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

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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).
- Healthcare Advanced Networked System Architecture Project (Hansa) (Endsleff *et al.,* 2000).

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 businesses 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-exit 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

No	Factors	References from Integration Area	References from Healthcare
1	Cost	Linthicum (1999)	Lee (2003)
2	Barriers	Themistocleous (2002)	Lopez (2002)
3	Benefits	Pushmann (2001)	Oxendine (2002)
4	IT Infrastructure	Zahavi (1999)	Grimson (2000)
5	IT Sophistications	Kalakota (1999)	Ball (2002)
6	Evaluation Framework	Themistocleous (2001)	-
7	Support	Themistocleous (2002)	Ball (2002)
8	Internal Pressures	Themistocleous (2001b)	Harkke (2003)
9	Trading Partners pressures	Iacovous (1995)	Harkke (2003)
10	External Pressures	Themistocleous (2002)	Pagni (1999)
11	Managerial Motivations	Kalakota (2000)	Oxendine (2002)
12	Technical Motivations	Kalakota (2000)	Carr (2003)

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

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

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

No	Factors	References from Integration Area	References from Healthcare
1	Access of patients data	Ferrara (1998)	Ginneken (2002)
2	Telemedicine	Grimson (2000)	Tyler (2001)
3	Patients data security	Rindfleish (1997)	Carr (2003)
4	Return on investment	Pushmann *et al,* (2001)	Hickory (1999)
5	Support Research	Ball (2002)	Ball (2002)
6	Decision-making	Raghupathi *et al,* (2002)	Ginneken (2002)

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 4. Factors Influencing for EAI Adoption in Healthcare Organisations

Level	Factors	Description
1	Cost	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).
1	Barriers	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 l 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 organisation.
1	Benefits	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)
1	Internal Pressures	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.
1	External Pressures	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.
1	Evaluation framework	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
2	Support	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.
2	Managerial Motivations	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.

Level	Factors	Description
2	IT Infrastructure	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
2	IT Sophistication	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.
2	Trading Partners Pressures	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
1	Research Support	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 5. New Factors for EAI Adoption in Healthcare Organisations

Level	Factors	Description
1	Access of patients data	Patients demographic and clinical data is widely being required by the departments for various purposes such as by physicians**,** laboratories**,** finance department, administration department, researchers and insurance service providers. Access of patient's medical data is being required to perform long distance medical diagnosis. Technologies such as magnetic resonance image record the patient's data on film to perform long distances diagnoses ((Raghupathi *et al.,* 2002). The non-integrated IT infrastructure in health organisations limits the access of data by all the concerned departments
2	Return on Investment	Return on investment is important in healthcare organisations. As the IT budgets of the health care organisations are lower comparing to other organisations. As a result, they do not want to invest their money in a technology, without significant benefit.
1	Telemedicine	Telemedicine involves the use of modern telecommunication technology especially two-way interactive audio/video communication, to deliver healthcare services to remote patients and to allow information exchange between physicians and specialists. Telemedicine applications store the patient medical results, which are being transmitted by various modalities such as RMI and CT (Tyler, 2001). Recent improvement in communications and computer technology, including data compression, image enhancement, graphical user interfaces, and high-speed computing, have allowed more accurate transmission of medical data (Chou *et al*., 2002). However the non-integrated nature of many healthcare applications does not allow fully uses and take the advantage of telemedicine.
1	Research Support	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.
1	Decision making	Healthcare organisation needs to improve decision-making process for the patient treatment in real time. This can be achieved by integrated IT infrastructure. A number of clinical applications employing artificial intelligence, neural networks, any fuzzy logic techniques are being developed to give physicians clinical decision support (Raghupathi *et al*., 2002). Decision support requires the higher level of integration for exchanging and sharing of patients data between various decision support applications, to generate warnings, provide diagnostics suggestions, offer treatment advice (Ginneken, 2002).
2	Patients data security	Patients data may contains some of the most sensitive information such as the emotional problems, psychiatric care, sexual behaviours, sexually transmitted diseases, HIV status, physical abuses and so on. Access to such information must be controlled because disclosure can harm the patient

