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Recent developments in the field of integration technologies like Enterprise Application Integration (EAI) have emerged to support organizations towards improving the quality of services and reducing integration costs. Despite the importance of EAI, there is limited empirical research reported on its adoption in the healthcare sector. Khoumbati et al. [2006] developed a model for the evaluation of EAI in healthcare organizations. In doing so, the causal interrelationship of EAI adoption factors was identified by using fuzzy cognitive mapping. This paper is a progression of previous work in the area and seeks to contribute by validating the model through a different case environment. Thus, this paper contributes by deriving and proposing the MAESTRO model for EAI adoption. MAESTRO identifies a set of factors that influence EAI adoption and it is evaluated through a real-life case study. It provides an understanding of the EAI adoption process through its grounding on empirical data. In doing so, the MAESTRO model supports the management of healthcare organizations during the decision-making process for EAI adoption.

KEYWORDS: healthcare organizations, Enterprise Application Integration (EAI), adoption, case study

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INFORMATION SYSTEMS AND HEALTHCARE XXIV: FACTORS AFFECTING THE EAI ADOPTION IN THE HEALTHCARE SECTOR

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I. INTRODUCTION

The non-integrated Information Technology (IT) infrastructure causes medical errors that are related to the loss of human lives [Raghupathi and Tan 2002]. As the information needed is not available on time, errors often occur in prescribing, administering, and dispensing drugs to patients [Cowan 2004]. It is reported that the limitations of healthcare information systems are related to the loss of more than 23,000 people per annum in the UK, due to problems associated with medical [Khoumbati et al. 2005]. Thus, the need for integration becomes critical for the healthcare sector as it is expected to reduce medical errors and improve healthcare services [Khoumbati et al. 2006]. To overcome these problems integration approaches have emerged, such as Health Level 7 (HL7), CEN/TC251, Synergy Extranet (SynEx), and Synapses and have been of benefit to healthcare organisations. But to the contrary integration approaches have their limitations, since they: (a) are invasive in nature and cause changes to applications code; (b) result in complex solutions with high maintenance costs; and (c) can not support business process integration [Themistocleous 2004].

As a result, Enterprise Application Integration has emerged to overcome integration problems in a more flexible and manageable way [Stal 2002]. It presents the infrastructure to rapidly integrate information between intra-organisational and interorganisational applications [Pinkston 2001]. EAI also provides a flexible infrastructure to integrate heterogeneous platforms [Stal 2002]. The benefits that EAI provides are very important as they reduce integration costs and data and application redundancy [Sharif et al. 2005]. Evidence from case studies published in the area of EAI reports a 50 percent cost reduction [Themistocleous 2004]. In addition, applications can communicate freely with each other through a common integration infrastructure rather than using point-to-point links, as in traditional interconnection approaches [Linthicum 1999; Lam 2005]. Traditional integration technologies require an intimate, low-level knowledge of each proprietary technology, which consumes much time and resources to acquire. On the contrary, EAI eliminates the need for expensive programming. It supports a component-based application development architecture, where developers build applications as a network of sections, each devoted to an individual task [Linthicum 1999]. The re-usable, modular architecture of EAI combined with an incremental development approach enhances productivity. Unlike traditional interconnection approaches, EAI attempts to fully automate and integrate business processes and does not enforce standard business processes [Duke et al. 1999].

This paper focuses on the adoption of EAI technology in healthcare organisations and investigates its influential factors. The next section refers to the theoretical foundations of this research and presents a model for EAI adoption. The proposed model consists of a set of influential factors that are tested and evaluated through a real-life case study. Section III explains the research methodology that was used to test the proposed model, and Sections IV and V present and discuss the empirical data respectively. A research synthesis follows where key findings are extrapolated and grounded in the normative literature, and conclusions are drawn.

II. THEORY FOUNDATION FOR THE EVALUATION OF EAI ADOPTION IN HEALTHCARE ORGANISATIONS

The majority of the normative literature focuses on EAI adoption in private organisations. An example of this is the model proposed and validated by Themistocleous [2004] in the context of multinational organisations. Themistocleous' model proposes that EAI adoption is influenced by factors such as: (a) benefits, (b) barriers, (c) IT infrastructure, (d) costs, (e) external pressures, (f) internal pressures, (g) IT sophistication, (h) IT support, (i) an EAI evaluation framework for EAI technologies, and (j) an EAI evaluation framework for EAI packages.

The limitations of EAI literature in the area of healthcare led Khoumbati et al. [2006] to use the model proposed by Themistocleous [2004] as the basis for their research investigating EAI adoption in the health sector. There are many differences among private and healthcare organisations, and Khoumbati et al. [2006] identified several other factors that can be used during the study of this phenomenon. As a result, Khoumbati et al. [2006] combined these factors with those proposed by Themistocleous [2004] in a model as depicted in Figure 1.

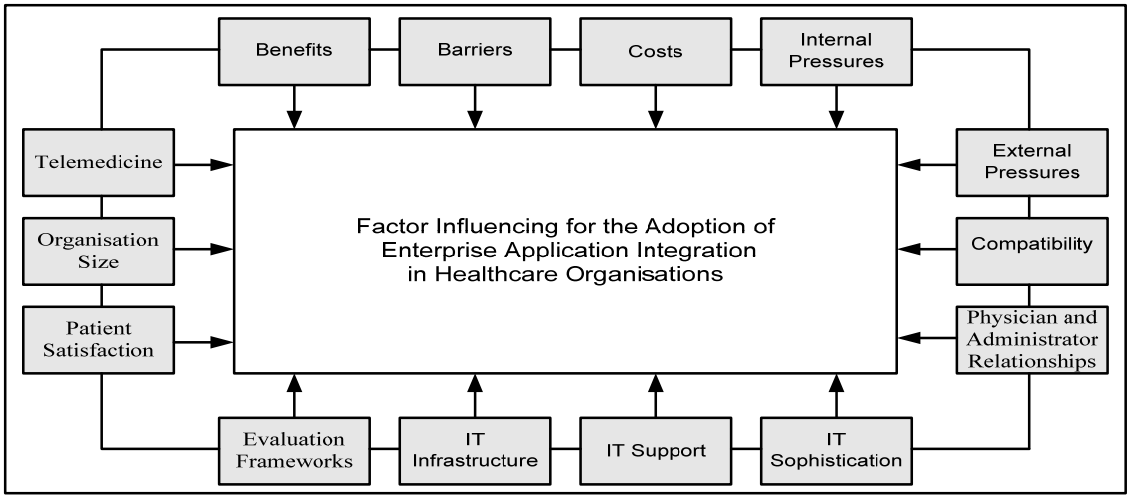

Figure 1. The Proposed Conceptual Model for EAI Adoption in Healthcare Organizations - MAESTRO

