

Enterprise Information Architecture (EIA): Assessment of Current Practices in Malaysian Organizations

Rafidah Abd.Razak rafidah@uum.edu.my,
Zulkhairi Md. Dahalin zul@uum.edu.my,
Rohaya Dahari @ Damiri roha@uum.edu.my,
Siti Sakira Kamaruddin and Sahadah Abdullah

*Faculty of Information Technology
Universiti Utara Malaysia, 06010 Sintok, Kedah
Tel: 604-9284701, Fax: 604-9284753*

Abstract

In this paper we described the findings based on a research study on current Enterprise Information Architecture (EIA) practices in Malaysian organizations. Ten organizations from public and private sectors were chosen for case study analysis. The Zachman Framework was chosen as a guideline to assess the current practice of EIA in these organizations. This study had successfully investigated the current practice and conditions of EIA in selected public and private organizations in Malaysia. The study found that majority of the organizations do practice some kind of enterprise information architecture either in-house or outsource to third parties. The study also found that certain aspects of the framework were not addressed at all, whilst other aspects that were addressed vary in terms of the different perspectives. This gives a general outlook of EIA implementation in the selected organizations, which could be incomplete or not adequately addressed. The study revealed a poor knowledge and understanding of EIA among the organizations though there had been efforts at implementing EIA focusing on the Data, Function and Network architectures. The study discovered gaps in the current practice and provides suggestions for organizations to consciously embark on the EIA paradigm in order to better align the whole organization to its goals. Results of this study can be used by the government and private sectors to formulate new policies and guidelines on enterprise architecture so that the enterprise's IT adoption and information requirements fit nicely into its business strategy.

1. Introduction

In the past two decades, Malaysia has been transformed from an agriculture-based to a manufacturing-based economy. During the 1990s, Malaysia's industrial development has moved towards capital-intensive, high technology and high value-added industries. Therefore, defining and planning for strategic information is a very important to Malaysian organizations. Organizations with proper planning of their Enterprise Information Architecture (EIA) and other IS will create global competition for all products and services, and has great advantages over those organizations that don't. According to Jessup and Valacich (2004), using Information System (IS) to support business strategy is the most effective approach to create the most business value. Information Architecture is used to identify major information category used within an enterprise and their relationship to their business processes. It is essential for guiding application development and facilitating the integrations and sharing of data. Organizations with good business models use EIA and IT to execute successful business models and succeed (Md. Dahalin et. al., 2006).

According to Zachman (1987), the increasing size and complexity of the implementation of information systems, it is necessary to use some logical construct for defining and controlling the interfaces and integration of all of the components of the system. Therefore, it is necessary to any enterprise to define enterprise information architecture to enable an integrated vision and global perspective of the enterprise information resources; to enable the discovery and elimination of redundancy in business

process; to having information systems that reflect common goals and performance measures for all managers, to encourage cooperation within enterprise; and to become the bridge between the business and technical domains (Pereira & Sousa, 2004).

The importance of aligning an enterprise's information requirements in terms of its data and processes that constitute its information infrastructure with the business strategy has been recognized ever since IBM brought up the idea of Business Systems Planning in the early 1980s. Surveys of IS executives highlight the importance of Enterprise Architecture ranked among the top IS issues (Neiderman et al., 1991; Brancheau et al., 1996). These articles suggest the development of IS-related innovations need to be considered in a systematic manner within the framework of various architectures encompassing the business architecture, information architecture, data architecture, systems architecture and computer architecture.

According to King (1988), the business strategy of an enterprise is translated into enterprise's information systems strategy through the process of information system planning. This IS strategy, according to the author, guides the development of the enterprise information architecture. EIA provides the framework for planning and implementing a rich, standards-based, digital information infrastructure with well-integrated services and activities. Among others, these would amount to: (1) Easier information sharing and exchange; (2) Improved security and privacy; (3) More effective response to customer requirements through easier and faster building of information services; (4) Increasingly effective matrix organization structure because of the use of common information services, resources, and tools; (5) Easier sharing with collaborators outside through wider use of industry standards; (6) Easier incorporation of outside vendors within chains of needed capabilities and better integration within industry; and (7) Lower overall institution-wide EIA-related costs (Watson, 2000).

2. EIA in Malaysia

In Malaysia EIA is becoming more and more popular among organizations based on the keen interest on the subject and the overwhelming participation among key IS players in workshops and seminars on Enterprise Architecture organized by professional training and consulting companies (Seow, 2000). However, he expressed doubt that enterprises are doing the same with EIA where its actual practice may have been very

minimal as enterprises adopt a wait-and-see approach. This may suggest that up to the present moment, no empirical evidence have been gathered on the extent of current practice on EIA among enterprises in Malaysia.

