Enterprise Architecture Adoption for Higher Education Institutions

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Abstract — Education is considered a pillar of any society. Monitoring the performance of education institutes is of high importance to satisfy its goals. Enterprise Architecture (EA) lends itself well to the goal of monitoring performance in higher education institutions (HEI) by providing several benefits. Moreover, Enterprise Architecture (EA) refers merely to the practice of conducting enterprise analysis, planning, design and more so implementation. This paper elaborates on the importance of adopting EA in the Higher Education Institutions. It analyzes the EA components, historical advancements, frameworks, tools and benefits. The paper reviews some of the best works detailing adopting enterprise architecture and the used methodology behind its success. The researchers’ use SWOT to provide a comprehensive and easy way to come up with the most appropriate EA for any education sector. Lastly, it discusses the Higher Education Institution (HEI) methodology and its Stages, the purpose of each stage, and the possible outcomes. HEI methodology implemented based on Architecture Development Method (ADM) and the used SWOT analysis in this paper. All these stages ensure that the entire process is conducted in accordance with the set rules and timeline to fulfill all the established goals and objectives.

Keywords — Architecture Development Method (ADM), Enterprise Architecture (EA), EA frameworks, Higher Education Institution (HEI), SWOT analysis.

I. INTRODUCTION

Enterprise Architecture EA is the practice and controls that apply the vision and strategy of the institution by making the necessary changes to align the business objectives and actions of the organization with the information technology (applications, data, technology infrastructure) used to achieve this vision. Moreover, the adoption of the enterprise architecture framework in the university has a number of vital implications for the entities set to be investigated. Firstly, EA provides a coherent platform to manage and operate fragmented organizational processes so as to improve overall efficiency. Secondly, EA leads to the creation of data and analysis of information that can be used to make strategic decisions for higher education institutions. Thirdly, EA provides higher education institutions (HEI) with reliable infrastructure and technology to sustain learning and meet diverse educational needs [1]. Therefore, it is important for such institutions to adopt EA because it helps them to better leverage their current resources, capabilities, and competencies to meet institutional needs and manage change effectively. Subsequently, this paper aims at exploring more on the various EA layers and the role they play in the process of adoption of EA in the education sector. These layers comprise of the Business layer, Data layer, Application layer and the technology layer with all of them being critical for EA. In addition, it further explores the various Enterprise Architecture frameworks such as Zachman, FEEF, and TOGAF which are supported by multiple EA tools to facilitate strategic decision making. Additionally, the paper uses SWOT analysis which is presented in various stages to provide several phases to come up with the most appropriate EA for any education sector. These stages include developing EA plan and structures, building both current and future architectures, forming a transition plan, maintenance, and lastly continuous activities. These stages have already proven to be of great importance in other sectors and therefore would be vital to the education sector which is in need of shifting towards a vigorous premeditated management. All these stages involve have their own architectural deliverables and therefore are dependent to each other for effective implementation of HEI methodology.

The rest of this research is organized as: literature review of the enterprise architecture frameworks, Insights from other analysts are outlined to provide an array of opinions concerning the enterprise architecture framework’s utilization in higher education institutions. Also, it introduces SWOT Analysis in seven stages about the important stages in adopting an enterprise architecture in HEI. Similarly, the paper seeks to describe the various layers of the enterprise architecture framework and their composition. Moreover, in this paper there are comparative points between EA Tools. This paper focus to present a proposed HEI methodology as a guidebook and any higher education institution can adopt it and gain an understanding of the detailed effort in each stage and see the possible deliverables.
II. LITERATURE REVIEW

Previous research conducted has shown that EA will help the firm in overcoming a number of definitional difficulties experienced in the four main tenets of technology, business, information, and application. The term “Enterprise Architecture” refers to the strategic and conceptual framework that defines how organizations function and operate. That is, EA represents the blueprint with which organizations achieve their goals and objectives. An EA comprises of four layers as shown in figure 1: business layer, data layer, application layer, and technology layer. The business layer captures organizational objectives. The data layer entails the storage of information for facilitating planning functions in the business layer. The applications layer consists of software applications that generate data and information flow across the organization.

