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ROLE OF ENTERPRISE ARCHITECTURE IN HEALTHCARE ORGANIZATIONS AND KNOWLEDGE-BASED MEDICAL DIAGNOSIS SYSTEM

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ABSTRACT

Enterprise architecture (EA) is a tool that aligns organization's business-process with application and information technology (IT) through EAmodels. This EA model allows the organization to cut off unnecessary IT expenses and determines the future and current IT requirements and boosts organizational performance. Enterprise architecture may be employed in every firm where the firm or organization requires configurations between information technology and business functions. This research investigates the role of enterprise architecture in healthcare organizations and suggests the suitable EA framework for knowledge-based medical diagnostic system for EA modeling by comparing the two most widely used EA frameworks. The results of the comparison identified that the proposed EA has a better framework for knowledge-based medical diagnostic system.

Keywords: Enterprise Architecture, Knowledge Base, Electronic Medical Record, Information technology and Information system.

1. INTRODUCTION

Enterprise architecture (EA) is a tool that creates a connection between business functions and information technology. EA is a tool for the plan of actions; the main task of EA is to describe the layout of an organization's components and relationships among them as well as to align IT and Business (Kamran Ahsan, Hanifa Shah and Paul Kingston, 2009). EA provides guidelines for decision making within a firm or organization. EA can perform radical changes in a firm or organization. The intention of EA is to offer a big picture about how business functions and IT work combine within a framework. EA enhances the managerial decision-making capability and enables the organization to better understand IT capabilities by aligning business functionalities with relevant IT resources (Christian Braun and Robert Winter, 2007). An enterprise architecture framework provides an environment for software, network and hardware to work jointly. Enterprise architecture is effectively employed in healthcare

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organizations in order to maximize the gains of ICT advantages. Resultantly these organizations enjoy the integration of resources, the interoperability between two or more organization's data and cut off the unnecessary ICT cost. Knowledge-based diagnostic systems are also part of the healthcare system, which assist the paramedical staff, medical professionals and patients in a disease diagnosis process. A knowledge-based diagnostic system lacks the appropriate enterprise architecture framework that depict the functionality and relation among various components of system. This research describes and compares the TOGAF and ZEAF methodologies and selects a better framework for the knowledge-based medical diagnostic system and determines whether the identified framework can better depict the functionalities and relations of all the major components.

2. BACKGROUND

There are many architecture frameworks that are used in the development of organization's enterprise architecture, four top architecture frameworks are briefly defined as under:

- **Zachman Framework:** This framework suggested a logical structure to categorize, arrange and depict the detailed picture of a firm. A primary objective of the Zachman framework is to create an infrastructure that supports a firm or organization in developing, integration, design, management and access organization's information system. The Zachman framework concerns information technology (IT) in an organization or firm and is normally depicted in six rows and six columns. The rows show perspective, such as Planer (Scope), owner (Enterprise Model), designer (System Model), builder (Technology Model), Subcontractor (Detailed Representations), Actual System (Functioning Enterprise) and the columns represent six basic questions (What, How, Where, Who, When, Why) in the scenario of perspective (Carla Marques and Pedro Sousa, 2004). A well-defined architecture is very helpful for a new development in existing processes and information technology systems to identify important alterations. In this context developers need tools or instruments to help the development of an IS/IT system from architecture to implementation. UML is an instrument which can be helpful in the implementation of the Zachman framework
- **Federal Enterprise Architecture Framework (FEAF):** The FEAF is composed by exercising the classification of five models which are known as reference models. These reference models listed below.

  (i) Performance Reference model.

  (ii) Business Reference model.

  (iii)Service component reference model.

  (iv)Data Reference model.

  (v) Technical Reference Model.

  The FEAF facilitates U.S. Federal Agencies to exchange information and design generic processes amongst other agencies. It also focuses on functional roles and on EA core team member's responsibilities.

