

# EVALUATING INTEGRATION APPROACHES BENEFITS ADOPTED BY HEALTHCARE ORGANISATIONS

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## Abstract

*Healthcare organizations consist of a large number of disparate information systems (IS). These have been deployed to support specific needs of healthcare organisations. The information sharing among these disparate and heterogeneous systems has always been one of the most prominent issues for the management. As every day people die in hospitals, due to medical errors, which is generally caused due to non-integrated IT infrastructure. Various integration approaches have been adopted to solve integration problems. Although, some of them have partially supported the integration efforts, there are still many issues remaining to be solved such as level of integration, interpretability, cost reduction, and patients' data security. There is marketplace confusion in healthcare organisations, due to the variety of integration approaches that support the integration of healthcare IS. This paper seeks to describe the current deployed integration approaches in healthcare organisations. In doing so, the benefits of these approaches are evaluated. This evaluation will help researchers to better understand issues surrounding the benefits of integration approaches.*

*Keywords: Healthcare, Evaluation, Integration*

## 1 INTRODUCTION

At an organisational level, the structure of healthcare organisations is divided into different tiers such as primary health care centres, secondary and tertiary hospitals (Ferrara, 1998a). The objective of this structure is to provide healthcare facilities to the citizens at a local and regional level with continuity across different levels of hierarchy (Tsiknakis *et al.*, 1996). In such a distributed environment, Information and Communication Technology (ICT) has a leading role and significant impact on the practice of healthcare at all levels. Numerous Information Systems (IS) have been deployed at different levels in the healthcare sector, with these systems ranging from computerised patients' record to department-specific decision support systems (Hakkinen *et al.*, 2003). According to Xu *et al.*, (2000) information systems that manage data have been developed with different technologies. This has resulted in healthcare organisations having left with the islands of technologies that are difficult to integrate. As a result, the need for integrating these systems has increased enormously (Toussaint *et al.*, 2001). As a result, several integration standards, systems, projects such as Health Level 7, CEN/TC251, Synergy Extranet (SynEx), Synapses, etc) have been deployed in healthcare organisations to address integration problems.

The implementation of these integration approaches has provided significant benefits to healthcare organisations (Bernd and Holena, 1997). However, there are still many problems relating to their adoption. Among other problems the cost of the development of healthcare integration standards is high and the level of interoperability remains very low Carr and Moore (2003). The integration of the heterogeneous IS in healthcare is needed to support various issues such as:

- Clinical and administrative tasks
- Better healthcare
- Patients' data security
- Interoperability
- Healthcare process integration

In this paper, the authors have discussed the classification of healthcare information systems, which raises the need for the integration of healthcare IS. Integration approaches that have been adopted by healthcare organisations are summarised by evaluating the benefits.

## 2 CLASSIFICATION OF HEALTHCARE INFORMATION SYSTEMS

The computerisation of healthcare records has been around since the early 1960s, when hospitals first started using computers. Since then, incremental developments have taken place in healthcare industry, with IT playing an increasingly significant role in its delivery, which includes:

- Medical Informatics
- Computerised Patients Record (CPR) System
- Adoption of Internet along with other networks (e.g. intranets and extranet)
- Integration Approaches
- Asynchronous Transfer Mode (ATM) networks
- Telemedicine

The extensive use of IT in healthcare organisations has resulted in the development of various information systems. Murray (2002) states that in healthcare institutions there are numerous information systems like: patients', laboratory, radiology, pharmacy, administrative and human resource management systems. These applications have been developed to support particular business processes in healthcare organisations. In exploring this, the authors have attempted to present a classification of the most common information systems deployed in healthcare organisation. These systems are described in Table 1.

### **3 INTEGRATION STANDARDS, PROJECTS AND SYSTEMS ADOPTED IN HEALTHCARE ORGANISATIONS**

The electronic transfer of data between heterogeneous systems has raised the need for integrating healthcare IS (Spyrou *et al.*, 2002). However, integration of such applications in existing, multi-architectural computing environment has been proved to be a complicated task and difficult to accomplish (Zviran and Armoni, 1999). For many years, several efforts have been made to achieve integration in healthcare organisations, which include:

- Health Level 7
- CEN/TC251
- Synergy Extranet (SynEx)
- Synapses
- Healthcare Advanced Networked System Architecture Project (Hansa)
- Common Object Broker Architecture in Medicine (CORBAMED)
- Digital Imaging Communications in Medicine and Common Object Broker Architecture in Medicine (DICOM)
- Electronic Data Interchange (EDI)
- Enterprise Resource Planning Systems (ERP)

The description of these standards, projects and systems are discussed in Table 2.