The authors will refer to this **M**odel for the **A**doption of **E**nterpri**s**e Application Integra**t**ion in Healthca**r**e **O**rganizations using the coded name MAESTRO. MAESTRO has not been empirically tested and validated. Others, such as Khoumbati et al. [2006], have, however, studied this model and used fuzzy cognitive mapping as a technique to explore the interrelationships that exist between the factors that constitute MAESTRO. Therefore, there is a need to empirically test and validate the MAESTRO model in a different case environment.

III. RESEARCH METHODOLOGY

In order to test the MAESTRO model, the authors evaluated a variety of research strategies as proposed by Yin [2003]. In doing so, the research focus dictated their choice to use a case study. The research strategy that has been adopted in this study was exploratory case study research. The case study provided the opportunity to examine the information systems via a series of interviews, document analysis and observation. In addition, the exploratory single case-study strategy helps the authors to focus on the EAI adoption process in healthcare organisations. This research strategy was adopted to test the factors proposed in Figure 1. Figure 2 illustrates the empirical research design that guides the authors to process the research enquiry and investigate the factors that influence the adoption of EAI in a healthcare organisation.

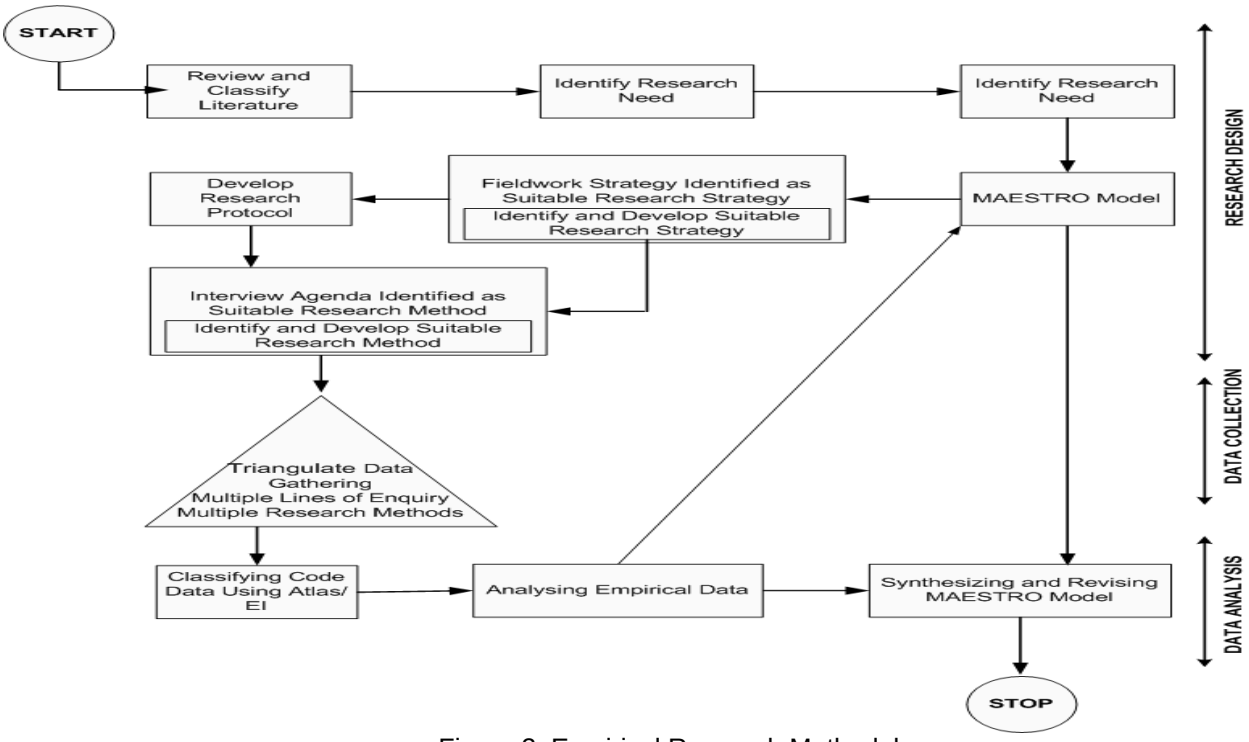

Figure 2. Empirical Research Methodology

The authors conducted multiple interviews to collect data and to capture the verbatim responses. This is considered a primary source as it provides: (a) in-depth information about a particular research issue or question, and (b) recognition as the verbal confirmation or disconfirmation of answers to the questions [Lee 1991]. A predefined interview protocol was used to determine the data needed for the research. Structured and semi-structured interviews were conducted with different stakeholders of the hospital. Several stakeholders of the case organisation were interviewed. Initially, the authors attempted to collect data from the top executives of the hospital and NHS IT department. However, despite several attempts the authors were unable to get an appointment. Therefore, the authors focused more on middle level management and lower management. As a result 12 interviews were conducted that included the director of Information Management and Technology (IM&T), the director of the medical department, the project director, the deputy medical director, consultants, the manager of IT infrastructure, integrators, programmers, and two persons from the vendor organisation. All the interviews took place at either the hospital or in the office of the vendor organisation. The interviews lasted between 40 and 50 minutes and were on a one-to-one basis. In addition to the interviews, the organisation's website was used as a further source that provided background information and other documentation, e.g., annual reports. Telephone and e-mail were also used as a secondary source to elucidate and probe unclear issues that, in some cases, occurred subsequent to the transcribing of the interviews.

