

# A CONCEPTUAL MODEL OF ENTERPRISE APPLICATION INTEGRATION IN HIGHER EDUCATION INSTITUTIONS

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## Abstract

*It is eminent that several applications' systems are deployed at different levels in Higher Education (HE), ranging from academic and administrative to staff and students record systems. Many of these systems suffer from different problems due to the lack of integration such as data redundancy, inconsistency and maintenance cost. Enterprise Application Integration (EAI) can provide substantial benefits to these systems, such as assisting with business process integration, facilitating e-service based transformation and supporting collaborative decision-making. However, some factors that influence EAI adoption process in HE will be defined. This paper introduces a conceptual model to explain the outcome of using EAI in Higher Education Institutions (HEIs). Analyzing the combination of the existing classification of EAI factors with the HE factors will enhance the implementation of EAI in HEI at both organizational and operational levels. A pilot study at King Abdulaziz University (KAU), Kingdom of Saudi Arabia will be presented in this paper to show that the integration of the multiple information systems gives an integrated view to facilitate information access and reuse. Moreover data from different information systems is combined to gain a more comprehensive basis to satisfy the educational needs.*

*Keywords: Enterprise Application Integration, Higher Education, EAI conceptual model, EAI in education, EAI adoption, EAI applications.*

## 1 INTRODUCTION

Most HEIs implement several information systems despite these systems lack integration and consistency. Information Technology (IT) has become very critical for successful functioning of any enterprise in this world. Breakthrough in IT has developed a unique global economy that consequently raises new challenges for mankind. Educations helps prepare people to cope with these challenges (Ching et al., 2007). HEIs have integration problems due to isolated and fragmented computerized applications. The contents and overlapping functionality in the applications are “isolated islands of technology” (Peristera& Tarabanis, 2000). Kamal &Themistocleous (2006) illustrate that there are many problems due to lack of integration, such as data redundancy, inconsistency and maintenance cost. EAI provides substantial benefits, such as assisting with business process integration, facilitating e-service based transformation, supporting collaborative decision-making. This in fact means that HEIs have a problem to keep up with the pace of change in the rapid growth in enrolments and mounting pressure for changes and unable to match demands for expansion. Moreover, they are not good at handling content of educational programs. Significant benefits have been acquired in organizations which integrated their IT infrastructures through EAI (Bass & Lee, 2002). For example, (Themistocleous & Irani, 2001) provided information of the use of EAI and the benefits that result from it. These benefits were classified as organizational, managerial, operational, strategic and

technical. In addition, EAI has a motive to integrate separate applications into one. This allows the data and process to communicate with each other across an application (Stal, 2002; Sharif et al., 2005). Many organizations have deployed EAI solutions (Khoumbati et al., 2008). This paper aims to develop a conceptual model of EAI to be adopted in HEIs. A case study will be introduced as the application of this model at KAU. This model includes a number of consistent influential factors for EAI adoption in addition to the factors that are adapted from HE area, such as student satisfaction, student record, curriculum, learning community, and instructor satisfaction. The paper concludes that the proposed EAI adoption model will support the decision makers within the HEIs. It gives an integrated view to facilitate information access and reuse through the integration of multiple information systems. Moreover, data from different information systems are combined to gain a more comprehensive basis to satisfy the educational needs.

Several computerized applications ranging from academic and administrative are presented to staff and students record systems arranged at different levels in higher education. For example at KAU, these systems can be classified as follows:

Student Services Systems (SSS): (Examples: E-Management Education System (EMES), Online Student Services (OSS) and On Demand University Services (ODUS). Academic and Staff Services Systems (ASSS): (Example: Educational Affair System (EAS), Performance Management System (PMS). Administrative Services Systems (ASS): (Examples: University Jobs System (UJS). University Bids System (UBS) Other Extra Services Systems (OESS): (Example: Communication Systems).

To maximize the benefits of all these systems, HEIs have to follow a strategic approach to integrate all these individual applications in a coordinated way. In particular, this model when applied at KAU will reduce data redundancy, data inconsistency and high operational and maintenance cost. On the contrary, it will increase sharing of services, interconnectivity of applications and improve privacy, security, and the standards of data sharing. This research aims to identify factors that enable the development a novel conceptual model for the EAI to be adopted in HEIs.

Section 2 introduces the EAI adoption in HEIs and the related previous applications. The EAI adoption factors are described in Section 3 then, Section 4 presents the proposed HE-EAI adaptation model. The HE-EAI model as experimented at KAU will be highlighted in Section 5 conclusions will be drawn and listed at the end with a summary of the main findings.