Information Systems	Description	Characteristics	References
Patients' Information Systems	Various terms are used in IT to describe the computerisation of patients' data, such as electronics medical record, patients' information system and computerised patients' record system. However, these terms are just for non-paper patients' record system.	<ul style="list-style-type: none"> <li>• Store a wide range of data about a patients' clinical visits, hospitals admission notes, problem lists, allergies, discharge orders, diagnostic tests, medications etc.</li> <li>• Patients' electronic data are being stored, captured, manipulated, retrieved, and transmitted for clinical, biological and administrative purposes</li> </ul>	Grimson <i>et al.</i> , (2000) Ginneken, (2002)
Administrative Information Systems	Hospitals have implemented administrative information systems to deal with patients' admissions, discharge and billing purposes.	<ul style="list-style-type: none"> <li>• Reduces billing errors</li> <li>• Increases customer satisfaction</li> <li>• Reduces personnel costs</li> </ul>	Southard <i>et al.</i> , (2000) Hickory, (1999)
Laboratory Information Systems	Laboratory information systems are designed, developed and evolved independently from the rest of the information systems of the hospital	<ul style="list-style-type: none"> <li>• Provides connectivity with other equipments</li> <li>• To support decision making in results diagnoses</li> <li>• Provides support to doctors in decision making regarding the patients' treatment</li> </ul>	Vagelatos and Sarivougioukas (2003)
Telemedicine Information Systems	Telemedicine involves the use of modern telecommunication technology to deliver healthcare services to remote patients.	<ul style="list-style-type: none"> <li>• Designed to exchange the patients' medical results, which are transmitted by the various modalities.</li> <li>• Support information exchange between doctors and specialists.</li> </ul>	Tyler, (2001) Chou and Chou, (2002).
Web Information Systems	Web applications have a crucial role in bridging the gap between healthcare providers and users, by making available the required information	<ul style="list-style-type: none"> <li>• Provides on-line access such as to patients', physicians, suppliers for required information</li> <li>• Facilitates communication between patients' and physicians</li> <li>• Daily input from patients' are recorded and analyzed for better care.</li> </ul>	Raghupathi and Josph, (2002) Ginneken, (2002)
Pharmacy Information Systems	The pharmacy is one of the most complex departments in healthcare organisations. In pharmacy department, applications are developed to maintain the drug records for various purposes.	<ul style="list-style-type: none"> <li>• Supports in maintaining drug record such as for ordering, stocking and distribution.</li> <li>• Supports for screening drugs interactions such as drug-drug, drug-food, dose range checking, allergies and duplicate drug protection.</li> </ul>	Austin and Boxerman, (2002)
Education and Research Information Systems	In many healthcare organisations, research is a continuous process that focuses on new healthcare innovations. The complete computerised patients' clinical and biological information has become a good resource.	<ul style="list-style-type: none"> <li>• Supports in further developments in research of diseases diagnoses</li> <li>• Opened up new dimensions of research</li> </ul>	Ball, (2002) Grimson <i>et al.</i> , (2000)
Human Resources Information Systems	In human resource department, various modules are developed to provide information and advices	<ul style="list-style-type: none"> <li>• Supports staff and management for personal management, pay rolls, superannuation policy, manpower training, employment law</li> <li>• Supports in identifying staff needs, scheduled interviews and recruitment of staff</li> </ul>	Austin and Boxerman, (2002)
Decision Support Information Systems (DSS)	In healthcare organisations four types of DSS were developed such as traditional decision support systems, group decision support systems (GDSSs), executive information systems (EISs) and information warehousing.	<ul style="list-style-type: none"> <li>• Facilities in financial and scheduling domain</li> <li>• Supports in diseases diagnosis</li> <li>• Advices for further treatments</li> </ul>	Ginneken, (2002) Southard <i>et al.</i> , (2000)