- **Treasury Enterprise Architecture Framework (TEAF)** This framework is inspired by Zachman and supports the Treasury's business affair. The TEAF offers guidelines for developing and redesigning business methods in order to fulfill requirements of modern legislation in an expeditiously changing technology environment. TEAF describes four basic active (i) enterprise architecture strategies (ii) enterprise

architecture management process (iii) enterprise architecture approach (iv) and development of an enterprise architecture repository.

- **The Open Group Architecture Framework (TOGAF):** It is based on "United States Defense Department Technical Architecture Framework". The TOGAF was introduced in 1995 for information management. It is a generic framework and, for this reason, any firm may employ the TOGAF freely to design EA. The TOGAF enables any organization to evaluate and build their appropriate architecture. The TOGAF is split in four categories i) **Business architecture:** it explains the method of a business to achieve its objective. It also provides an overview of different parts of the organization and the relation between them. ii) **Data architecture** explains methods of data storage and retrieval. iii) **Application architecture** deals with the development of different applications and the interaction between them. iv) **Technical architecture** explains how software and hardware infrastructure support various applications and their relations.

  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. This foundation architecture includes Information System (IS) defining a method for building blocks, detailed information about how to fit together these building blocks, a set of instruments, a common vocabulary, suggested standards lists and compliant products lists for the implementation of building blocks.

3. ROLE OF EA IN HEALTHCARE

Healthcare organizations are confronting various issues; the major issue in these issues 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; it will never get 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)

Proper and timely information regarding health is extremely important for making strategic decisions that improve health-providing services and saves lives. EA provides support to achieve and ensuring this. Healthcare information systems (HIS) are weak in most developing countries such as Pakistan and India. Integrated healthcare information systems may provide reliable and timely health information to professional health providers and these health providers look at the HIS for more comprehensive points of view. 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.

- **The Health Metrics Network (HMN) -** in 2005 the HMN was started to support the Ministry of Health and stakeholders to improve world healthcare by ensuring the accessibility and proper utilization of information about health for advance evidence-based decision making. This is a first global healthcare collaboration and this collaboration concentrates in two main requirements. The first requirement deals with a

visualization of information systems (IS) that hold the healthcare system and the second requirement is convincing the country's leadership to invest and strengthen healthcare information management and its use. The HMN framework is designed based on a group of guiding operating principles. These principles are developed by more than 65 participating countries. These principles are as follows:

- Conventional use of better information is linked with better healthcare results and a strong healthcare information system (HIS) is one important procedure for providing capacity.
- Encouragement of top country leaderships is essential for maintaining healthcare benefits and enabling healthcare information systems.
- Country implementation challenges and requirements carefully understood and addressed directly for a HIS to be successful.
- Stakeholder consensus and commitment are required to improve performance of the healthcare system and health policies.
- Long term strategic plan is needed for health information system strengthening

Enterprise architecture describes methods or processes to design HIS in order to have a well organized set of building blocks as well as to provide a mechanism for fitting or combining together building blocks and communication among them. International organizations such as the World Bank regard enterprise architecture as an enabler to comprehensive reforms in the public sector (World Bank, 2008). An enterprise architecture approach to the development of healthcare information systems allows identifying essential interrelationships between components which need to be aligned. The perception from a government organization and a commercial organization has shown that a well designed EA overcomes the risk of big mistakes from applying different ICTs. Enterprise architecture will serve as a global repository of standards and tools that any worldwide government organizations and commercial or private organizations can apply to make strong healthcare information systems. Furthermore, enterprise architecture will play an important role to describe the current condition of a country's health information system. Enterprise architecture will help to explain the recent condition of a country's healthcare information system, and provide assistance and steps to achieve growth with the passing of time, which countries could use to inform plans for healthcare information system investments.