![Fig. 1. Enterprise Architecture Layers.](image)

Over the years, researchers have proposed several EA frameworks [3]. One of the pioneering EA frameworks is the Zachman Framework, a model developed in 1987 [4]. Zachman is a conservative model of EA, commonly defined as taxonomy. The framework emphasizes on players and perspectives [5]. The strength of this framework lies in the ability to provide different perspectives and insights in complex projects [6]. Another EA framework is the FEAF developed by the U.S. government to facilitate EA management by government agencies [4]. FEAF is relatively more complete compared to the Zachman Framework as it integrates taxonomy, similar to the Zachman and processes, similar to the TOGAF framework. FEAF is commonly applied in managing healthcare programs, with minimal application in the education sector [7]. The Gartner framework focuses on strategic management of IT resources by facilitating the integration of various stakeholders in IT projects including project owners and technical implementers[4]. The Gartner framework has evolved over the years and currently outlines eight aspects that influence EA implementation [8]. Another EA framework is TOGAF, a generic EA model that
categorizes EA into four aspects: business, application, data, and technical architecture [4]. This framework rather represents a process for providing high-level view of EA design. The distinctive feature of TOGAF is its open nature [9] [10]. The TOGAF document has five parts defined in eight phases of the Architecture Development Methodology ADM cycle shown in figure 2.

Supporting the EA frameworks are various EA tools or software applications. The EA tools facilitate strategic decision making by capturing organizational structures of enterprises. Some of the common EA tools in use include the Dragon [11], used for modeling and prototyping, ArchiMate [12] for analysis and visualization of architectures, and Sparx systems EA [13], for sharing enterprise architecture. Corso [14] is another powerful EA tools that helps in sharing architecture assets. Table 1 is a comparison between EA Tools.

<table>
<thead>
<tr>
<th>Comparative Points</th>
<th>dragon 1</th>
<th>ArchiMate</th>
<th>Sparx systems</th>
<th>Corso</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automation capabilities.</td>
<td>Sufficient automation capabilities which are provided by a set of ten web applications hosted on the cloud [11].</td>
<td>Sufficient automation capabilities [12].</td>
<td>High automation capabilities provided by more than a dozen features [13].</td>
<td>Sufficient automation capabilities [14].</td>
</tr>
<tr>
<td>Operation capabilities</td>
<td>High operation capabilities including modeling, simulation, and data analytics [11].</td>
<td>Sufficient operation capabilities that can further be increased by a competent user [12].</td>
<td>High operation capabilities due to lots of feature to cater for a wide range of business needs [13].</td>
<td>Sufficient operation capabilities [14].</td>
</tr>
<tr>
<td>Vendor credibility and quality of client support</td>
<td>Credible vendor with sufficient online customer support [11].</td>
<td>Credible vendor, customer support is limited due to its free nature [12].</td>
<td>Highly credible vendor with a track record of excellent customer support [13].</td>
<td>Credible vendor and good customer support [14].</td>
</tr>
</tbody>
</table>

III. RELATED WORK

In a study [3], Syynimaa investigated the role of EA adoption in Finnish higher education. According to the author, poor understanding of EA concepts is the major challenge confronting Finnish institutions of higher education in terms of IT utilization. The researcher recommends institutions to focus on readiness, change management, and EA training to address these challenges. In another study [15], Oderinde examined the impact of EA adoption in UK universities. According to the author, EA fosters alignment between strategic planning and information systems management, with enhanced capacity to exploit IS investments and improve IT resource utilization. The author identifies four crucial factors for EA adoption on higher education: support from top management, stakeholder involvement, resource availability, and evaluation and monitoring. In a related study [9], Ramadhan and Arman investigated the role of EA adoption in universities using data gathered via interviews and observation. Based on the TOGAF framework, the study focused on determining the effectiveness of the business architecture deployed in universities. The findings demonstrated that EA adoption foster the alignment of IT and business goals in universities. Several studies have also highlighted EA adoption in the healthcare sector with important insights on how to implement similar EA in higher education [16] [17]. The overall conclusion from these studies is that every HEIs needs to focus on integrating the dimensions of people, processes, and technology [1]. Educational institutions implement Education Enterprise Architecture (EEA) for various reasons including the need to shift towards robust strategic management of IT and in response to planned reforms. Whatever the reason, adopting EA allows HEIs to align data with technology across four areas: business, information, application, and technology. The process should entail a roadmap addressing these integral areas.

