Conceptual Model for the Adoption of Enterprise Application Integration in Healthcare Organizations

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Abstract

Enterprise Application Integration (EAI) has emerged to provide significant benefits to organisations. From a technical perspective, EAI overcomes integration problems at all integration levels (e.g. data level, process level etc) by providing a flexible and manageable Information Technology (IT) infrastructure. From a business perspective EAI reduces the overall integration cost due to the reduction of integration time and maintenance cost. A review of the literature in the area of EAI indicates that the impact of EAI adoption has not been widely studied and researched in healthcare organisations. As a result there is a relative void in the literature. Healthcare organisations seek answers to the impact of EAI adoption. As well in practice, with this paper exploring the issues related to EAI adoption in healthcare organisations. In doing so, a conceptual model for EAI adoption in healthcare organisations is proposed. Decision makers in the healthcare organisations, when considering the adoption of EAI can use the model.

Keywords: Healthcare organisations, adoption, enterprise application integration

Introduction

Organisations have turned to the use of IT to automate and improve business processes. IT implementation decisions are often made at departmental levels, with each department choosing technologies and solutions based on its own needs and beliefs (Erasala, 2002). These applications are often not developed in a co-ordinated way but have evolved as a result of the latest technological innovation (Themistocleous et al., 2000). As a result, IT infrastructure in departments consists of a number of autonomous and heterogeneous solutions, which cause integration problems.

There are numerous information systems in healthcare, ranging from personal management to department-specific decision support systems. (Hakkinen et al., 2003). These information systems function independently and their interconnectivity and interoperability has always remained a big issue. The reason for this is that it is vital to retrieve information from disparate information systems in healthcare organisations.

EAI has emerged to overcome integration problems at all levels (e.g. data level, process level etc) in a more flexible and manageable way. EAI software provides the infrastructure to rapidly connect and interface information between an organisations internal and external applications (Pinkston, 2001). The advantages of this approach are that enterprises develop a flexible and sufficient IT infrastructure by integrating functionality from existing and new applications (Wilson, 2002).

This paper, investigates the adoption of EAI in healthcare organisations. Initially the problems that are related to the integration of healthcare information systems are explored. Thereafter, the role of EAI in healthcare organisations is examined. In doing so,
the authors investigate factors that are related to EAI adoption in healthcare organisations. Then factors reported in literature and influence the adoptions of EAI as well as the adoption of IT in healthcare are discussed. As a result, the authors combine all these factors to develop a framework that focuses on the EAI adoption in healthcare organisations. The proposed conceptual model for EAI adoption in healthcare organisations requires empirical validation and thus, further research is needed.

Healthcare Information Systems

The idea of computerizing the healthcare record has been around since the early 1960s, when hospitals first started using computers. Murray (2002) states that in healthcare institutions there are numerous information systems like: (a) patients information system, (b) laboratory system, (c) radiology system, (d) pharmacy system, (e) administrative system and (f) human resource management system.

Specific information systems have been developed to support particular business processes in healthcare organisations. The most common are listed as below.

- Patient records system
- Administrative department system
- Laboratory system
- General practitioners system
- Web applications system
- Telemedicine system
- Education and research system
- Human resources system

In most of the cases these systems function independently and do not share their data/knowledge. According to Harkke et al., (2003) the real benefits of modernizing the healthcare systems can not be realized unless the IS in different departments function together to provide better healthcare services. There is a need to integrate healthcare information systems to meet the healthcare needs (Spyrou et al., 2002). This is of high important, as 64 persons die every day in UK due to the limitations of information systems in healthcare organisations. For instance, patients are given inappropriate medications or doctors can not make accurate diagnosis, as important data can not be received, due to the non-integrated IT infrastructure.

Information Systems Integration Problem In Healthcare Organisations

By nature, healthcare organisational structure is distributed, being a geographical spread at different levels such as centres, general hospitals and individual GPs (Ferrara 1998). At a technical level the healthcare industry has been faced with the challenge of moving from mainframes to client-server computing with PCs (Grimson et al., 2000). Due to numerous information systems, healthcare institutions face the problem of heterogeneous computing systems. Integration of existing information systems is a high level priority of healthcare organisations, It will allow the whole organisation to meet the increasing clinical, organisational and managerial needs (Ferrara, 1998).

Many efforts have been made to achieve the integration in healthcare organisations such as:

- Health level 7 (HL7) (Grimson, 2000, Beeler, 1998).
- Digital Imaging and Communications in Medicine (DICOM) (Ferrara, 1998).
- European Committee for Standardisation/Technical Committee 251 (CEN/TC 251) (Ceusters et al., 1997).
- Synergy Extranet (SynEx) (Ferrara, 1998).
- Synapses (Spahni et al., 1999).