## **2 EAI ADOPTION**

In any modern society IT applications are considered as the requirement for success of any organization and have become necessary for the continuation and success of any institution. Z. Irani et al. (2003) stated that the continuing evolution in technology in the world requires a follow-up of each innovations resulting from this development, especially the variable ones. M.Themistocleous et al. (2009) refer to the new research concerned with the adoption of EAI and find the best methods and solutions to be implemented to achieve the necessary integration. There are limited available researches for EAI adoption in higher education area. Most of the EAI adoption researches are in healthcare, Small and Medium Enterprises (SMEs) and private sector (M.M. Kamal et al., 2013). Most of the existing EAI adoption models are common. These models implement EAI adoption through a set of important factors. These factors can be reused in different EAI frameworks since they can be considered as common factors, such as benefits, barriers and costs. On the other hand, factors like student's satisfaction is domain specific factors and thus, it can be used only in educational organizations. In addition to this, there are differences indicating that the factors influencing the decision-making process for EAI adoption differ from an organization to other. This is obvious due to the different nature and size of each organization. Hence, the set of factors used to support EAI adoption in healthcare organizations differ from those applied in educational organizations.

Extensive literature review of factors affecting the adoption of EAI has been proposed in several areas such as:

- Healthcare Sector (K. Khoubati et al., 2003), (V. Mantzana et al., 2008) and (M. Themistocleous et al., 2009).
- Banking System (Lam 2005).
- Manufacturing Sector (X. Liu et al., 2008).
- Local Government (M.M. Kamal, 2009), (M. M. Kamal, 2010) and (L. Liming et al., 2010).
- Stock Market (N. Roztocki et al., 2009).
- Supply Chain (M. Themistocleous et al., 2004).
- Information System Lifecycle (Z. Irani et al., 2003).
- Public Sector Organizations (Z. Ibrahim et al., 2004).

Wide review on relevant areas that support the adoption of EAI in higher education environment was performed. In this paper, the applications of factors that maintain IT and integration technology adoption in HE domain were reviewed. The identification of new factors which are necessary for the development of EAI adoption model in an HE environment is considered as a challenging task. Most HEIs implemen.

### **3 EAI ADOPTION FACTORS IN HE**

High Education Institutions may provide a number of services such as student services, academic and staff services, administrative and other services. Among others such attributes distinguish EIs from other organizations. Therefore, in this paper other relevant areas that support IT and integration technology adoption in HE domain are critically reviewed. The reviewing study shows that HEIs use a diversity of information systems to support their academic and administrative services. However, this diversity of heterogeneous in many cases incomputerate solutions causes numerous integration problems. EAI has been initiated to tackle integration problems in a more flexible and controllable way (Stal, 2002). Strategic business solutions can be integrated within and across the component parts of information system infrastructures of an organization using the EAI technologies (Sharif et al., 2004). EAI can be described as the procedures and tools to modernize consolidate and integrate computer applications within an organization (Mckeen & Smith 2002). Essentially EAI is a wide concept that covers business process, business models and organizational renovation (Sharif et al., 2004). After examining a number of EAI applications, several factors assisting the adoption of EAI in such areas can be constructed. These factors can be summarized as follows:

#### **3.1 Technological Factors (TFs)**

Technology factors are considered as the main and vital factors that affect the decision to adopt EAI in the HE domain. HEIs require a substantial degree of technical capability to ensure smooth and productive adoption. This can be achieved through matching between the HE innovation and the current technological setting of an institution. A number of cases showing that factors affecting the adoption of TFs will be examined as follows: -

- 3.1.1 Technological Risk (TR): *the risk and uncertainty associated with new technologies can make risk adverse managers require higher rates of return before they intend to invest.*
- 3.1.2 IT capabilities: *refer to IT infrastructure, personnel IT knowledge and IT sophistication of an enterprise (Akbulut, 2002).*

### **3.2 IT Supportive Factors (SF) refers to:-**

- 3.2.1 *Data Security & Privacy (DS&P): this factor is important in an open and distributed environment. Key security functions present important challenges to the security administration function across an integrated solution.*
- 3.2.2 *Evaluation Framework (EF): integration technologies combined together to integrate an IT infrastructure. This framework is a tool to support decision-making for EAI adoption.*

