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A Literature Review on Enterprise Architecture: Towards a Research Agenda

Sharmistha Kar[a], Rahul Thakurta[b,*]

[a] *Ph.D., Scholar, Information System, Xavier Institute of Management, XIM University, Bhubaneswar, India*
[b] *Associate Professor, Information System, Xavier Institute of Management, XIM University, Bhubaneswar, India*

A B S T R A C T

Enterprise Architecture and its management focuses on the integration of business processes and IT infrastructure, and have received considerable attention from the academic and the practice audience. Despite this attention, some lacuna can be observed that questions some of the fundamental pillars of the domain. The current business environment demands in the response to digitalization add to further challenges which call for the need to reconceptualise enterprise architecture to be relevant to the emerging context. We respond to this call by presenting a comprehensive review of the literature concerning enterprise architecture and management to facilitate future work. Our review revealed various facets related to enterprise architecture and enterprise architecture management which we present and discuss here. Further, we also chart out possible areas of future explorations. By doing so, this research lays a foundation for continuing inquiry on enterprise architecture and management, contributing to new knowledge for the field.

Keywords: Enterprise Architecture, Enterprise Architecture Management, Literature Review

Ⅰ. Introduction

Enterprises are changing the way they conduct their business activities with information technology (IT) assuming an integral part of the business processes (Da Xu, 2011; Vargas et al., 2016). The presence of multifarious information systems (IS) catering to the diverse requirements of an enterprise, however, has resulted in complexity (Bellman and Rausch, 2004; Da Xu, 2011). Hence there is a need to define these IS and their relevance in a less complicated way as those systems that are more aligned with the organizational goals have been adopted successfully in enterprises (Bernaert et al., 2014; Law and Ngai, 2007; Petter et al., 2013). Enterprise Architecture (EA) is a blueprint for the alignment of IT and business management practices to enable enterprises to get maximum utility out of existing sys-

*Corresponding Author. E-mail: rahul@ximb.ac.in

tems (Langenberg and Wegmann, 2004). Enterprise Architecture (EA) is used by enterprises for providing an integrated environment to support the alignment of the enterprise's business and information technology (Clark et al., 2012; Šaša and Krisper, 2011). EA span over people, processes, systems and technologies of an enterprise and represents their relationships with one another and the external environment. The purpose of EA is to represent the status of the organizations' working structure including business strategies, information systems and its underlying required resources, application systems, and technological structure so that the gaps and weaknesses in their functions can be identified, and future actions planned (Bernaert et al., 2016; Dang and Pekkola, 2017a; Rouhani et al., 2015). EA centres around business, technology, data, and application architecture and their integration (Kappelman and Zachman, 2013). Consequently, EA has been important to the two specialists and professionals (Niemi and Pekkola, 2016), just as since it has a different application in an undertaking (Balabko and Wegmann, 2006).

In the last three decades, significant numbers of academic and practitioner writings have been published on topics such as Enterprise Architecture, its value and benefits (Ross et al., 2006), EA frameworks (Fischer et al., 2007; Zachman, 1987), the developing process of an Enterprise Architecture (Lankhorst, 2009), and how to describe and model architectural aspects (Antunes et al., 2015; Jonkers et al., 2006; Steen et al., 2005) and other related aspects of EA (Kotusev et al., 2015a). However, despite so much of enthusiasm around EA and management, some publications report fundamental issues related to extant research. For example, Foorthuis et al. (2016) report the absence of explanatory theories and lack of studies that establish whether IS projects effectively utilize EA theories in practice. Kotusev (2018a) concludes that despite a legacy, the domain of EA still lacks empirically valid conceptual models accurately describing what EA is and how EA works in successful EA practices. This has resulted in several EA endeavours (e.g., Bischoff et al., 2014; Gill, 2015; Hanschke et al., 2015; Mueller et al., 2013; Nakakawa et al., 2013; Taleb and Cherkaoui, 2012; Zadeh et al., 2012) to resort to structures (e.g., say TOGAF), whereas the extant evidences do not provide empirical examples on how implementations following such structures are realizable. Besides, with the rapid revolution in technology, modern organizations are facing challenges to cope up with the complex and dynamic needs of their business environments. The new technologies of the Internet of Things (IoT), cloud computing, ubiquitous computing, and cognitive computing represent the potential signs of a modern enterprise today, and organizations must survive in the complex world of these technologies (Zimmermann et al., 2015). The current business environment demands in the response to digitalization have made enterprise architecting even more challenging (Korhonen and Halén, 2017). Berman (2012, p. 17) defines digitalization as "*a set of complementary activities – reshaping customer value propositions and transforming their operations using digital technologies for greater customer interaction and collaboration*". Yeow et al. (2018) attribute this development to the rapid internal (organizational) and external environmental changes that organizations need to navigate through. These changes have several implications on how IT is viewed, and how operations and processes are designed. The existing approaches to EA addressing integration and coherence are found to fall short in the face of complexities of digital ecosystems. These observations and the developments appear problematic, and researchers have called for the need of reconceptualization of EA to

be appropriate to the emerging context (Korhonen and Halén, 2017; Kotusev, 2018a). These advances will base on the present understanding of EA and the ensuing trends. While the literature related to enterprise architecture and management is rich and mature, an up-to-date and comprehensive review of the domain incorporating the new developments and trends can be useful to facilitate future theoretical work. This is particularly important given the positive impacts of EA practice and on-going practitioners' interest. As such the goal of this study is threefold: (1) to present a review of the literature concerning enterprise architecture and management, (2) to synthesize the findings of these studies, and (3) to chart out possible areas that could be addressed in future research.

The paper is organized as follows: In the next section, we present our review method. The findings from the review are described next where we discuss the dominant themes along with our observations related to enterprise architecture and enterprise architecture management literature. In the subsequent section, based on the literature findings, we outline some of the research possibilities. In the final section, we provide a summary of the presentation, state the contributions, and also acknowledge the limitations of the design.

Ⅱ. Review Method

We initiated our search for academic literature on enterprise architecture and management based on queries in the Google Scholar search engine. We resorted to the keywords: 'Enterprise Architecture', 'Enterprise Architecture Management' in our search. The queries result gave us an insight into the broad range of publications and sources on the subject. Further, the number of records returned by the query is enormous (around 2,610,000 results related to publication related to Enterprise Architecture as of October 2020). To narrow down, we shortlisted the databases listed below for our search. These databases were chosen as they provide coverage to relevant outlets related to enterprise architecture and management (Rouhani et al., 2015).

- ACM Digital Library (http://portal.acm.org),
- IEEE Xplore (https://ieeexplore.ieee.org/Xplore/home.jsp),
- Science Direct – Elsevier (http://www.elsevier.com),
- Springer Link (https://www.springer.com/),
- Taylor and Francis (https://www.tandfonline.com/)

We specified the starting year of the search as 1987, which marked the year of introducing one of the most influential EA contributions: the Zachman Framework (Zachman, 1987), which revolutionized the domain of EA. We employed the following checklist for the screening of the articles:

- The article has been written in English.
- The article is accessible and describes issues that are meaningful and intuitive to follow.
- The article has been cited by others unless it is a very recent article. We assume that a work cited and used by others is a hint of its usefulness.

The potential studies relevant to our research were identified based on applying the screening criteria on the candidate articles returned by running the keyword-based search queries as indicated above. The results of the queries gave us an insight into the wide range of publications and sources on the subject. Furthermore, we also checked other sources like books, thesis, and websites whenever specific

contents referred to these sources (as obtained from the citations) concerning enterprise architecture and management concepts. We excluded editorials, prefaces, summaries of articles and tutorials, workshop proceedings, and panels and poster session contents as these may not include enough details relevant to our research and may not be peer-reviewed. It was not possible to provide a definitive, all-inclusive review of every publication published in the concerned field of research. The search carried out in this manner resulted in over 1,000 articles, excluding duplicates. The contents of the articles identified in this manner were further manually screened for appropriateness. The screening process involved a manual inspection of titles, and if unsure, the abstracts to determine whether the concerned document was addressing enterprise architecture and management related issues. If the same was still not clear, we further analysed the content of the published document in search of evidence. This process led to a shortlisting of 56 articles for a detailed review.

To analyse the vast literature, we resorted to the concept matrix approach (Webster and Watson, 2002). A blank Excel file was used to develop the concept matrix. The concepts were recorded column-wise for each paper (recorded row-wise). This was synthesized at the end leading to the findings from the study which we discuss in the next section. Our overall review process is summarized in <Table 1> below.