To overcome the contradiction associated with data gathering across multiple sources, the data were cross-checked several times. To overcome bias, data triangulation was employed, such as documentation and observation. In this research, ATLAS/ti software was used to assist the authors in analysing the data and to finish the coding process visually in an efficient way.

Since the authors can not generalize the data derived from a single case study, they suggest that the research findings will allow others to relate their experiences to those reported herein. This will act as a frame of reference that will allow others in both this and associated areas of research to ground their understanding within the presented context. Hence, this paper offers a broader understanding of the phenomenon of EAI adoption in the healthcare organisation.

IV. EMPIRICAL CASE STUDY

Due to confidentiality reasons, the name of the hospital cannot be published. Instead, the authors will use the coded name EAI-HOSPITAL as a reference. EAI-HOSPITAL is one of the UK's oldest foundation trusts as it was established in 1805. With the formation of the NHS in 1948 it lost its status as a voluntary hospital, and in 1965 officially gained the status of NHS trust. It has more than 1,200 employees on 11 different sites in UK, with a teaching and research institute. It has almost 40 departments including pharmacy, pathology, medical imaging, electrophysiology, personnel, finance, planning, and development, research and development, clinical audit and Information Management and Technology (IM&T). The trust has the largest team of consultants in the country, each with a particular sub-specialization. The trust, with its partner the Institute of Special Diseases, is also a major national centre for postgraduate teaching and research. The hospital provides services to London in particular, where approximately 40 percent of the referrals are seen by the trust.

THE NEED FOR INTEGRATION

The EAI-HOSPITAL has accumulated multiple technologies including, monolithic, two-tier and three-tier client/server architectures and data repositories that include Microsoft SQL, Oracle, Access, and Visual FoxPro at its main site, along with the other 11 sites. Service providers were working with no common interface and with no means of easily tying together all of the information that might be relevant for each individual. In some instances, the results were unnecessary duplications of overlapping information. In other cases, individuals were not receiving all of the appropriate information.

Therefore, one of the primary challenges facing the EAI-HOSPITAL was to create a single view of the patient that interfaces with a variety of services across the hospital network over the course of time. Thus, EAI-HOSPITAL started to work on traditional integration interfaces. This has been in part due to the large diversity of systems and specialized requirements in the healthcare environment. Developing and maintaining the custom interfaces along with managing and monitoring them, was costly and time-consuming.

As a national centre for special care, the EAI-Hospital's main challenge is not filling beds, but managing the high volume of outpatients—usually more than 1,000 patients coming through the door every day from all over the country. Thus, one of the main driving forces for changing the organisational system at the hospital was the introduction of a patient's charter with its restrictions on waiting lists. Furthermore, the system should be able to check whether the service level agreement with the appropriate health authority has the capacity to be met. It will also show the optimum appointment or admission time to fit with these requirements.

Given the nature of its work, EAI-HOSPITAL needs to access current patient records and the associated charts and photographs easily and consistently across its 11 different sites. It also considers integrating several different applications and devices. Integration is one of biggest problems related to EAI-HOSPITAL and as a result, decided to seek more efficient solutions for its IT infrastructure.

THE STRATEGY FOR EAI ADOPTION

By 1997 the hospital, with the support of the Commission for Health Improvement, decided to make significant improvements, as it did face many problems, including:

- Lack of communication between the trust and its patients from admission to discharge
- Lack of integration of research and development with audit and learning as a continuous process
- Unsatisfactory levels of quality of patient services and care
- Development of a patient-centric approach to support involving patients in the medical decision-making process and keeping them informed on issues like delays, admissions and treatment
- Need to keep the health professionals up to date and informed in their practices and to have them properly supervised where necessary
- Need to introduce telemedicine and e-health applications
- Reduction of errors and adverse events as well as a commitment to learn from mistakes and to share that learning with others
- Excessive length of patient waiting times and the need for a booking system

Nonetheless, the UK healthcare sector modernisation effort has been one of the main driving forces for changing the information at EAI-HOSPITAL. During recent years, the UK government, through the UK NHS care plan, has focused on the development of an essential patient centric information system, to provide care efficiently and effectively within an integrated infrastructure between health and social care. The key objectives for the UK government Health Sectors, within the National Health services, in this era are to provide quality of care to patients 24 hours a day, seven days a week (24/7) and to modernize healthcare services especially through the new information systems strategy. Furthermore, EAI-HOSPITAL also started to realize the pressures to comply with government legislation concerning patient data and care. EAI-HOSPITAL decided to seek more efficient solutions for its existing IT infrastructure. Overall, it has significant IT investments compared to other hospitals. According to the Director of Information Management and Technology (IM&T) the hospital spends almost 4.5 percent of its annual budget on IT infrastructure development. That is almost double compared to other UK hospitals.

In this case there was no need to go through a lengthy procurement process, as the software vendor had invested in this project, as it expects to replicate this solution in other hospitals. Thus, in other cases EAI-HOSPITAL was expected to pay 100 percent of the amount, but in this case the hospital paid just 25 percent for the initial implementation cost and about 20,000 pounds for the maintenance cost. Therefore, it was very easy to justify the investment, because the hospital saves 60-70 percent of the amount annually during the investment evaluation process [Department of Health 2002].

EAI-HOSPITAL developed partnerships with a small number of software suppliers to redevelop and integrate the existing systems. The hospital turned to consultancies and suppliers to provide software packages that match its business process. This practice is in accordance with the published literature which suggests that organisations seek support from consultants and other experts to evaluate and adopt EAI solutions [Themistocleous 2004]. The consultants initiated a pilot project to support integrated IT infrastructure. Initially, EAI-HOSPITAL decided to integrate the Patient Administration System (PAS) that holds all patient demographics (e.g., address, date of birth, admission details) with existing administrative and clinical systems as shown in Figure 3.