### **3.3 Organizational Factor (OF)**

Organizational factor is a source of structures, processes and attributes that constrain or facilitate the adoption of any application. The role of top management, financial readiness, degree of centralisation, formalization, quality of human resources, and amount of slack resources available internally, and size of organisation are several dimensions of the organisational context which can influence the implementation process of e-government (Ebrahim et al., 2004). This factor covers the following parameters:-

- 3.3.1 *Formalisation: clear procedures, norms and formal processes to carry out organisational tasks. Systems planning and information processing may use structured environment that is created by highly formalised processes. EAI adoption .can be facilitated and any ambiguities will be eliminated when written procedures and formal environment are implemented.*
- 3.3.2 *Centralisation: the degree of power or decision-making authority in an organisation and it encompasses participation in decision-making and authority hierarchy.*
- 3.3.3 *Managerial capability: is one of the significant factors for IT adoption; personnel who are available to take brave and ample competencies to produce new ideas.*
- 3.3.4 *Student record: it provides essential data given by the following: Data and detailed information obtained from the approved application. Data relating to the progression record: the administration of student records such as change of course, serious disciplinary and any other information. The change of student records, such as giving up enrolment, graduation and completing a course, is not a programmed work in the administration of student records, but it has complex and dynamic features and has a long cycle.*
- 3.3.5 *Curriculum: materials that prepare students to contribute to their field of study. Continuous improvement that involves constant assessment is a necessary process for successful curriculum.*

### **3.4 Environmental Factors (EFs)**

The area is in which organisation conducts and influences its individuals. Organisation adoption could be driven by the actions of competitors and may establish connections with other organisations for better collaboration. These factors include:

- 3.4.1 *External Pressure (EP): pressure from other parties outside the organisation. For instance, an organisation may be pushed to search for new ways to enhance their efficiency by increased competition. Better collaboration is expected when an organisation interacts with several stakeholders and governmental organisations. Better services, such as instant query response, data security and availability of data, wherever is required, are demanded by citizens. This factor can be considered when the development of EAI model is tackled.*
- 3.4.2 *Internal Pressure (IP): pressures such as technical and managerial inside an organization. This factor is essential in initiating the adoption of EAI in organisation. There are several internal pressure partners in HEIs, such as collaboration of students and instructors with the institution and the demand for better educational services by students. This factor will be implemented in the process of adoption of EAI in HEIs.*
- 3.4.3 *Student Satisfaction (SS): factors to be considered in the evaluation of learner satisfaction. In general, there is a positive relationship between learner's attitudes and overall learner satisfaction. Particularly, it gives recognition to the role that students, instructors, and institution play in successful e- learning.*
- 3.4.4 *Instructor Satisfaction (IS): instructors' attitudes toward e-learning will positively influence student's satisfaction due to the strong relationship between the instructor's quality and learner's perceived satisfaction.*
- 3.4.5 *Learning Community (LC): the served community population through the educational services in which the larger educational institutions would adopt more sophisticated and advanced information technologies compared to smaller institutions. LC factor would influence EAI adoption in HEIs due to interactions that enhance learning achievement. Users' satisfaction will be improved by assessment feedback when an e-learning system provides more or diversified assessment tools and methods.*

### **3.5 Financial capability (FC)**

Organisation capital is available for adoption technology, so EAI adoption is highly influenced by FC factor since any organisation that have available resources can afford costly innovations, can absorb failure, and can explore new ideas in advance of the actual need. The effective FC factors are:

- 3.5.1 *Return of Investment (ROI): it is an important factor in the application of EAI adoption technology. HEIs are reluctant to invest without significant ROI. This can be attributed to:*
- Lack of skilled staff or opposition to adoption of new technologies.
  - Lack of understanding and knowledge of EAI in the HE organisation.
  - HE organisations have been very slow or even unprepared for technological transformations.
  - Low allocated IT budgets in the HEIs will prevent the transition of EAI.
- 3.5.2 *Cost: the cost of adoption of EAI is a significant factor. Therefore, cost benefit analysis is performed before taking any important decision regarding the investment in the adoption of innovation.*

## **4 THE PROPOSED HE-EAI ADAPTATION MODEL**

As indicated in section 3, different EAI models have highlighted that several factors influence the EAI adoption in their respective domains. These models have several factors in common such as: benefits, barriers, IT infrastructure, costs, internal and external pressures and IT sophistication. This paper innovatively identifies and analyses new factors related to educational environment as described

earlier. To provide a better understanding, these factors have been categorised into the following two aspects as shown in Figure 1:

1. Technical aspect :
  - Technological Factors (TF).
  - IT Supportive Factors (SF).
2. Social aspect:
  - Organizational Factor (OF).
  - Environmental Factor (EF).
  - Financial capabilities (FC).

