Systematic Literature Review of Essential Enterprise Architecture Management Dimensions

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Abstract
Many organisations turn to enterprise architecture (EA) to assist with the alignment of business and information technology. While some of these organisations succeed in the development and implementation of EA, many of them fail to manage EA after implementation. Because of the specific focus on the management of EA during and after the initial implementation, the enterprise architecture management (EAM) field is developed. EAM is characterised by many dimensions or elements. It is a challenge to select the dimensions that should be managed and that are vital for successful EA practice. In this study, we executed a systematic literature review (SLR) of primary EA and EAM literature with the aim of identifying dimensions regarded as key areas of EAM. The main contribution of this work is a concept map of the essential EAM dimensions with their relationships. The results of the SLR indicate that dimensions that used to be considered important or seemed to be the most essential for EA, such as frameworks, EA principles and reference models, are no longer emphasised as strongly and more focus is placed on people, skills, communication and governance when considering EAM literature and EAM maturity.

1 Introduction
The term architecture is a common notion in the building/construction industry. Even in this industry, the term is not unambiguous; it could mean the art or science of design or the style of design [1]. Architecture at an organisational level is known as enterprise architecture (EA) and can be described using the four main domains of architecture, namely, business architecture, application architecture data/information architecture and technology architecture [2]. Looking at the organisation holistically, this approach focuses on both the business and technical aspects [3] and assists organisations to structure how they meet strategic objectives [4]. This approach is commonly referred to as enterprise architecture planning (EAP). The goal of EAP is to "improve the efficiency, timeliness and reliability of business information" [4], while the goal of Enterprise Architecture Management (EAM) is to maintain and manage EA after implementation [5].

Huge investments are continually made to increase organisations' effectiveness and efficiency, yet many organisations constantly find it challenging to bring strategy to execution [6]. EA is generally believed to be the solution that aligns information and communication technology (ICT) strategy and business strategy, and many organisations make substantial efforts to implement EA but neglect the efforts required to follow through with aspects related to enterprise architecture management (EAM) [7, 8]. EAM is recognised as the accepted solution by organisations to assist with strategic transformation in a rapidly changing economic, technical and regulatory environment [9], yet there is no commonly accepted understanding of maturity in EAM [9, 10]. It is consequently difficult for organisations to identify and agree on the essential components of EAM and the level of maturity that is required to be successful in managing the EA practice.

Research has provided many different frameworks, methodologies and models, but all have a generalised view and often need to be customised or require the organisation to select what is appropriate to its objectives in order to derive value from them [11, 12]. While preliminary investigations suggest that there is little research in the area of EAM maturity in information systems (IS), we cannot embark on such studies without understanding where EAM dimensions are placed within the existing frameworks and the implications when considering people, processes and technologies. For the purpose of this study, an EAM dimension is described as a measurable component of EAM that could have different maturity level associations. When these EAM dimensions are identified, questions such as the following can be investigated: What dimensions increase success in EAM? Which part of existing EA frameworks can be adapted to support EAM success? How do people facilitate EAM success? In our study, we also included the identification of dimensions that add to the challenges or failures of EAM.

While an increasing number of studies on the value and the importance of EAM and the adoption of EAM are being undertaken, there is little information on the essential dimensions and how to mature them throughout their existence in an organisation. Olsen and Trelsgard [13] argued that many organisations choose to implement an EA strategy but most fail, sharing the same EA challenges. The literature provides enough information on frameworks and methodologies for EA but little or no information on what to assess and improve in EAM to increase its maturity and to support success. Failure is often due to a lack of understanding and an unclear vision of how the different components of EAM fit together, therefore understanding the different dimensions and the level at which they need to operate is imperative for success.

To identify the most essential dimensions of existing frameworks, the following question is the focus of the paper: *What are the EAM dimensions in existing EA and EAM literature that support EAM success?*

The motivation for the research question is to separate those dimensions into what contributes to the success and what provides little or no value. In this paper, the findings from a systematic literature review (SLR) on dimensions that are essential to EAM were identified. Limited comprehensive research has been published that provides a view of the dimensions in EAM that are key to the success of EA after implementation. By starting work in this area, research should assist in determining a baseline that can be critiqued and improved as further studies are conducted. This systematic approach to identifying and analysing published studies allows for the selection of reliable literature with specific themes that present recurring or conflicting findings, as well as gaps in the existing body of knowledge.