- **EA Integration in healthcare organizations:** Integration is a key feature of enterprise architecture that plays a very significant role in the integration of healthcare resources such as staff, technology and healthcare delivery process. Nowadays, various healthcare organizations or firms work on joint projects to provide extreme healthcare and cure. In this context, they face integration problems because of the different backgrounds and different IT/IS infrastructures. Generally, these integration problems occur on two levels, including the business process level and the IT/IS level. The basic reason of business process level problems is a collaboration of two or more organizations that using different business architectures.

  The IT/IS level problem is occurring when two different healthcare organizations are connected by using different IT applications/infrastructure. The business process level problems are overcome by using the Unified Enterprise Modelling Language (UEML) and the IT/IS level problems are solved by employing an Enterprise Service Bus (Victor Anaya and Angel Ortiz, 2005; Tu et al., 2012).

- **Enterprise interoperability in healthcare organizations:** After the 1990s, the idea of enterprise integration has been converted into a new emerging concept of Enterprise interoperability (Hervé Panetto and J. Cecil, 2013). To share data, information,

knowledge, within or across organizational boundaries by utilizing ICT procedures and business processes are called interoperability (Chen D., Doumeingts G., 2003) and interoperability between two or more firm's is called enterprise interoperability. Healthcare Organizations need to access information from different recourses in this context or else an organization faces an Information interoperability problem. Several healthcare organizations store their important and valuable information in different locations, such as a distributed database form and conflicting formats, which create a data management problem. Solotruk and Kristofic define three principles for interoperability, and these are Unification, Intersection and Interlinking.

- **Unification principle:** IT is used for designing the common model for different information systems. There are different types of unification such as multiple entities that are combined and merged in an entity and the standardization of multiple systems.
- **Intersection principle:** The unification in all systems that are accessible from other systems to get information and update information is called the Intersection Principle (Mats-Åke Hugoson, Thanos Magoulas and Kalevi Pessi, 2009). The main idea behind the Intersection principle is to improve the quality and accessibility of information and improve management of information by the elimination of redundancies. This principle provides shared workspace environment for participating organizations on the basis of business demand, through this shared work space of different participating organizations can share data, information and knowledge as well, as they can also update the database on demand.
- **Interlinking Principle:** The Interlinking Principle changes the idea of sharing into messaging. The interaction between two or more organizations is bridged by predefined messages according to organization relations. It is not necessary to understand other organization's system data; it is about information understanding of the information is sent and shared between two or more organizations. In the Interlinking Principle data structure of participating organizations remains different and connected through mapping. The advantages of interlinking are that the system can be replaced without any modifications (Kalevi Pessi, Thanos Magoulas and Mats-Åke Hugoson, 2011).

Healthcare organizations such as hospitals, clinics and, health centers use computers to keep a record of patients, doctors, employees, rooms allotted, pathology report and billing. Computers also keep details of a hospital such as appointments, patient registrations, operation theatres, laboratories, radiology, and pharmacy inventory management. AI enables computers to perform a diagnosis on a specific disease called medical expert system and the new form of expert system is called a knowledge-based system. Knowledge-based system is developed to incorporate medical knowledge and reasoning strategies into the automation of medical diagnosis. Knowledge-based medical diagnostic systems (KBMDS) is also a part of a healthcare system that support doctors, paramedical staff and patients in a disease diagnosis process. KBMDS is a software that is developed by adopting artificial intelligence (AI) techniques.

The knowledge-based medical diagnostic systems were introduced in 1970s and their first proper application was launched in 1980s (Mrs. S. S. Gulavani and R. V. Kulkarni, 2009). To date, numerous medical diagnostic systems have been developed for performing diagnostic processes for diagnosing different types of disease. Some widely use system is shown in table 1.