For this reason, the researchers became aware that it would be more meaningful to investigate the situation itself and to gain insight into actual EIA implementation to discover the empirical evidence of EIA in Malaysian organizations. The outcome of the study is very important to those who are involved in developing the Information Architecture. The findings could promote the awareness of the extent of EIA implementation in terms of lessons learnt, pitfalls, contributing factors and benefits. This study could also provide evidence concerning trends in EIA implementation, which is useful for academicians that can impact curriculum development, in order to give accurate and updated knowledge to students in terms of training and consultation in EIA. Another importance of the study is to provide explicable guidelines for EIA implementation and its implication to IT policy.

3. Purpose of the Study

The main purpose of this study is to assess the current practice of EIA in public and private organizations in Malaysia. In order to achieve this, three general objectives have been outlined, i.e.: (1) to identify the current practice of EIA by organizations in planning their IT Adoption; (2) to map the current practice with the requirements Zachman Framework; and (3) to come out with suggestions to formulate new policies and guidelines on enterprise architecture so that the organizations' IT adoption and information requirements fit nicely into its business strategies.

4. Research Methodology

An in-depth study of selected organizations was carried out to examine actual practice and how current implementations compared to the established framework. The study followed the Zachman Framework as a theoretical base in a structured way for acquiring the necessary knowledge about organizations with respect to the EIA.

The research approach follows the case study method, in-depth study of selected enterprises was conducted, in which the unit of analysis is the department responsible for planning the organizations' IS usage and IT

adoption. A case study protocol was constructed to help facilitate investigation and fact-findings to ensure consistency across multiple cases. Techniques of data gathering that were used are interviews, documentation and questionnaires. Reliability is measured against responses from the multiple cases where inter-item discriminant analysis was determined based on patterns of evidence. Ten enterprises were selected for the case study. These represent both public and private sectors. The aim is to achieve theoretical generalization where according to Yin (1989), a minimum of four units of analysis suffice though a single unit is still permissible when certain conditions were met.

Interviews were recorded and transcribed, and scripts were returned to the interviewees to ensure validity of responses. Respondents of interviews were mainly the IS Planning analysts or the person(s) responsible for developing the EIA or the enterprise's IT master plan. Questionnaires were distributed to key user representatives for cross validation and intra-organizational consistency. Documentations such as annual reports and the enterprise's business strategies were analyzed to determine the enterprise's motivations, concerns, and performance indicators. Pattern-matching technique was used to analyze the

data. This was then mapped against Zachman Framework to determine the extent of practice. The Zachman Framework is probably the most recognized and popular approach to enterprise modeling (Khoury & Simoff, 2004). For this reason, this study focuses on Zachman Framework for the purpose of cross analysis of EIA practice.

5. Background of the Case Study Organizations

The background profiles of the case study organizations are presented in Table 1. Four organizations represent the public sector (Gov't), three represent government link companies (GLC) and the remaining four are from the private sector, each from IT, financial institution and education. In terms of size, the sample belongs to the medium and large organizations and they are situated in various cities in Malaysia. For reasons of confidentiality, the organizations' names are presented anonymously. All the organizations have a formal IT department typical of any medium to large organizations with IT staff ranging from 4 to 200.

Table 1: Profiles of the case study organizations

	Type of business	No. of employees	IT department	Respondent Job title	No. of IT staff	IT investment (annually)
Case 1	Gov't	200	yes	IS Officer	36	RM1m
Case 2	Gov't	500	yes	IS Officer	17	RM1m
Case 3	Education	935	yes	IT Manager	n/a	RM2m
Case 4	GLC	7000	yes	Deputy Director	95	RM10m
Case 5	GLC	4000	yes	SA	130	n/a
Case 6	Gov't	714	yes	IT Officer	4	RM350k
Case 7	Financial	1200	yes	Vice President	27	RM23m
Case 8	IT	200	yes	Senior Manager	200	RM100m
Case 9	Gov't	500	yes	Director, SA	23	RM10m
Case 10	GLC	1300	yes	AGM	26	RM21m

6. Organizations EIA Practice

In terms of EIA practice (Table 2), all ten organizations conduct EIA planning with eight formal and two informal planning. It is surprising that a moderately large financial institution practices informal EIA planning given a substantial RM23 million annual IT investment. However, a closer look at the data shows that the same institution outsource their EIA planning and implementation to third parties. This is also true for Case 5, which also have informal EIA planning, and practiced third party outsourcing. Recently, however

there is an indication that the organization is just starting to carry out EIA planning formally.