IV. SWOT ANALYSIS OF THE IMPORTANT STAGES OF BUILDING EA IN THE EDUCATION SECTOR

The conclusion from several researches about the methodologies of building and developing enterprise architecture differs according to the different type of work in the organization and the different criteria and different work outcomes. In implementing the best concepts and practices in the field of education. In table 2, shown after the references section due to its size, by using business SWOT analysis to reach to a unified, comprehensive and easy methodology to build and develop the appropriate enterprise architecture for any education sector.
V. HIGHER EDUCATION INSTITUTION METHODOLOGY

Developing HEI methodology based on Architecture Development Method (ADM). HEI methodology is consisting of seven major stages. The execution of the stages is in sequence, however it can be tailored to suit the purpose of agency EA. Each stage has its own architecture deliverables. In HEI, a continuous set of activities are carried out throughout the seven stages. HEI methodology will be followed to plan, analyze, design, and implement in order to make decisions about what the problem that exist, what to change, and how to change to formulate the “To-Be” model. Figure 3 below illustrates the HEI Methodology.

A. Goals of Higher Education Institution Methodology

In order to better understand EA needed by a higher education institution, one has to better define its goals. The first goal is the definition of the scope and requirements of the university programs whereby it will ensure that all the stakeholders involved in the implementation of the system are well versed in what the systems aim at doing as well as the regulatory and perfunctory requirements. This helps them to avoid any legal battles and ensures the efficacy of the stratagem. The second goal is to help the institution to have a smooth and effective EA implementation which will finally bring forth outputs that are up to par with the firm. The subsequent objective noted is the due stipulation and implementation of the enterprise architecture with the set business objectives of the institution which will further boost productivity as well as service provision.

B. Features of Higher Education Institution Methodology

The enterprise architecture used by HEI comprises a myriad of features. The first is the enabled guidance for the development and implementation of the EA which makes certain that the architects conform to the requirements that will boost the efficacy of the system. The second feature is the detailed description of the lifecycle of the system which ensures to provide clarity to the different stakeholders in the firm. This conforms with the final feature of the system which is the analysis of organizational processes and subsequent decision making while guiding the management on how they can formulate and implement decisions with zero hassles.

C. Objectives of Higher Education Institution Methodology

As noted in the introductory tenet of this research paper, the enterprise architecture needed for higher education institutions goes a long way in achieving a number of goals. But before implementing it, the architects need to set a number of objectives that will ensure that the stakeholders conform to them. The primal objective of the HEI involves the acceleration of the development of the enterprise architecture which will finally bring forth outputs that are up to par with the firm. The subsequent objective noted is the due stipulation and implementation of the enterprise architecture with the set business objectives of the institution which will further boost productivity as well as service provision.

D. The Overview of HEI Methodology

The HEI methodology can be simply stated to be a collective system that comprises of different facets that work in tandem with each other to ensure efficacy. [18]

- Stage One – Develop EA Project Plan: This stage is tailored in a manner through which the key activities in the enterprise architecture are effectively described while obtaining the required permission for resources needed in the development of the project. The purpose of this stage revolves around the team tasked with the development of the EA presenting a project plan for the project with the overarching outcome being set to be the obtaining of permission from the management as well as their subdued commitment on the resources and schedules needed in the development of the system.

- Stage Two– Build EA Structure: This stage involves the construction of vital pillars from the HEI methodology such as the principles, goals, mission, and vision which are needed in the project. The main aim of this stage is the presentation of the main fundamentals of the enterprise architecture that will ensure that the architects are steered
and well guided in the development of the system in all stages. This will come soon after the approval of the project plan for the enterprise architecture by the management.