<Table 1> Review Process Snapshot

Specifics	Details
Search Descriptors *(Search for published content based on the criteria adopted)*	Data Sources: ACM Digital Library, IEEE Xplore, Science Direct – Elsevier, Springer Link, Taylor and Francis Keywords: Enterprise Architecture, Enterprise Architecture Management Metadata fields: title, abstract, and keywords Search Coverage Duration (Years): 1987 onwards Additional Sources Referred (based on citation evidence): Books, Thesis, and Websites
Screening Criteria *(Screening conditions specify the inclusion and exclusion basis and is used to screen content returned from the searching process)* No of Articles: over 1000 (excluding duplicates)	Basis for Inclusion: • The article has been written in English. • The article is accessible and describes issues that are meaningful and intuitive to follow. • The article has been cited by others unless it is a very recent article. We assume that a work cited and used by others is a hint of its usefulness. Contents Excluded: Editorials, prefaces, summaries of articles and tutorials, workshop proceedings, and panels and poster session contents.
Shortlisting Criteria *(Finalizing articles for detailed review based on the appropriateness)* No of Articles: 56	Manual Inspection of • Article Title • Article Abstract • Article Introduction and Conclusion and/or Relevant Sections
Analysis Approach *(For analysing the shortlisted articles)*	Concept identification and tabulation following the concept matrix approach (with concepts recorded column-wise, articles recorded row-wise)

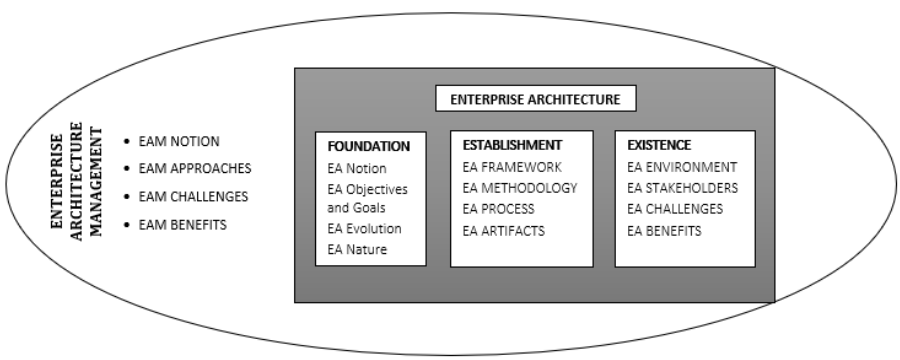
Ⅲ. Findings

Here we present various facets related to enterprise architecture and management based on evidence from the extant literature. <Figure 1> presents the dominant themes relating to enterprise architecture and enterprise architecture management, following which we have structured our findings. The literature addressing enterprise architecture has addressed various aspects which conceptually relate to the foundation, establishment, and existence of enterprise architecture. Within the foundation, we discuss evidence relating to the understanding of enterprise architecture, objectives and goals, and its nature and evolution. By establishment, we imply instituting enterprise architecture, within which we combine enterprise architecture framework, methodology, process, and artifacts related evidence as the figure depicts. Finally, we integrate the enterprise architecture environment, stakeholders, challenges, and benefits under the umbrella term existence to imply how enterprise architecture relates to its surroundings. The three conceptual segregations into foundation, establishment, and existence are purely from an explanatory perspective to enable readers to perceive the occurrence of the respective themes within the figure that constitutes this review. Accordingly, we do not further discuss these three entries in the contents below. Enterprise architecture management broadly relates to managing the enterprise architecture, thereby subsuming it as per the representation in the figure. The evidence relating to enterprise architecture management presented in this section relates to the notion, approaches, benefits, and challenges, as described below. Following this diagrammatic representation, we first present the review on enterprise architecture and then address enterprise architecture management in the subsections below.

3.1. Enterprise Architecture

3.1.1. Notion of Enterprise Architecture

An architecture presents the view of the entire city plan and does not just consider the architecture of a house building, similarly, an enterprise architecture (EA) provides the view of the entire IT landscape of an enterprise and does not consider a single information system architecture (Rohloff, 2005). Even though EA conceptually is an integrated view of architectures of four different domains i.e., business architecture, information architecture, application system architecture, and technology architecture, there is still no uniform interpretation of EA (Jonkers



<Figure 1> Dominant Themes relating to Enterprise Architecture and Enterprise Architecture Management

et al., 2006; Saint-Louis and Lapalme, 2016; Tamm et al., 2011). EA has been described and defined in various ways (Saint-Louis et al., 2017). In <Table I> (<Appendix>), we provide a listing of the various definitions following the chronological order. While some consider EA as a description of the enterprise, some present it as a set of guidelines and designs for the construction of a potential enterprise, and many others view it as an evolution plan from current to future states. Moreover, some judge EA equal with IT architecture, while many others attribute EA as a tool for providing an overall architecture of an enterprise or an approach for planning and running the business, facilitating management with knowledge about the enterprise, and is instrumental in implementing business strategies (Kappelman, 2007). It is also understood as a taxonomy, a methodology, a master plan, or perhaps a combination of all three simultaneously (Dang and Pekkola, 2017a). The description of EA from 1990 onwards has evolved from the term architecture, blueprint, structures, model, framework, tool, management practice, analytical methodology, technology, instrument, structured descriptions and documentation, representation concept, organizational logic, etc. in its various representations (Buchanan and Soley, 2002; Dang and Pekkola, 2017a; Gartner and Bellamy, 2008; Wegmann, 2002). Although EA has been documented in different terms, it is broadly a description of an enterprise from the perspective of interoperability and interrelationship of the components of an enterprise such as strategy, business processes, and technology (Dang and Pekkola, 2017a; Goethals et al., 2006; Janssen and Estevez, 2013; Lemmetti and Pekkola, 2014). Further, from the conceptualizations, we also observe that EA has been described both as a noun and as a verb. EA behaves as a noun when it is defined as the blueprint of an organization and delivers artifacts like models, principles, guidelines, and standards to the enterprise. EA behaves as a verb when it is presented as a set of activities to document the current and future state and facilitate in transition effort from existing to target state (Lapkin et al., 2008).

3.1.2. EA – Objectives and Goals

EA has emerged as a management discipline with objectives to enhance integration and standardization of varied systems, improve IT-business alignment, growth, stability, reduce complexity, create effective IT management process, and to aid value to the organization in terms of tactical planning, innovation, and efficiency (Syynimaa, 2013). The objective of the EA effort is to create a coherent structure of the organization using systematic approaches (Armour et al., 1999; Riege and Aier, 2009). Creating a documented structure facilitates viewing the present status, understanding weakness, and suggesting desired remedies. As such, EA expects to create a suggested future condition of the organization's business processes and IT systems and to give an arrangement to achieving this objective from the present status (Lange and Mendling, 2011). The objective of EA is to guide the establishment of the organization's operating platform with the IT systems and digitized business processes to enhance the organization's core capabilities (Hiekkanen et al, 2013; Ross et al., 2006). Schöenherr (2008) notes that EA aims at bringing business requirements in harmony with IT assets, reducing costs involved in IT and business processes, standardization and optimization to improve project management activities of project delivery, decision making and agility to add flexibility, risk management, and governance. According to the author, EA is the reason behind improving the competitiveness

and reducing complexity in an enterprise. Tamm et al. (2011) record that the objective of EA is to provide a perspective plan of integrated business processes and IT systems, and to describe the enterprise-wide vision in greater detail. Janssen and Estevez (2013) indicate that the objective of EA is to serve as an instrument to tackle the complex relationship of heterogeneous components of the organization by aligning IT with business functions effectively and strategically. Lemmetti and Pekkola (2014) state that EA focuses on improving the interoperability and efficiency of both homogenous and heterogeneous IT systems.

The domain of EA has evolved over years with a broad range of uses and purposes (Kappelman, 2009; Lange and Mendling, 2011; Lankhorst, 2009; Op't Land et al., 2008; Ross, 2003; Schöenherr, 2008). The goals of EA, as documented in the extant literature are summarized below:

- To improve business-IT alignment - The key role of EA is to develop the entire view of enterprise resulting in effective business-IT alignment. This eliminates redundancy (Castellanos et al., 2011) and reduces complicity and realizes the benefits like cost savings, risk management, and increased reusability of resources, etc. (Minoli, 2008; Roth et al., 2013; Tamm et al., 2011). EA is responsible for improving overall organizational functions (Kappelman, 2007).
- To enhance managerial decision-making capability- The consistent alignment of IT assets with business strategies improves the organization's core activities and allow the organization to know its state well and improve capabilities (Braun and Winter, 2007)
- To continuously evaluate IT Infrastructure- EA practices continuously evaluate IT resources and analyse the gaps. Consequently, EA improves the IT infrastructures (Andersen et al., 2015).
- To provide opportunities for innovation - EA is a methodology of preparing plans of how IS will resolve future problems. It implements change in organization for improvements and provides opportunities for innovation within a business strategy (Gilliland et al., 2015; Tamm et al., 2011).
- To build effective IT management- The Clinger-Cohen Act in 1996 mandated federal agencies to use IT architecture and prescribed the uses of EA for its benefits in risk management, save costs, increase IT receptiveness, increase organization contentment, and optimize resource management (Salmans and Kappelman, 2010).
- To bridge the gap between business and technology – A goal of EA is to identify the gap between business and technology and provide solutions (Doucet et al., 2009).
- To improve strategic competences- Huge IT investments are done to fulfill the organization needs. EA provides the tool to effectively align IT with business strategy. This results in optimizing IT investments and resource management (Doucet et al., 2009; Wegmann, 2002), and can facilitate in gaining strategic competences and business value for the organization (Ross et al., 2006).
- To effectively handle change management- Another goal of EA is to handle change management. EA translates and converts the planned requirements into systems, data, and technology and provides a detailed view of the organization (Tamm et al., 2011).
- To increase system integration and standardization- EA creates consistent and integrated IT settings for business processes, thus increases system interoperability and overcome the issues

of system incompatibilities (Boh and Yellin, 2006; Minoli, 2008; Richardson et al., 1990).