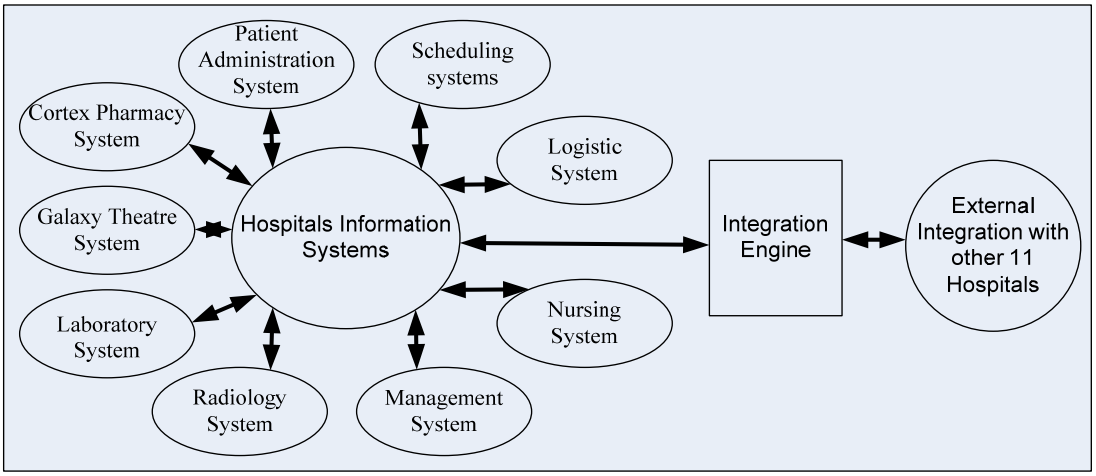

Figure 3. Integration Strategy of the EAI-HOSPITAL

V. DATA ANALYSIS AND FINDINGS

It was apparent from the empirical data that several factors have influenced the EAI adoption. The main findings drawn from the evaluation of EAI adoption in the hospital are summarised below:

INFORMATION TECHNOLOGY (IT) INFRASTRUCTURE

The EAI-HOSPITAL had a heterogeneous IT infrastructure that consisted of several incompatible systems. Consequently, EAI-HOSPITAL faced significant integration problems while working with other hospitals and government bodies. It was very difficult for EAI-HOSPITAL to integrate all the applications that run on the mainframe and the non-mainframe platforms. In addition, there was a redundancy of data and functionality as many applications stored similar data or ran systems overlapping in functionality. As a result, the hospital could not: (a) gain the advantages of IT or (b) support closer collaboration with its various stakeholders. Thus, the existing IT infrastructure represents an influencing factor for the adoption of EAI in the EAI-HOSPITAL.

EVALUATION FRAMEWORKS FOR EAI TECHNOLOGIES AND PACKAGES

The IT department of the EAI-HOSPITAL did not evaluate integration technologies and packages, as the vendor organisation had implemented the EAI project based on its own solution. Therefore, all the evaluation work for the selection of the particular integration technology and packages was carried out by the vendor organisation. Thus, the vendor organisation was contacted to discuss the evaluation process of the integration technology. When the interviewees of the vendor organisation were asked about the importance of this, the manager of the integration project reported that:

> *In my opinion, when an organisation is deciding to implement an EAI project, it is important to clearly define the criteria and the main architectural components. Using the right set of criteria the organisations can identify appropriate integration solutions for their needs. They can save time and money and reduce the risk.*

When the interviewees were asked to report information about the evaluation frameworks they used for the selection of particular integration technologies, they refused to do so due to confidentiality reasons. However, they discussed several important criteria for the evaluation of EAI. When the IM&T director was asked to comment on the importance of evaluating the EAI technologies, he replied:

> *There are several reasons: firstly there is marketplace confusion regarding the EAI technologies, therefore it is very difficult for the organisations to decide the selection of the particular technology for the particular problem. Secondly, EAI solutions are relatively costly, and so organisations want to ensure that the solution they are selecting will be the one that best supports their needs, now and down the road. This means establishing the weighted set of criteria and then conducting the evaluation.*

From the discussions, it appears that the vendor organisation used its own evaluation framework to configure its solution. As a result, this validates the normative literature and represents an influencing factor for the adoption of EAI technologies.

EAI BENEFITS

In this section, the benefits achieved by the EAI-HOSPITAL with the adoption of EAI are discussed. According to the interviewees, the EAI adoption resulted in several important benefits to EAI-HOSPITAL. Those include clinical process improvement, enabling the sharing of best medical practices, and clinical outcomes are improved through collaboration, teamwork, and care process improvement initiatives. All these benefits have been grouped into five broad categories of benefits: operational, managerial, strategic, IT infrastructure and organisational which are based on the model developed by Shang and Seddon [2002]. Below is the description of benefits that were identified.

Operational benefits include cost reduction from decreased administrative, staffing and resources management. Financial gain is reflected in revenue enhancement from billing practices. Even reductions in lengths of waiting time can be measured in pounds and have significant impact on an organisations financial operations.

Managerial benefits include the provision of greater understanding and the control of processes. In addition to that, improvement in work efficiency has been cited as an important managerial benefit.

Strategic benefits are achieved through care process advances from better adherence to clinical protocols and improvements in clinical decision-making. Improved quality of patient outcomes through real-time alerts, and clinical decision support provide help in the reduction of medical errors.

Benefits related to the IT infrastructure include the reduction of the number of interfaces. Before EAI adoption the hospital had a large number of interfaces, which were increasingly difficult to manage, and thus, were increasing the complexity. These findings demonstrate that the use of EAI has reduced the complexity.

Organisational benefits The key organisational benefits include the simplification of a patient's process in the hospital. One-time information gathering has made this possible, where patient information is easily available between one required service and another without the wastage of a long-time stay, where both use a single integrated view of patients from the different locations. This has thus resulted in reduced paper work and a simplification of the referrals process.

EAI BARRIERS

This section summarizes the barriers that EAI-HOSPITAL experienced during the adoption of EAI and were identified during the data collection process. All these barriers are classified based on the model developed by Shang and Seddon [2002] and are discussed below:

Operational barriers: At the operational level, EAI-HOSPITAL faces several problems such as financial requirements and the fear of an increase in expenses. It is observed that the previous IT implementation strategy had caused a number of problems, especially when it came to the matter of cost. Therefore, the hospital management decided to carefully control future costs to avoid such problems.

