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The role of the Enterprise Architecture (EA) in improving healthcare delivery: a literature review.

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Abstract

EA “is a blueprint for organizational change defined in models [using words, graphics, and other depictions] that describe (in both business and technology terms) how the entity operates today and how it intends to operate in the future; it also includes a plan for transitioning to this future state" (Zachman).This paper uses literature review to explore the importance/ benefits of enterprise architecture and its contribution towards improving healthcare delivery. This included studies and relevant reviews on the state of art of the Enterprise Architecture's application in Healthcare Systems. Inclusion criteria were that, studies should relate to the importance/benefits of an EA application, Justification of EA application, challenges to EA adoption in healthcare systems, the most used methodologies, frameworks and best practices guide for the application of EA in Healthcare systems and EA success factor benefits in healthcare systems. In conclusion, benefits and success factors for application of EA, serve as a strong evidence for the need of EA implementation to improve healthcare service delivery especially in low developed countries like Uganda.

Keywords: Enterprise architecture, healthcare delivery.

1 Introduction

Healthcare is currently experiencing a major transformation in its use of information and digital health technologies (Wilson, 2004). Many organizations are increasingly adopting more information technology (IT) systems to assist in providing care. However, these organizations are facing issues such as standardization, integration and alignment with the business strategy (Jitendra, 2020). Enterprise architecture (EA) is a blueprint—a coherent framework of principles, methods and models—used in the design and realization of the enterprise’s organizational structure, business process, information systems and digital health infrastructure (Jonkers , 2006).

Enterprise Architecture was first developed by John Zachman while with IBM in the 1980s, after observing the building, airplane construction industries and the IT industry. He saw similarities between the construction of buildings, airplanes and the information systems used by an enterprise (Clive Finkelstein, 2004). Enterprise architecture (EA) is defined as a discipline for holistically leading enterprise responses to disruptive forces by identifying and analyzing the change's execution toward desired business vision and outcomes Gartner (2020).

EA seeks to reflect the complexity of modern IT systems, which comprise hundreds of components, organized in different layers, with many relationships among them (Yoo et al., 2010). Although there are different perspectives to describe EA (Niemann, 2006; Ross et al., 2006; Simon et al., 2014; Winter and Fischer, 2006; Zachman, 1987), they all explain EA as a strategic instrument to control and manage the complexity in an organization through structured description of the enterprise and its relationships. EA has tended into a holistic management of information systems in organizational approaches (Ross et al., 2006; Winter and Fischer, 2006).

Benefits of EA in healthcare service delivery

Integration of health care systems: The general goal of health information systems (HIS) integration is to build a strong establishment for the whole health system (Sajid, 2016). Healthcare resources such as staff, technology and healthcare delivery process play an important role in the integration process (Siti, 2020). Integration issues arise due to the different backgrounds or business architecture and different technology infrastructures or IT applications (Sajid, 2016). EA identifies these integration issues which can be used as a start to develop ways to resolve them and develop integration friendly systems in the future (Siti, 2020).

Alignment of IT and Business components**:** This has become a critical point for organizations to continue their activity in current IT development. Thus, organizations need a suitable method to construct this alignment to ensure all the IT requirement and business requirement are taken into consideration for the whole organization (Siti, 2020). EA is the method used to drive the organizations, setting their strategic planning and taking into account of every business processes, all resources, every unit in the organization, and every actor involved (Yahaya, 2018).

Global repository of standards and tools: EA can be used as a standard that any international government organizations and private organizations can implement to make effective healthcare information systems (Sajid, 2016).

Displaying current status of a HIS: EA will assist in interpreting the as-is condition of a country's HIS, providing steps for expansion with the passing of time which could be used for to-be planning such as HIS investments (Sajid, 2016).

Enterprise Architecture helps an enterprise to captures the essentials of the business, IT, and its evolution. Enterprise Architecture is a coherent principle, methods, and models used in the design and realization of organizational structures, business processes, information systems, and Enterprise Infrastructure (Saat, 2010).

Justification of EA application in healthcare

Healthcare organizations are confronting various issues; the major issue is medical errors and providing medical services where doctors are inexperienced or absent. The healthcare industry addresses the lack of interoperability and integration among systems; this will hinder it see the advantages of an Electronic Medical Record (EMR). Many healthcare organizations operate Electronic Medical Record systems independently. These systems are incapable to connect with other systems. The basic reason of incapability of these systems is different business procedures, IT/IS architecture. Enterprise Architecture offers a way out of this issue (Visumpoint, access on 30, October 2013).