Table 1: Classification of Healthcare Information Systems

Integration Approaches	Description	References
Health level 7 (HL7)	In 1987 HL7 was developed by Pennsylvania University Hospital to provide connectivity between hospital information systems and the hospitals medical equipment. Several versions of HL7 have been developed so far. The latest version 3.0 is based on XML syntax. HL7 standard provides the facility for electronic data exchange. Data exchange is implemented by exchanging messaging mechanism. This approach provides a way of solving basic communication problems between systems and achieves data integration.	Beeler (1998) Lenz and Klaus (2002) Ferdinand and Syed (2000)
European Committee for standardisation Technical Committee 251 (CEN/TC 251)	In 1990, European Standardisation/Technical Committee for Medical Informatics 251 for standardisation of health informatics was established. Basic implementation is based on EDIFACT but since 1999 XML is being implemented. This solution is dealing specifically with issues such as terminology, knowledge base and semantics in healthcare informatics. The architecture of this standard is based on three co-operative layers, such as application, middleware and bit ways, each individually is responsible for addressing specific needs of the information systems.	Ceusters <i>et al.</i> , (1997) Spyrou <i>et al.</i> , (2002) (Ferrara, 1998a).
Digital Imaging and Communications in Medicine (DICOM)	In 1985, the American College of Radiology (ACR) and National Electrical Manufacturers Association (NEMA) developed a standard that addressed the issue of vendor-independent data formats and data transfers for digital medical images. The goals of DICOM are to achieve compatibility and to improve workflow efficiency between imaging systems and other information systems in healthcare environment.	Ferrara (1998b)
Common Object Broker Architecture in Medicine (CORBAmed)	CORBAmed is the division of CORBA that is devoted to the domain of healthcare. The main objective to introduce this technology was to improve the quality of care, reduce costs and improve interoperability throughout the global healthcare community. CORBAmed defines standardised object-oriented interfaces between healthcare related services and functions	Lenz and Klaus (2002)
Synapses	The Synapses project funded in the year 1995, under EU 4 <sup>th</sup> framework health telemetric programme. The main objective of Synapses is to solve problems of sharing data between autonomous information systems. Synapses use the CEN/TC251/12265 architecture. This aims at promoting the middleware approach for healthcare information systems applications and establishing interfaces standards.	Spahni <i>et al.</i> , (1999)
Synergy Extranet (SynEx)	SynEx is European health telemetric project started in 1998. SynEx is an industry-led standard of middleware products for shared and distributed health records on heterogeneous systems. This addresses the issues inherent in the provision and use of multimedia patient records across large enterprise-wide networks. SynEx aims to provide the integration platform for both the new and legacy application deployed in the healthcare organisations.	Spyrou <i>et al</i> (2002) Xu <i>et al.</i> , (2000).
Healthcare Advanced Networked System Architecture (Hansa)	The mission of the project was to integrate different systems on an open middleware approach. This was achieved by using the Distributed Healthcare Environment (DHE), which provides an open infrastructure, capable of integrating heterogeneous applications.	Spyrou <i>et al.</i> , (2002)
Enterprise Resource Planning Systems	Initially, ERP systems were implemented in the healthcare organisations to solve its Y2K problems. Also these systems were deployed to manage the hospitals data and processes, and to provide an integrated infrastructure. Leading ERP vendors provide complete suite of applications dealing with the business processes of healthcare organisations. In many organisations, the adoption of packaged applications like ERP systems could not provide a flexible, manageable and maintainable integrated IT infrastructure.	Siau (2003) Grimson <i>et al.</i> , (2000)
Electronic Data Interchange	EDI technology has evolved as an electronic data carrier replacing paper documents. This refer to the computer-to-computer exchange of business documents electronically, between or within firms in a structured, machine-retrievable data format that permits data to be transferred without re-keying from a business application in one location to as application in another location EDI technology is being used in healthcare organisations internally for admissions, clinical and financial purpose, as well externally with other stakeholder such as suppliers and insurance providers.	Raghupathi and Josph (2002) Kaefer and Bendoly (2000)

Table 2: Description of Integration Approaches

#### 4 EVALUATING THE BENEFITS OF INTEGRATION APPROACHES

Evaluating the benefits that derived from the use of IT is considered a complex exercise (Irani and Love, 2001). In addition, Khalifa *et al.*, (2001) explains that in the benefits of IT no single evaluation method can be applied to all situations. The reason for this is that evaluation happens in a many ways (e.g. formally, informally), this uses several criteria such as financial, technical and social (Serafeimidis and Smithson, 2003). As a result, many authors such as Irani and Love (2001) have classify the benefits (e.g. Strategic, Tactical and Operational). Shang and Seddon (2002) proposed a model to classify the benefits (e.g. Operational, Managerial, Strategic, IT Infrastructure, Organisational). These benefits are derived from integrated IT infrastructure. Serafeimidis and Smithson (2003) have proposed models to evaluate the IT adoption benefits. The model proposed by Shang and Seddon (2002) can be used for classifying the benefits of integration technologies adopted in healthcare organisations. Shang and Seddon (2002) model is based on various case studies of ERP adoption in different organisations, one of the major case studies discussed by the authors is for healthcare organisation. Therefore, this gives the sufficient justification for the use of this model for classifying the benefits of integration technologies adopted in healthcare organisations. The adoption of integration standards, projects and systems in the healthcare area provides significant benefits to the healthcare organisations. Most of the integration efforts developed for healthcare organisations are based on the middleware technology (Spahni *et al.*, 1999). Middleware technology aims at reducing the impact of problems related to the development of complex applications within heterogeneous environment (Spahni *et al.*, 1999). From a technical perspective these efforts achieve the integration at data level and some of them at object level. From an organisations perspective, the close collaboration among the various health care originations improves the sharing of patients' clinical and medical data. Based on the literature surveyed, the authors have summarised the benefits of integration approaches adopted by healthcare organisations, which are presented in Table 3. In this classification the authors have identified the benefits of these approaches, which can provide support for management of a hospital to overcome the marketplace confusion regarding the adoption of integration approaches.

