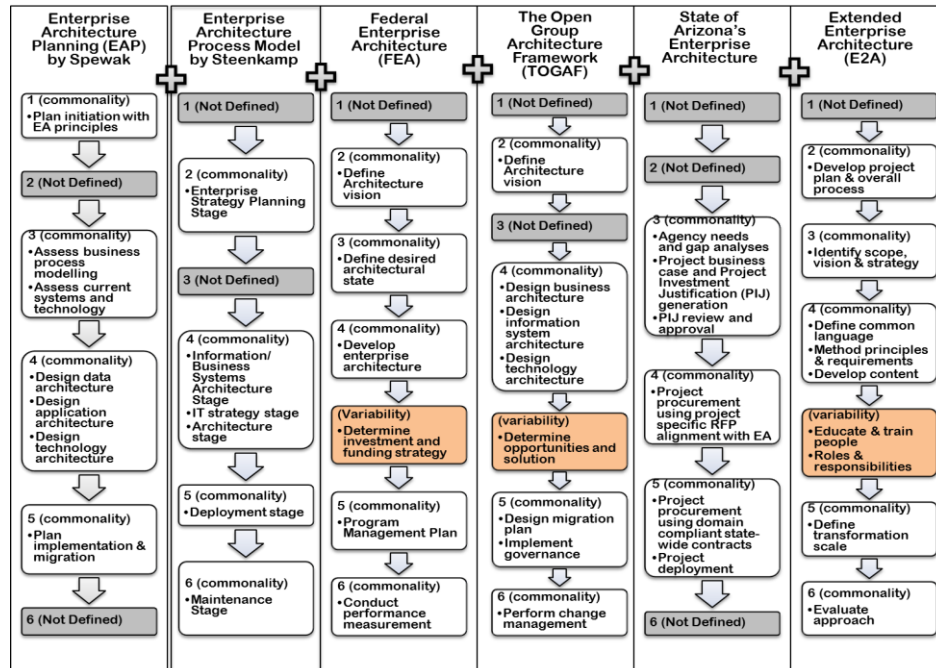


Figure 3. List of individual processes from selected EA frameworks

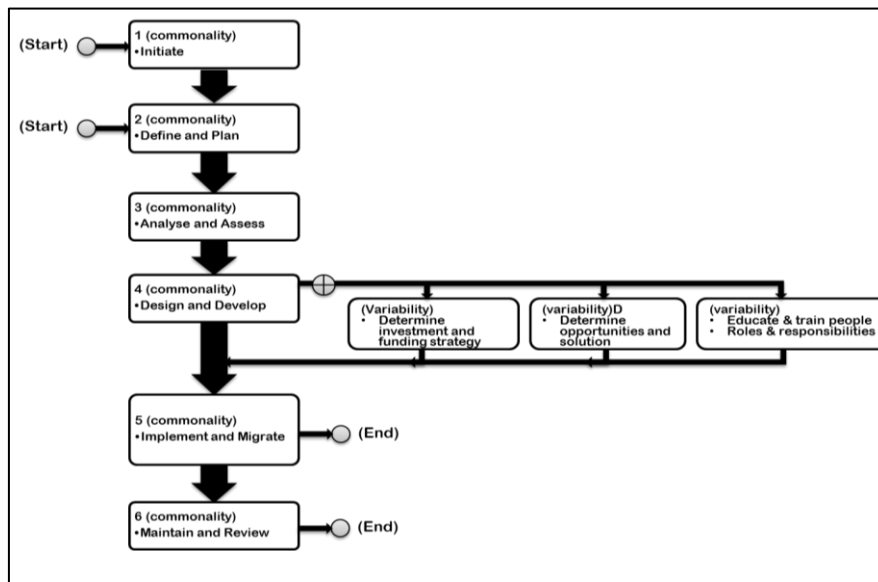


Figure 4. Merged EA establishment process

CONCLUSION

This study has reviewed various EA frameworks exist in order to understand the common steps involved in establishing any EA solution. As a result, six EA frameworks are selected because it has the most defined steps which can be analysed in this paper context. The pro-

cesses are carefully reviewed and were mapped accordingly by using CPM method. Thus, it will provide a common ground of most EA frameworks when dealing with EA establishment process. In future this proposed EA establishment process shall be tested and evaluated by the EA experts and selected organisation for further refinement.

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