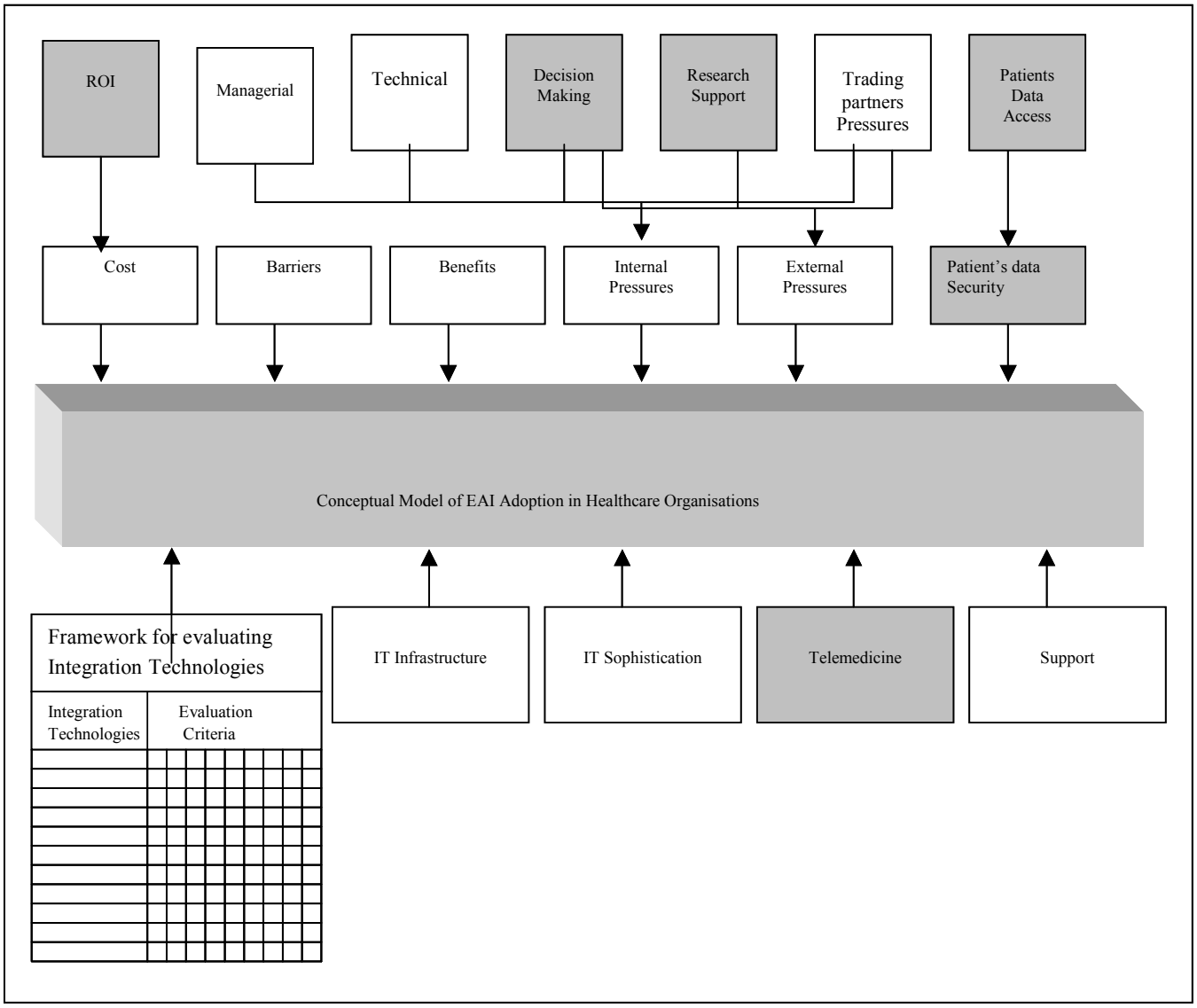

Figure 1. The Proposed Conceptual Model for EAI Adoption for Healthcare Organisations

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.

