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The Role of Enterprise Architecture in Healthcare-IT

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Abstract

As far as Enterprise Architecture is a strategic planning tool, Main objective of architecture is to define the layout of organizational components and relationship among them in order to understand the integration of objects for further improvement. Enterprise architecture has several benefits and it is imperative for defining the IT components and their association with human (paramedical staff) involvement. However, the problem is, how to choose and create enterprise architecture framework for healthcare. Due to importance and pragmatic of enterprise architecture, the architectural concepts should be clear to senior management. Since, it is their responsibility to select the appropriate organizational architecture/framework for Business-IT alignment. Paper provides the enterprise architecture concepts. Since, it provides the overall picture of organizational concepts of well known architectural framework. Paper also proposed ArchiMate framework for modeling the healthcare organizations due to its coherence within EA elements. The main reason behind the use of such framework is the limitations of the existing ones in this cohesiveness of EA elements.

1. Introduction

Architecture is the description of the set of components and the relationships among these components n a given domain [1]. Several key issues ought to be addressed in order to define and formulate a holistic view of strategic planning in any business/enterprise domain [2]. These issues are basically the clarification of meanings, goals and abstraction levels within considered knowledge or application domain [3]. From an IT infrastructure viewpoint, several architectures could be considered such as hardware architecture, software architecture, system architecture and in organization level enterprise architecture [4]. One of the major objectives of architecture is to define the layout of components and relationship among them and define the integration of objects so as the enhancement of architecture become subject to further improvement [5]. For example, hardware architecture defines how hardware components are organized and software architecture describes the layout of the software modules and connections and association among them [1]. On the other hand, these connections and association can be applied to single or family computer/information systems [1]. Consequently, these connections are mainly dependent on the architecture approach and stakeholder point of view. Information system architecture covers hardware, software, data, and structure of data with behaviour and integration of data. Actually, this connection information system architecture is similar to meta-architecture [5]. In this context, enterprise architecture can be related to meta-architecture because it defines the relationships of enterprise information systems on various levels throughout the organization including technical infrastructure and strategic vision of the enterprise [1]. This is the highest level of architecture among all architecture as it is not restrictive to defines the highest level of concepts for any organization but also cover all aspects of organization [3]. Enterprise architecture clarifies the concepts of organizational memory and help to define the clearer picture for roles and responsibilities of the actors for inter and intra enterprise functions [1].

2. Architecture and Framework relation

When defining the enterprise models, the consideration of architecture and framework are common practice in business area [6]. As such, enterprise modelling approaches ought to be formulated in advance regarding healthcare organization before designing and development of IT projects. This enterprise modelling is a means of providing the necessary clear guidance for Information systems integration with human (paramedical) prospect. Moreover, it facilitates not

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only the successful and useable information systems but also provide the roadmap for future development and effective strategy for continuous efficient development [7]. In this connection, the terms architecture and framework are very commonly used for enterprise modeling approaches [8]. Prior to the consideration of any framework or architecture for mapping the IT-alignment with healthcare organization, it is crucial to clear the ambiguity of these interlink terms [9]. Usually framework is much more focused to industry or business sector while architecture focuses in building the enterprise system [10]. While framework defines various points of the organization [11], Architecture targets the end system. Framework helps to create an architecture, which is centrally focused for organizational system [9]. Figure 1 illustrates Architecture and Framework relation with enterprise systems and industry.