The basic purpose of integrated health information systems is to build a strong foundation which addresses the entire health system. Without integrated information, health workers face different problems such as duplicate data, conflicting methods and instruments for data collection. There are several information and communication technology (ICT) launches for providing help to information system, but these are disjointed in design and implementations are in general not systematic (Sajid, 2016).

Unfortunately, most developing nations lack the experts, funds and ICT infrastructure necessary for the implementation of such modern healthcare technology to ensure continuity of care. Another challenge facing the developing world relates to sustainable energy, a key indicator for

socio-economic development. Availability of and reliable access to electricity is essential in healthcare delivery development. Implementing an EMR system or any HIS in a clinical practice is a daunting task. It requires good planning, strong management, clinical leadership and supportive staff. (Faustine, 2008).

Enterprise Architecture is a tool that facilitates the adoption and implementation of technologies. For HIEs, EA provides an overarching view of its business and IT architecture. Once a complete view of the HIE's architecture is developed, a pathway for the realization of desired future goals can be easily created (Osei-Tutu, 2020).

Challenges to EA adoption

The adoption of appropriate enterprise architecture and the principle of management of information systems will eliminate the eHealth interoperability challenge (Brown, 2004; Najafi, 2010). As pointed out in (Peterovic, 2001) architecture will provide an extensive impact on the operation of healthcare delivery. He added that the architecture will define the structure of healthcare, which will dictate the capabilities of healthcare in using eHealth.

According to Jitendra (2020), participants reported that before EA adoption, there were issues with their business and IT alignment, interoperability, governance, standardization, ownership and knowledge. Interoperability was also identified as a very important factor across all organizations. Sixteen participants also reported that interoperability affected their decision to adopt EA (Jitendra, 2020). Throughout our thematic analysis, funding, interoperability and lack of EA awareness were consistently identified as the key difficulties faced by the organizations before adoption. Participants identified the lack of EA experience in the leadership as the key challenge during the EA adoption process (Jitendra, 2020). This is consistent with existing perceptions that the adoption of EA is particularly difficult in organizations where the senior management does not have adequate experience with EA (Jitendra, 2020). Participants strongly felt a need for effective communication between the senior management and EA implementers for successful adoption and implementation. Half of the participants said they were willing to hire external EA experts to address this issue. However, they would also like to use any free resources that can assist with EA adoption (Jitendra, 2020).

The adoption of EA is incipient in Asia eHealth Information Network (AeHIN) member healthcare organizations. To encourage EA adoption, these organizations need to invest in

internal capacity building, senior management training and seek independent EA expert advice to systematically identify and address the barriers to adopting EA (Jitendra, 2020).

The lack of communication would make the adoption process more difficult and less efficient. In an earlier study, the lack of soft skills, such as people skills and leadership skills among practitioners has been attributed to poor communication during EA adoption (Chuang, 2010).

The most used methodologies, frameworks and best practices guide for the application of Enterprise Architecture in Healthcare systems

There are many architecture frameworks that are used in the development of organization's enterprise architecture, four top architecture frameworks are briefly defined (Sajid, 2016):

Zachman architecture model

John Zachman presented an enterprise architecture model in 1987, which consists of six columns, various views, and five rows (Olugbenga, 2015). The Zachman enterprise architecture is today recognized as ontology. The model presents the perspectives of planner, owner, designer, builder, and sub-contractor (Brown, 2004; Wegmann, 2008; Ebneter, 2010). The attribute of this model is the 5W1H, (Rosascon, 2011), which stands to question the 5Ws and H, i.e. what, where, who, when, why, and how? The model advantage is that it provides clarity to a complex enterprise (Olugbenga, 2015). It is, in addition, a model that describes enterprise business requirements in information technology. The disadvantages come from the fact that there is no procedure in the application of the architectural model. Also, the model is too idealistic, which makes it difficult to define a product based on this model (Olugbenga, 2015).

Federal enterprise architecture model

The federal enterprise architecture model was introduced in 1998 by the Chief Information Office (CIO) consortium (Olugbenga, 2015). This architecture provides guidance for enterprise integration information technology to the United States government (Olugbenga, 2015). The architecture model prioritizes certain architectural segments, while it also provides the mechanism for identification, development, and documentation (Kim, 2005; Brown, 2004). In addition, the architecture advantage is that it standardizes the organization's mission and vision, which makes it better in enhancing effectiveness. The drawback of this model is that it has no template or products for development (Olugbenga, 2015).