References

Ball, M.2003. "Hospital information systems: perspectives on problems and prospects, 1997 and 2002", International journal of medical Informatics, (In-Press).

Beeler, G. 1998. " HL-7 Version 3- An Object Oriented Methodology for Collaborative Standards Development", International journal of medical Informatics, 48(1-3): 151-161.

Carr, C. and Moore, M.2003. " IHE: a model for deriving adoption of standards", Computerized Medical Imaging and Graphics, 27(2-3): 137-146.

Ceusters, W., F. Buekens, G., DeMoor, J., Bernauer, L., DeKeyser and G. Surján.1997 " TSMI: a CEN/TC251 standard for time specific problems in healthcare informatics and telematics ", International Journal of Medical Informatics, 46(2): 87-101

Chalmeta, R. Campos, C. and Grangel, R. 2001 " References architectures for enterprise integration", The Journal of Systems and Software, 57 (3): 175-191.

Chou, D., and Chou, A.2002 " Healthcare Information Portal: a Web Technology for the Healthcare Community", Technology In Society, 24(3): 317-330.

Davenport, T. 1998. 'Putting the Enterprise into the Enterprise System', Harvard Business Review, July-August 1998: 121-131.

Demetriades, J.2000. " Twenty Questions for Jim Demetriades", eAI journal, January (2000): 44-47.

Endsleff, F., Ferrara, F., Olsen, A., Sottile, P., Thomsen, J.2000 " The Integration Environment of the Copenhagen Hospital Corporation ", www.dadnet.uk

Erasala, N., David, C. Yen. and Rajkumar, T.M. 2003. "Enterprise Application Integration in the Electronic Commerce World", Computer Standards & Interfaces 52 (2): 69-82.

Ferrara, F.1998."The Standard Healthcare Information Systems Architecture and the DHE middleware", International Journal of Medial Informatics, 52 (1-3), 39-51.

Ginneken, A.2002." The Computerized Patient record: balancing effort and benefit", International journal of Medical Informatics 65(2): 97-119.

Grimson, J. and Grimson, W. 2000. "The SI Challenge In Healthcare ", Communication of ACM 43(6): 49-55.

Hakkinen, H., Turunen, P., Spil, T. 2003 Information in Healthcare Process-Evaluation Toolkit Development", Proceedings of the Hawaii International Conference on System Sciences-, USA: [CD- Proceedings]

Harkke, V., Alessi, D.and Collan, M. 2003." IT and Institutional Constraints of Legaland Administrative Constraints to use IT in Production of Healthcare Services-Focus on Finland", Proceedings of the Hawaii International Conference on System Sciences-2003, USA: [CD-Proceedings]

Hickory.1999." Catawba Memorial Hospital", **www.dic.com**

Iacovou, C., Benbasat, I. And Dexter, A. 1995 " Electronic Data Interchange and Small Organisations", Adoption and Impact of Technology, MIS Quarterly, 19(4): 465-485.

Johannesson, P., Perjons, E. 2001." Design principles for process modelling in enterprise application integration" information Systems, 26(3): 165-184.

Kalakota, R. and Robinson, M. 1999. "E-Business: Roadmap for Success", Addison-Wesley, Boston, Massachusetts, USA.

Kalakota, R. 2000. "Inter-Enterprise Fusion - The Future of Supply Chains", EAI Journal, May 2000: 72-76.

Lee, J. Siau, K. and Hong, S.2003." Enterprise Integration with ERP and EAI", Communications of the ACM 46(2): 54-60.

Lenz, R. and Kuhn, K.2002 " Integration of Heterogeneous and Autonomous Systems in Hospitals", Businesses Brifing: Data Management & Storage Technology, www.wmrc.com

Linthicum, D. 1999. "Enterprise Application Integration", Addison-Wesley, Massachusetts, USA.

Linthicum, D. 2000. "B2B Application Integration", Addison-Wesley, Massachusetts, USA.

Lindgreen, R., Jannas, H., Hultas, A." Security when outsourcing Concepts Constructs and Compliance", Computers and Security: 16(3): 208-209.

