Patient Information System for National Health Care: An Intranet Internet-based Model for the State of Kuwait

By

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The candidate confirms that the work submitted is his own and that appropriate credit has been given where reference has been made to the work of others.

Dedication

This thesis is dedicated to my beloved parents for their love, support and encouragement throughout the years of my childhood, study and career, and to my wife and children, who offered me continuous and unconditional love and encouragement throughout this long-suffering journey, without which this thesis would be incomplete. I deeply regret that I can never repay them for their unfailing affection.

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Declarations

Some parts of the work presented in this thesis have been published in the following articles:

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ABSTRACT

This research seeks to introduce for the first time a conceptual solution to Kuwait's problems in healthcare delivery. The core objective of the study which is to promote and recommend the basis for the best possible patient information and national healthcare delivery system in the State of Kuwait. The research question is directed towards the appropriateness and usefulness of introducing the pay-per-use concept in the context of national (Kuwait) and global use.

The research introduces a new pay-per-use concept for IT services associated with Kuwait's healthcare delivery system within an environment that is investment, communication, technology, platform, database and application-independent. Being the first study on health informatics in Kuwait, the research also sheds light on the contemporary health industry and addresses issues that focus on health information management within the State of Kuwait.

The new paradigm for healthcare delivery is presented in such a way that both the potential practical benefits for national users (Kuwait) and the advantages that may be reaped by global users within the health industry are described. The required shift in the paradigm in Kuwait healthcare will take the form of cultural and social transformations, namely, changes in the doctor-patient relationship and in the increase of patient empowerment where health issues are concerned.

The research methodology uses a social process (Grounded Theory) to delineate a social context (clinical scenario) in order to understand the relationships between medical work and IT networks. Analysis of the data obtained from the clinical scenario and implications of human experiences within the social settings enable the interpretation and the development of a theory, and a model architecture, that can be used for pay-per-use.

The State of Kuwait has developed its medical facilities but it lacks the resources to meet the rising demands of the medical and IT worlds. It is argued that the proposed pay-per-use concept can prove feasible, adaptable and globally accessible with an infrastructure that is less burdensome on the national budget. Additionally, the conceptual 'open' architecture to be used with the concept, with its integrated and independent features, is anticipated to provide ample scope for future amendments and development within an evolving technological world. Thus protecting from technologically obsolescence.

The study concludes with proposed for further research work on the subject so as to enable additional evaluation and verification of results and thus fully establish the concept, prior to its potential implementation in the national and international healthcare delivery system.

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Chapter 1
Introduction

Information Technology (IT) in recent years has revolutionised man's living and thinking and the emergence of new information and communication technologies has facilitated better and easier living standards for the common man. Today, IT has pervaded almost every aspect of life, including the health information sector, which is the focus of this thesis. Several technologies have evolved and several have faded from use (Wyatt and Keen 2001). Efforts are still ongoing for a system that will prove to be generally appropriate and fully adequate, and thus can cater to the emerging needs of not only the healthcare delivery systems but also the IT world.

This chapter focuses on the importance of developing IT within healthcare, in the light of emerging problems and the challenges imposed by the electronic health record. The research question seeks a conceptual IT solution within the healthcare industry and also attempts to find the relevance of introducing a new concept within Kuwait's healthcare and also to identify its benefits for a country like Kuwait.

1.1 Healthcare Delivery and IT

National healthcare delivery in most countries has come under strong and growing pressures to implement major structural reform. While conditions vary in different countries, the challenges for reforms are remarkably common in most nations. They are challenges by externally generated demands from demography, technology and economy (Wolvaardt, 1998). National policy makers are in turn insisting that existing patterns of health services be modified to achieve higher levels of responsiveness, efficiency and effectiveness (Warner, 1998). Those responsible for the provision of healthcare believe that it is possible to enhance the quality of patient care and the cost-benefit balance by the effective introduction of IT, which will ultimately transform the traditional structure of healthcare provision (Sosa and Levett, 1995; Warner,1998).