Managerial barriers: It was also observed that physicians, as a group, perceive integration technology as inherently disruptive and assume that they are taking a risk when it is introduced. This is due to their concerns regarding the impact on patients and the loss of autonomy. It appears that this is compounded by lack of knowledge regarding EAI benefits.

Strategic barriers: There is another problem related to the political issues, such as the internal politics within departments which play a huge role when these systems are being integrated. It therefore appears that various departments' resistance to EAI adoption is due to reasons such as physicians' concerns about the monitoring of practices as a medical-legal issue and changes that result in the care process. Moreover, employees have other fears, including the loss of their jobs.

IT infrastructure barriers: Integration technologies have vastly improved the ability to electronically record, store, transfer and share medical data. While these new advances have the potential for improving health care delivery, it is observed that they also create serious questions regarding who has access to this information, and how it is protected. Additionally, this technology is threatened by potential unauthorized interruption, such as computer hackers who have been known to tap illegally into private information on computer networks and could possibly gain access to and even alter patient records. Thus, EAI-HOSPITAL faces the problems of security and confidentiality of patient information. Clearly, privacy and security concerns are not unique to the hospitals.

Organisational barriers: The lack of understanding of EAI technology was found to be a major barrier for the IT department of the EAI-HOSPITAL. The reason for this was marketplace confusion regarding the integration

technologies. It was difficult for the management of the EAI-HOSPITAL to understand the nature of EAI technology. According to the director of IM&T:

> *The management was unable to understand the complexity of the existing systems that the hospital has with custom interfaces, and due to this it was very difficult to approve the adoption of EAI.*

EAI COSTS

When the researchers interviewed the hospital director of IM&T and asked him to elaborate on the EAI adoption costs, his reply was that the vendor expects the benefits from the EAI solution to be integrated by other hospitals. Therefore, in this situation EAI-HOSPITAL was not expected to pay 100 percent of the amount, but just 25 percent for the initial implementation cost and about 20,000 pounds for the maintenance cost. As a result, EAI-HOSPITAL saves 60-70 percent of the amount annually. The interviewees reported training costs as one of the main expenditures. As the users were not familiar with the use of the systems after the adoption of EAI technology, major provision was made to provide training for users of the systems.

EXTERNAL PRESSURES

During this study, it has been observed that external pressures from government organisations (e.g., NHS) and partners (e.g., hospitals) represent an influencing factor for the adoption of EA. The pressures from citizens, patients and local health authority members such as primary care and social services providers were also important. All of these external pressures represented a decisive influential factor for EAI adoption.

INTERNAL PRESSURES

It appears that internal pressures, such as pressures from physicians, influenced the adoption of EAI in EAI-HOSPITAL. These pressures arose from the problematic provision of information to support decision making. For instance, timely clinical information, such as laboratory and radiology results required for diagnosis, was frequently unavailable or missing.

VI. LESSONS LEARNED FROM EAI-HOSPITAL

The analysis of the empirical data derived from the EAI-HOSPITAL revealed many lessons that might be helpful to healthcare organisations, as well as to integrators, researchers and IT practitioners. These lessons are summarized below:

- **Lesson 1** The evidence from the empirical data suggests that IT implementation decisions in the UK NHS hospitals have gone through several phases. As a result, the IT infrastructure of the EAI-HOSPITAL was non-integrated. Consequently, the hospital faced significant integration problems while working with other stakeholders. It was very difficult for the hospital to reconfigure and integrate all the applications that run on the mainframe and non-mainframe platforms, and integration had not been achieved. As a result, the hospital could not take advantage of IT to support closer collaboration with their various stakeholders. Therefore, the limitations of the existing IT infrastructure motivated the hospitals towards integration.

- **Lesson 2** The data of the EAI-HOSPITAL l shows that benefits are important factors during the evaluation of EAI. The hospital has achieved several benefits that accompany increased availability of the right information at the right time and in the right place. Those benefits include reduced medical errors and increased patient satisfaction, integration of clinical process and support in the provision of better healthcare services.

- **Lesson 3** Security and confidentiality of the patients' data have proven to be critical issues. The community view of the information requires protection of patients' information at different levels. For example, there may be instances where core information, such as a patient's address, needs to be protected. In other instances, the entire patient record may require the application of an additional level of security. The security policy still needs guidance from a national perspective. This means that further work should be done in this area, as these two issues are critical for the success of the integrated system.

- **Lesson 4** The fact that the EAI-HOSPITAL hospital has relied on the vendor's analysis in adopting EAI indicates that the level of IT sophistication was low. To address this issue, the organisations should employ practitioners with EAI skills or at least train their IT staff before they start the project.

- **Lesson 5** Marketplace confusion regarding EAI technologies and insufficient IT sophistication were problems during the implementation of EAI. Therefore, with the support of vendors and external consultants, the hospital evaluated the EAI packages and technologies suitable for their integration problem. This shows that the

use of evaluation frameworks for the assessment of EAI technologies and packages is of high importance. It is for that reason that it is not enough to rely on the vendors' support since in many cases the vendors choose their EAI products and not the best EAI solution available.

- **Lesson 6** The integrated system supports information sharing, and therefore frees clinicians' time from administrative tasks. As a result, it gives more time to clinicians to deal with their patients, thereby improving patient care and clinical efficiency.

VII. SYNTHESIS AND REVISED MODEL FOR EAI ADOPTION

The findings of the empirical analysis that are illustrated in previous section are used to develop an evaluation matrix that shows the similarities and differences of factors across two case studies (first the NEW-HOSPITAL reported by Khoumbati et al. [2006] and second the EAI-HOSPITAL). Table 1 shows the synthesis and analysis of the MAESTRO model using the findings derived from the two case studies. The findings of EAI-HOSPITAL have also derived new influential factors associated with the revised framework in which they played an important role in the process of EAI implementation.