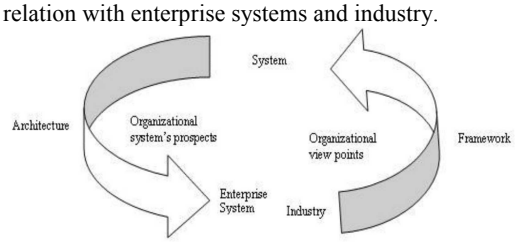


Figure 1. Architecture and Framework relation with enterprise systems and industry

3. Enterprise Architecture Benefits

Enterprise architecture is a management tool which is beneficial for IT-business alignment and provides the current state of the organization and future vision of enterprise [12]. Some other benefit could conclude as under:

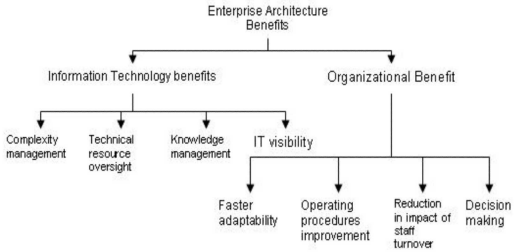
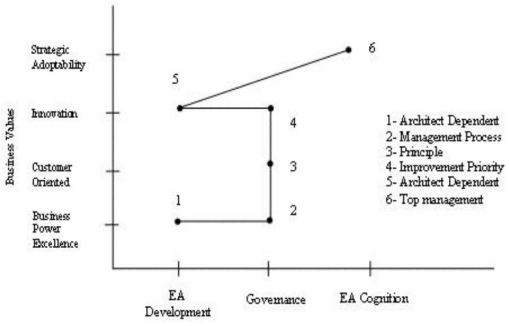


Figure 2. Enterprise Architecture benefit hierarchy [adopted from (Shah and Kourdi, 2007)]

From an organizational perspective, EA initiative is concerned about the governance which consists of IT principles, IT architecture, IT investment management and prioritization. This governance is certainly related with business values of the organization [13]. These Business values are brought by EA influential factors into the organization and they are beneficial [14] in terms of Business process and Information systems visibility, productivity, and Excellency to the Business process, customer oriented innovation and strategic decisions for the origination as a whole. The influential factor and Business values relation are shown in figure 2, which is a graph of EA effectiveness pattern modified from Kamogawa (2005).



Graph 1. Pattern of EA effectiveness

4. Experts' responsibility

Organizations are typically complex entities with dispersed resources and different organizational units with different operational procedures and environment. However, organizations are striving to effectively allocate the needed resources to satistfy their business objectives and optimizer their working procedures [7]. It is experts' responsibility to direct the organization to realize their competitive advantages and also to satisfy the stakeholder's needs [5].

Establishing and maintaining a coherent EA, on the other hands, is a complex task [1]. EA deign experts frequently coordinate with various people with different background using diverse notations for presenting the enterprise architecture on different abstract levels [15]. More specifically, a focus on defining architecture framework for classifying and positioning the various architectural descriptions with respect to each other [15] in order to capture these EA complexities. Such as Zachman Framework for EA. A common problem in the complex EA frameworks is that they divide and categorize architecture description rather than providing insight into their coherence [16]. A good example of these frameworks is Zachman framework [17]. It is two dimensional matrixes with 36 views identified in architectural cells based on six levels (scope, business model, system model, technology model, detailed representations and functioning enterprise) with six different aspects (data, function, network, people, time, motivation) [17].

Indeed, it is very complex task to select or develop a general meta-model for enterprise architecture. It should be sensible balance between considered architecture domain with the modelling language and view of the system with conceptual relation of interrelated entities [18]. It is defined on a different level of specialization. Modelling concepts

(languages and standards) applies within specific organization which depends on the definition of its meta-model [19].