Lopez, T.2002."13th Annual HIMASS leadership Survey", **www.superiorconsultant.com**

Loos, P.2000. "Advanced Information Technology Application in ERP Systems", Proceedings of 2000 Americas Conference on Information Systems, AMCIS 2000, Long Beach, California, USA: pp.635-639.

Murray, M.2002."An investigation of specifications for Migrating to a Web Portal framework for the Dissemination of Health Information within a Public Health network" Proceedings of the 35th Hawaii International Conference on System Sciences, USA, [CD-Processings].

Oxendine, J.2002." Study of Technology adoption in California Medical Groups, IPAs, and Community Clinics ", **www.chcf.org**

Pangi, a. and Plebani, M.1999." The laboratory and the general Practitioner", Clinical Chimica 280(1-2): 13-24.

Pinkston, J.2001." The Ins and Outs How EAI Differs", eAI Journal, August (2001): 48-52.

Puschmann, T. and Alt, R .2001." Enterprise Application Integration- The Case of the Robert Bosch Group", Proceedings of the 34th Hawaii International Conference on System Sciences, 2001: [CD Proceedings].

Raghupathi, W. and Tan.J. 2002." Strategic IT Applications in Healthcare ", Communication of the ACM 45(12): 56-61.

Rindfleisch, T. 1997. " Privacy, Information Technology, and healthcare ", Communication of the ACM 40(8): 93-100.

Sia, S., Tang, M., Soh, C., and Boh, W. 2002 " Enterprise Resource Planning (ERP) Systems as a Technology of Power Empowerment or Panoptic Control", The Data Base for Advances in Information Systems 33(1): 23-37.

Stal, M. 2002." Beyond Component-based Computing " Communications of the ACM 45(10): 71-76.

Southard, P., Hong, S., and Siau, K.2000."Informational Technology in the healthcare Industry A Primer", Proceedings of the 33rd Hawaii International Conference on System Sciences, [CD Proceedings].

Spahni, S., Scherrer, J., Sauquet, D., and Sottile, P.1999 " Towards Specialised Middleware for Healthcare Information systems", International Journal of Medical Informatics 53(2-3): 193-201.

Spyrou, S., Bamidis, P., Chouvarda, I., Gogou, G., Tryfon, S. and Maglaveras, N. 2002 " Health Information Standards: Comparison of the approaches", Health Informatics Journal 8(1): 14-18.

Themistocleous, M. (2002) Evaluating the Adoption of Enterprise Application Integration in Multinational Organisations, PhD Thesis, Department of Information systems and Computing, Brunel University, London

Themistocleous, M. and Irani, Z. 2002."A Model for Adopting Enterprise application Integration Technology", Proceedings of IFIP TC8 WG8.6 International Working Conference on Diffusion Adoption and Implementation of Information Technology, 2002,Sydeny, Australia: pp. 61-75.

Themistocleous, M. and Irani, Z. 2001b. " Evaluating Application Integration: An Exploratory Case Study", Proceedings of Seventh Americas Conference on Information Systems, AMCIS 2001, Boston, Massachusetts, USA: pp.1376-1380.

Themistocleous, M., Irani, Z. and Sharif, A. 2000. "Evaluating Application Integration", Proceedings of 7th European Conference on Evolution of Information Technology (ECITE 2000), Dublin, Ireland: pp.193-202.

Tyler, J.2001 " The Healthcare Information Technology Context: A Framework for Viewing Legal Aspects of Telemedicine and Telemedicine and Teleradiology", Proceedings of the 34th Hawaii International Conference on System Sciences, USA, [CD Proceedings].

Yen, D., Chou, D., Chang, J. 2002. " A Synergic analysis for Web-based enterprise resources planning systems", Computer Standards Interfaces 24(4): 337-346.

Wilson, A.D.2002." Managing Information IT for Business Processes", Chartered Management Institute, USA.

Zahavi, R. 1999. "Enterprise Application Integration with CORBA*", John* Wiley and Sons Inc, New York, USA.

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