The open group model

The open group model, developed by the architecture forum in the mid-1990s, with its first version presented in 1995, It is based on "United States Defense Department Technical Architecture Framework" (Sajid, 2016). This architecture provides a comprehensive approach for designing, planning, implementing and governing enterprise information architecture (Haki, 2010; Lange, 2011). It has a holistic approach to design, modeled at business, application, data, and technology; however, it depends on modularization, standardization and already-existing technologies (Olugbenga, 2015). The essence of the TOGAF is the Architecture Development Method (ADM) and the Architecture Content Framework (Antunes, Jos´ e Barateiro, Christoph Becker, Jos´ e Borbinha and Ricardo Vieira, 2011). ADM address enterprise's business and IT needs. ADM consists of a stepwise cyclic method to design the whole EA. Another important component of the TOGAF is foundation architecture; the architecture team can predict the current and future situation of the architecture (Sajid, 2016). Four types of general architecture are part of the EA, including Business Architecture, Data Architecture, Applications Architecture, and Technology Architecture. Information Systems architecture is a combination of data architecture and application (Kridanto 2009).

Treasury Enterprise Architecture Framework (TEAF)

This framework is inspired by Zachman and supports the Treasury's business affair (Sajid, 2016). The TEAF offers guidelines for developing and redesigning business methods in order to fulfill requirements of modern legislation in an expeditiously changing technology environment (Sajid, 2016). TEAF describes four basic active (i) enterprise architecture strategies (ii) enterprise architecture management process (iii) enterprise architecture approach (iv) development of an enterprise architecture repository (Sajid, 2016).

According to Susanne (2006), every framework has several strengths and different weaknesses and no framework covers all requirements regarding the basic elements of a method; the TOGAF, for example, does not have the detail of a Meta model while the MDA is used to describe the Meta model (Sajid, 2016). Although there are several EAs, but here TOGAF and ZEAF methodologies are compared, since these are widely used and accepted frameworks. Susanne (2006) examines these two EAF on the basis of four constitutive elements (i) Meta

model (ii) Procedure model (iii) Technique/modeling technique (iv) Specification document and conclude that no EAF meets all requirements (Sajid, 2016).

In terms of cumulative knowledge, each government, unfortunately, develops, tailors, and uses a framework based on their own economic, socio-economic, and infrastructure status (Dang, 2017). As the public sector is constantly examined, evaluated, and monitored by the media and citizens, their EA investments and failures are equally examined. Poor EA implementation and execution easily lead to increased public spending, little reward, and the denouncement of failing EA. As the EA benefits are evident (Tamm et al., 2011; Boucharas et al., 2010; Kappelman et al., 2008; Lange et al., 2012; Niemi & Pekkola, 2017), the need to understand and steer EA implementation and adaption is thus evident (Dang, 2017).

EA Success Factor Benefits: Subsequently, another classification of EA benefit done by Jusuf et. Al 2017 divides types of EA benefits into a few categories such as operational, managerial, strategic, IT infrastructure and organizational which are displayed in the figure 3 as EA Success Factor Benefit Model (EA-SFBM) (Jusuf, 2017). These categories were the result of interviews with EA experts where the success factors are placed into four categories. These success factors determine the five categories of EA benefits. The model is useful in guiding future studies of EA benefits and determining which factors are needed to manage and achieve the benefits (Siti, 2020), this may apply for the healthcare sector.

Conclusion

The responsibility of the architect is to deal with concerns, show how these concerns and the requirements are going to be addressed, and document the transactions that are going to be made in reconciling the potentially conflicting concerns of different stakeholders. Without the architecture, it is highly unlikely that all the concerns and requirements will be considered and met (TOGAF, 2000). Normally, enterprise architecture ought to show properties that can be verified with regard to user needs, such as open or closed architecture, interoperable or compatible, and centralized or decentralized. All organizations believed that their interoperability and infrastructure would improve after adopting EA (Jitendra, 2020). Lack of EA knowledge and leadership among senior management is a major issue that needs to be addressed for a successful EA adoption (Jitendra, 2020). This study highlights the need for capacity building in the areas of

EA implementation, adoption, ivestiment and evaluation targeted towards the senior management in the first instance so as to improve healthcare service delivery especially in low developed countries like Uganda.

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