Dimension	Benefits	Reference
Operational	<ul style="list-style-type: none"> <li>• Reduce medical errors</li> <li>• Reduce operational cost</li> <li>• Reduce paper work processes</li> <li>• Reduce operational cost</li> </ul>	Ginneken (2002) Tsiknakis and Katehakis, (2002) Martinez and Redondo (2001) Philip and Pedersen (1997)
Managerial	<ul style="list-style-type: none"> <li>• Improve quality of patients' care</li> <li>• Improve work efficiency</li> <li>• Improve managerial control</li> </ul>	Ceusters <i>et al.</i> , (1997) Zhanjun <i>et al.</i> , (2003) Chwelos <i>et al.</i> , (1997)
Strategic	<ul style="list-style-type: none"> <li>• Increase patients' satisfaction</li> <li>• Increase collaboration among hospitals</li> <li>• Improve decision support</li> </ul>	Ferrara (1998a) Grimson <i>et al.</i> , (2000) Ginneken (2002)
IT Infrastructure	<ul style="list-style-type: none"> <li>• Reusability of objects</li> <li>• Achieve data integration</li> <li>• Integrate packaged applications</li> <li>• Reduce development risk</li> </ul>	Altmann <i>et al.</i> , (2002) Ferdinand and Syed (2000) Endsleff <i>et al.</i> , (2000) Martinez and Redondo (2001)
Organisational	<ul style="list-style-type: none"> <li>• Improve accessibility of data</li> <li>• Achieve effective clinical and administrative management</li> <li>• Reduce hospitalisation</li> <li>• Increase business efficiency</li> </ul>	Ginneken (2002) Zhanjun <i>et al.</i> , (2003) Ginneken (2002) Markus and Tanis (1999)

Table 3: Benefits of Integration Approaches Adopted in Healthcare

In Table 4 the analysis is made according to the scale used by Miles and Huberman which follows a low (○), medium (◐), high (●) scale of ranking and symbol (x) is used for ranking to show that there is no applicability.

Scale of ranking: Low (○), medium (◐), high (●) and (x) no applicability								
Integration Approaches								
Benefits	EDI	ERP	HL7	DICOM	COBR-AMED	SYNEX	SYNERGY	CEN/TC 251
<b>Operational</b>								
Reduce medical errors	○	○	◐	◐	◐	○	○	○
Reduce paper work processes	●	●	○	○	○	○	○	○
Reduce operational cost	●	○	◐	○	○	○	○	○
Reduction of personnel cost	●	●	◐	○	○	○	○	○
<b>Managerial</b>								
Improve quality of patients care	◐	○	◐	○	○	◐	◐	●
Improve work efficiency	◐	◐	○	◐	X	◐	○	◐
Improve managerial control	○	◐	○	X	X	○	○	○
<b>Strategic</b>								
Increase patients' satisfaction	○	○	◐	○	○	○	○	◐
Increase collaboration of hospitals	◐	○	◐	○	◐	●	●	●
Improve decision support	○	○	○	X	X	X	X	X
<b>IT Infrastructure</b>								
Reusability of objects	○	◐	X	X	●	X	X	X
Achieve data integration	●	●	●	●	●	◐	✓	●
Integrate packaged applications	○	◐	X	X	X	X	X	X
Reduce development risk	◐	◐	○	X	X	X	X	○
<b>Organisational</b>								
Reduce hospitalisation	○	○	◐	○	○	◐	◐	◐
Improve accessibility of data	◐			◐	◐	●	●	◐
Achieve effective clinical and administrative management	◐	◐	●	○	◐	◐	○	○
Increase business efficiency	●	●	◐	X	X	X	X	X

Table 4: Benefits Evaluation of Integration Approaches Adopted in Healthcare Organisations

## 5 CONCLUSIONS

The adoption of healthcare information systems at different level in healthcare organisations are developed in different computer languages, compiled on different platforms, execute on different hardware, and have different data structures, types and formats. These information systems were not developed in a coordinated way but evolved as autonomous and heterogeneous systems. Thus, in most of the cases these information systems functions independently and do not share their data. As a result, this raises the need for integration. Therefore, several integration approaches adopted in healthcare organisations to overcome the integration problem.

Due to these various integration approaches in marketplace there is a confusion regarding the adoption of these integration technologies in healthcare organizations. The authors have attempted to clarify this

confusion by classifying the benefits of these integration approaches adopted in healthcare organizations. The classification of the benefits is based on the model developed by Shang and Seddon (2002), which classify the benefits (e.g. Operational, Managerial, Strategic, IT Infrastructure, Organisational). The novelty claimed is that the analysis of benefits provides the better understanding to the management of the healthcare organisations, and contributed to the body of knowledge by clarifying the confusion regarding the adoption of integration technologies.

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