Most hospitals have made considerable investments in computer systems, particularly for administration and finance operations. However, these investments have generally failed to benefit patient care greatly (Duncan, 1994; Murphy et al, 1999). The data often lack the required quality and standards and hence are of little benefit to those who use it in the 'share' concept. Data must be collected in a form that is useful for healthcare professionals and checked before use. It can be argued that the use of the electronic patient health record (EPHR) in a network setting will help to facilitate the flow of information and enhance the quality of care (Burns, 1998). However, these new patient care supporting systems differ fundamentally from traditional management support systems, as they have to be comprehensive, covering all areas of patient care and hospital activity, highly accurate, available for access in real time, and ensure shared access only by authorised users (Chin, 1998). Today, many systems are not linked, outmoded, non-flexible or difficult to use (Rogers and Reardon, 1999).

In recent years, two noticeable areas of growth in the computer industry as a whole have been the number of distributed applications being shared using multi-databases, which typically integrate information from pre-existing, heterogeneous local databases in a distributed environment and global users with transparent methods to use the total information in the system, and the rapid growth in the area of telecommunications.

With this new model (Kim, 1995) come new requirements, as distributed business applications must be able to operate in a heterogeneous environment, and to operate on different hardware and software platforms (Bernstein et al, 1996). Information technology offers a number of quite different approaches to the problem of data sharing. For example, the database community has engaged in extensive research into the development of inter-operable database systems (Grimson et al, 1998). They must also integrate old and new technology and make use of existing infrastructure. This technology supports best-of-breed inter-operability on a scalable three-tier client /server architecture that integrates and presents shared medical record information throughout an institution (Wallis, 1999).

1.2 Emerging Problems in Healthcare

The care of patients is increasingly being delivered by different care providers in different locations in the home, in general practice surgeries, in healthcare centres, acute hospitals and special centres. This leads to greater demands on the administration and management of patient-related information both within and between organisations (Lincoln and Essin, 1995). These demands have resulted in an increased emphasis on new IT to deliver timely, decentralised services in an efficient and cost-effective manner (Sambamurthy and Zmud, 1996).

The traditional method of transferring information about a patient is to use paper documents such as referral letters, discharge letters and, whilst in hospital, case notes that provide follow-up on patient details. As hospitals and other healthcare institutions have become computerised, patient data is captured in each department and the medical record is available at all times, anywhere within the unit (Frandji and Cooper, 1996). Unfortunately, there is still a gap when it comes to communicating between different healthcare institutions by paper, fax or over the telephone. From the health information system point of view, this is due to lack of communication functions and integrated databases (Kuma and Tsuchiya, 1995). These isolated systems need to be able to interconnect for inter-organisational communication. However, inter-connectivity guarantees only communication, not inter-operability (Nicol et al, 1993). This lack of inter-operability between existing hospital-based facilities, which has resulted from decades of purchasing of proprietary products, is now a well-recognised problem (Dogac et al, 1998). Based on their size and the investment they represent, current 'closed' in-hospital systems can only migrate slowly towards an 'open' systems architecture to achieve the ultimate goal of inter-operability.

Healthcare delivery is being decentralised from large hospitals into a range of areas including home and ambulatory care, as well as day care in doctors' surgeries, health centres and outpatient clinics. This fragmentation makes it difficult to fulfil the demand of the service: the patient expects a coherent service, and the professionals need sufficient relevant information about the patient's medical history. The healthcare professionals' aim is to deliver a high quality, cost-effective service, based on relevant knowledge and the latest information. The authorities require a high level of efficiency and established quality in treatment, care, and rehabilitation. By adopting an 'open system' standard approach the healthcare providers can empower all stakeholders to become partners in quality health delivery. However, healthcare organisations are about ten to fifteen years behind other organisations in the use of IT (Raghupathi and Tan, 1999).

People living in rural areas have limited access to basic healthcare. Efforts to encourage physicians to establish practices in rural areas have been only partly realised. Telemedicine holds great promise to enhance healthcare delivery in rural areas by allowing a physician to examine a patient while linked by a distant medical centre (Mitka, 1998; Nakajima and Chida, 2000). By eliminating distance as a factor in medical care, telemedicine has the potential to address some of the access, quality and cost problems facing public and private healthcare providers (Sosa-Ludiciss et al, 1997; Alger, 1998). However, issues related to information integrity and security need to be addressed carefully.