Table 1. Synthesis and Analysis of Two Case Studies

Factors	NEW-HOSPITAL	EAI-HOSPITAL
IT Infrastructure	The IT infrastructure was non- integrated with very little link between few systems.	Internal IT infrastructure was integrated with traditional interfaces.
Organization Size	65 GPs, 4,500 staff, 1300 beds split across three sites.	More than 1200 employees on eleven different sites, with a teaching and research institute.
External Pressures	Pressures from NHS, patients, other hospitals, GPs and social services.	Pressures from NHS, patients, other hospitals, GPs and social services.
Internal Pressures	Increasing demands form pressures for availability of the required information.	Pressures from management to reduce complexity and maintenance costs.
IT Sophistication	The lack of skilled EAI staff is a problem.	The IT department facing the IT sophistication issue.
IT Support	Hired the services of the external consultant to support them regarding the suitable integration solution.	The software vendor provided the support regarding the integration problem.
Evaluation Frameworks	The vendor organisation developed its own framework for the assessment of integration technologies.	The vendor organisation invested in the project, thus it developed its own framework.
Benefits	The hospital has experienced more organisational and operational benefits.	Technical and strategic benefits identified as major benefits.
Barriers	Organizational and technical barriers identified as major barriers.	Resistance to change and political issues experienced as major barriers.
Costs	Education and security costs identified as indirect costs.	The major cost was the maintenance cost.
Physicians and Administrators Relationship	The role of the physicians during the implementation process was highly influential.	Close collaboration with physicians was decisive during adoption.
Patient Satisfaction	Provision of better healthcare	Close collaboration has supported

Table 1. Synthesis and Analysis of Two Case Studies		
Factors	NEW-HOSPITAL	EAI-HOSPITAL
	services has enhanced patient satisfaction.	the enhancing of patient satisfaction.
Telemedicine	The integration of telemedicine was an important element in the modernisation process.	Future plans include integrating telemedicine with e- health systems.
Compatibility	Increased use of IT by clinical staff enabled the acceptance of the EAI technology.	EAI found concurrent in use with existing systems.
Security and Confidentiality	----------	Faces problems of security and confidentiality of patient information.
Education	----------	Proper education found to impede EAI adoption.

The following section seeks to extrapolate the key findings and integrates the "new" factors that have emerged from the case study. The authors will then ground the relevance of these new factors through the literature to support the external validity of the revised MAESTRO model (Figure 4).

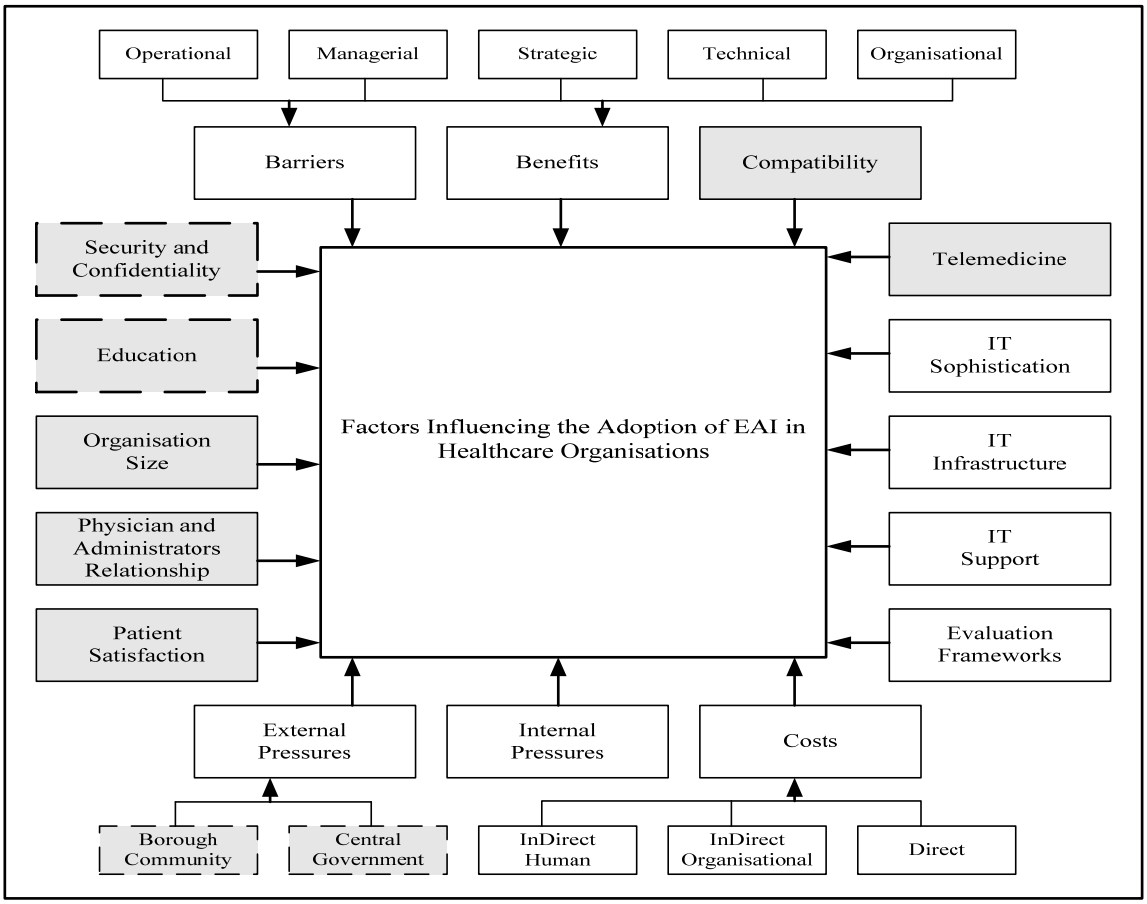

Figure 4: Revised MAESTRO Model for EAI Adoption in Healthcare Organizations

In Figure 4, the new factors that were derived from empirical evidence are included in a dashed box (e.g., education and security and confidentiality). The highlighted text boxes (such as organisation size and patient satisfaction) represent factors that influence the adoption and evaluation of EAI in healthcare organisations. Text boxes that have

no shadow (or colour) indicate factors and subfactors (such as benefits, barriers costs, direct, indirect human and indirect organisational costs) that are identified by the original MAESTRO model.