- To overcome system complexity- EA resolve the problem of system complexity (Sessions, 2007) via presenting a transparent view of IT architecture and its relationship with the business process (Schekkerman, 2004).
- To focus on engineering and transformation of the enterprise- EA facilitates in engineering and create system designs and structures for control over complex systems (Hoogervorst and Dietz, 2008).

3.1.3. History of EA Evolution

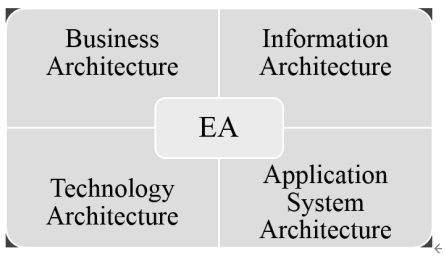
The EA concept and practices have spanned across academic and practitioner domains, and ranging across government, public and private organizations (Dang and Pekkola, 2017a). EA discipline has emerged from both business and IT perspectives (Winter and Fischer, 2006) and has originated from the Business Systems Planning (BSP), a methodology introduced by IBM in the 1960s for managing organizational functionalities and information systems along with IT (Kotusev, 2016b). BSP information systems plans depict the connections between organization, business processes, data, and information systems. It makes use of relationship matrices, information systems networks, flowcharts, and other procedures to represent systems, processes, and data (Kotusev, 2016b). In 1986, PRISM (Partnership for Research in Information Systems Management) research service of Index Systems and Hammer and Company introduced the PRISM EA framework. It aimed at portraying an architecture of distributed systems (Rivera, 2013). In the following year, John Zachman introduced the popular Zachman framework which he published in the IBM Systems Journal (Zachman, 1987). While it is claimed that the Zachman Framework is the first important EA publication that profoundly influenced the EA discipline, the framework is limited to architecture and does not provide a methodology for strategic planning. The NIST EA model was implemented by the National Institute of Standards and Technology (NIST) in 1989. The architectural definition is grouped by NIST EA into five separate architectural levels, such as the business unit, information, information system, data and delivery system.

In 1992, Steven Spewak introduced the first methodology for implementing EA which he termed as the Enterprise Architecture Planning (EAP) (Spewak, 1992). A similar approach for federal agencies was adopted at around the same time by another public agency, the Government Accountability Office (GAO). The best practises learned from top private and public entities have further strengthened the EAP. In 1994 the Technical Architecture Framework for Information Management (TAFIM) was published by Defence Information Systems Agency (DISA) to accelerate the delivery of information systems, reduce costs, and promote integration and flexibility (Buss and Shillabeer, 2012; Kotusev, 2016b). Following the Clinger-Cohen Act in 1996, TAFIM was replaced by the Command, Control, Computers, Communications, Intelligence, Surveillance and Reconnaissance (C4ISR) framework (C4ISR, 1997) (Levis and Wagenhals, 2000), which was subsequently replaced in 2003 with the Department of Defence Architecture Framework (DoDAF) (Goikoetxea, 2007; Schekkerman, 2004). In 1995, the Open Group introduced the "The Open Group Architecture Framework (TOGAF®)" standard (Bhagwat, 2009; Haren, 2011). In 1999, the Federal CIO Council introduced the Federal Enterprise Architecture Framework (FEAF) (Council, 1999). In 2005, the Gartner Framework was released. The

framework involves assessing the existing architectural state, defining objectives to build a future state, and managing the enterprise constantly during the process (Bittler and Kreizman, 2005).

3.1.4. Nature of EA

Enterprise Architecture describes the entire set of business processes in a comprehensive manner and defines how information technology integrates the various subsystems, strategies, technologies of the business to realize the mission and vision. As shown in <Figure 2>, the core architecture of EA contains the Business Architecture, Information Architecture, Application System Architecture, and Technology Architecture, and presents a holistic view of the enterprise (Salmans and Kappelman, 2010; Winter and Fischer, 2006). We discuss these architectures below:



<Figure 2> Core Architecture of EA

Business Architecture: This describes the business process and operation of an enterprise, its prospective strategy, the technological settings, and the interaction with the environment. It also focuses on the associations of the different stakeholders including the public and private agencies, regulatory and standard making committees, customers, employees, stockholders, etc. Business architecture is used to devise competitive structures and processes, leverage the strength, and identify prospective investments that would advance the enterprise mission and drive innovation (Rohloff, 2005).

Information Architecture: This focuses on the application systems like the cognitive intelligence system, management information systems, database system and analytics, that put the information needs along the line of enterprise's needs. This represents the planning of the system architecture, data architecture, and computer architecture. It specifies the information storage and how to access it efficiently. Information architecture maintains the availability, consistency, and quality of rapidly growing volumes of information (Rohloff, 2005).

Technology Architecture: It is associated with the technical principles, and designs the technology platform for the distribution of data and applications. It presents all the physical equipment and logical entities (software) that build the technological infrastructures for the other architectures. Technology architecture blends new and existing technologies to provide accessibility, security, availability, and reliability (Rohloff, 2005).

Application System Architecture: It presents all the application systems of an enterprise. Applications architecture describes the properties, interrelationships between applications operating in an organization and their interactions with data, business functions, and the other entity who uses them (Rohloff, 2005).

3.1.5. EA Process

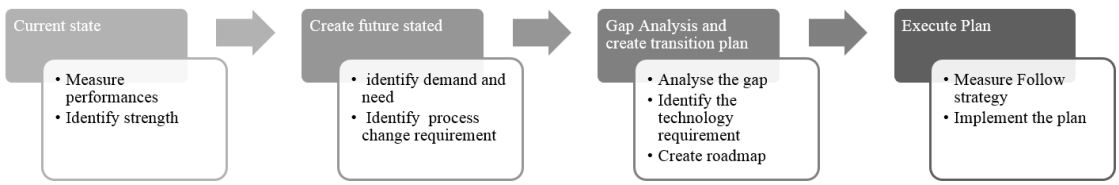
The EA process comprises a set of activities to establish an EA endeavour (Bakar et al., 2015). The EA establishment process can be categorised into three divisions: *(1) EA decision making, (2) EA delivery, and (3) EA conformance.* In EA decision-making activ-

ity, all changes or modification in existing EA is planned or new EA is approved. (Van Der Raadt et al., 2008). The EA delivery activity is responsible for developing EA models, principles, and guides EA decision making. The EA delivery does the validations of projects and operational changes, checks conformity with the EA, and facilitates in implementation of EA architectures and principles. The EA conformance activity executes and implements the changes through the solutions design prescribed in the desired architectures, comply with EA principles, and reviews the utility of the EA products (Van Der Raadt et al., 2008).

Several authors and vendors agreed with the sequential process of EA methodology and proposed their own EA development process with variations (Bernard, 2012; Haren, 2011; Spewak, 1992). The EA process is depicted in <Figure 3> and indicates a sequence of four activities. In the first stage, the business process and IT landscape are documented with models, blueprints, and diagrams. The current state is documented with identifying how IT is being used in the organization and what technologies are deployed and how much business value it is providing. In the second stage, it is determined whether any new plans being initiated or implemented that involves IT resources. Then what future state would be after implementing new plans is documented. The desired business processes from the IT perspective are described according to the enterprise's strategy and objective. In the third stage, a gap analysis is conducted between the two future states that identifies the deviation between the two i.e., to understand the difference between where the organization is heading and where it is supposed to be. Then a plan for the transition from an existing state to a potential state is developed to decide how the information system needs to be implemented to transform the enterprise to its targeted state. Lastly, in the fourth stage, the plans are executed and necessary IS are implemented. The process is continuous and iterative and the same sequence of activities is carried for analysis and decision making (Kotusev et al., 2015b).

3.1.6. EA Artifacts

Various EA objects such as EA principles, EA models, technology reference models, business capability models, guidelines, roadmaps, landscape diagrams, solution overviews and solution designs are developed as a part of the EA development process (Kotusev, 2017; Lemmetti and Pekkola, 2014). The purpose of these artifacts is to validate the structured view of the entire enterprise, to understand the business strategies and drivers, to link all the components together (Oracle, 2012). EA artifacts are also instrumental in enabling effective decision-making and IT planning in organizations. EA artifacts are important for the various stakeholders involved in strategic decision-making and implementation of IT systems. We describe the artifacts below:



<Figure 3> Enterprise Architecture Process

- The Principles artifact represents the business-focused standards policies that significantly influence business and IT entities. Principles are the classic artifacts that evaluate and conforms business and IT decisions according to established principles. Principles represent the IS planning documents.
- EA models serve as an abstraction of the structure of the enterprise in its current state. Rather than modifying the systems in the current architecture, these models demonstrate the mapping from the current state (AS-IS) to the future state (TO-BE) and thus serve as a valuable aid to communication and decision making (Buschle et al., 2010). EA models serve as aids for planning, analysis, communicating, and documenting EA architecture (Ghani et al., 2010; Johnson et al., 2014).
- Technology reference models (TRMs) are the technologies, applications, and other reference models that are used in all IT projects. TRMs are developed and reviewed by architects to achieve the technological consistency of the IT landscape.
- Business capability models (BCMs) presents views of whole organizational business capabilities. BCMs are useful in assessing the strengths and suggest best practices for accomplishing desirable business outcomes.
- Guideline artifacts prescribe the best practices that are followed in all IT projects in the respective technology domains TRMs are concerned with technologies to be used, while guidelines prescribe its usage.
- Roadmaps present the structured views of target states of the IT environment. Roadmaps are developed by both architects and senior executives. Roadmaps propose a plan for IT initiatives, IT investments, and initiate IT projects.
- Landscape diagrams represent the dependencies between various applications, databases, platforms, systems, and business processes. For instance relational diagrams, UML models, landscape diagrams are very useful in planning.
- Solution overviews are designs and solution architectures that describe IT projects and about expected business value, costs, risks, and duration.
- Solution designs are high-level designs or the detailed designs that describe IT projects in detail.