In terms of the rate of EIA implementation (Table 2), with the exception of Case 3 and Case 9, the rest of the organizations have between 50% to 90% rate of EIA implementation that is considered high. Both Case 3 and Case 9 implement 20% of its EIA, which is considered too low. The scope of EIA is enterprise wide as indicated by all organizations.

Reviews are conducted quarterly, half yearly or yearly except for Case 7 because of short term projects. A

closer examination of Case 7's requirements shows that instead of periodic reviews, they would prefer those personnel involved with EIA to accumulate requirements through post-mortem sessions and bring these forward to the next EIA exercise conducted yearly. This would ensure current EIA planning and implementation to run smoothly and are not hindered by new and additional requirements along the way.

In terms of frequency of IT planning, some organizations conduct regular short term (yearly) planning whilst other organizations prefer long term planning between five to seven years. The planning

time frame ranges between two months to twelve months. However, Case 7 is the only organization that did not address planning time frame.

The involvement of key people, top management, and IT users are crucial in determining the success of EIA. (Md. Dahalin, 2002). Findings from this study indicate that various people participate in the EIA planning. These include top management, directors, consultants, IT officers, key personnel, end users, and other expert groups. However, the participations of top management in the EIA planning are relatively low, with the exception of Case 1, Case 5 and Case 9.

Table 2: Organizations EIA Practice

	EIA Plan	Percentage implemented	Planning review	Planning scope	Frequency of IT Planning	Planning time frame	Participants
Case 1	Formal	80%	Quarterly	Enterprise-wide	Yearly	3 months	Top management, IS officer and vise
Case 2	Formal	87%	Yearly	Enterprise-wide	5 years	12 months	User, Officer, Director, Consultant
Case 3	Formal	20%	Yearly	Enterprise-wide	5 years	7 months	IT representatives from each branch, end users, managers
Case 4	Formal	50%	Yearly	Enterprise-wide	5 years	10 months	MIS division & project owner MIS division & project owner
Case 5	Informal	90%	Halfyearly	Enterprise-wide	Yearly	12 months	Top management, IT staff, user & consultants
Case 6	Formal	80%	Yearly	Enterprise-wide	Yearly	12 months	IT staff, user
Case 7	Informal	75%	No because short-term project	Enterprise-wide	Yearly	no	IT staff, end user
Case 8	Formal	90%	Yearly	Enterprise-wide	5 years	3 months	Management & user
Case 9	Formal	20%	Yearly	Enterprise-wide	Yearly	2 months	Top management, Director, IS/IT staff, user
Case 10	Formal	70%	Yearly	Enterprise-wide	7 years	6 months	Key person, end user, internal expertise, internal consultant

7. Cross Analysis of EIA Practices

The Zachman Framework was developed taking into consideration of all participants involved and identifies six aspects of architectures to focus about enterprise with five levels of models representing different development views. The views begin with the planner's perspective, followed by the owner's perspective, the designer's perspective, the builder's perspective and the subcontractor's perspective. Each

of the leveled view corresponds to the six dimensions of the architectures, i.e. data, function, network, people, time and motivation (Spewark, 1992; Pereira & Sousa, 2004). Data from the findings are map against the Zachman Framework. The results show a mix pattern of practices in various dimensions, some focused on outsourcing whilst others practiced in-house and some dimensions are included or involved whilst others totally not done.

Table 3: PLANNER PERSPECTIVE - Data Mapped Against the Zachman Framework

	Data	Function	Network	People	Time	Motivation
Case 1	In-house	In-house	In-house	Involved	Not done	Involved
Case 2	In-house	In-house	Out-source	Involved	Not done	Involved
Case 3	In-house	In-house	In-house	Involved	Not done	Involved
Case 4	In-house	In-house	Out-source	Involved	Not done	Involved
Case 5	Out-source	Out-source	Out-source	Involved	Not done	Involved
Case 6	In-house	In-house	In-house	Involved	Not done	Involved
Case 7	Out-source	Out-source	Out-source	Involved	Not done	Involved
Case 8	Out-source	Out-source	Out-source	Not done	Not done	Not done
Case 9	In-house	In-house	In-house	Involved	Not done	Involved
Case 10	In-house	In-house	In-house	Involved	Not done	Involved

In the PLANNER perspective, the DATA and FUNCTION dimensions are largely in-house, whilst there is a mix pattern of in-house and outsourcing in the NETWORK dimension. For PEOPLE dimension, all the case organizations are involved except for Case 8. In the case of Case 8, people are not involved in the

PLANNER perspective because they totally outsource the EIA planning to a third party. Note that the TIME dimension is not included at all in the PLANNER perspective. As for MOTIVATION dimension, again Case 8 is not involved.