Among others Enterprise Recourse Planning (ERP) systems were deployed to manage the hospitals data and processes, and to provide an integrated infrastructure (Grimson et al., 2000). Initially, ERP systems were implemented in the healthcare organisations to solve its Y2K problems (Sia et al., 2002). According to Yen et al., (2002) leading ERP vendors provide complete suite of applications dealing with the business processes of healthcare organisations, like SAP R/3, Baan, Peoplesoft and etc. (Grimson, 2000). Sia et al., (2002) reports that different departments in the same healthcare organisation have deployed different
ERP systems to support business processes. In many organisations the adoption of packaged applications like ERP systems could not provide a flexible, manageable and maintainable integrated IT infrastructure. As a result ERP systems co-exist along side other IT applications. Therefore, there is still a need to integrate all these systems.

The integration of all these systems is not cost effective (Pushmann et al., 2001). Healthcare organisations realised this situation and seeks for a cheaper solution for integration that results in manageable, maintainable integrated IT infrastructure. This can be achieved through EAI.

**Enterprise Application Integration**

One of the first sectors that adopted EAI was the healthcare. The reasons for this are that: (a) a healthcare organisation consists of a bigger number of departments comparing to other organisation. Integrating this big number of departments using other technologies (e.g. middleware) could not provide a manageable, maintainable integrated IT infrastructure, (b) healthcare organisations did not have enough money for the IT department. The integration of these different information systems with other integration solutions was very costly. This is the reason that healthcare organisations turned to EAI. According to Demetriades (2000) EAI solutions achieve a cost reduction around 90% comparing to other integration solutions. However, other published case studies reports cost reduction around 50% (Themistocleous, 2000). As a result EAI can provide cheaper integration solutions.

Furthermore, EAI aims at integrating individual applications into a seamless whole, enabling business process, and data to speak to one another across applications (Johannesson et al., 2001). Themistocleous et al. (2000) specify that EAI can efficiently incorporate custom applications, packaged systems and e-business solutions into a flexible a manageable infrastructure. According to Stal (2002) EAI provides a flexible architecture to integrate heterogeneous platforms. All these literature evidences support that EAI can be used to create an integrated infrastructure in healthcare organisations.

Published case studies in the area of EAI such as Themistocleous (2002) and Pushmann et al. (2001) reported several benefits that are achieved from EAI adoption in the organisations. Apart from the other benefits, which EAI provides, the benefits like reduction in cost, increase the collaboration among partners, support efficient data sharing, reliable data transfer, better security system, flexible maintainable and manageable IT solutions, achieves return on investment influencing the adoption of EAI in healthcare organisation.

**Factors Related to the Adoption of EAI in Healthcare Organisations**

Healthcare organisations use a diversity of information systems to support their organisational and financial business process. However, this diversity of heterogeneous and in many cases incomputerate solutions causes numerous integration problems. EAI has emerged to solve the integration problems. Today, to the best of author’s knowledge, there is no EAI adoption model exists to provide the support to decision maker while taking the decision for EAI adoption in healthcare organisations.

Themistocleous et al., (2002) identified several factors that inhibit the adoption of EAI for multinational organisations such as: Benefits, Barriers, Costs, Motivations, Evaluation Framework, IT infrastructure, IT Sophistications, Support, Internal pressures, Environmental pressures, Managerial Motivation, Technical Motivations, Competitive Pressures, Trading partner. Table 1 summarises these factors.
Table 1. Factors that Influence EAI Adoption

<table>
<thead>
<tr>
<th>No</th>
<th>Factors</th>
<th>References from Integration Area</th>
<th>References from Healthcare</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Evaluation Framework</td>
<td>Themistocleous (2001)</td>
<td>-</td>
</tr>
</tbody>
</table>

The integration issues in the healthcare organisations are relatively different from the other information intensive industries, because of the following listed in the Table 2.

Table 2. Integration Issues

<table>
<thead>
<tr>
<th>No</th>
<th>Issues</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Slow adoption of standards</td>
<td>Grimson (2000)</td>
</tr>
<tr>
<td>2</td>
<td>Inadequate revenue</td>
<td>Demetriades (2000)</td>
</tr>
<tr>
<td>3</td>
<td>Security &amp; confidentiality of patients data</td>
<td>Lindgreen et al., (1997)</td>
</tr>
<tr>
<td>4</td>
<td>Unique patients identifier (Patients ID)</td>
<td>Lenz et al., (2002)</td>
</tr>
<tr>
<td>5</td>
<td>Shared care</td>
<td>Southard (2000)</td>
</tr>
<tr>
<td>6</td>
<td>Pressure from the well informed public</td>
<td>Grimson (2000)</td>
</tr>
<tr>
<td>7</td>
<td>Quality of care</td>
<td>Raghupathi et al. (2002)</td>
</tr>
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</table>

The authors believe that the issues summarised in table 2 can be considered for identifying factors related to the development of EAI adoption model for healthcare organisations.