5. Healthcare and Enterprise Architecture

In NHS (UK), most of the IT project fails or are outdated due to lack of integration and ineffective user prospective functionality [20]. If IT project design and develop through appropriate analysis with the help of effective enterprise architecture then the use of IT application could increase productivity in an organization by raising the usage of IT application among organization people [20]. It is also one of the major reasons in failure of IT application in NHS that paramedical staff refuses the use of IT system most of the time due to lack feasibility of the system within their working environment [21]. Enterprise architecture refers to how IT components fit together to support organizational functions [21]. In this connection, Enterprise architecture is the best method for analysing and defining the healthcare organization on high level of abstraction which could leads to characterize the healthcare IT components and align them with their current functions and future needs [1], [5]. For instance, in automobiles industry, there is no way of changing or defining the existing products without design sheet and description [13]. Design sheets define what considered product does and provide analytical approach if there is any possibility for improvement. Similarly Business architecture defines the business strategies based on current business functionality and potential for improvement in business through exploiting the IT [14]. Same happens in healthcare organization, it is vital to describe what they do, and how they will do it using IT [20]. Although enterprise architecture effectiveness is still little uncertain for healthcare organizations but there are sufficient evidence from business sector to establish the argument that enterprise architecture is good approach for defining and integration of IT in healthcare sector [21]. Enterprise architecture could provide the better results from IT projects in healthcare functionality improvement [7].

6. Right Enterprise Architecture:

It is vital to define the IT components and their association with human (paramedical staff) integration though enterprise architecture [22]. Then the question about how to choose and create enterprise architecture framework for healthcare is getting important [23]. It is not only important question for choosing the right EA framework for developing and describing the enterprise architecture but also more important to know that the chosen EA framework meets the requirement for healthcare organization or not [5]. It is important to identify the feasibility of current EA framework with their lacking and areas of further improvements. It is imperative to choose or define a coherent and comprehensive modeling approach for complex information systems and technology [24]. There are many approaches available for defining the IT components and association of their relationships. Some approaches support the development of architecture description leads to words framework.

7. Enterprise modeling from available Architecture or Framework

It is clear that framework and architecture approaches are available to apply in any business scenario and the application of tools and methods are mainly dependent on the particular goal and feasibility of the organization which is fluctuating in nature [1]. While considering the enterprise architecture or framework for building the absolute model for an organization, some properties or characteristics must consider for long term feasibility of the model before selecting it for implementation [2]. These characteristics should be maintainability (precisely characterize the enterprise at all time), dynamic (provide important information on both the rate of change and the reason for change and must change itself when system change), expandable (model must also support the addition of new subsystems), decompositional (the enterprise must support not only the understanding, but also the decision making and control of the system at various levels of detail), consistent with key enterprise metrics (enterprise model is to ensure that the model has intrinsic value, consistent with current enterprise metrics, and may drive the metrics, the model should be an integral part of the enterprise) and driven directly from actual enterprise data (inputs and outputs of enterprise model must be actual data from the enterprise, the model must drive the enterprise and the enterprise must drive the model) [7]. Figure 3, based on these characteristics model will be selected for information technology implementation and integration within culture of an organization.

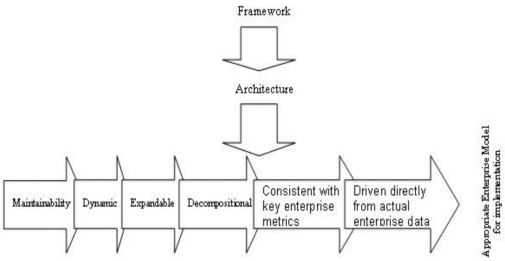


Figure 3. Appropriate enterprise modeling

Modelling of an enterprise is very complex task as it varies according to the viewer perception and goal of enterprise [23]. Modelling it is influenced by four major objects: universe, viewer, conception and representation [16]. Universe is the world around the viewer, viewer is the actor perceiving and conceiving the universe, using their sense, conception is the result in the mind of a viewer (interpretation what they perceive), representation is the denotation of viewer result by using some language for expression. Figure 1.4 designed from the research available (Proper *at el.*, 2005).