The increasing mobility of the population has necessitated accessibility of patient data on a national and even a global scale. Increasing mobility requires patients to be fully involved in their own healthcare management and to have a right to know what information is being gathered and who will be authorised to access that information (Mandle et al, 1998; Peifer et al, 1998). At the present time, the most suitable and easily accessible means of doing this may be argued considered to be via the World Wide Web, the popularity of which has increased dramatically in recent years (Slack, 1997, 1998, 2000).

Healthcare organisations faced with unprecedented pressure for quality services, and managed healthcare, are now exploring the opportunity of using IT to improve the quality while simultaneously reducing the cost of care. Computers carry an enormous amount of information for patient records and the vendor of each clinical system tends to use different internal data structures (Espinosa, 1998). On the other hand, each organisation tends to define its own unique and idiosyncratic codes for test and clinical observations (Stokes, 1995). So the lack of communication standards and formats is a major obstacle to electronic information exchange (Bernstein et al, 1996). This requires accurate, fast, and safe communication of information that will have a critical effect on cost reduction and service quality. However, personal health data could move across the network based on international standards that provide appropriate security for confidentiality and privacy protection (Scott, 1999;

Alexander, 2000). Two kinds of standards are particularly important: message standards which define the data structures of the records sent between individual systems (e.g. Health Level 7), and clinical codes standards which define 'disease' and have been developed or are under development internationally (Bentley and Robinson, 1999).

For healthcare organisations in this new environment, there is a need to shift to a new paradigm for the capture, dissemination and storage of patient information (Riley, 1995; Murphy et al, 1999). Within this new paradigm, the healthcare organisation is no longer the centre of the storage of patient information. The driving force is the patient, not the institution, who is now the centre of the healthcare delivery 'universe'. A key characteristic of patient-centred care is the active involvement of the patient in the care delivery process. The gradual but deliberate transition of health services from the hospital and clinic to the home and community creates an environment in which patients must independently assess and interpret symptoms, seek appropriate health services in a purposeful manner, and engage in health promotion, disease prevention, and illness management activities (Gustafson et al, 1999; Brennan et al, 2000; Slack, 2000). This change in emphasis requires the boundaries between information systems to be eliminated, and for patient information to be accessible at every delivery point within a healthcare organisation.

1.2.1 Challenges of Electronic Health Records

Information management, both administrative and clinical, is critical in today's healthcare environment. Physicians are challenged to increase productivity and simultaneously improve the quality and reduce the cost of the care they provide. Electronic Patient Health Records (EPHR), also known as Electronic Medical Records

(EMRs) and Computer-based Patient Records (CPR), are information tools ideally suited to help physicians meet these challenges (Dick et al, 1997; Yamazaki and Satomural, 2000). EPHRs supplement traditional paper-based medical records with computer-based functions for the acquisition, processing, display, and reporting of clinical and related administrative data. The overall prospect of storing health information in electronic form raises concerns about standards, patient privacy, confidentiality of data and security (Pronkin and Shifrin, 1999; Bourka et al, 2001). If the concerns are not sufficiently addressed, they can discourage healthcare organisations from exploiting IT, and the healthcare consumer will be hesitant to share information (Drucker, 1999).

Several major impediments remain as barriers to the full implementation of EPHRs. These impediments include the lack of standards that define complete infrastructure inter-operability among different healthcare information settings, lack of agreement on the data sets and code sets that make up the content and structure of the EPHR applications, lack of standards to ensure data quality and completeness in one operational integration architecture, and lack of national legislation in several countries to protect adequately the privacy of health records (Audit Commission 1995; Anderson, 1996; Rogers and Reardon, 1999). Even though these impediments have not been completely overcome on a local or national basis, the requirements of a mobile international society are already starting to recognise the need for a framework for a global EPHR (Waegemann, 1999).