IT INFRASTRUCTURE

Empirical evidence suggest that the decisions for IT implementations in the hospitals depend on several factors. The IT infrastructure of the case hospital was heterogeneous and consisted of several incompatible systems. Thus, it was very difficult for the hospital to integrate all the applications across mainframe and non-mainframe platforms. In addition, there was a redundancy of data and functionality as many applications stored similar data or ran systems overlapping in functionality. As a result, the hospitals could not take advantage of IT and support closer collaboration and the sharing of information with their various stakeholders. Since integration could not be achieved, the limitations of the existing IT infrastructure motivated the case hospital to adopt EAI technology. Thus, the existing IT infrastructure represents an influencing factor for the adoption of EAI. These findings are in accordance with the literature findings of Iacovou et al. [1995], Heck and Ribbers [1999], Waarts et al. [2002], Bradford and Florin [2003], and Themistocleous [2004], who considered the existing IT infrastructure as an influential factor for the adoption of different integration technologies.

ORGANISATION SIZE

Another factor associated with the adoption of EAI is organisation size. The organisational size factor is based in these case organisations on the capacity of beds, healthcare services and centers for the treatment of special diseases, the number of GPs' clinics and the number of employees. The EAI-HOSPITAL has more than 1,200 employees on 11 different sites, with a teaching and research institute. It has almost 40 different departments and the trust provides services to London in particular, where about 40 percent of the referrals are seen. Therefore, this implies that the organisation size factor has an important role in the process of EAI implementation. The larger the size of the organisational structure, the larger is the need for integrating its distributed IT infrastructure.

EXTERNAL PRESSURES

The empirical data collected from EAI-HOSPITAL indicates that external pressures represent an influencing factor for the adoption of EAI. In this context, the pressures from: (a) government organisations (e.g., NHS) for the provision of better healthcare services to the citizens, and (b) partner organisations for closer collaboration represent external pressures. The pressures from local health authority members such as primary care service providers and social service providers for the sharing of patient information also represent external pressures. The pressures from citizens for the improvement of healthcare facilities such as the availability of their healthcare records also represent external pressures. All these external pressures influenced the adoption of EAI in EAI-HOSPITAL. This supports the previous literature findings of Iacovou et al. [1995], Heck and Ribbers [1999], Martinez and Redondo [2001], Waarts et al. [2002], Bradford and Florin [2003] and Themistocleous [2004], which present external pressures as a factor for the adoption of different integration technologies such as EDI, EAI and Web services.

INTERNAL PRESSURES

In the EAI-HOSPITAL, the non-integrated IT infrastructure was causing problems to the provision of better healthcare services as patient information was distributed over several systems, with very limited links. Thus, the relevant information was not accessible to the physicians at the required time. Most of the pressures were for the better utilization of the existing IT infrastructure and for getting the maximum benefits from IT to provide better healthcare services. Therefore, the evidence confirms that the internal pressures represent a factor that influences EAI adoption in these case hospitals. This corroborates findings of Themistocleous [2004] and Chen [2003] that internal pressures influence adoption of integration technologies.

IT SOPHISTICATION

Themistocleous [2004] reports that IT sophistication is related to the level of understanding and addressing technical problems within the organisation. The empirical data show that the level of IT sophistication in the case organisation affected the adoption of EAI. The case study analysed indicates that there was a lack of skilled employees who understood integration problems or technologies. As a result, the hospital hired the services of external consultants and the vendor organisation to improve its IT sophistication. Thus, IT sophistication is an influencing factor for EAI adoption. Regarding this factor, the empirical data are in line with the literature that reports that the level of IT sophistication affects the decision making process for adoption [Chwelos et al. 2001].

IT SUPPORT

The empirical data show that there was a lack of skilled staff with knowledge of EAI. The reasons are, first, that EAI is a new emerging technology, and second, there is market place confusion regarding this technology. To overcome this problem, the EAI-HOSPITAL hired the services of the external consultant to support them in the selection of a

particular technology suitable for their integration problem. Therefore, the software vendor provided all the support in deciding on the right integration technology. Thus, these findings confirm the literature which suggests that during the EAI adoption process organisations seek support from consultants and vendors when implementing their EAI applications [Themistocleous 2004].

EVALUATION FRAMEWORKS FOR EAI TECHNOLOGIES AND PACKAGES

The analysis of the interviews revealed that the evaluation model developed by Themistocleous, Irani, and Love [2004] presents a broad range of parameters necessary for the evaluation of such technologies. The data analysis from the interviews reports that there is no single technology that supports the integration of all applications. Thus, evaluation frameworks represent an important tool for the selection of EAI technologies and packages. These findings suggest that the EAI evaluation frameworks represent an influential factor for EAI adoption.

EAI BENEFITS

This factor refers to the level of benefits that EAI can provide to the hospital. The findings of the normative literature indicate that Iacovou et al. [1995], Themistocleous [2004], and Wu [2004] presented benefits as a factor during the adoption of various integration technologies such as EAI and Web services. The empirical data from the analysis of the case hospital includes many EAI benefits that had been reported previously. However, several new benefits were derived with particular focus on the healthcare context. These benefits were classified using the model proposed by Shang and Seddon [2002] into: (a) operational; (b) managerial; (c) strategic; (d) technical; and (e) organisational factor. Benefits appear to influence EAI adoption.

EAI BARRIERS

The findings indicate that EAI-HOSPITAL has experienced several barriers during the implementation of EAI. The data shows that the factor *barriers* was one of the most significant issues during the EAI implementation process in this case. The hospital was experiencing several barriers. It appears from the empirical data that the willingness of physicians and GPs was an important concern. It was also reported that it is not possible for the case organisation to adopt EAI solutions without the support of the clinicians. This finding is consistent with findings reported by Davenport, [1998].