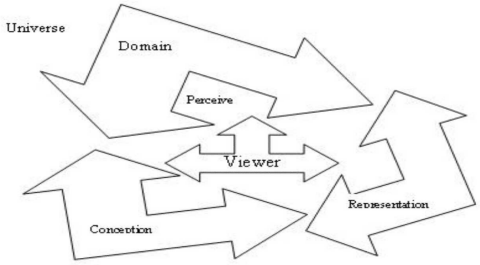


Figure 4. Viewer concept in enterprise modeling

With the domain knowledge, the viewer represent the model of the enterprise through their conception and represent the information system within organization by integrating and optimizing the system to fit the economy of information and to satisfy the value of information for its user or owner. This is achieved by using several approaches and methodologies such as automation for reducing cost of operation with increasing accuracy and effectiveness of each individual enterprise operation and considering each task within complete set of interlink processes [25]. Another common aspect is to optimize the cost with respect to system value by considering dynamic nature of enterprise domain.

8. Discussion

Typically, simple and understandable architecture is more useful in enterprise environment which can entertain various stakeholders together. In this connection, ArchiMate Framework is thought to be one of the most suitable approaches because of it simplicity and expressive power [16]. Although simplified version of Zachman describes the level of abstraction and level of granularity by proposing the matrix in which the questions what, how, where, who, when and why are answered on three level of abstraction enterprise model (owner), system model (designer) and technology model (builder) [17]. However, enterprise modelling language in ArchiMate clearly defines the domains which enable the complexity of architectural domain analysis, especially their relations with instruments and visualization techniques. Presentation and views techniques depends on the stakeholders needs [26]. These provide the insight to the stakeholder in a particular domain analysis.

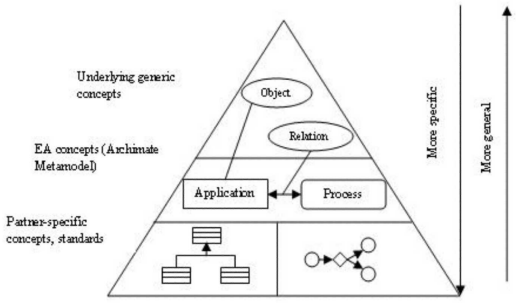


Figure 5. Meta-models from generic to specific on different levels (Business Process Project Team, 2001)

ArchiMate context views are precise by viewpoints, which define the abstractions on the set of models which represent the EA [16]. This viewpoint address the particular set of concerns and stakeholders interest so that it can use solely and can be related with two or more then two aspects of management interest [27]. Context of ArchiMate are illustrated in figure 6.

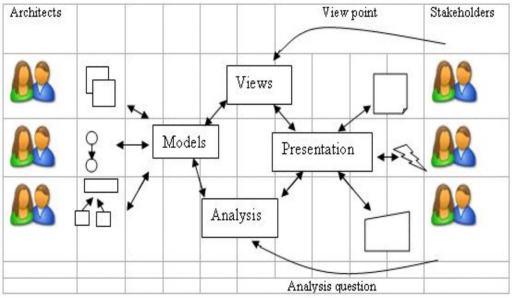


Figure 6. Context of ArchiMate Framework (jonkers *et al.*, 2003)

In practice, enterprise architectural descriptions within organizations have several layers [26]. Typically, the layers comprise three parts, business, application and technology [28]. Practically lower layer functionalities support to further higher layers [19]. Modelling support in these layers is straightforward and appropriate selection of modelling for each layer is very necessary for Business (healthcare)-IT alignment [29]. Appropriate selection of modelling/conceptual view is also essential for representing processes, applications, activities, components, objects and processes relations in a systematic way [26]. Enterprise architecture is appropriate approach for representation the healthcare processes onto different layers for designing and implementation the suitable healthcare application [26]. In figure 1.6, ArchiMate framework, which is simple and easy to be understand [16], is illustrated. As matter of the fact, the framework is suitable for representing the healthcare enterprises. Complex and sensitive functionality and service of healthcare can be easily decomposed onto three layers as describe in

ArchiMate framework (see above figure). Healthcare processes representation and linking with each other in conjunction with healthcare functionality and IT alignment is necessary for proposing an appropriate framework [28]. ArchiMate Enterprise architecture framework could give the methodology for representing and linking of healthcare processes [19].