The structure of the paper includes background information in Sect. 2, followed by the method used for the SLR in Sect. 3 and the results, accompanied by a discussion, in Sect. 4. The paper is concluded in Sect. 5.

2 Foundation
"A well-defined architecture is an important asset in positioning new developments within the context of the existing processes, IT systems, and other assets of an organisation, and it helps in identifying necessary changes" [1]. Jonkers et al. [1] continue to explain that having an integrated practice of business and information technology (IT) is necessary for understanding the impact of introducing a new product into the organisation. It may require

new people, processes and technologies to support the change; it may even require a change in organisational structure.

When EA started in 1975, it was known as business system planning (BSP), developed by IBM. Zachman's framework [14] was the first evolution of EA and introduced a framework that conceptualised architecture from multiple perspectives to information system professionals. During the 1990s, EA went through its second evolution. As a result of technological advancements and an increase in organisations wanting to digitise their business processes, it introduced a new era of complexities expanding to the different stakeholders of organisations. Today we see the next evolution of how EAs have evolved with the relevance of EAM.

Most industries find that it is a challenging task to manage EA in their organisations once implemented [10]. Every organisation experiences a set of unique challenges together with some common challenges [9, 13]. The common challenges that impede the process of moving towards a common understanding of EAM include [9, 13]:
• Executive management's understanding of EA
• Unclear EAM roles
• Ineffective communication and adoption
• Low EA maturity and governance.

Further to the common challenges are some unique ones that include socio-technological literacy and lack of process integration within the organisation or a low level of this. To gain a better understanding, these challenges need to be examined further to determine what makes them essential components of EAM. The literature provides enough information on frameworks and methodologies for EA, but limited information on what to assess and improve in EAM to increase its maturity to ensure success.

The concept of EAM is far more than just modelling. A big part of it includes the management of tasks related to planning and executing business changes from an architectural point of view [15]. EAM has many dimensions and not all may be relevant to all organisations. Understanding which dimensions are pertinent to meeting one's objectives is the key to EAM success.

There is a strong association with EAM as part of the EA project, which suggests that there is a beginning and an end to EAM, but there is another aspect of EAM, which relates to the continuous management of the functions and other relationships of EA at an enterprise level after implementation. For the purpose of this paper, we are interested in this definition of EAM. While this section aims to identify and relate to the key areas within EAM, these have not reached the maturity level required, considering their contribution to the competitiveness of enterprises [16].

3 Method
The steps detailed in this section ensured that most of the important content was included and that all steps could be repeated easily, maintaining the integrity of the research. There are many SLR approaches that can be followed [17–19]. For the purpose of this research, the phased approach to conducting an SLR was described by Okoli and Schabram [19].

This protocol was first piloted by performing searches based on rules within the protocol. Through this exercise, the pilot study uncovered a few concerns, which contributed to the

quality of the results. Changes were accordingly implemented to correct these concerns and strengthen the quality, using the guidelines recommended by Kitchenham [18], which focus on three viewpoints, namely, the population, intervention and outcomes.

Keywords were used in the SLRs to search databases in a specific academic realm. These keywords were expanded to include synonyms referring to the constructs identified for each research question.

The source selection criteria included the evaluation of all relevant electronically available scientific databases. It also included features and functionality that allowed for the use of keyword searches for abstracts, titles and citations with an advanced searching capability that allowed for the use of concatenation and truncation functions. All databases used for the searches were required to be in the English language and of an academic nature and include: IEEE Explore, ACM Digital Library, Google Scholar, ScienceDirect, ISI Web of Science and Springer Link.

Executing the search string in a database yielded a large number of articles in the resulting dataset. It was not practical to analyse each and every one of these articles, and many were deemed inapplicable to the research question of this review. This step was required to conduct an early-stage separation of articles that might have potential and those that would not contribute to the value of this SLR. This was achieved by reading through the abstract of the article and applying criteria that were either in favour of proceeding with the article or discarding it.