3.1.7. The Enterprise Architecture Framework

The Enterprise Architecture Framework (EAF) is defined as a structure to develop and use comprehensive enterprise architecture (Rohloff, 2005). The EA framework defines, organizes, and structures technology and application and other requirements in support of an enterprise's strategic goals. The ISO/IEC/IEEE 42010 standards define an architecture framework as "*a skeleton of conventions, principles and practices for the establishment of architectures within a specific domain of application and/or community of stakeholders*" (ISO/IEC/IEEE, 2011). The EA framework is used to establish an EA and provide standard terminology for discussing, documenting, and practicing EA, and also addressing the weaknesses or inconsistencies in an organization (Hanschke, 2009; Urbaczewski and Mrdalj, 2006). EA frameworks organize conventions, principles, artifacts, processes, templates, and reference models that are much useful to stakeholders (Hanschke, 2009). The EA Framework connects all the software development processes within the enterprise and represents how they relate and interact to accomplish the enterprise's mission. The framework supports integration between business processes and technology and structures them to support to achieve the

enterprise's strategic direction. The EAF is used for (i) documentation, (ii) design, and (iii) analysis (Fischer et al., 2007). EAFs assist managers to understand and assess the organization's assets, performances, and production, and guides in decision-making.

An EA framework comprises of basic elements, which ensure that EA programs are complete and effective. These elements establish convention and contribute to the development of shared perspectives, commitments, or common paths for interoperation (Armour et al., 1999; Janssen and Estevez, 2013; Mondorf and Wimmer, 2016). Janssen and Estevez (2013) identified the four basic elements as follows: (1) *Architecture principles* describe strategic directions and guide information system design, (2) *Architecture guidelines* determine recommended practice with some degree of freedom, (3) *Standards* or well-defined specifications establish commitments across organizations, and (4) *Common frameworks* provide an analytical structure to develop architecture outcomes.

Several frameworks have been proposed in the literature with each having its constituent deliverables, processes, and participants. EAFs vary according to different needs of stakeholders (Schekkerman, 2004). These frameworks are categorised into different sub-domains which are further divided into business architecture representing the business operations, information architecture representing the information and its storage description, and technical architecture detailing the technology infrastructures (Salmans and Kappelman, 2010; Spewak, 1992). Each framework defines its own EA establishment process. While many of these frameworks address similar objectives, some have been customised to address specific concerns. There are over 90 EAFs in the literature or on the web (Kaisler and Armour, 2017). Among these, the following has been popular: 1. *The Zachman framework* (Zachman, 1987), *2. The Technical Architecture Framework for Information Management (TAFIM)* (TAFIM, 1996), *3. Department of Defence Architecture Framework (DODAF)* (DoD, 2009), *4. The Open Group Architecture Framework (TOGAF)* (Haren, 2011), *5. Federal Enterprise Architecture Framework (FEAF)* (Kotusev, 2016b; Nikpay et al., 2017), *and 6. Gartner Framework* (Bittler and Kreizman, 2005).

3.1.8. EA Methodology

The Enterprise Architecture methodology specifies the techniques followed to implement EA. EA methodology includes all aspects of the EA lifecycle right from preparing the project schedules and planning, the identification and analysis of business requirements, creating the design of systems, the evolution of systems, and the ongoing augmentation of all of the above. The EA methodology complements the EA framework by utilizing models for developing the required infrastructure for the enterprise (Rouhani et al., 2015). The methodology serves as a rational guide for professionals. It is both complete and specific, allows intended content to be selected and tailored for application on specific projects. We summarize some of the methodologies documented in the literature below.

Spewak (1992) propose the Enterprise Architecture Planning (EAP) methodology for implementing EA (Behrouz and Fathollah, 2016; Spewak and Tiemann, 2006). By considering the four EA architectures of Business, Data, Application, and Infrastructure, EAP defines the processes for presenting the future architecture. As the main driver, EAP focuses on the business task, then on the information needed to accomplish the task, the applications generated using that information, and finally the technology

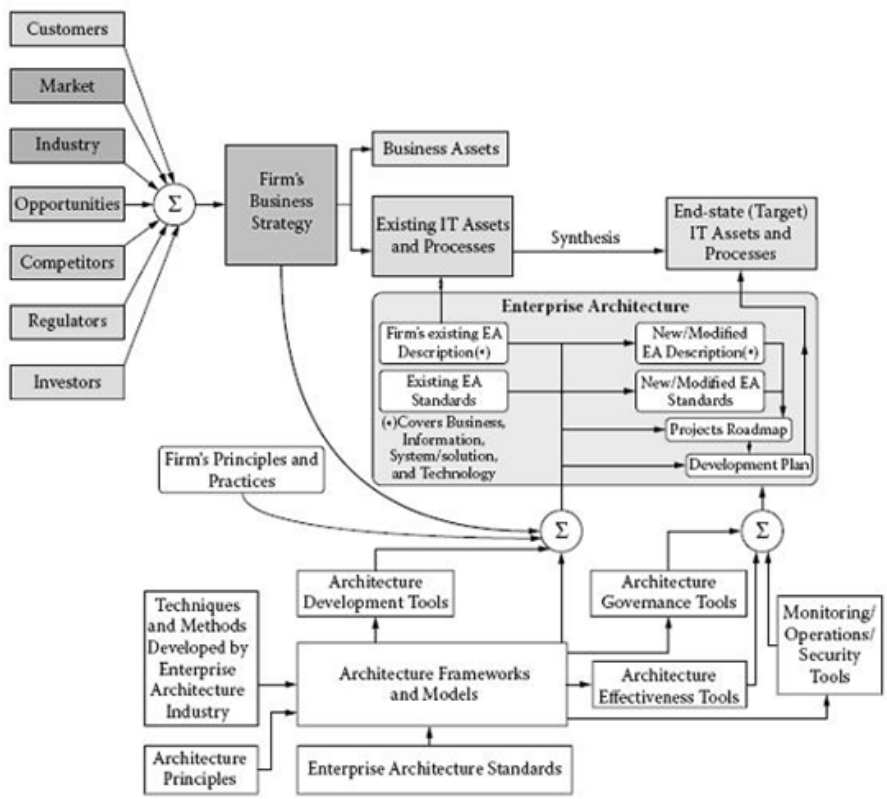
to execute the applications (Rouhani et al., 2015). EAP prescribes a series of steps to practice EA in any organization as follows: 1. Describe the current state. 2. Design the desired future state. 3. Identify and analyse the gaps between the existing state and desired states. 4. Plan the implementation set up. 5. Execute the plan (Spewak, 1992).

Chen et al. (2010) describe a methodology that integrates the service-oriented enterprise system development framework and an instantiated design process model based on an action research case study with a Fortune 50 company belonging to the financial services sector. The methodology is intended to support the engineering of enterprise-wide service-oriented systems, also referred to as service engineering.

Nogueira et al. (2013) propose a methodology to support and facilitate the implementation of the business, system and technology models of the Zachman framework. The proposed approach aims to address EA problems created by inadequate cooperation between EA and stakeholders in the organization. In doing so, the work enhances the guidelines for enterprise architecture with collaborative activities to allow efficient execution of tasks based on collaboration.

3.1.9. EA Environment

EA environment consists of a comprehensive view of EA and its setting. Minoli (2008) presents a representation of the EA environment which we have reproduced in <Figure 4>. The part of the figure on the left hand represents the external entities that



<Figure 4> Macro View of EA Environment (Minoli, 2008)

can drive a corporation. These include the clients, the business, the sector in which the company is based, the possibilities that may exist or may grow, and rivals, regulators, and investors, etc. A firm responds to its external environment through its business strategies. The firm also has an existing range of assets for business and IT. The aim is to build the IT infrastructure to help and promote the business strategy of the target IT environment. The organization may have developed an enterprise architecture for this purpose, which is a blueprint of its environment for information, processes, and technology. This blueprint defines the principles and standards for standards for hardware and software, standards for protocols, norms for interfaces, etc. The firm may have developed the architecture using the structures of the industry seen in the figure's lower end. These include techniques and methods of the IT industry to establish enterprise architecture; principles of architecture; norms of the IT industry; frameworks and models; and tools for architecture creation. EA considers the existing IT assets, the existing EAs and its standards, principles and practices, the desired business strategy, and the available frameworks to develop new EA or modify the existing one. The consequence of this synthesis is a collection of new IT techniques, a new or modified EA, a new or modified set of standards, a strategy to define the IT projects that need to be effectively implemented and to achieve the desired state (Minoli, 2008).