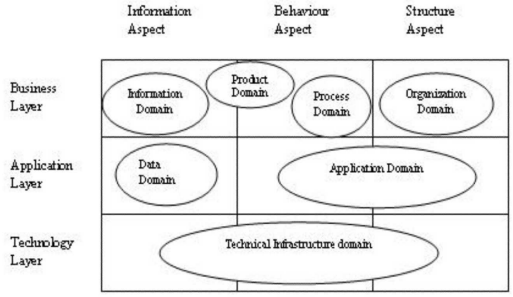


Figure 7. ArchiMate Framework (Lankhorst *et al.*, 2005)

Figure 7 shows the classification of concepts, which depend on conceptual domain. The conceptual domain is divided into layers and aspects [26]. Despite the fact, it is very difficult to define the exact boundaries between layers and aspects, it is important to understand the role of each concept with respect to its layer and aspect. The concepts which link aspects and layers play an important role for architectural description. The concepts with multiple aspects and layers could be complex but it most of the time concepts within particular domain link more than one aspect for each layer and each layer could be inter-related. Nevertheless, this plays a significant role for overall architectural integration. For example, Patients' care concept in healthcare domain covers all three aspects with business (healthcare) and application layers.

9. Conclusion

The importance of EA architecture is well known in the Business sector due to its Organizational and IT benefits such as it is provides Complexity management, Technical resource oversight, Knowledge management, Faster adaptability, Operating procedures improvement, Reduction in impact of staff turnover, Decision making. It is management tool and various enterprise framework and architectures are available which provide holistic view of the enterprise. It is the senior management's responsibility to select the appropriate EA for their organization. As far as healthcare organizations are not mainly profit focus, the effectiveness of their operations and efficiency of the services are of relevant concern. In this connection, the healthcare IT alignment is essential and critical for management through using EA as a tool for designing the current view of organization as well as future state of the origination This could increase significantly the success factor of IT project in healthcare generally and in NHS (UK). Our research recommends ArchiMate framework as a good tool for healthcare organizations because of it simplicity and well defined components among three layer and three aspects despite the fact that it is derived from Zachman framework. Differently from ArchiMate, Zachman framework is not only complex framework but it is divided into categorical architecture description rather than providing insight into their coherence.

10. References

[1] Armour, Frank J., Stephen H. Kaisler and Simon Y. Liu, A Big-Picture Look at Enterprise Architectures, IEEE, IT Pro, 1520-9202, (1999).

[2] Garlan D, Monroe, RT, Wile D., An Architecture Description Interchange Language, in Proc.CASCON '97, ACME, p. 169-183, (1997).

[3] Nuseibeh, B.A., A Multi-Perspective Framework for Method Integration. PhD thesis, Imperial College, University of London, (1994).

[4] Schefstroem D, and G. van den Broek., Tool Integration: Environments and Frameworks, New York: Wiley, (1993).

[5] Mirja Pulkkinen, Systemic Management of Architectural Decisions in Enterprise Architecture Planning, Four Dimensions and Three Abstraction Levels 0-7695-2507-5/06/2006 IEEE Proceedings of the 39th Hawaii International Conference on System Sciences, (2006).

[6] Avison, D., Information Systems Development: Methodologies, Techniques and 32 Tools. McGraw-Hill, New York, New York, USA, 2nd edition. ISBN 0077092333, (1995).

[11] Baskerville, R., Investigating Information Systems with Action Research. Communications of the Association for Information Systems, 2(19), (1999).

[7] H.A. Proper, A.A. Verrijn-Stuart and S.J.B.A. Hoppenbrouwers, On Utility-based Selection of Architecture-Modelling Concepts, Australian Computer Society Inc, ACM, (2005).

[8] Baskerville, R., Investigating Information Systems with Action Research. Communications of the Association for Information Systems, 2(19), (1999).