Finally, healthcare delivery is not just restricted to local hospitals and doctors. Medical expertise is global and the patient can now be diagnosed and treated by a team of doctors distributed globally, yet all contributing collectively to patient healthcare delivery. This new healthcare delivery mechanism necessitates the global availability of the patient's health information (Murphy et al, 1999).

To serve the above-mentioned outline, a conceptual problem definition, focusing on the electronic patient health record (EPHR) as a major entity in the health delivery system, can be stated as the need to provide:

1. Access to patient health records anywhere with security.
2. A system architecture infrastructure that allows the authorities to incrementally implement healthcare systems for different medical, surgical and pharmaceutical disciplines and other operational areas of patient information.
3. A system architecture that allows the selection and deployment of the best available application software for the required medical discipline and that facilitates maintaining the patient health record information with security.
4. A system architecture and model that would allow 'application and platform independence' as well as data independence from the application that is used to record the patient health record.

1.3 Research Questions

The research question addressed by this thesis is *Can 'pay-per-use' allow easy national and international access to electronic patient health /medical records and is it an appropriate approach for healthcare in a country such as Kuwait?*

The above question address several concerns that have evolved from the emerging problems in healthcare and IT and seek conceptual solutions to them. The main issues raised in the research question are addressed in individual chapters. While the Chapters One to Three set the research background, literature review of the IT and healthcare, and the social context of using advanced technology within healthcare environment to tackle the research question, Chapter Four discusses the need for a conceptual solution for Kuwait in particular as a test bed to deploy the 'pay-per-use' concept; Chapter Five addresses a scenario building concept to allow tacit knowledge to drive the interpretation model for 'pay-per-use'; Chapters Six and Seven consider the appropriateness and accessibility of communication technology as a necessary requirement to deploy the concept using Internet-based architecture, and the social impact introduce as a result of new role in the doctor-patient relationship using Internet and network communication in this new healthcare paradigm.

1.4 Research Implications

To relate the implications of the research for a specific sector such as health, in the State of Kuwait, it is necessary to have a brief background and history of the development of healthcare and the emergence of IT in this particular country.

Kuwait is an oil-rich Arab country and ranks third in the Middle East in proven oil reserves (after Saudi Arabia and Iraq). This small nation has experienced rapid development since the oil boom and has established itself as a Welfare State, focusing on healthcare as one of the prime objectives in the national agenda. The country has a reputation for providing sophisticated medical care to all its citizens and residents free of charge at all government facilities. The period since independence 1961 has seen significant development in health services, with a developed, comprehensive and responsive health system well suited for its people. The growth of services was very rapid as the years passed. Increased demand for quantity and quality of health services and the high costs of implementing IT utilities have posed problems in the health sector with difficulties in providing sufficient local resources and experience with knowledge to invest in IT. Based on their empirical research, Khalfan et al (2001) pointed out that a shortage of IT skills in Kuwait, as an example of a developing country, has always been problematic (Khalfan and Gough, 2001). IT skills are an essential ingredient for IT diffusion and assimilation.

Kuwaiti medical services used to be recognised as the best in the Gulf. In 1995/96 KD270 million Kuwaiti Dinar (£540 million) was allocated to healthcare, the fourth largest allocation of any ministry (Kuwait Online, 2001). Prior to the Iraqi Invasion (02/08/1990), free medical services were rendered to all residents. However, the rising costs of medical services during the post-invasion period and the financial burden of reconstruction of Kuwait prompted the government to impose subsidised charges for health services and treatment, while according free medical care for Kuwaiti citizens. Every year the government of Kuwait is pressured with the task of providing medical healthcare to the increasing population, which now exceeds two million. Ever-expanding global technology imposes newer changes, especially in the medical arena in the modern world. The growing demand for quality of health services, its rising cost, tedious paper work at hospitals, and lack of easy and quick access to the latest modern medical services and amenities, and challenges to keep apace with the emerging developments around the world are all various factors that necessitate a newer and more efficient medical healthcare system for the country. Therefore, the aim of this research is to propose a concept that is to some extent considered feasible, adaptable, accessible, affordable, quality-oriented, investment and technology-independent due to the nature of the healthcare delivery service in the State.