S.No.	Reference	System	Usage
1	(Wolfram D. A. 1995)	INTERNIST–I	Diagnose problems in general internal medicine.
2	(Ato Ogoe, 2005)	MYCIN	Blood infections.
3	(Patrick Winston and Karen A. Prendergast 1985)	CADUCEUS	Diagnose 1000 diseases
4	(Lemaire J. B., Schaefer J. P. and Martin L. A., Faris P. 1999).	QMR–Quick Medical Reference	Helps physicians to diagnose adult diseases.
5	(Aikins, J. S., Kunz J. C., Shortliffe E. H., Fallat R. J. 1983),	PUFF–Pulmonary Function	Lungs disease
6	(K. Henriksen, et al., 2005)	ATHENA	ATHENA DSS encourages blood pressure control and recommends guideline-concordant choice of drug therapy in relation to comorbid diseases.
7	(Morelli R. A., Bronzino J. D. and Goethe J. W. 1987)	CEMS	Mental health decision support system
8	(Bury, M. Humber and J. Fox. 2001)	ERA–Early Referrals Application	Web-based decision support and cancer referral system
9	(Ato Ogoe, 2005)	GIDEON–Gloabal Infectious Disease and Epidemiology Network	For diagnosis of infectious diseases, tropical diseases, epidemiology, microbiology and antimicrobial chemotherapy.
10	(K. Henriksen, et. al., 2005)	PERFEX–Knowledge Based Interpretation of Myocardial SPECT Imagery	Diagnosis of heart disease

Table 1 Some widely used systems in Medical Diagnosis Systems

The diagnostic systems described in Table 1 are technically effective; however, it does not depict the whole system in the form of a model like service, application and technology model. Therefore, no mechanisms found that show the association between its service elements, application components and technology (hardware) elements. Similarly, it is hard to understand the ICT requirement and functionalities of different components for the management. However, these problems may be addressed by employing suitably the enterprise architecture framework.

4. RESEARCH METHOD

This research adopts a comparison method through critical analysis of literature/related work to propose a better enterprise architecture framework for developing Knowledge-Based Medical Diagnosis System for EA modeling.

COMPARISON OF TOGAF AND ZEAF

Although there are several EAs, but here TOGAF and ZEAF methodologies are compared, since these are widely used and accepted frameworks. Zachman Framework has some deficiencies when a comparison is made with the TOGAF. These deficiencies are defined below.

Every row segment of the Zachman Enterprise Architecture Framework is independent and show discontinuity among cells and there is no solution described in this framework for consistency between cells, rows and columns. In this scenario, this is very difficult to understand how a structure interacts from one part to another; this problem can be addressed by using Elastic Metaphors Modeling. Elastic Metaphors ensures that the IS enterprise model reflects well the structures and functions (Gerald R., Khoury and Simeon J. Simoff, 2004). The Zachman framework does not address semantic behavior and that's why it is failing to determine behavior's effectiveness of the interactions and functioning of components. There are no clear rules or principles defined in the Zachman framework.

The TOGAF has advantages when compared with Zachman framework: i) It provides verified methods; these methods are developed by comprehensive research. ii) It provides shared vocabulary and that's why everyone can read and understand information in organizations. iii) It gives a visual representation to business concepts. iv) It provides knowledge about an organization and enables managers to make better informed decisions. v) It ensures that IT solutions are aligned to the needs of the business. vi) It increases data sharing, enhanced reliability of the solutions as well as easier maintenance. Roger Sessions (Microsoft, 2007) compare TOGAF and ZEAF and the result is summarized in Table 2:

Criteria	**Rating**	
	TOGAF	**ZEAF**
Methodology to categorize the different architectural artifacts	P	G
Methodology to guide a step-by-step process for designing EA	G	P
Instructions for building a set of reference models	G	P
Focus on a technology that reduced expenses and increased income	G	P
Practice guidance	G	P
Governance guidance	G	P
Guidance on effective autonomous separate sections of the organization which is used for managing complexity	G	P
Catalogue management about architectural assets that can be reused in future	G	P
Information availability	G	P

Table 2. The TOGAF and ZEAF comparison by Roger Sessions (Microsoft, 2007)

Legend: P: Poor; G: Good

The above table analysis shows that the ZEAF got only 1 good where TOGAF got 8 goods out of 9.