By studying the above classifications, the author found that EAI in higher education can be implemented through the interaction between technical aspect and social aspect. Moreover, it was found that some sub-factors which are contained within the technical and social aspects can be adopted in the model. The proposed HE-EAI adaptation model will integrate the multiple information systems within HEIs through combining of the required systems in use. In addition, the proposed model will provide an integrated view to facilitate information access and reuse of the integrated information systems. Data from different complemented information systems are combined to gain a more comprehensive basis. This comprehensive basis satisfies the educational needs.

The proposed HE-EAI adaptation model integrates the multiple information systems within HEIs through combining of the required systems. The integration of multiple information systems facilitates information access and reuse.

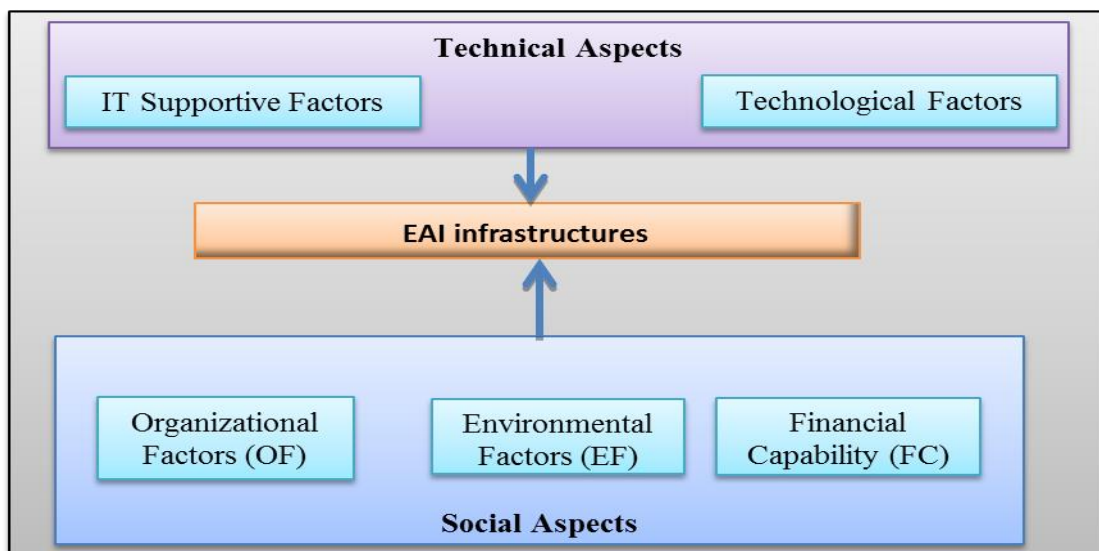


Figure 1. HE-EAI adaptation Model

## 5 KAU CASE STUDY

A small scale preliminary case study to implement the proposed model is conducted at the environment of King Abdulaziz University (KAU) to develop a flexible and maintainable IT infrastructure that integrates all types of applications. The proposed case study is used to test that EAI supports a robust IT infrastructure to achieve:-

- Closer collaboration with student, staff members, and university managerial employees.
- Better coordination of all university processes.

These achievements would help the Deanship of Information Technology (DIT), which represents the central department that is responsible of all IT activities, to justify the adoption of EAI solution within KAU. The study started in July 2012 and lasted 3 months. The study is designed to incorporate the

academic and managerial applications integration and hence interviews will include the following categories:

1. A number of involved employees from the DIT at KAU including:
  - IT consultants.
  - IT supports.
  - Technical staff.
2. A number of managers from different departments at KAU.
3. Staff and top management.

As mentioned earlier that in addition to the structured interviews that performed at KAU, the research constructed the EAI factors in which the proposed model will be adopted. It was found that several factors will influence the EAI adoption in HEIs. These factors can be summarised as:

1. Technical aspect:
  - a) Technological Factors (TF).
  - b) IT Supportive Factors (SF).
2. Social aspect:
  - a) Organizational Factor (OF).
  - b) Environmental Factor (EF).
  - c) Financial capabilities (FC).

Table 1 shows the names and positions of the employees at KAU who were interviewed for the purpose of this case study. These people were identified as responsible and were specifically involved in EAI adoption process. The purpose of the visit to the KAU was explained to the Vice Dean of DIT prior to the interviews. An interview agenda was used during these structured interviews. The author explicitly discussed the factors that influence EAI adoption in KAU and shared approximately identical views with stakeholders.