1.5 Research Objectives

In view of the long-term goals and in the light of emerging technologies in the field of health informatics as we are going to see in the Chapters 4, 5, 6 and 7 , the following objectives are addressed:

- To propose a conceptual IT solution that is apt for Kuwait's healthcare.
- To set the basic framework wherein the concept could be applied.
- To identify and interpret a suitable model to suit the proposed concept.
- To demonstrate future implications (social and technical) of the new concept with reference to Kuwait's healthcare.

1.6 Research Justification

In the current rapidly moving technological environment, healthcare organisations that aspire to stay ahead of the technological curve are in need of cost-effective and powerful applications that can improve the cost of care and overall enterprise performance without requiring huge capital investments. To do that, the 'pay-per-use' concept is proposed for healthcare delivery. This concept, which will be of interest to most healthcare organisations, is similar to a rental contract, in which organisations access and pay for what they use within a time scale via the Internet architecture. This 'pay-per-use' facility can be accessed by users as and when required, to accomplish a given task. So it has several value-added benefits. First, healthcare organisations that access applications through 'pay-per-use' typically pay only for what they use, not for unused time. There are no costly software contracts to maintain, and upfront costs associated with large hardware and software deployments are reduced. Since 'pay-per-use' serves as the technical services department of an organisation, the need for experienced, expensive technical staff to deal with installing, operating and maintaining applications is diminished significantly. Administrative processes also present opportunities to use this concept for the benefit of the healthcare institution.

The healthcare sector in almost all countries, including the most highly developed, is going through a period of restructuring. In countries where health was seen as a right for all, to be supplied or guaranteed by governments, declining budgets and mounting costs have forced reduction in government support coverage and opened up more scope to the private role (from 'free-of-service' to 'fee-for-service'). On the other hand, healthcare providers around the world are facing more potential changes over the next few years than they have ever faced before. New combinations of practitioners, institutions, and patients will have to share data in real time, not just sporadically, so that duplication is minimised and resource utilisation is optimised (Kilbridge and Conklin, 1998). With the evolution of distributed computer technology, paced by the rapid adoption of web technology, the need for developing a healthcare information system for a country with a small population like the State of Kuwait becomes more expensive and not feasible due to the lack of expertise. An infrastructure architecture with the 'pay-per-use' concept will suit health institutions that face a shortage of skilled people for developing their IT systems and which seeks to control its expenditure to a reasonable extent.

The motivation of this research is the optimism that the 'pay-per-use' concept can provide an effective solution to growing problems in healthcare and IT, due its adaptive feature in a fast evolving world of technology. Further, the concept provides a realistic link to an actual life scenario in the context of a small country with a small population, such as the State of Kuwait. Grounded in a realistic approach and focusing on minimal costs and effective use, it is believed that the concept will be of benefit and value in the future. However, not all healthcare disciplines can be addressed in deploying the 'pay-per-use' concept prior to cost benefit analysis. On the other hand, the ICT service provider (original vender not third party) may not comply with the required customisation rule for some disciplines (in case healthcare providers are to use Internet to access electronic patient health records when treating patients in the emergency room, individuals' health and lives are at stake, requires that information not to be corrupted before, during or after transmission across network and that networks and applications are operational 24 hours, 7 days a week).

1.7 Scope and Future of IT in Health Industry

The Internet has great potential to enhance people's health by enhancing communications and improving access to information for care providers, patients, health plan administrators, public health officials, biomedical researchers, and other health professionals (Klemencic and Todorovski, 1999; Roberts, 1999). Ongoing research and development (R&D) efforts, such as university hospitals and other health organisations, could aid the recognition of that potential. Such efforts support the establishment and deployment of new networking technologies to improve the Internet's capabilities, enabling a rising range of applications in healthcare and other sectors (Hollingsworth et al, 1999; Rotonen et al, 1999).

But what technical capabilities do healthcare applications demand of the Internet? How do these capabilities differ from those required by applications in other sectors, such as banking, airline reservation, defence, and entertainment? Since the capabilities required in networks are intertwined with other technical, organisational, and policy considerations (Glaser and Hsu, 1999), efforts are also required to overcome organisational and policy barriers to embracing the current technology of the Internet and Internet-based applications.