The quality appraisal assessment was completed for all research articles using assessment criteria and was applied to all research papers that satisfied the inclusion and exclusion criteria assessments. The inclusion and exclusion criteria, together with the assessment scoring, provided aggregated quality criteria as a guide to select quality research papers. The score alone had no bearing on the quality of the article itself. Quality was based on a combination of the criteria, the context of the paper and the score.

To ensure the reliability and replicability of this research, a set of steps were followed with prescribed data input values and templates. Following this, process and procedure yielded 45 primary studies that were used in answering the research question of the SLR, which is to identify dimensions that are vital to the success of EAM. A pre-defined search string was used within each qualifying search database. In cases where some database engines had limitations in the manner that the search string could be executed, the search string was altered to adhere to the manner in which that database required to provide a successful result. This was done in such a way that the altered search string still provided correct and valid results. The results from each database were captured individually against the respective database and then consolidated to provide a combined list of searched results.

The search results retrieved by applying the search criteria across the identified databases equated to 618 studies. Working through the exclusion criteria specified in the previous section, all duplicates were then removed. This was followed by removing any study that was listed as a book, non-English studies and non-full-text studies, based on the review of the studies' titles, abstracts or conclusions. This brought down the number of primary studies for a full review.

The primary studies that remained were then evaluated against the inclusion criteria. All studies that did not meet the criteria were moved to the exclusion list as non-related studies. By applying the exclusion and inclusion criteria, the number of studies was reduced by 473, leaving the researchers with 145 studies. Using the scoring appraisal mentioned in the previous section, each study was further evaluated and scored according to the criteria. Any study that satisfied the criteria was regarded as a selected primary study to be used to answer this SLR's research question through a critical review. After applying the quality appraisal and scoring, the total number of primary studies was reduced to 45. Once the primary studies had been identified, the data extraction process could begin. The purpose of the data extraction process was to answer the research question outlined in the section above.

4 Discussion
In-depth understanding of the EAM dimensions was acquired through the execution of this SLR. Many conclusions were extracted through synthesis of the results. For example, there is no consensus on what the exhaustive list of essential dimensions should be, but some agreement on a few dimensions. One of the key contributions from this study is that many of these dimensions have direct and indirect implications for one another. The key dimensions should be directly linked to the objectives of one's EAM mandate and a strong focus on people rather than technology for EAM to succeed. This can be viewed at a very abstract level in Fig. 1. Integration was identified as a vital dimension with the focus on people integration and process integration, tightly coupling governance and policy enforcement to these areas. EAM frameworks have lost focus or at least it is assumed that these frameworks are in place and are mature. Repositories and methodologies are becoming more important and are based on the frameworks. Communication has become more important as well. It is not enough for IT departments to understand and adopt EAM; business departments should be involved as well. Visibility is important for selling the EAM service so that value can be derived at all levels. The above analysis highlights areas for future research with a more detailed focus. Some other equally important dimensions that did not feature very often in this SLR was EAM adoption, the EAM mandate, EAM change management and the operating model, to mention a few needs to be explored further. Given that academic studies in this area are still growing, more practical case studies should be developed to test and verify the dimensions.