Table 4: OWNER PERSPECTIVE - Data Mapped Against the Zachman Framework

	Data	Function	Network	People	Time	Motivation
Case 1	Not done					
Case 2	Involved	Involved	Involved	Involved	Included	Involved
Case 3	Not done	Involved				
Case 4	Involved	Involved	Involved	Involved	Not done	Involved
Case 5	Involved	Involved	Involved	Involved	Not done	Involved
Case 6	Involved	Involved	Involved	Involved	Not done	Involved
Case 7	Not done	Not done	Not done	Involved	Not done	Involved
Case 8	Not done					
Case 9	Involved	Involved	Involved	Involved	Included	Involved
Case 10	Involved	Involved	Involved	Involved	Included	Involved

In the OWNER perspective, the DATA, FUNCTION and NETWORK dimensions are a mix pattern of in-house and outsourcing. The PEOPLE dimension, all case organizations are involved except for Case 1, Case 3 and Case 8. In the case of Case 1 and Case 3, people are not involved in the OWNER perspective because most of the requirements that are considered are specific to departments and management only. As in the

case of Case 8, people are not involved in the OWNER perspective because they totally outsource the EIA planning to a third party. The TIME dimension, all the case organizations are not involved except for Case 2, Case 9 and Case 10. As for MOTIVATION dimension, all the case organizations are involved except Case 1 and Case 8.

Table 5: DESIGN PERSPECTIVE - Data Mapped Against the Zachman Framework

	Data	Function	Network	People	Time	Motivation
Case 1	In-house	In-house	In-house	Involved	Not done	Involved
Case 2	In-house	In-house	Out-source	Involved	Included	Involved
Case 3	Out-source	Out-source	In-house	Not done	Not done	Involved
Case 4	In-house	In-house	Out-source	Involved	Not done	Involved
Case 5	Out-source	Out-source	Out-source	Involved	Not done	Involved
Case 6	Out-source	Out-source	In-house	Involved	Not done	Involved
Case 7	Out-source	Out-source	Out-source	Not done	Included	Involved
Case 8	Out-source	Out-source	Out-source	Not done	Not done	Involved
Case 9	In-house	In-house	In-house	Involved	Included	Not done
Case 10	In-house	In-house	In-house	Involved	Included	Involved

In the DESIGN perspective, the DATA, FUNCTION and NETWORK dimensions are a mix pattern of in-house and outsourcing. For PEOPLE dimension, most

of the case organizations are involved except for Case 3, Case 7 and Case 8. In the case of Case 8, people are not involved in the DESIGN perspective because they

totally outsource the EIA planning to a third party. For the TIME dimension, there are four case organizations consist of Case 2, Case 7, Case 9 and Case 10 which are also included in the DESIGN perspective. Note that

the other six cases are not included at all. As for MOTIVATION dimension, again Case 8 is not involved.

Table 6: BUILDER PERSPECTIVE - Data Mapped Against the Zachman Framework

	Data	Function	Network	People	Time	Motivation
Case 1	In-house	In-house	Not done	Involved	Not done	Not done
Case 2	In-house	In-house	Not done	Involved	Included	Not done
Case 3	Out-source	Out-source	Not done	Not done	Not done	Not done
Case 4	In-house	In-house	Not done	Involved	Not done	Not done
Case 5	Out-source	Out-source	Not done	Involved	Not done	Included
Case 6	Out-source	Out-source	Not done	Involved	Not done	Included
Case 7	Out-source	Out-source	Not done	Not done	Included	Not done
Case 8	Out-source	Out-source	Not done	Not done	Not done	Not done
Case 9	In-house	In-house	Not done	Involved	Included	Included
Case 10	In-house	In-house	Not done	Involved	Included	Included

In the BUILDER perspective, the DATA, FUNCTION, and NETWORK dimensions have the same number of outsource and in-house development. For the PEOPLE dimension, majority of the people are involved except for case 3, 7 and 8. In these cases, development efforts were outsourced except for case 3 where the NETWORK was carried out in-house, as the system

was inherited from previous organization. As expected, the TIME dimension was largely not addressed except for cases 2, 7, 9 and 10. In these cases, all events were incorporated in the development of the system. The MOTIVATION dimension was however included in only four of the cases.