Saber Abdallah and Galal Hassan Galal-Edeen (2006) compare TOGAF and ZEAF and the result is summarized in Table 3:

Objectives	Result	
	ZEAF	**TOGAF**
Definition of Architecture and Understanding	PS	FS
Process of Architecture	NS	FS
Evolution of Architecture Support	NS	FS
Standardization	NS	FS
Knowledge-Based Architecture	NS	FS
Drivers of Business	PS	FS
Model of Business	FS	FS
Visualization tool	FS	FS

Table 3. The TOGAF and ZEAF comparison by Saber Abdallah and Galal Hassa Galal-Edeen (2006)

Legend: PS: Partially supports; FS: Full supports; NS: No Support

The assessment of table 3 shows that the TOGAF secures 8 numbers in Full Support while the ZEAF secures only 2 numbers.

Lise Urbaczewsk compares the TOGAF and the ZEAF on the basis of their different viewpoints and aspects. Table 4 shows a comparison by Views/Perspectives and table 5 shows Comparison by Abstractions (Lise Urbaczewski, 2006).

Comparison by Views/Perspectives

Framework	**Planner**	**Owner**	**Designer**	**Builder**	**Subcontractor**	**User**
Zachman	Scope	Model of Business	Model of System	Model of Technology	Full and Complete Representation	Working System
TOGAF		Business Architecture View	Technical Architecture Views			

Table 4. The TOGAF and ZEAF comparison by Abstractions (Lise Urbaczewski, 2006).

Comparison by Abstractions

Framework	**What**	**How**	**Where**	**Who**	**When**	**Why**
Zachman	Data	Function	Network	People	Time	Motivation
TOGAF		Guidance for Decision Making		Guidance IT resource		

Table 5. The TOGAF and ZEAF comparison

The vast majority of EA frameworks are abstract because of their general conditions. So, validity or the ability to work within a framework could be questioned. Table 4 and 5 show that the Zachman framework uses many viewpoints in different aspects that is why it appears as a more comprehensive framework.

According to Leist, 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. Table 6 shows different capabilities of the TOGAF and the ZEAF to support the design and management of enterprise architecture descriptions (Susanne Leist and Gregor Zellner, 2006).

Criteria	**TOGAF**	**Zachman**
Specification document	Not accomplished	Fully accomplished
Meta model	Not accomplished	Partly accomplished
Technique	Partly accomplished	Not accomplished
Procedure model	Fully accomplished	Partly accomplished

Table 6 The TOGAF and ZEAF comparison by Susanne Leist and Gregor Zellner, 2006.

Susanne Leist and Gregor Zellner (2006) examine 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.

5. DISCUSSION AND FINDINGS

The critical analysis and comparison of two widely used frameworks show that the TOGAF secured the highest score of 16 in the comparison section. On the other hand, the Zachman Framework score is only 3. It is noticed that there is no relation between Zachman matrix cells and no clear rules or principles are defined. It is also observed that the Zachman is not an appropriate framework for designing a new architecture because of the absence of a step-by-step process. The TOGAF is the best to develop an enterprise architecture model for Knowledge-Based Medical Diagnosis Systems because it provides a step-by-step process in the

form of layered architectures. The TOGAF divides enterprise architecture into four layered categories

- **Business architecture** explains the processes used for a business to achieve its goals for instance the business architecture of health information system consist of health services like patient records, individual health records, classification of diseases, symptoms and procedures, diagnostic reports, suggestions, prescriptions and treatment plans, etc.

- **Application architecture** deals with the development of different applications and the interaction between them. This architecture is highly applicable in the designing and development of relevant software requirement for interfacing with healthcare systems like standardized instruments for data collection, data-communication services, data analysis and modeling, report generating and speech recognition application in local language.
- **Data architecture** explains methods of data storage and retrieval, Data models, Metadata dictionary, Classification standards and systems
- **Technical architecture** explains how software infrastructure and hardware infrastructure support applications and their interactions, Local/wide area networks, Operating system Interoperability, mobile phone technology, speech recognition technology and web technology.