Apart from the factors, reported in table 1 the authors take into consideration other factors that derived from the literature like: decision-making, access of patient’s data, telemedicine, return on investment, security of patients data and support research for the development of EAI adoption model for healthcare organisations listed in table 3.

Table 3. Factors for the Development of EAI Adoption Model for Healthcare Organisations

<table>
<thead>
<tr>
<th>No</th>
<th>Factors</th>
<th>References from Integration Area</th>
<th>References from Healthcare</th>
</tr>
</thead>
</table>

So all factors reported in table 1 and 3 can be used for the development of a conceptual model for EAI adoption in healthcare organisations.
### Conceptual Model for EAI Adoption in Healthcare Organisations

Many models were proposed in the normative literature such as Rogers (1995) model for the adoption of information technology. To the best of authors’ knowledge Themistocleous et al., (2002) model is the only one currently available that discusses EAI adoption. However, this model focuses on the adoption of EAI by multinational organisations. The authors excluded factors from Themistocleous (2002) model that do not exist in healthcare organisations. Factors such as competitor’s pressures, because the competitor’s pressure can only supportable in situations when the organisations are under pressure to launch new products in the market and increase productivity services and increase their profit. As healthcare organisations are not for-profit organisations they have no any such intention to earn more money, but their priority is to provide better healthcare services to all citizens. The authors combine factors summarised in table 1 and 3 to propose a conceptual model for EAI adoption in healthcare organisations. These factors are analysed below in table 4 and 5 with Figure 1 illustrating the model.

<table>
<thead>
<tr>
<th>Level</th>
<th>Factors</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cost</td>
<td>Many organisations conduct a cost benefit analysis before taking any important decision regarding the adoption of technologies. Cost is a significant parameter that influences the adoption of EAI in healthcare organisations. Cost influences the adoption of technologies that were seen as integrated packages or suites e.g. ERP systems. A significant benefit of application integration is the reduction of overall integration cost (Puschmann et al., 2001). The basic concept of EAI adoption is mainly integration with lower costs and less programming using existing applications (Lee et al., 2003).</td>
</tr>
<tr>
<td>1</td>
<td>Barriers</td>
<td>EAI clearly presents barriers with organisations needing to consider these barriers before proceeding to EAI adoption. Healthcare organisations have similar barriers such as operational, managerial, static, technical. The adoption of technologies like ERP has caused many problems to the organisations such as bankruptcy, as they did not consider the impact of these technologies in the organisations before adopting them (Davenport, 1998). Barriers are also reported by Themistocleous et al. (2002) and Lopez (2002). Thus, the authors suggest that the barriers of EAI are a factor that influences its adoption in healthcare organisations.</td>
</tr>
<tr>
<td>1</td>
<td>Benefits</td>
<td>Benefits are extended to cover: (a) operational (e.g. reduces costs); (b) managerial (e.g. increases performance); (c) technical (e.g. results in flexible infrastructure); (d) strategic (e.g. achieves customer satisfaction) and (e) organisational costs (e.g. allow organisations to do business more effectively)</td>
</tr>
<tr>
<td>1</td>
<td>Internal Pressures</td>
<td>This factor initiates the adoption of EAI in the organisation. Healthcare organisations have various drivers such, patient’s care, ROI, efficient decision making that motivate the adoption of new technologies.</td>
</tr>
<tr>
<td>1</td>
<td>External Pressures</td>
<td>In healthcare organisations there are several stakeholders such as patients, suppliers, insurance service providers that collaborate with the organisation. They always expect better collaboration with organisations. Also patients always demand for better services such as appointment, correct record keeping, proper care, availability of data where ever is required, data security and etc. Therefore, this factor can be considered for the development of EAI model.</td>
</tr>
<tr>
<td>1</td>
<td>Evaluation framework</td>
<td>The integration marketplace is extremely complex with a diversity of EAI products and technologies solving different types of problems. Themistocleous et al. (2002) proposed framework for evaluating these technologies. This can be used as a decision-making tool to support the adoption of integration technologies in healthcare organisations. This provides the assessment facility to the organisations for EAI technologies.</td>
</tr>
<tr>
<td>2</td>
<td>Support</td>
<td>This factor is related to vendors’ support, consultant’s support, management support etc. The adoption of EAI requires organisations to invest considerable amount of money on their IT infrastructure such as hardware, software and maintenance. Therefore, it is essential for healthcare organisations to have a support from vendors and consultants. Support affects the introduction of enterprise application integration in healthcare organisations.</td>
</tr>
<tr>
<td>2</td>
<td>Managerial Motivations</td>
<td>This factor is related to the issues that influence management decisions (e.g. the need for gaining competitive advantages). There is a need to improve decision-making process and support management with real-time data implies the development of integrated IT infrastructures in healthcare organisations.</td>
</tr>
</tbody>
</table>
The non-integrated nature of IT infrastructure causes numerous problems to organisations, which need to unify their information systems and fully automate their business processes. This influenced the decision regarding EAI adoption in healthcare organisations, to provide the better patient care services, improve decisions making process etc. Grimson (2000) also reported the exiting IT infrastructure in healthcare organisations. The existing IT infrastructure is factor that effects the introduction of EAI in healthcare organisations