Code	Name	Position
DITVD	Dr. Mohammad Aweddh	Deanship of Information Technology Vice Dean
CAEP	Mr. Abdullah Bataweel	Chief Administrator of E-Management Programs
ISQM	Eng. Waleed Abdulmajeed	Information Security Quality Manager
PDM	Eng. Mohammad Farouk Aboalsoud	Portal Department Manager
NE	Eng. Abduhaleem Al-Hilo	Network Engineer MCSE-CCNP
SDM	Eng. Wajih Abu Ghazzaleh	Servers Department Manager
TAA	Eng. Zohair Mollah	Technical Affairs Administration
NVCE	Eng. Abdulrahmans Bin Gursain	Network & V.C Engineer
CAAP	Eng. Mazen Shafi	Chief Administrator of Academic Programmes
SEDM	Eng. Masaed Al-Sahafi	System Engineering Dept. Manager

Table 1. The KAU case study stakeholders

One of the main objectives of the study is to enhance coordination among colleges, departments and university management by integrating all business processes. Table 2 shows information data for KAU.

Ser.	Category	Number
1	IT employees	200
2	Colleges	37
3	University branches	13
4	University students	162000
5	University academic staff	6892
6	University managerial staff	8932

Table 2. KAU data

KAU IT infrastructure is built on a central integrated fiber optics infrastructure based on two main core switches which are linked to 14 aggregated nodes; each node is aggregating several buildings. Each building has a main switch that connects distribution floor switches to provide UTP 1 GB end point connectivity. There are four information systems as shown in Appendix 1.

The academic system covers the following processes:

- Admission: The admission process produces electronic file that contains the personal data for all admitted students.
- Scheduling: Preparing the class schedule for foundation year program using one shared pool resources:
  - Instructors
  - Facilities
  - Course Catalog
  - Buildings & Rooms
- Registration: All registration transactions for foundation programs students are covered by the system DB.
- Grading: The grading areas covered in the system are:
  - Academic Standing Rules & Calculation.
  - Student's Classification
  - Grading Modes definition.
  - Grade Entry and Grade Rolling.
  - GPA Calculation
  - Data Migration for foundation year data to the Original Institute Banner DB.

The proposed model will reduce data redundancy, data inconsistency and high operational and maintenance cost. Sharing of services, interconnectivity of applications, privacy and security, and the standards of data sharing will be improved significantly.

Most of KAU systems typically cannot communicate with each other to share data or business rules. These applications are considered as islands of automation or information silos. This lack of communication leads to inefficiencies (integrity problem), similar data are stored in several locations (data redundancy), or difficult to automate straightforward processes (flexibility problem).

Figure 2 depicts the configuration of KAU that represents a single business unit in our case study including the following:-

- ERP Legacy systems hosted on Mainframes platform.
- ERP SAP systems with DB2 database hosted on IBM Mainframes.
- Academia Systems hosted on hp superdome as a platform.
- KAU Portal hosted on Windows environment as a platform.