[9] Larry Whitman, Kartik Ramachandran and Vikram Ketkar, A TAXONOMY OF A LIVING MODEL OF THE ENTERPRISE, Proceedings of the 2001 Winter Simulation Conference, ACM, (2001).

[10] Bernus, P., and Nemes, L., Modeling and methodologies for enterprise integration. Chapman and Hall, (1996).

[11] Curtis, B., Kellner, I. M., and Over, J., Process Modelling. Communications of the ACM, 35(9), (1992).

[12] Shah H., and Kourdi M. E., Frameworks for Enterprise Architecture, IT Pro September October 2007 Published by the IEEE Computer Society 1520-9202/07, IEEE, (2007).

[13] Takaaki Kamogawa and Hitoshi Okada, A Framework for Enterprise Architecture Effectiveness; SAP, Japan, IEEE, (2005).

[14] C.Petrie.Jr., Enterprise Integration Modeling Technology, in Roc. 1st International Conf., MIT Press, Boston, (1992).

[15] Stephan Aier, How Clustering Enterprise Architectures helps to Design Service Oriented Architectures IEEE International Conference on Services Computing (SCC'06) 0-7695-2670-5/06, IEEE, Computer Society, (2006).

[16] M.W.A. Steen, D.H. Akehurst, H.W.L. ter Doest1, M.M. Lankhorst, Supporting Viewpoint-Oriented Enterprise Architecture Proceedings of the 8th IEEE Intl Enterprise Distributed Object Computing Conf (EDOC 2004) 1541-7719/04, IEEE, Computer Society, (2004).

[17] J. Sowa and J. Zachman, Extending and Formalizing the Framework for Information Systems Architecture, , IBM Systems J.,Vol. 31, No. 3, pp. 590-616, (1992).

[18] Lankhorst M. et al, Enterprise Architecture At Work, Springer Verlag, Heidelberg, (2005).

[19] Business Project Team, ebXML Business Process Specification Schema Version 1.01, UN/CEFACT and OASIS, (2001).

[20] I.R. Bowns, G. Rotherham, S. Paisley, Factors associated with success in the implementation of information management and technology in the NHS, Health Informatics Journal, Vol. 5, No. 3, 136-145, (1999).

[21] Chapman J., A systems perspective on computing in the NHS, Informatics in Primary Care, Volume 10, Number 4, pp. 197-199(3), (2002).

[22] Zacarias M., Caetano A., Magalhães R., Pinto, H. S., Tribolet J., Adding a Human Perspective to Enterprise Architectures, IEE, Computer Society, (2007).

[23] Victor Anaya and Angel Ortiz, How Enterprise Architectures Can Support Integration, Research Center on Production Management and Engineering, IHIS'05, Bremen, Germany, ACM, (2005).

[24] Susanne Leist Gregor Zellner, Evaluation of Current Architecture Frameworks, SAC'06, Dijon, France, ACM, (2006).

[25] Akehurst, D.H., S. Kent, and O. Patrascoiu, A relational approach to defining and implementing transformations between metamodels, Journal on Software and Systems Modeling, vol. 2, pp. 215, (2003).

[26] Jonkers, H., Steen, M., Bryant, B.R., Towards a Language for Coherent Enterprise Architecture Description, IEEE International Enterprise Distributed Object Computing Conference (EDOC 2003), Brisbane, Australia, (2003).

[27] Creasy, P. N. and Ellis, G., A Conceptual Graph Approach to Conceptual Schema Integration. In Proc. ICCS'93, Conceptual Graphs for Knowledge Representation: First International Conference on Conceptual Structures, (1993).

[28] Arkin, A., Business Process Modelling Language, BPMI.org, available: http://www.bpmi.org/bpmi-downloads/BPML1.0.zip, (2002).

[29] Jonkers H., Lankhorst M., Buuren R. V., Hoppenbrouwers S., Bonsangue M., Torre L. V. D., Concepts for Modelling Enterprise Architectures, International Journal of Cooperative Information Systems, (2004).