- **Stage Three– Build Current Architectures:** The approval and establishment of the EA structure are followed by the capturing of the existent institution architectures in a bid to ensure that they are well versed in both the informational and business landscapes. This allows the management to get a clear vision of the interconnections among the system components and the existing architecture as well as the efficient analysis of the challenges, issues, and opportunities seen in the deanship. The data derived from this stage is inclusive of the four main facets highlighted in the introduction. The overarching purpose of this stage is noted to be the analysis of the modeling through the use of any enterprise architecture tool as well as documenting the current status of the business and information landscapes of the enterprise system. The initiation process of the stage begins with the development of reference models that will provide structured information on the institution. The second step is the identification of the different opportunities presented in every architectural area which include the technology, data, application and business facets.

- **Stage Four- Building Target Archives:** The analysis of the current existent architectures of the institution is followed by the development of the target architectures needed in order to improve the business and information technology facets. The architectural team will ensure to produce a target architecture for the institution with the basis being made on the vision and principles of the system as stated in the second stage. The overarching deliverables presented by this stage is the statement of the target business architecture as “to-be” whereby the architectural principles, existing business architecture, and deliverables will ensure the success of the system. The second deliverable is noted to be the target application and data architecture in which a description is given on the future scenarios with solutions being provided to the existing problems facing the firm. These solutions may be the improving the reachability of data in order to ensure the acceleration of the performance of the organization as well as reducing the workload of the staff. The second solution may be the improving of the presentation of data and information that will support the making of efficient business decisions. The third outcome from the stage is focused on the target technology architecture by describing future occurrences as well as providing resolutions to the existent challenges faced by the firm. The stage will be initiated by due consideration of a number of deliverables which include the existing business, application, data and technology architectures as well as providing a summation of the opportunities needed for improvement.

- **Stage Five – Develop Transition Plan:** The transition plan is used in offering the definition and prioritization of any transitional projects, systems, and activities that will help in the implementation of the future state of the required architectures. The primal focus of this stage is the development of a transitional plan which consists of the budget, timeline, resources as well as the projects or activities. The completion of the different architectural targets noted in the previous stage brings forth a need to plan and manage the process of transition. There is an existent space between the target and current architectures which if not managed will render the whole plan useless. The deliverables expected from this enterprise architecture plan include analyzing the target business, application, data, and technology architecture.

- **Stage Six–Maintenance:** The final stage involves the organization executing and maintaining its enterprise architecture. This stage majorly concerns the institution taking into account the different deliverables and steps needed in ensuring that the system turns into a reality. The expected outcomes from this stage include the training of the architects on how they can use and maintain the system as well as the management of the transitional activities. The stage will be initiated after the successful execution of the previous stages with the team being tasked with ensuring that the transitional plan and architectures are coeval to the organization objectives.

- **Stage Seven- Continuous Activities (applicable during all stages):** Owing to the fact that the systems are normally set to run in the long-term, they are bound to be faced by a number of issues. It is important that the continuous activities of the system work together to efficiently ensure that they are a success.

**VI. RESULTS AND DISCUSSION**

The adoption of EA by the Higher Education Institution is worth to go strategy that various governments should develop strategic methods to ensure that EA is effectively assimilated to the education sector. According to SWOT analysis in adopting EA in HEI, the related work, and based on the concept of Architecture Development Method (ADM) which can often be modified to suit specific needs. Therefore, the researchers reached to develop HEI methodology which is a unified, comprehensive and easy methodology to build the appropriate enterprise architecture for any higher education institutions and its unique. Notably, in developing ADM to fit any higher education institution, we developed EA plan in the preliminary phase with the aim of initiating the project activities. Additionally, the HEI methodology can as well create the project plan and analyze the current state of the project. The stage should then proceed by building reference models including the technological aspects of the project. Tapping into the ADM processes opportunities, HEI should build target architectures and further plan on transitions to the new architectures. In developing the methodology based on ADM techniques, the HEI should put to use correct governance and plan on change management procedures since EA is a huge long-term project. Additionally, HEI methodology developed in a well-organized and more so
VII. CONCLUSIONS AND FUTURE WORK

Success, stability, operability, and agility in changing of any enterprise rely heavily on decision making process which align between IT and business goals. Traditionally, the business processes faced challenges and causes several problems such as increased consumption cost, long processes and sometimes include non-value tasks, and unformed decisions. However, adopting enterprise architecture covers most of the challenges and more reliable solutions are sought. In regard to future work, we will apply HEI methodology in the deanship of graduate studies KAU by following the seven stages of the methodology to study in major the outcomes. Therefore, believes it would bring with a lot of benefits to the deanship.