EAI COSTS

In the case of EAI-HOSPITAL cost was an important factor for EAI adoption. This is also in line with the literature which highlights costs as a factor for the adoption of various integration technologies like EAI. The empirical evidence gathered from the EAI-HOSPITAL illustrated that software, communication and consultancy costs were major direct costs. In addition, hardware and communication costs were reported as less important direct costs for EAI adoption. The most significant indirect costs identified were education costs and training costs for the IT staff, clinicians and other administrative staff. Moreover, management time, project team time, and external consultants were experienced as significant indirect costs.

PATIENT SATISFACTION

The rapid changes taking place in the healthcare sector have prompted healthcare organisations to pay more attention to the satisfaction of their patients. In the literature, the implementation of new IT applications has been considered as a means for enhancing patient satisfaction. The findings from the EAI-HOSPITAL hospital indicate that patient satisfaction is an important influential factor for EAI adoption. It has been identified that the integrated IT infrastructure has resulted in improvements for physicians and staff, such as increased availability of the patient's medical record, pathology, and radiology results at the required place and time. This also supports the findings of Zabada et al. [2001], which suggest that emerging IT tools can help to improve patient satisfaction.

PHYSICIAN AND ADMINISTRATOR RELATIONSHIPS

From the data, it appears that the relationships between the administrators and the physicians have an important role in EAI adoption. During the EAI implementation process the physicians were actively consulted in the systems evaluation and selection process. These findings confirmed the findings of Kim and Michelman [1990] who suggest that for the integration of healthcare systems physicians are very important, and that hospital administrators need to involve the physicians during the integration process. It therefore presents an important factor for the adoption of EAI technology.

TELEMEDICINE

The findings show that the case organisation had many concerns regarding the integration of its telemedicine applications with other clinical information systems. This is also in line with the literature as Tan et al. [2002] highlight

the importance of incorporating telemedicine applications within the overall IT infrastructure. In the case of EAI-HOSPITAL the importance of telemedicine applications was outlined in the future plans for the integration of these applications with the rest of the information systems. The hospital's trust board realized that the successful implementation of telemedicine depends on the integration of these systems with its IT infrastructure.

COMPATIBILITY

This factor has been frequently discussed in the literature, and it is stated that compatibility can occur on several dimensions, such as existing values, past experiences, and needs of the adoption [Roger 1983; Chen 2003; Wu 2004]. In the context of EAI adoption the empirical evidence reflected these dimensions. For example, physicians believe that improvements in the quality of medical care can only occur when the required information is available regarding the treatment protocols. In EAI-HOSPITAL, it was considered that EAI adoption is compatible. Another dimension of the compatibility is linked to previous experience, for example in this context the empirical data shows that physicians and other clinical staff found this system more compatible because of their prior experience. Finally, compatibility addresses the key needs addressed by the decision makers. In this context, the empirical data shows that EAI adoption has achieved this. For example, the administration of the hospital were having concerns regarding the provision of better healthcare services, integration of different systems in a more flexible and manageable way, reduced complexity, data redundancy, medical errors and reduced integration costs. Thus, all these findings show that EAI is compatible with the existing values, past experiences and needs. Therefore, compatibility represents a factor for EAI adoption in healthcare organisations.

SECURITY AND CONFIDENTIALITY

This is the new factor derived from the empirical data, and refers to the security and confidently concerns about patient data. In the literature these have always been considered important in the distributed processing environment [Huston 2001]. The findings show that security and confidentiality comprise a factor that affects the adoption of EAI.

The data from EAI-HOSPITAL demonstrate that in a distributed environment the access to patient information is problematic. Thus questions about *who* has access to this information and *how* it is protected were raised. This is of high importance, since the technology is threatened by potential unauthorized access, such as by computer hackers. Therefore, the EAI-HOSPITAL initiated several processes to address security and confidentiality issues. All these reasons represent security and confidentiality as an important factor during the EAI adoption process.

EDUCATION

The analysis of the empirical data indicated that the EAI-HOSPITAL identified the need of education for their clinical staff and patients during the EAI implementation process. This decision was taken due to several reasons, in particular, resistance to change was an issue from the staff of the EAI-HOSPITAL. Thus, motivation efforts by the hospital management were used for support in overcoming this problem. All these case findings support that education forms an influential factor for EAI adoption in healthcare organisations.

VIII. CONCLUSIONS

In this paper, the authors have aimed to test and assess the MAESTRO model for EAI adoption in healthcare organisations. The MAESTRO model suggests that the factors like Benefits, barriers, costs, evaluation models, IT infrastructure, IT sophistication, IT support, internal pressures, external pressures, organisation size, compatibility, telemedicine, patient satisfaction, and physicians' and administrators' relationships influence the adoption of EAI in healthcare organisations.

The findings from the case study organisation confirmed and validated the proposed conceptual framework. In addition, the empirical findings suggest modifications in the conceptual model by adding new factors that should be incorporated within it namely, education, security, and confidentiality. These factors have an important role during the evaluation process. In doing so, a revised model has been proposed.

Hence, this paper offers an in-depth understanding of the phenomenon of evaluating EAI adoption in the context of healthcare organisations by identifying factors that are central to decisions regarding the adoption of EAI in healthcare organisations. Further, the revised MAESTRO model can support researchers to analyse and understand the adoption process of EAI. Since the authors cannot generalise the data derived from the single case study, they suggest that the research findings will allow others to relate their experiences to those reported herein. MAESTRO acts as a frame of reference that will allow others both in this and associated areas of research to ground their understanding within the presented context. As a result, this paper offers a broader understanding of the phenomenon of EAI adoption in the healthcare organisation.

The most important difficulty the authors faced was the restricted access to information such as hospital documents, due to confidentiality issues. In some cases the interviewees were not able to provide information for confidentiality reasons as well. Moreover, despite several attempts the authors failed to get appointments with top executives of the hospital and the NHS IT department, and this necessitated changing the interviewee level from executive management to middle and lower management.

Realization of EAI adoption benefits is an important issue. Therefore, for the future research it is recommended to transform the proposed EAI benefits taxonomy into a large-scale survey questionnaire by using an interpretive epistemology. A large-scale survey will give the opportunity to determine the identification and validation of the EAI adoption benefits in the context of healthcare organisations, and will contribute in better decision making regarding EAI adoption.

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