3.1.10. Stakeholders in EA

The stakeholders associated with EA are the individual or board members of the organization that are directly or indirectly involved in the EA venture (Van Der Raadt et al., 2008). According to IEEE standard 1471-2000, "*a stakeholder is a person, team, or organization with interests in an EA*" (IEEE, 2000). This means stakeholders are the individuals or entities involved in EA right from its inception to its completion (Nikpay et al., 2017). The stakeholders play a crucial role in the EA process and outcome (Niemi, 2007; Van der Raadt et al., 2010). Typically EA stakeholders include senior management, program and project managers, software architects, and enterprise architects (Van Der Raadt et al., 2008). Niemi (2007) identifies various stakeholders in individuals or groups associated with EA in various roles and responsibilities which we have listed in <Table 2>.

<Table 2> Roles and Responsibility of Stakeholders Source (Niemi, 2007)

Stakeholder Category	Roles & Responsibilities
Applications Developer	The developer creates applications using architectures. They also produce architectural documents while constructing applications.
Architect-Enterprise, Solution & Technology	Responsible for analysis, planning, and development and maintenance activities in their respective domain architectures.
Architecture Board	Formulate strategic planning and define principles of EA. These stakeholders are highly involved in the evaluation and assessment of EA success.
Architecture Group	Involved in requirement analysis and EA planning. Conducts EA, development, maintenance, and operational management of the organization.
Board of Directors	These stakeholders are associated with EA in decision making, approval, and management activity.
Business User	Provides business requirements for EA work and sometimes uses the EA products for carrying out their daily work.

<Table 2> Roles and Responsibility of Stakeholders Source (Niemi, 2007) (Cont.)

Stakeholder Category	Roles & Responsibilities
Competitor / Other Company	Uses the organization's EA and sometimes refers to EA for its own EA development work or defining framework.
Customer	Provides feedback and requirement.
Development Project Team	Responsible to plan architectural layout and establishment in the project area, ensures conformity between project outcomes and EA.
Enterprise Architect	Describes the organizations' business functionalities, its properties, and the relationships between business processes within and outside the boundaries. Enterprise architects ensure that the whole enterprise architecture has integrity and consistency.
Evaluator	Conducts assessment using EA.
ICT Maintenance personnel	Use EA in all maintenance of Information and Communication Technology (ICT).
ICT Operators	Refer EA for ICT operations.
ICT Organization	Make use of EA in the maintenance and management of ICT. The ICT department controls and manages the whole of EA-function.
Investment Board	Deals with estimation, investments of EA work.
Legislator	Responsible for developing reference architectures and standards. Also provides feedback based on the outcome of EA.
Manager / Management	Supports and sponsors EA work and also make use of the EA principles in the process of decision making.
Proprietor or owner	Direct the board of directors in the approval of EA ventures.
Partner	Partners are the consultants who provide guidance in EA planning, development, and maintenance in the organization.
Program Management Office	Controls and monitors project work.
Project Steering Group	Produces architectural descriptions and facilitates EA work.
Research & Design	Use EA work products in Research and Development (R&D) activity and suggest new facts, information, and widen research scope.
Security	Responsible for devising security policies.
Solution Architect	Defines the solution to each IT and system-oriented problem and ensures that each solution has technical credibility and continuity at a certain point of its life cycle. Solution Architects recommend design specification, review, and requirement implementation practises, ultimately setting up IT operations.
Sponsor	Supports in funding resources required in EA.
System Development	Refer architectures in system development and produce architectural descriptions.
Technical Architect	Provides technical support for development teams. These architects usually have a more hands-on approach, defining best practice standards to follow. For example, Technical Architects are Java Architects, Infrastructure Architects, etc.

The stakeholders have been classified into enterprise-level or domain-level, project-level, and operational-level with stated functions and roles (Van Der Raadt et al., 2008). At the enterprise level, the general

management comprising of executive board members decide on the target enterprise architecture. The role of the executive board is to form a strategy for each area the stakeholders are responsible for. EA stakeholders at the domain level are the domain owners or business heads or managers responsible for overall performance in their domain area. The Division Information Officer (DIO) coordinates the business-IT alignment process, information management and IS development and maintenance for a specific business domain. In the technical aspect area, the manager looks after the operational part of the technical platform and guides all related changes. The EA stakeholders at the project level execute and implement projects. The project manager ensures the timely delivery of the desired solution according to the business needs. The business process designer decides the solution's specifications and design. An information analyst defines the criteria for information and designs a database design accordingly. The project managers manage the projects that develop the software applications and components of the infrastructure. As per the functional and non-functional requirements, the software designer realises the design. Engineers look after the configuration of the infrastructure components. Finally, the EA stakeholders at the operational level are responsible for the day-to-day operations and reporting. They carry out maintenance and improvement activities regularly to optimize performance and stability (Van Der Raadt et al., 2008).

3.1.11. Benefits of EA

A number of benefits of EA have been documented in the literature (Foorthuis et al., 2016; Foorthuis et al., 2010; Niemi, 2008; Ross et al., 2006; Tamm et al., 2011). These benefits relate to the organizational level which we have listed author-wise in <Table 3>.

In short, EA benefits include reduced cost, more shared capabilities, reduced management costs, a more agile workforce, more organization, better en-

<Table 3> EA Benefits

Author	Stated Benefits
Ross et al. (2006)	EA is beneficial in organizing and structuring enterprise-wide information and facilitates the different stakeholders to view from different perspectives and decision making. It is beneficial for effectively interconnecting different aspects of business
Niemi (2008)	EA benefits are business-IT alignment, better decision making, smooth change management, risk management, better interoperability and integration, enhanced communication and collaboration among stakeholders, and reduced IT costs
Tamm et al. (2011)	The benefits of EA are reduced risk, improved integration, steadiness, improved business processes, and increased responsiveness and guidance to change
Moshiri and Hill (2011)	EA is beneficial to IT infrastructure as it reduces the complexity in operations and thus the investment is restricted upon the need only
Rodrigues and Amaral (2010)	Classify the benefits of EA to the organization as governance benefits, operational benefits, strategic benefits, and communication, collaboration, and compliance benefits.
Radeke (2010), Simon et al. (2014)	Recognize EA as a mean for organizational forms that allow timely reconfiguration and guide to strategy-aligned change
Dang and Pekkola (2017a)	Complements the existing listing of the benefits of EA by recognizing the contribution of EA towards re-use of resources and regulatory compliance.

forcement, less complexity, duplication, and redundancies, and increased efficiency for more productive business operations.

3.1.12. Challenges in EA

EA faces several challenges during the long process of EA establishment. Several studies have focused on EA development issues and challenges (Jahani et al., 2010; Kaisler et al., 2005; Kappelman and Zachman, 2013; Rouhani et al., 2015; Seppanen et al., 2009). The following are some of the challenges associated with EA:

- The underlying concepts of EA are explicitly not defined.
- The adoption of EA is also a challenge for organizations (Iyamu, 2018). Although the maturity of the EA related standards and practices have improved over the years, the process of adopting EA is still slow in the organization and, as a result, contributes to the low adoption rate of EA and, in some cases, not widely accepted by organizations (Ahmad et al., 2019; Dang and Pekkola 2017b; Syynimaa, 2016).
- Adaptation of EA methodologies by organizations remains troublesome. This arises because organizations typically adapt these EA methodologies to their specific needs rather than using them directly "out of the box", and therefore the actual EA practices often differ substantially from the original EA methodologies (Kotusev, 2018b).
- There is no standardized EA implementation approach that has been defined considering the dynamic environment in any enterprise. A number of architecture proposals, its overlapping approaches, and the absence of a general vocabulary pose a challenge (Simon et al., 2014).
- EA is not concise as it details each component artifact describing the existing and target architectures (Kaisler et al., 2005; Shah and El Kourdi, 2007).
- EA does not focus on business; rather it targets IT and its services to achieve business objectives. Business is not only about information technology, it encompasses a broader range of activities (Fischer et al., 2007).
- EA endeavours can encounter several kinds of risks that need to be dealt with appropriately, such as the risk of component's failure, information security as a whole, EA project risks, or EA implementation risks (Garg et al., 2006; Grandry et al., 2013).
- EA involves significant costs and needs a long time to complete its process. It is a slow process, by the time it adopts one technology, another new and better technology may be already available (Amiri, 2012).
- EA is iterative as the EA methodology focuses on the present state first and then the desired state. The iterative nature suggests the absence of any fixed and pre-defined finishing point.
- Availability of vital resources like manpower and funds to sustain an EA initiative is also an issue (Rouhani et al., 2015).
- The heterogeneous nature of the EA artifacts does not seem to portray how a firm with multiple information systems will be able to implement EA and meet the business requirements. Hence many organizations struggle to realize the potential of EA (Hope, 2015).
- The effort needed to put the enterprise architecture framework into operation is tedious. Thus often organizations refrain from implementing EA because of its excessive rigidity with complex processes and a large number of descriptive components (Kotusev, 2017).