This factor refers to the technical expertise in the organisation. It is related with the level of understanding in addressing technical problems at the internal and external level in the organisation. IT departments in healthcare require a high level of IT sophistication regarding integration. Thus, a sufficient level of IT sophistication for EAI and integration technologies influences the adoption of EAI.

The pressures from suppliers and insurance agents often demand closer collaboration. Therefore, healthcare organisations need to better co-ordinate with their suppliers to associates efficiently support their business processes. Thus the authors suggest that the trading partners pressures can be a factor that influences the adoption of EAI in healthcare organisation

This factor is related for conducting the research of various aspects in the field of the medical. Patient data can become a good resource for the further development in the related diseases.

<table>
<thead>
<tr>
<th>Level</th>
<th>Factors</th>
<th>Description</th>
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<tbody>
<tr>
<td>2</td>
<td>IT Infrastructure</td>
<td>The non-integrated nature of IT infrastructure causes numerous problems to organisations, which need to unify their information systems and fully automate their business processes. This influenced the decision regarding EAI adoption in healthcare organisations, to provide the better patient care services, improve decisions making process etc. Grimson (2000) also reported the exiting IT infrastructure in healthcare organisations. The existing IT infrastructure is factor that effects the introduction of EAI in healthcare organisations.</td>
</tr>
<tr>
<td>2</td>
<td>IT Sophistication</td>
<td>This factor refers to the technical expertise in the organisation. It is related with the level of understanding in addressing technical problems at the internal and external level in the organisation. IT departments in healthcare require a high level of IT sophistication regarding integration. Thus, a sufficient level of IT sophistication for EAI and integration technologies influences the adoption of EAI.</td>
</tr>
<tr>
<td>2</td>
<td>Trading Partners Pressures</td>
<td>The pressures from suppliers and insurance agents often demand closer collaboration. Therefore, healthcare organisations need to better co-ordinate with their suppliers to associates efficiently support their business processes. Thus the authors suggest that the trading partners pressures can be a factor that influences the adoption of EAI in healthcare organisation.</td>
</tr>
<tr>
<td>1</td>
<td>Research Support</td>
<td>This factor is related for conducting the research of various aspects in the field of the medical. Patient data can become a good resource for the further development in the related diseases.</td>
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</tbody>
</table>

<table>
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<tr>
<th>Table 5. New Factors for EAI Adoption in Healthcare Organisations</th>
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<tr>
<td>Level</td>
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<tr>
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<tr>
<td>1</td>
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<tr>
<td>2</td>
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<tr>
<td>1</td>
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<tr>
<td>1</td>
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<tr>
<td>1</td>
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<tr>
<td>2</td>
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</table>
The proposed conceptual model makes novel contribution at the conceptual level. The model incorporates factors reported in previous studies for the adoption of EAI technology in multinational organisations. With other factors derived from healthcare literature. Thus, resulting in the development of a conceptual model that can be used as decision tool for the adoption of EAI in healthcare organisations.

**Conclusions and Future Research**

EAI has emerged to provide significant benefits to the organisations to overcome integration problem and reduce the overall integration cost due to reduction of integration time and maintenance cost. This paper explores the EAI adoption in healthcare organisations. The issues relating the adoption of EAI in healthcare organisation are discussed. As healthcare organisation structure is distributed and consists the numerous information systems. Organisations face the problem of heterogeneous computing systems. The integration of these systems is of high priority.
The authors proposed a model for EAI adoptions in healthcare organisations by combining factors identified separately from EAI literature with other from healthcare area. The proposed model suggests that the factors like Benefits, Barriers, Costs, Motivations, Evaluation Framework, IT Infrastructure, IT Sophistications, Support, Internal Pressures, Environmental Pressures, Managerial Motivation, Technical Motivations, Competitive Pressures, Trading Partner Pressures, Decision-Making, Access of Patient’s Data, Telemedicine, Return on Investment, Security of Patients Data and Support Research influence the decision for EAI adoption in healthcare organisations.

Future research in this area should be conducted to test the conceptual model. The proposed model can be used as a decision-making tool and support management when taking decision regarding the adoption of EAI in healthcare organisations.

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