Table 7: SUB-CONTRACTOR PERSPECTIVE - Data Mapped Against the Zachman Framework

	Data	Function	Network	People	Time	Motivation
Case 1	Outsource	Outsource	Outsource	Involved	Not done	Not done
Case 2	Outsource	Outsource	Outsource	Involved	Not done	Not done
Case 3	Outsource	Outsource	In-house	Not done	Not done	Not done
Case 4	Outsource	In-house	Outsource	Involved	Not done	Not done
Case 5	Outsource	Outsource	Outsource	Involved	Not done	Not done
Case 6	Outsource	Outsource	Outsource	Involved	Not done	Not done
Case 7	Outsource	Outsource	Outsource	Not done	Included	Not done
Case 8	Outsource	Outsource	Outsource	Not done	Not done	Not done
Case 9	Not done	Not done	Not done	Not done	Not done	Not done
Case 10	Not done	Not done	Not done	Not done	Not done	Not done

In the SUB-CONTRACTOR perspective, the DATA, FUNCTION, and NETWORK dimensions are largely outsourced except for Case 9 and Case 10 which were not done. Besides that, Case 4 was using in-house Sub-contractor for their project for DATA and FUNCTION dimensions and only Case 3 was using in-house for NETWORK dimension. For PEOPLE dimension, there is a mix pattern of people involved and not involved. Note that the TIME dimension is largely not included at all in the PLANNER perspective except for Case 7. In Case 7, time is included because they claim that event trigger is one of the important aspects to be considered while developing IT/IS project. As for MOTIVATION dimension, all ten cases were not involved.

8. Discussion on Findings

The study examined ten organizations from government agencies, government-linked companies (GLCs), and private sectors using the case study research strategy. The Zachman Enterprise Architecture Framework was chosen as a guideline to assess current practice of EIA in these organizations as the framework is particularly known world-wide and has become a de-facto standard for enterprise information architecture practiced by organizations in the developed countries.

In terms of current EIA practice, the findings found that all ten organizations conduct variations of EIA, particularly at the planning level. This is equivalent to the Planner perspective in the Zachman Framework.

Organizations called this Information Strategy Planning (ISP), IT planning, or IT master plan; with none of the participating organization made reference to the Zachman Framework. A number of the organizations also outsourced their EIA planning whilst a small number carried out EIA planning informally. Data, Function and Network dimensions appeared to be the common dimensions implemented across all ten organizations. This suggests that these three dimensions represent the architectures and models practiced currently by many organizations, from planning right down to the design and implementation stages.

On the extent of the current EIA practice based on the mapping of the Zachman's EIA framework, most of the EIA work focused on all dimensions except for TIME across all perspectives. Whilst EIA planning is carried out and is evidenced in all ten organizations, there is a mixed pattern of practices in the various dimensions. Majority of the organizations prefer to conduct in-house EIA activities at the DATA and FUNCTION dimensions from the PLANNER perspective. The rest of the development efforts were equally distributed between in-house and outsourcing. Apart from DATA, FUNCTION and NETWORK dimensions, PEOPLE and MOTIVATION are also commonly practiced by the organizations. However, for organizations that do outsourcing, PEOPLE dimension is usually given less emphasis. TIME dimension is not addressed in almost all perspectives particularly at the higher level such as PLANNER and OWNER perspectives and to a lesser extent, the DESIGNER perspective. Experience of the researchers found that the TIME dimension was the least understood. This may suggest that the time factor may not be critical at the higher level, and perhaps due to its detailed characteristics such as event triggers, interrupts and if-then-else conditions, it is more appropriate to include it at the lower level perspective, namely BUILDER and SUB-CONTRACTOR perspectives. However, there is a reason to believe that the TIME dimension is also appropriate at the higher level. OWNER perspective for instance can gain from TIME dimension by incorporating changes to affecting business processes as results of introducing new technology that affect delivery and service time. Strategic analysis techniques such as Technology Impact Analysis and Business Process Re-engineering can be used for the PLANNER perspective to assess potential changes that could result in competitive advantage and new opportunities. The need to align IT adoption to the business strategy is clearly evidenced from involvement of majority of the cases in the higher level perspectives namely, PLANNER, OWNER and

DESIGNER. However, this was not adequately addressed in the lower level perspectives namely, BUILDER and SUB-CONTRACTOR. A closer examination of the data reveals that the DATA, FUNCTION, and NETWORK dimensions exist across all ten cases from the PLANNER, DESIGNER and BUILDER perspective. This may give indication that these three dimensions represent the most common architectures and models available currently, and they can represent most of the architectural work from the planning perspective right down to design and development.