The paper concludes with the identification of a list of vital EAM dimensions extracted from 45 studies. The list of key dimensions is depicted in Fig. 2. Based on the dimensions identified, four categories emerged, namely, the *EAM agenda*, c*ompliance, enablement* and *transition*.
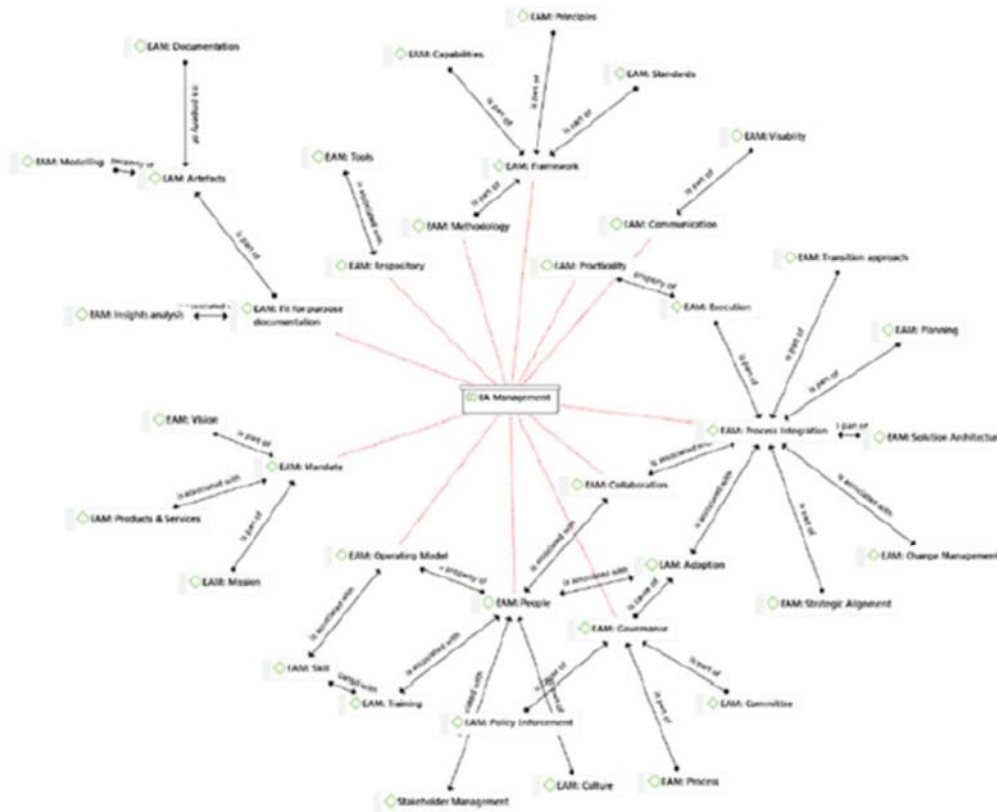
Fig. 1 EAM dimensions and their relationships

EAM Agenda	EAM Compliance	EAM Enablement	EAM Transition
• Application Architecture		• Tools	• Capabilities
• Business Architecture	• Balance Score Card	• Standardisation	• Maturity
• Mandate	• Business/IT Alignment	• Modelling	• Operating Model
• Mission	• Strategic Alignment	• Visibility	• Ease of adoption
• Artefacts	• Goals Alignment	• Insights analysis	• Stakeholder Management
• Solution Architecture	• Governance	• Maturity Models	• Practicality
• Principles	• A framework to systematically integrate	• Process Integration	• Change Management
• Data Architecture		• Documentation	• Collaboration
• Standards	• Regulatory Compliance	• Interoperability	• People
• Information Architecture	• Committee	• Outdated data	• Concern
• EA Framework	• Develop an EA strategy and metrics	• Stability	• Communication
• Skill		• Fit for purpose documentation	• Culture
• Technology Architecture	• Policy Enforcement	• Repository	• Flexibility
• EA Definition	• Quality Assurance	• Modelling: Consistency	• Modelling: Ease of use
• Framework		• Granularity	• Adoption
• Vision			• Training
• Methodology			• Transition approach
• Planning			• IT Operational Management
• Execution			• Maturity Levels
• Products & Services			

Fig. 2 List of EAM dimensions

4.1 EAM Agenda

The literature provides a huge spectrum of dimensions for the EAM agenda as depicted in Fig. 2. It is fair to assume that some of the common dimensions, such as frameworks, methodologies, principles and domain architecture deliverables, are strongly evident. Skills, on the other hand, are generally seen as something that will be developed over time.

The skills of resources in an EA team are cross-cutting and there are often small overlaps among the different domains. The expectation is then that over and above the specialist skills of a particular domain, practitioners must have good all-round experience in other domains as well. Second to skills as an essential dimension is the EAM mandate. Many organisations are still very unclear when it comes to how decisions are to be made and the processes to be followed [20]. Low integration into the organisation leads to the EAM team building ivory towers. Ultimately, this will result in the organisation not making use of EAM services, leading to the failure of the practice.