REFERENCES


<table>
<thead>
<tr>
<th>Stage Name</th>
<th>Ref.</th>
<th>Strength</th>
<th>Weakness</th>
<th>Opportunities</th>
<th>Threat</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Develop EA Plan</td>
<td>[19]</td>
<td>Emphasizes on commitment by the senior management/leadership of the</td>
<td>Does not focus on project management and stakeholder involvement, which</td>
<td>Envisions business process reengineering and customization.</td>
<td>Failure to involve stakeholders can lead to resistance of new technology.</td>
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<td></td>
<td></td>
<td>university.</td>
<td>is key in university administration/management.</td>
<td></td>
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<tr>
<td>2. Develop EA Structure</td>
<td>[20]</td>
<td>Can elaborate university vision and governing structure/body</td>
<td>May ignore organizational goals/objectives, and organizational structure</td>
<td>Vision can create motivation for improved EA structure</td>
<td>Possibility of misalignment between processes/goals and IT</td>
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<tr>
<td>3. Build Current Architectures</td>
<td>[21]</td>
<td>Provides for the analysis of the current business environment of the</td>
<td>Does not address the external value chain of the university or threats</td>
<td>Can help in the identification of weaknesses in the current architecture and</td>
<td>Misalignment between business and IT</td>
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<td></td>
<td></td>
<td>university and IT architecture</td>
<td></td>
<td>alignment with business goals through restructuring</td>
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</tr>
<tr>
<td>4. Build Target Architectures</td>
<td>[23]</td>
<td>Provides holistic understanding of university processes to connect the</td>
<td>Poor integration between the 'As is' and 'To-Be' technologies</td>
<td>Capability to identify gaps between 'As-Is' and 'To-Be' and address underlying</td>
<td>Interoperability issues due to poor integration of As-Is and To-be</td>
</tr>
<tr>
<td></td>
<td></td>
<td>university with its business drivers and underlying IT</td>
<td></td>
<td>weaknesses</td>
<td>environments</td>
</tr>
<tr>
<td>5. Develop Transition Plan</td>
<td>[24]</td>
<td>Addresses the four-layer model, which provides a comprehensive</td>
<td>Does not describe the change management process to create organizational</td>
<td>Could provide a roadmap for establishing target architecture and aligning</td>
<td>Changes in technology could require changes to the target architectures</td>
</tr>
<tr>
<td></td>
<td></td>
<td>understanding of the desired EA</td>
<td>value</td>
<td>processes and IT</td>
<td></td>
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<td></td>
<td>[25]</td>
<td>Transition planning is critical in higher education IT contexts</td>
<td>Lack of long-term IT strategic plans in universities</td>
<td>Ability to integrate IT as a strategic resource</td>
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<td></td>
<td></td>
<td>Changes in university regulations could render transition plans useless</td>
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<tr>
<td>6. Maintenance</td>
<td>[25]</td>
<td>Ability to enhance user support activities</td>
<td>Laxity in information security programs and lack of IT expertise could</td>
<td>Opportunity to integrate security awareness and training in maintenance</td>
<td>Changes in IT strategy could affect maintenance activities</td>
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<td></td>
<td></td>
<td>lead to poor maintenance activities</td>
<td>activities</td>
<td></td>
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<tr>
<td>7. Continuous Activities</td>
<td>[25]</td>
<td>Focus on management skills, competencies, and attitudes</td>
<td>Lack of internal IT management skills</td>
<td>Stakeholder involvement</td>
<td>Rapid changes in technology could lead to outdated EA management plans</td>
</tr>
</tbody>
</table>

TABLE II. SWOT ANALYSIS ABOUT THE IMPORTANT STAGES IN ADOPTING AN ENTERPRISE ARCHITECTURE IN HEI
| [22] | Suits IT usage in university settings to support pedagogy and administration purposes | Paucity of IT expertise could hamper EA value creation and delivery | Higher education institutions tend to have strong management and control structures with an opportunity to implement strong corporate management plans | Ensuring long-term value creation remains a challenge without explicit EA usage and management plans |