9. Conclusions

The main purpose of this study is to assess the current practice of EIA in public and private organizations in Malaysia. This study had successfully investigated the current practice and conditions of EIA in selected public and private organizations. The study found that majority of the organizations do practice some kind of enterprise information architecture either in-house or outsource to third parties. In planning their IT adoption, the findings found that all ten organizations conduct variations of EIA, particularly at the planning level. Organizations called this Information Strategy Planning (ISP), IT planning, or IT master plan; with none of the participating organization made reference to the Zachman Framework. This may suggest that the Zachman Framework is relatively new in Malaysia.

The study revealed a poor knowledge and understanding of EIA among the organizations though there had been efforts at implementing EIA focusing on the Data, Function and Network architectures. Future studies should look into formalizing the People, Time and Motivation architectures based on the perspectives of the Planner, Owner, Designer, Builder, and Sub-contractor. The study also found that certain aspects of the framework were not addressed at all, whilst other aspects that were addressed vary in terms of the different perspectives. This gives a general outlook of EIA implementation in the selected organizations, which could be incomplete or not adequately addressed.

The study also discovered gaps in the current practice and provides useful information for organizations to consciously embark on the EIA paradigm in order to better align the whole organization to its goals. In view of this findings, efforts should be made by organizations not only to formalize the EIA practice in organizations, but also to links of organizational

knowledge and its business requirements to its mission and strategic objectives so that acquisitions and adoption of IT can closely match and support the organization's key performance indicators. It is hoped that the results of this study can be used by the government and private sectors to formulate new policies and guidelines on enterprise architecture so that the enterprise's IT adoption and information requirements fit nicely into its business strategy.

10. References

- [1] J.C., Brancheau, B.D., Janz, and T.C., Wetherbe, "Key issues in information systems management: 1994-1995 SIM Delphi Results", *MIS Quarterly* 20(2), 1996, pp. 225-242.
- [2] Jessup, L.M. and Valacich, J.S. *Information System Today*, Prentice Hall, Washington State University, 2004.
- [3] W.R., King, "How effective is your information systems planning", *Long Range Planning*, 21(5), 1988, pp. 103-112.
- [4] G.R., Khoury, and S.J., Simoff, "Enterprise Architecture Modelling using Elastic Metaphors", *First Asia-Pacific Conference on Conceptual Modelling (APCCM 2004)*, Dunedin, New Zealand, 2004, pp. 65-69.
- [5] Md. Dahalin, Z, "Strategic Application Portfolio in Small Medium Enterprises", *Malaysian Management Journal* 6 (June/Dec), 2002.
- [6] Z, Md. Dahalin, R, Abd. Razak., R, Dahari., S. S, Kamaruddin., and S, Abdullah, "Enterprise Information Architecture: Empirical Evidence to Support Zachman Framework in Malaysia", *Knowledge Management International Conference and Exhibition (KMICE'06)*, Kuala Lumpur, Malaysia, 6-8 June, 2006.
- [7] F, Neiderman, J.C., Brancheau, and T.C., Wetherbe, "Information systems management issues for the 1990s", *MIS Quarterly*, Dec., 1991, pp. 475-502.
- [8] C.W, Pereira, and P, Sousa, "A Method to Define an Enterprise Architecture using the Zachman Framework", *2004 ACM Symposium on Applied Computing*, 2004, pp. 1366-1371.
- [9] Seow, S.P.S., *The Zachman Framework for Enterprise Architecture: Finding Out More*, The Analyst LLC, USA, 2000.
- [10] Spewark, S.H, *Developing a Blueprint for Data, Applications and Technology: Enterprise Architecture Planning*, QED Publishing Group, Princeton, NJ,1992.
- [11] R. W., Watson,. "An Enterprise Information Architecture: A Case Study for Decentralized Organizations", *Proceedings of the 33rd Hawaii International Conference on System Sciences*, Hawaii, 2000.
- [12] Yin, R.K., *Case Study Research: Design & Methods*. Sage Publications, Beverly Hills. 1989.
- [13] J, Zachman, "A Framework for Information Systems Architecture", *IBM Systems Journal*, 26(3), 1987.