While the relevance of an EAM methodology is obvious, many problems have been identified related to this dimension including the image issue affecting EAM as a result of poor implementations of a methodology. Organisations adopt complete methodologies without aligning and adapting these to the existing methodologies in the organisation. The existing EAM methodologies are guiding principles and not prescriptions for implementation.

4.2 EAM Compliance

While it is not surprising that governance was identified as the most essential dimension under compliance, organisations do place enough focus on this area in general. However, the analysis provided a little more insight into some of the less prominent detail of governance implications. Some of these lower-level implications were EAM goals alignment, policy enforcement and process integration. There is a stronger focus on the integration between the different areas of the organisation and EAM. It is not enough to create principles, standards and policies; adoption has to be increased through awareness and socialisation. Figure 1 provides a view of the relationships with other key dimensions that are prominent in current EAM practice. Governance assists with the communication of EAM artefacts among different stakeholders. This form of communication ensures compliance and alignment between business and IT, which fall outside other existing forms of governance, such as IT and corporate governance.

Stakeholder management was the second-highest dimension identified within compliance, as well as throughout the 45 primary studies. In many of the studies, it was highlighted as an area of concern and one of the biggest contributors to EAM failure [13, 20]. Understanding who the key stakeholders from both business and IT becomes crucial for EAM, including having them participating in decision-making committees. It is clear that top management buy-in is essential for EAM, but middle management involvement is becoming equally important to drive the EA agenda. High stakeholder participation is required for improved decision-making. To ensure that stakeholder participation is engaged at the correct level, understanding the stakeholder hierarchy is crucial.

4.3 EAM Enablement

Tools and technology were always important; however, the mindset has shifted from entry-level platforms/applications such as Excel sheets and modelling tools as standalone solutions to more insight-driven, relationship-mapping software that can automatically model architectures or dynamically produce dashboards and views for quicker decision-making.

These capabilities tie into the second and third most essential dimensions in EAM enablement, namely, collaboration and fit-for-purpose documentation.

Making the information that one already has available to all those who require it is fundamental to EAM success. There is no benefit in putting full effort into recording and documenting architectural information if it is not available for use. Not being able to use information was noted as one of the most common problems experienced, as no one knows where or how to find the relevant information. On the other hand, one might be able to find what one wants, but it is not at the right level of detail. Finding the balance of relevant information for each stakeholder is key to understanding that tools should not be adopted to provide something new, but rather enhance the existing process to satisfy information needs, which will lead to long-term success [21].

4.4 EAM Transition

As with EAM compliance, stakeholder management is an important dimension of EAM transition. Understanding the stakeholder hierarchy and its needs is a concern identified through the SLR. It is necessary to satisfy stakeholders' needs while providing the value that is required by EAM. To affect culture change, a combination of EAM agenda requirements comes into play. These can be described as policy enforcement, rewards and recognition, support, training, awareness programs, roadshows, etc. Communication and marketing become essential for driving buy-in across the organisation. Educating the entire organisation assists in working towards the same goal; this ties in with goal alignment dimensions in the EAM agenda.

Communication was identified as one of the key challenges in EAM. This stems from the lack of a shared dictionary [22]. Every area of the organisation develops key/common terms in its respective realm. Often stakeholders, EA practitioners and IT personnel assume that these terms are also common outside their area. This leads to misunderstanding and misalignment of outcomes and objectives. Communication extends further than this, as it touches on everything EA practitioners do, including communicating the services they provide so that the rest of the organisation is aware of them and more importantly, makes use of them. If the EAM team is not providing a service to satisfy a particular stakeholder's needs, it is seen as ineffective in the organisation, which ultimately leads to its demise.

5 Conclusion

In this report, the findings presented were based on the SLR identifying the key dimensions considered essential for EAM success. These dimensions with their relationships are depicted in a concept map, which is the main contribution of the study. Since the inception of EA and EAM with their associated frameworks and methodologies, no research results have been published that provide a view of what the key dimension for EAM success is. By initiating work in this area, this research should assist enterprises in understanding their current state of EAM and focus on key dimensions, which could accelerate the maturity of EAM.

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