6. CONCLUSION

Integration and interoperability are the most important requirements of healthcare organizations and their systems. They need to access information from different recourses but they face information interoperability problems and EA provides a solution to these issues. The TOGAF is best to develop a knowledge-based medical diagnostic system when compared with the Zachman. The TOGAF divides the architecture into four layers that provide a progressive process to design an EA model. These layers depict the behavior of all components and the relationship between them. The four-layer model provides a better understanding of ICT elements and business process/services. The TOGAF also provides verified methods, shared vocabulary for understanding information in an organization, knowledge regarding an organization or firm for enabling managers or a system to make better-informed decisions. It also increases data sharing; it enhances solutions reliability and easier maintenance.

On the basis of a detailed critical review, it is concluded that the TOGAF is the best enterprise architecture framework when compared with the Zacman. Despite the extensive study of enterprise framework, no study defined a framework for knowledge-based medical diagnostic system. However, the study suggests an enterprise framework for knowledge-based medical diagnostic system, which is a main contribution of the work.

This study is simply based on analyzing two popular enterprise architecture frameworks. However, in the future, the study can be extended by the comparing other frameworks with the TOGAF as well as designing an EA model for a knowledge-based medical diagnostic system, possibly by using ArchiMate modeling language tools which are an essential part of an open group architecture framework.

REFERENCES

Aikins J. S., Kunz J. C., Shortliffe E. H., Fallat R. J. (1983), PUFF: An Expert System for Interpretation of Pulmonary Function Data. Comput Biomed Res. 16(3) (1983) 199-208.

Antunes, Jos´ e Barateiro, Christoph Becker, Jos´ e Borbinha and Ricardo Vieira. (2011). Modeling Contextual Concerns in Enterprise Architecture. 15th IEEE International Enterprise Distributed Object Computing Conference Workshops, DOI:10.1109/EDOCW.2011.9

Ato Ogoe. (2005). Medical Informatics: A look at Computer -Aided Diagnosis. [Online available at http://users.abo.fi/mwalden/SemiUpps05/AO_final.pdf] Access on 23 Oct 2015.

Bury, M. Humber, J. Fox. (2001). Integrating Decision Support with Electronic Referrals Proceedings of the Tenth World Congress on Health and Medical Informatics (Medinfo 2001), London, UK. September 2-5.

Carla Marques , Pedro Sousa. (2004). A Method to Define an Enterprise Architecture using the Zachman Framework. ACM Symposium on Applied Computing. P 1366-1371

Chen D., Doumeingts G. (2003) European initiatives to develop interoperability of enterprise Applications basic concepts, framework and roadmap. Annual Reviews in Control Volume 27, Number 2, pp. 153-162(10)

Christian Braun, Robert Winter. (2007). Integration of IT Service Management into Enterprise Architecture. Seoul, Korea. ACM 1-59593-480-4/07/0003

Dave Mayo. (2011). The Role of Enterprise Architecture in Federal Cloud Computing. ACT-IAC Enterprise Architecture SIG. www.actgov.org (p) (703) 208.4800 (f) (703) 208.4805

Dimitra Simeonidoub. (2013). Towards an optimized abstracted topology design in cloud environment. Elsevier Future Generation Computer Systems (FGCS), vol. 29, n° 1, pp. 46-60, DOI: RAEDMGELSEVIER2013.