3.2. Enterprise Architecture Management (EAM)

3.2.1. Notion of EAM

EAM provide the necessary guidance and practical help in the design and the development of an EA and fulfil its objective successfully (Ahlemann et al., 2012). It has evolved from the domain of IS architecture and management and concerns all aspects of an enterprise from business to technical operations including application and infrastructure. The EAM process is responsible for developing and maintaining EA (Ahlemann et al., 2012). EAM is different than EA. EA represents the basic structure of an enterprise through models whereas EAM comprises activities of establishing, managing, and maintaining the EA in a holistic manner (Ahlemann et al., 2012; Radeke, 2010).

EAMs constituted as a management discipline since the 1990s after Zachman introduced the Zachman framework for the management of information systems (Zachman, 1987). Several concepts, methods, and tools have been developed for EAM (Aier et al., 2008). The practice of EAM has been widely accepted in academia and practice as a management process (Aier et al., 2011; Jonkers et al., 2006; Radeke, 2010).

3.2.2. Approaches to EAM

Several approaches to EAM are available (Winter et al., 2010). Some of these approaches resort to frameworks, some recommend modeling nomenclature for EAs, and others define certain EA management action plans (Jonkers et al., 2006; Niemann, 2006; Steen et al., 2005). While some of the approaches propose to conduct EAM in the course of an EA project, others view it as a management practice that needs to be set up like any business management functions and monitored continuously (Winter et al., 2010).

Considering the former approach, Niemann (2006) proposes an iterative and stepwise EAM practice for developing, using, and maintaining an EA. This approach is practical insofar as it depicts the EA as a snapshot in time. However, it is limited in terms of providing support to develop architecture solutions and test against different scenarios, benchmarks, and standards as dictated by the ever converging business and IT strategy. Considering the latter approach, Jonkers et al. (2006) introduce ArchiMate, a method for describing the activities of EAM through visualization, communication, and analysis of integrated architectures. It presents a technical standard from The Open Group and is based on the concepts of the IEEE 1471 standard (The Open Group, 2017). Kotusev (2016a) documents three approaches to EAM: the traditional approach, the Massachusetts Institute of Technology (MIT) approach, and the Dynamic Architecture (DYA) approach, which are discussed below:

The Traditional Approach: This suggests a stepwise process to examine the current state, develop the target state, prepare the roadmap, and execute implementation and iterate the steps. In the first step, the enterprise architect examines and prepares a blueprint for the current business processes and IT settings. An enterprise architect then develops the target state considering the vision and mission of the organization. In the next step, the gap between two states is identified and a roadmap is prepared to evolve the organization into the target state. The roadmap includes the intended information systems that will facilitate the transformation to the new desired state. The same sequence of steps is iterated for the continuous development of EA projects and

producing documents for stakeholder needs. This approach is best suited for small to mid-scale organizations (Kotusev, 2016a).

The MIT Approach: This also suggests sequential steps for the establishment of long-term EA. First, an organizational operating model is created. This model serves as the basis for integration and standardization of processes (Ross et al., 2006). In the second step, a core diagram is prepared explaining the key business and IT capabilities, information, prime clients and customers, and key technologies. The core diagram is then abstracted in a document with the enterprise-level architectural vision. In the last step business and the IT engagement model is established that defines three crucial elements: Enterprise-level IT governance (a decision-making framework along with the core diagram), project management (a systematic project delivery methodology with necessary milestones), and linking mechanisms (procedures for mapping the enterprise-level decisions to the project-level activities). The core diagram is continually used to make concrete project-level decisions after the IT engagement model is developed. The MIT strategy achieves both local and global goals and eventually brings the organization to the desired architectural vision (Kotusev, 2016a).

The Dynamic Architecture Approach (DYA): This approach is dynamic and proposes architecture when there is a need. The EA activities are carried out through architectural services and activated by concrete business proposals that arise during the strategic dialogue process, when business and IT managers jointly determine which goals to follow. Once the possible business initiatives are identified, specific business cases and project proposals are detailed. The architectural services contribute to decision-making, impact analysis, and financial analysis by providing necessary principles and models. In order to ensure that this project blends seamlessly into the current IT landscape, architectural services recommend a project-start architecture along with the scope, design, specifications, and guidelines for the new IT project. For organizations operating in vibrant, competitive, and volatile environments and markets, this strategy is suitable. EAM is used here as a reactive reaction to particular business initiatives. (Kotusev, 2016a).

3.2.3. Benefits of EAM

Enterprise Architecture has gained increasing attention during the last few years among academics and practitioners due to the benefits it provides to the organization. EAM acts as a means for communicating, modeling, visualizing, and analysing EA (Lankhorst, 2009). EAM offers a range of benefits to both the enterprise and its stakeholders. Some of the stated benefits of EAM are listed below:

- EA Governance- EA governance relates to evaluating EA from the strategic perspective taking into account EA's overall quality and function. The defining values describe EA effectiveness, data quality, and documentation-related aspects (Capirossi and Rabier, 2013; Davoudi and Aliee, 2009).
- IT Cost reduction- The detailed view of an EA provides information about an organization and its business processes and IT. This enables the processes to be integrated, standardized, and shareable resulting in reducing redundancy (Niemi, 2007; Ross et al., 2006). EAM facilitates in reducing the IT-related and business process related costs.
- Achieving interoperability and strategic adaptability- EAM documents the current status of the

interdependencies of the components in an enterprise and analyse the business-IT alignment to create models that optimally achieve business strategy (Farwick et al., 2011),

- Integration and standardization- EAM is a governance mechanism (Boh and Yellin, 2006) that ensures that EA is developed as per the plan (Lux et al., 2010). Standardization and consolidation efforts together with management and governance also improve the decision making.
- Improved handling of complexity- Architecture provides a clear understanding of different aspect areas (Capgemini 2007; van der Raadt et al. 2004). This detailed description may reduce the complexity through the modular approach of representing the components and their relationships (Jonkers et al., 2006). Also, the implementation of standard processes will reduce difficulty in setting complex technology (Ross et al., 2006).
- Governance in IT implementation- EAM helps to harmonise an enterprise's architectural specifications into an accessible collection of rules, protocols, procedures, and standards, all of which comply with real business requirements to ensure that the visions and standards of an organization are compatible.
- Responsiveness to change- Change is continuous. Change is happening faster now than ever. If the organization is complex, it is difficult to transform it in response to external pressures. EA provides you with a good picture of where you are and where you want to be, which makes it easier to understand how best to adapt to change. EAM contributes to the ability of IT to cope with changing business requirements.
- Business and IT strategies- EAM may complement processes for forming, planning, and implementing IT strategies; planning and implementing business strategies; and forming business strategies depending on whether EA's scope covers IT, business capability, or business strategic elements of an organization (Rahimi et al., 2017).
- Business IT alignment- EAM aims to connect the organization's process and IT systems (Lange et al., 2016).
- IT Success- The presence of a matured EAM process is found to positively impact IT success measured in terms of successful execution of IT projects, duration of procurement projects and operational departments' satisfaction with IT (Lagerström et al., 2011).

3.2.4. Challenges to EAM

Despite the availability of wide variety of EA frameworks, best practices collections, tools, and increasing skilled and experienced practitioners, EAM venture faces numerous challenges. Several challenges for EA management are identified by Lucke et al. (2010): lack of management engagement, lack of qualified architects, the difficulty for EA teams to recognise specifications, inadequate support for instruments and rapidly changing environmental conditions. The lack of clearly defined EA roles and responsibilities has also been pointed out by researchers (Levy, 2014; Lucke et al., 2010). The uncertainty of the EA definition to the stakeholders seems to be a major part of the obstruction, and that there is still a lack of shared understanding and methodological clarity (Lemmetti and Pekkola, 2012). Lemmetti and Pekkola (2012) note that the EA concept has many understandings, and point out that ensuring that all actors share the same perception of what EA is, is imperative. Olsen (2017) attributes these EA concept and terminology ambiguities as root causes that contribute to the following EAM challenges: unclear roles in

<Figure 5> Word Cloud Visualization

business architecture, ineffective communication, low EA maturity and dedication, and complicated EA tools. The communication barriers arise from the misperception that EA is a technical task and not a business task (Bakar et al., 2013; Shaanika and Iyamu, 2015). Hauder et al. (2013) indicate lengthy documentation process, effort required for data collections, and difficulty in achieving consistency and completeness as some of the EAM challenges. Moreover, the process of institutionalizing EAM and governance are itself difficult for many organizations (Aier et al., 2011; Cram et al., 2015).

Before we conclude the section, we also include the word cloud visualization (<Figure 5>) pertaining to our coverages on EA and EAM. Given that we have reviewed vast and complex domains that characterize the representations of EA and EAM in the extant literature, the word cloud is just an attempt to demonstrate the often-used words (distinguished by the word sizes) of the respective coverages. A scrutiny of the diagrams (<Figure 5>) can identify the differing emphasis of the concerned coverages and has already been detailed in the subsections above.