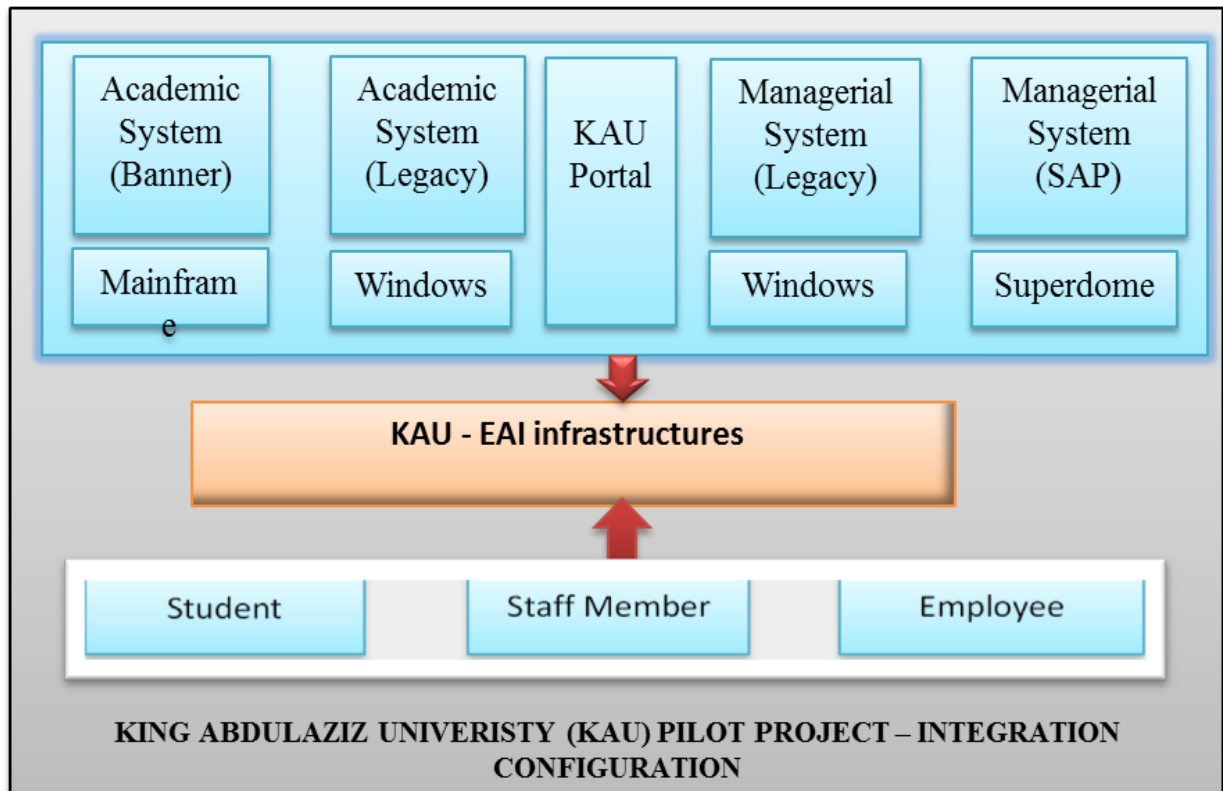


Figure 2. KAU as a single business unit – integration configurations

The integration of multiple information systems within KAU combines needed systems to form a unified system which enables users to interact with one single information system and facilitates information access and reuse. As a result, the implementation of the proposed EAI model within KAU will:-

- Provide better access, understanding, management and reporting to ensure valuable information necessary for decision making.
- Plan and manage the use of the resources of entire university.
- Increase efficiency for better and creative education.

## 6 CONCLUSIONS AND SUGGESTED FUTURE RESEARCH

In spite of numerous current IT applications in the HEIs, there is still an increasing demand to integrate these applications to benefit from their capabilities. The implementation of EAI in the HEIs is considered as a new field of research. Hence, the lack of well-established theoretical and conceptual models means innovative factors that influence the decision making process for EAI adoption should be identified. The integration of various IT applications, particularly information systems, in the HEIs is increasingly demanded due to their widely distributed nature.

The paper proposed a novel conceptual model for EAI, adopted in HEIs. The proposed Higher Education Adaptation Model (HEAM) implements both influencing factors, as illustrated in the literature, and factors that are adapted from HE, such as student satisfaction, student record, curriculum, learning community, and instructor satisfaction. The adoption factors from the evaluation of the EAI adoption in various applications areas can be classified as follows:

- Technological Factors (TF).
- IT Supportive Factors (SF).
- Organizational Factor (OF).
- Environmental Factor (EF).

- Financial capabilities (FC).

As a suggested future research, the proposed conceptual model will be examined to investigate the impact of EAI adoption in HE domain. Moreover, at each stage of the adoption process it would be advantageous to map the identified factors influencing EAI adoption. Furthermore, it would be beneficial to identify the causal relationship between EAI adoption decision of the HEIs and the factors of the model at each stage of the adoption process that influence the overall performance. The proposed EAI adoption model will enable the understanding for EAI and assist the decision makers within the HEIs. For instance, EAI adoption model can:-

- Help to establish a remarkable ranking position among the international universities.
- Assist the management, faculty, staff and governing bodies in decision making across the board in its resource and academic program development.
- Support academic activities at all levels appropriate to basic purposes of KAU.

#### Appendix 1 Information Systems at KAU

- ERP Legacy systems running on ZOS with custom made (locally developed) with DB2 database hosted on IBM Mainframes Z196 platform. This is currently being migrated to SAP systems.
- ERP SAP systems running on Z-Linux with SAP packaged applications with DB2 database hosted on IBM Mainframes Z196 platform.
- Academia Systems running hp UNIX with SunGard Higher Education Banner packaged applications with Oracle RAC as a database hosted on hp superdome as a platform.
- KAU Portal and some other decision support systems running on ASP and ASP.NET custom made (locally developed) applications with MS SQL or Oracle database hosted on Windows environment platform.

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