Gerald R. Khoury, Simeon J. Simoff. (2004). Enterprise Architecture Modeling Using Elastic Metaphors. APCCM '04 Proceedings of the first Asian-Pacific conference on Conceptual modeling - Volume 31. P 65-69

Hervé Panetto, J. Cecil. (2013). Information Systems for Enterprise Integration, Interoperability and Networking: Theory and Applications. Enterprise Information Systems 7, 1 (2013) 1-6. DOI : 10.1080/17517575.2012.684802

J. A. Zachman. (1987). A framework for information systems architecture. IBM SYSTEMS JOURNAL, VOL 26. NO 3.

Kalevi Pessi, Thanos Magoulas and Mats-Åke Hugoson. (2011). Enterprise Architecture Principles and their impact on the Management of IT Investments. The Electronic Journal Information Systems Evaluation Volume 14 Issue 1, (pp53-62

Kamran Ahsan, Hanifa Shah, Paul Kingston. (2009). The Role of Enterprise Architecture in Healthcare-IT. Sixth International Conference on Information Technology: New Generations. IEEE DOI 10.1109/ITNG

K. Henriksen, J. B. Battles, E. S. Marks and D. I. Lewin (Eds). (2005). Advances in Patient Safety: From Research to Implementation. 1. Research Findings AHRQ Pub Numb 05-0021-1. Rockville, MD 20850, AHRQ. 1. 331-339

Lemaire J. B., Schaefer J. P., Martin L. A., Faris P. (1999). Ainslie M. D., Hull R. D., Effectiveness of the Quick Medical Reference as a Diagnostic Tool. CMAJ. 161(6).

Lise Urbaczewski, Stevan Mrdalj. (2006). A comparison of enterprise architecture frameworks. IACIS(IIS) Volume VII, No. 2, pp. 18-23

Mats-Åke Hugoson, Thanos Magoulas and Kalevi Pessi. (2009). Architectural Principles for Alignment within the Context of Agile Enterprises. 3rd European Conference on Information Management and Evaluation, University of Gothenburg, Sweden. Published by Academic Publishing Limited, ISBN: 978-1-906638-44-3 Cd, P222

Microsoft, (2007). A Comparison of the Top Four Enterprise Architecture Methodologies. Roger Sessions Object Watch, Inc. http:/www.msdn.microsoft.com/en-us/library/bb466232.aspx, (access on 28 October 2013).

Morelli R. A., Bronzino J. D., Goethe J. W. (1987), Expert Systems in Psychiatry: A Review. Journal of Medical Systems 11:157-168.

Mrs. S. S. Gulavani and R. V. Kulkarni, (2009). A REVIEW OF KNOWLEDGE BASED SYSTEMS IN MEDICAL DIAGNOSIS. International Journal of Information Technology and Knowledge Management. Vol 2, No. 2, pp. 269-275

P. Dhugga and A. Addison, (2011). Strategic ICT Toolkit. The University of Nottingham UK, China. Vol. 2

Patrick Winston and Karen A. Prendergast 1985, The A.I. Business: The Commercial Uses of Artificial Intelligence, ed. ISBN 0-262-23117-4.

Saber Abdallah, Galal Hassan Galal-Edeen. (2006). Towards a Framework for Enterprise Architecture Frameworks Comparison and Selection. The Fourth International Conference on Informatics and Systems (INFOS2006), Faculty of Computers and Information, Cairo University

Susanne Leist, Gregor Zellner. (2006). Evaluation of Current Architecture Frameworks. SAC'06, Dijon, France. ACM 1-59593-108-2/06/0004

Victor Anaya, Angel Ortiz. (2005). How Enterprise Architectures Can Support Integration. IHIS'05. ACM 1-59593-184-5/05/0011

Visumpoint (access on 30, October 2013). Enterprise Architecture for Healthcare. http://www.visumpoint.com/pdfs/EnterpriseArchitectureforHealthcare.pdf

World Bank. (2008). Webcast on Enterprise Architecture as an Enabler of Public Sector Reform. (Access on 28 October 2013).

Wolfram D. A. (1995). An Appraisal of Internist-I Oxford University Computing Laboratory, Programming Research Group, UK., Artifil Internet Media, 7(2). 93-116.