Ⅳ. Continuing with Research – Possible Explorations

With an understanding of the extant contributions related to enterprise architecture and management, some opportunities can be documented. We mention some of these below and summarize the same in <Table 4> at the end.

Lacuna in EA Processes

Requirement Management in EA

An important feature of EA is providing a clear description of the problem and proposing solutions to the stakeholders. However, the stakeholders, both internal and external to the enterprise, come from different backgrounds, and belong to different levels ranging from senior executives at the top level to engineers at the bottom level. Prior research also demonstrates the need for stakeholder specific tailoring, following stakeholders who expect different abstraction levels of deliverables according to their hierarchical position in the organization (Hacks et al., 2017). As such, the involvement of heterogeneous stakeholders such as application owners, business developers, application developers, system analysts, enterprise architects, etc. can result in inconsistencies in requirements specification (Koukias et al., 2013).

Although few publications address this context (Bernard, 2012; Hacks et al., 2017; Jonkers et al., 2006), the extant literature still lacks a concrete representation of stakeholder concerns during the EA process (Hacks et al., 2017). This provides the opportunity to explore the requirements management scenario during the EA process in greater detail.

EA Documentation Processes

To meet the rapidly evolving business requirements and globalisation, today's organizations are forced to end up with several thousand applications, resulting in complex structures. The recording of EA information is often regarded as time-consuming, cost-intensive, and error-prone due to this complexity (Farwick et al., 2011; Fischer et al., 2007). Despite the variety of available EA frameworks (Shah and El Kourdi, 2007), the documentation of EA information, and the collection and maintenance of data have not been investigated in detail in the extant EA literature (Roth et al., 2013). The examination of the EA documentation process is hence open to scrutiny in future research endeavours.

Measuring EA Implementation Success

Assessing the success of information systems is a widely popular topic in IS and allied disciplines. The importance of IS in the used contexts also necessitates the need to conduct inquires to form an understanding that relates to the success of these information systems. Following this discourse, the dominant inquiries have attempted to provide a thorough understanding of the success of IS by defining, describing and explaining the relationships of concepts that define the most important dimensions of success along which information systems are generally evaluated (DeLone and McLean, 1992; Delone and McLean, 2003; Gable et al., 2008; Petter et al., 2013). Implementation of EA requires a tremendous amount of resources, in terms of money, time, and people for the EA implementation to be successful. However, what contributes to this success, or how the success of the EA implementation process can be measured has not been the subject of research (Syynimaa, 2013), and hence can be pursued in the future.

Organizational Readiness and Transformation

Managing Transformation

Many organizations, both public and private, operate in extreme dynamic environments due to frequent policy changes, new technologies, challenging customers, and potential competitors. These organizations need to adapt their business strategies and stay agile. EA is the process of transforming business vision and strategy into effective business change by developing, communicating and enhancing key criteria, values and models that represent the future state of the organization and allow it to evolve (Gartner and Bellamy, 2008). Publication related to EA mostly addresses the common topics of interest like frameworks, methodology, benefits, and challenges (Dang and Pekkola, 2017a). However little emphasis has been put on how EA projects might influence the organizational change process (Dang and Pekkola, 2017a). Although EA is responsible for effecting changes in organizations, research issues related to how to implement and manage the transformation are found to be lacking, which can be the subject of future investigations.

Readiness Assessment for EA

The understanding of the benefits of EA has prompted organizations planning transformation to adopt enterprise architecting (Ross et al., 2006; Simon et al., 2014). The EA transformation (i.e., from a

baseline state to the desired state) can be achieved in presence of EA strategy, roadmap, and governance (Saha, 2012). Despite the growing interest in EA, several issues can besiege the establishment of EA (Dang and Pekkola, 2017a). One such failure factor is the lack of organization readiness for change (Donaldson et al., 2015). The context of readiness of organizations is often not taken into account, leading to failure of the EA establishment (Desfray and Raymond, 2014; Hussein et al., 2017). It hence becomes necessary to determine the readiness of organizations to implement EA. Future inquiries analysing the readiness of organizations and characterizations of readiness (i.e., readiness measures and dimensions), can be notable contributions to the domain.

Institutionalization of EA Management

EAM is the practice of purposefully developing and maintaining EA in an organization (Aier et al., 2011). Although the contributions of EAM towards effective IS management are well understood (Foorthuis et al., 2010; Tamm et al., 2011), the process of institutionalizing EAM in an organization has not received the due share of attention in research (Weiss et al., 2013). This provides an opportunity to explore the mechanism in greater detail and appreciate related issues and challenges.

EA in the Academic Sector

The application of EA can be noted in organizations of various types and also spanning several industry sectors. Gorkhali and Xui (2017) include evidence of application of EA in business management, logistics, finance and insurance, manufacturing, healthcare, and also in the agricultural sector based on a review of several articles published on EA. The academic sector is no exception from the organizations which has shifted from traditional practice to digitized learning systems since the invention of the internet (Hiltz and Turoff, 2005). The academic unit has the core functions of learning and teaching, research, collaborations, and administration. Information technologies play an important role in academic functions, administrative operations, and management of the core functions in educational organizations. Most of the educational institutes implement IT on a large scale to attain the objectives and make a position in the competitive market. In this context, the importance of EA in facilitating academic institutions to realize their mission and objectives have been acknowledged (Ramadhan and Arman, 2014). Academic institutes need to embrace EA to improve the teaching and learning process, to widen research and community services, to improve competitiveness, and to have effective and efficient management practices (Olsen and Trelsgård, 2016). In academia, evidence of EA study is scarce and dispersed. The current literature deals with the complexities of academic EA adoption (Olsen and Trelsgård, 2016; Syynimaa, 2015), instances of implementation of EA based on existing structures, e.g., TOGAF (Soares and Setyohady, 2017), and associated design recommendations in the form of reference architectures and reference models (Sanchez-Puchol et al., 2017). This provides a scope for investigating the contributions of EA in the academic sector and expanding the knowledge base.

EA for Digital Transformation

In the present digital era, the technology revolution and new paradigm in IS have accelerated both the capacity and the productivity of the organization. Digital information and services (i.e., digitalization) is going viral and are adopted to enhance the performances. The development of smart industries

<Table 4> Overview on Future Research Avenues

Future Research Avenue	Issues for Exploration
Lacuna in EA Processes	*Requirement Management in EA:* • Investigating requirements specification inconsistencies due to stakeholder heterogeneity in the EA process • Exploring the requirements management scenario during the EA process
	EA Documentation Processes: • Investigating the EA documentation process to identify challenges and opportunities
Measuring EA Implementation Success	• Investigating the factors that contribute to EA implementation success • Exploring how the success of the EA implementation process can be measured
Organizational Readiness and Transformation	*Managing Transformation:* • Examining how EA projects might influence the organizational change process • Investigating ways of managing transformation following EA implementation in organizations
	Readiness Assessment for EA: • Investigating the readiness of organizations for EA • Exploring the characterizations of organizational readiness (i.e., readiness measures and dimensions) for the establishment of EA
Institutionalization of EA Management	• Exploring the process of institutionalizing EAM in organizations towards appreciating related issues and challenges
EA in the Academic Sector	• Exploring diverse issues related to EA in academia, for example, EA adoption, EA implementation, EA contributions, and others
EA for Digital Transformation	• Exploring the implications of digital transformation on EA in various sectors

and smart cities during the past decade exemplifies the transformative potential of digitalization. As the consequence of modern technology and digitalization, most enterprises are encountering business changing rapidly (Behrouz and Fathollah, 2016). Literature evidence notes that EA contributes to how enterprises are able to effectively adapt to the changes (Dang and Pekkola, 2017a; Lankhorst, 2009; Rouhani and Nikpay, 2012). Done well, strong enterprise architecture offers the backbone that allows businesses to be more flexible, rapidly and securely scale technologies, and eventually provide greater value to customers (Millares, 2020). While enterprise architecture was suggested to promote governance of business change (Op't Land et al., 2008), the emphasis was mainly on standardisation and incorporation of processes (e.g., Ross et al. (2006)), not on continuous adaptation to the evolving business, information, social and technological environment (Korhonen and Halén, 2017). This opens up research avenues for studying the EA implications in this digital era. The associated investigations can focus on the implications of digital transformation on enterprise architecture in different sectors, and the related considerations.

Ⅴ. Conclusion

In this paper, we present a review of research on enterprise architecture and management with the objective to uncover the future possibilities. The evidence revealed various facets related to EA and management. Specifically, the review brought out

the notion, nature, and foundation of EA, outlined the EA process and methodological prescriptions, listed the various EA artifacts and EA frameworks, discussed the EA environment and the stakeholders, and finally wrapped up the coverage on EA by outlining the benefits and challenges. Similarly, our review of EAM presented the notion of EAM, the various approaches to EAM, and the associated benefits and challenges. Finally, based on the treatment of the domain in the extant literature, we could chart out possible areas of future exploration and contribute new knowledge to the domain of enterprise architecture.

The contributions of this work to theory and practice warrant a mention here. Research contributions to enterprise architecture and management have been significant till now. The present business environments offer a new set of challenges to enterprise architecting and must be dealt with appropriately. This review is expected to facilitate researchers and practitioners to be familiar with an up-to-date presentation of the domain being reviewed, thereby enabling further progress. Second, based on our review, we have delineated several future research topics for possible explorations. These are expected to crystallize into new research projects, thereby promoting further theoretical work in the domain. Finally, by going through the review, the practitioners can be aware of the likely problems while dealing with enterprise architecture or in enterprise architecture management. This is expected to make them better prepared for dealing with these challenges. On the positive side, the practitioners can also appreciate the benefits that can be accrued in this process and plan to realize those benefits.

We now highlight some of the limitations of our work. First, it is possible to doubt the validity of the papers that influenced our literature review. It is also likely that we might have overlooked some related studies published in journals or conferences that have not been indexed in the databases selected. Given that the various outlets have clear priorities and objectives, the results and interpretations we make from the research are expected to be affected by this selection. Second, in the short-listed outlets, the sample of the papers that constitute our analysis is the product of using our search keywords. While we have taken a great deal of care in framing the search query and have referred to other relevant sources based on the list of citations, it still does not guarantee that all the articles related to enterprise architecture and management are returned from the search results. For example, an article may also address enterprise design, architecture, and management using the keyword “organizational structures”, but such an article might not have been found in our search if the terms used in our search keywords are not part of the identifiers that are searched during the enterprise architecture and management related article retrieval phase. However, due to resorting to citation-based inclusion based on relevance, we still assume that the risk of missing out on relevant papers is minimal. Acknowledging these limitations, future reviews could potentially apply other methods to overcome the stated shortcomings. We think that we have captured the current status and potential future direction of research on enterprise architecture and management in this essay. We hope that the concepts, discussion, and research issues outlined in this essay will stimulate interest and future work on the topic in various contexts.

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<Appendix>

<Table I> Notion of Enterprise Architecture

Definitions of EA	Source
"An architecture that defines and interrelates data, hardware, software, and communications resources, as well as the supporting organization required to maintain the overall physical structure required by the architecture".	Richardson et al. (1990)
"A theoretical framework of how an enterprise is created, outlining its main elements and the connections among these elements".	Rood (1994)
"A discipline to align more effectively the strategies of enterprises together with their processes and their resources (business and IT)".	Wegmann (2002)
"A thorough mockup of an enterprise, a principal sketch, which works as a planning, configuration, and mixing guide and force for an enterprise".	Chung and McLeod (2002)
"A group of strategic and architectural elements that embody the information, corporate system, and technical architectures".	Perks and Beveridge (2007)
"The strategic information resource that outlines the mission, the needed data to achieve the mission, along with the technologies needed to execute the mission".	Hjort-Madsen (2007)
"The harmony across all the different components that make up an enterprise and how those components connect".	By The Open Group (Schekkerman, 2004)
"A blueprint that documents all the information systems within the enterprise, their relationships and how they interact to fulfil the enterprise mission".	Langenberg and Wegmann (2004)
"Blueprints for systematically defining an organization's current (baseline) and/or desired (target) environment".	Bellman and Rausch (2004)
"EA defines the inherent structure of the main components of an organization, its information systems, the way in which these systems works together to achieve defined business objectives, and the way in which the information system support the business process of the organization".	Kaisler et al. (2005)
"An integrated framework for evolving or maintaining existing information technology and acquiring new information technology to achieve the organization's strategic goals and information resources management goals".	As per the Information Technology Management Reform Act of 1996, better known as the Clinger-Cohen Act (Sutharshan et al., 2005)
"The process of translating business vision and strategy into effective enterprise change by creating, communicating and improving the key requirements, principles and models that describe the enterprise future state and enable its evolution".	Bittler and Kreizman (2005)
"The fundamental organization of a system, embodied in its components, their relationships to each other and the environment, and the principles governing its design and evolution".	Steen et al. (2005)
"A structured description of the enterprise and its relationships, which may make it the fundamental management system for the enterprise. EA offers an integrated representation of different enterprise layers in descriptive models of past, current, and future states".	Niemann (2006)
"A governance instrument intended to facilitate the translation from corporate strategy to daily operations".	Jonkers et al. (2006)

<Table I> Notion of Enterprise Architecture (Cont.)

Definitions of EA	Source
"An approach for managing the complexity of an organization's structures, business, environments and different information systems and for facilitating the integration of strategy personnel business data and IT".	Goethals et al. (2006)
"A multi-disciplinary approach that enables enterprises to anticipate or react to necessary business or technical changes".	Balabko and Wegmann (2006)
"The organizing logic for business processes and IT infrastructure reflecting the integration and standardization requirements of the company's operating model".	Ross et al. (2006)
"The fundamental organization of a government agency or a corporation, either as a whole, or together with partners, suppliers and / or customers (extended enterprise), or in part (e.g. a division, a department, etc.) as well as the principles governing its design and evolution".	Winter and Fischer (2006)
"A meta-architecture that comprises many information systems and their relations (technical infrastructure). It also encompasses additional views of an organization that can incorporate work, process, and information".	Armour et al. (1999)
"A comprehensive manifestation of the organization, a principal proposal that represents a collaboration force amongst phases of business planning such as goals, ideas, schemes, and governance principles".	Schekkerman (2009)
"The process of translating business vision and strategy into effective enterprise change by creating, communicating and improving the key requirements, principles and models that describe the enterprise future state and enable its evolution".	Lapkin et al. (2008)
"A coherent whole of principles, methods and models that are used in the design and realization of an enterprise's organizational structure, business processes, information systems and infrastructure".	Lankhorst (2009)
"The inherent design and management approach essential for organizational coherence leading to alignment, agility and assurance".	Doucet et al. (2009)
"The fundamental organization of an enterprise embodied in its component, their relationship to each other and to the environment and the principle guiding its design and evolution".	Stelzer (2010)
"A formal description (a complete model) of an organization that brings together a collection of documents which describes all aspects of the organization taking into account the perspective of different group of users".	Rodrigues and Amaral (2010)
"The definition and representation of a high-level view of an enterprise's business processes and IT systems, their interrelationships and the extent to which these processes and systems are shared by different part of the enterprises".	Tamm et al. (2011)
"A design or a description that makes clear the relationships between products, processes, organization, information services and technological infrastructure; it is based on a vision and on certain assumptions, principles and preferences; consists of models and underlying principles; provides frameworks and guidelines for the design and realisation of products, processes, organization, information services, and technological infrastructure".	Engelsman et al. (2011)
"The management best practice that provides consistent view across all program and service areas to support planning and decision making".	Enterprise (2012)

<Table I> Notion of Enterprise Architecture (Cont.)

Definitions of EA	Source
"Enterprise architecture is about aligning an enterprise's IT assets (through strategy, design, and management) to effectively execute the business strategy and various operations using the proper IT capabilities".	Lapalme (2012)
"EA identifies the main component of the organization, its information system, the ways in which these organization works together in order to achieve defined business objectives and the way in which the information system support the processes of the organization".	Amiri (2012)
"One of several strategic planning programs that aim to align IT with business strategy".	Bui (2012)
"The organization logic for organization's IT infrastructure and business processes capabilities to address a firm's need for IT and business process integration and standardization".	Golooba and Ahlan (2013)
"A tool to help the organization to create capabilities to be flexible and react to the environmental changes and meet the market demands".	Ghahramany Dehbokry and Chew (2014)
"A blueprint to guide the manager and fill the gap between business and IT".	Bijarchian and Ali (2014)
"EA is integrated ISs in order to support alignment of their business and information technology".	Rouhani et al. (2015)
"The process of translating and converting strategic requirements to processes, data, and technology by providing the organization with a big picture in detail".	Behrouz and Fathollah (2016)
"The structured and aligned collections of plans for the integrated representation of the business and IT landscape of the enterprise in its past, current and future states".	Lange et al. (2016)

◆ About the Authors ◆

Sharmistha Kar

Sharmistha Kar is a Ph.D. scholar in the Department of Information Systems at Xavier Institute of Management, XIM University, Bhubaneswar, India. She has served in academic sector as faculty in Computer Science and Information Technology in the universities of national and international repute for thirteen years. Ms. Kar has presented papers in couple of international conferences on Information Systems like SPICE2012 in Spain and PACIS 2018 in Japan. Presently she is working as State Programme Manager(IT) in an externally aided project - Odisha Forestry Sector Development Project(OFSDP) implemented by Forest and Environment Department, Govt. Of Odisha and funded by Japan International Cooperation Agency(JICA). She is looking after the entire GIS and MIS domain of the project. Her research interest includes Information systems Management and Enterprise Architecture.

Rahul Thakurta

Rahul Thakurta is an Associate Professor of Information Systems at Xavier Institute of Management, XIM University, Bhubaneswar, India. He received his Fellowship in Management Information Systems from Indian Institute of Management Calcutta. During his doctoral tenure, he has been the recipient of Infosys Research Fellowship and DAAD Short Term Research Scholarship. At XIM University, he teaches courses pertaining to information systems (IS) and operations management disciplines. Rahul Thakurta has been working in the fields related to IS development and management. His broad research interests include areas like planning and implementation of IS infrastructures, management of software ventures and technology adoption and diffusion.

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