At present, healthcare institutions are ill prepared to deploy such applications because they need information upon which to support investment decisions, face a vague financial environment, and have difficulty attracting the talent essential to design, develop, and implement such applications. A number of public policy concerns dealing with patient privacy to the lack of payment mechanisms for some medical consultations delivered remotely also stand in the way of full deployment of Internet applications (Barber, 1995; Rind et al, 1997; Banahan and Buckovich, 2000). All of these concerns need to be tackled if healthcare institutions are to seize the benefit of the capabilities offered by an enhanced Internet (Kohane et al, 1996; Lasker, 1998).

With the IT revolution taking place in healthcare institutions, exponential growth is expected in the use of electronic patient health records (Chin, 1998; Reuters, 1999) and integrated hospital information systems (Raghupathi, 1997; Raghupathi and Tan, 1999). Intranets for sharing information among key stakeholders (McCormack, 1997, 2000), and the use of public networks such as the Internet for distributing health-related information and for providing remote diagnoses and therapy (Girishankar, 1996; Resnick, 1997) have a social impact on the patient. As the Internet becomes more ubiquitous and Web-enabled, access to electronic patient health records is becoming more commonplace by using these technologies (Nash, 1999). Even so, these Web-enabled patient health records still remain technologically isolated from other health records in the distributed continuum of care; much of the standardisation challenge still stands before us (Toyoda, 1998).

The emergence of the Internet / Intranet / Extranet as preferred communication vehicles makes it possible for healthcare providers to access laboratory results and X-ray and medical records via the World Wide Web (Deluca, 2000; Deluca and Enmark, 2001). However, solutions to the problems of security, integrity, legality and ethical issues could become critical barriers to realising the objective of the global provision of healthcare delivery system (Rind et al, 1997; Rogers and Reardon, 1999; Deluca, 2000).

Finally, a new paradigm is emerging around the world. This paradigm relies on an analysis of healthcare delivery as a process, fully integrated around the patient, rather than a set of disparate models that view healthcare automation in terms of buying entities focusing on bills, specimens, films, or prescriptions (Van Bemmel et al, 2000). The new generation of systems now emerging gives the health institution an opportunity to move directly to patient-centric, open systems (Masys and Baker, 1997; 1998), inter-operability, and co-operability (Keener, 1999).

1.8 Organisation of Thesis

This overall organisation thesis is depicted in Figure 1.1 at the end of this section. The thesis consists of eight chapters that are organised as follows:

Chapter 1: Introduction, provides the context for the study. It highlights prevailing problems and IT challenges in national healthcare systems world-wide. It presents the research question, the major objectives and motivates the introduction of the 'pay-per-use' concept as a relevant IT solution for healthcare information problems so that the healthcare institution will focus on its core business. The benefits of the concept are expected to influence the State of Kuwait. The chapter concludes on an optimistic note on the future of healthcare and IT.

Chapter 2: Literature Review: Technology Revolution and Healthcare Industry probes relevant literature to trace the development and evolution of information and communication technologies in relation to their impact on healthcare delivery systems. The chapter presents the standard guidelines that can enable effective use of technology within networks. It surveys the complex nature and performance of contemporary electronic patient records that pose challenges to modern health organisations, and dwells in detail on the technical solutions that modern technologies can offer for the future of IT in healthcare.

Chapter 3: Research Methodology: Social Process in Medical and IT Network surveys the significance of the social element and IT within healthcare, while establishing the Grounded Theory approach that is used in the research to help explicate the link between healthcare and IT. It focuses on human (social) behaviour in a typical medical scenario that enables the understanding and development of concepts and categories and the interpretation of a meaningful theory. Hence, it describes and represents the evolution of a new paradigm for healthcare and an information architecture model for the future.

Chapter 4: Healthcare In Kuwait provides an understanding of the historical setup of the country, the governing policies, regulations and legislations on healthcare delivery. The chapter presents the supporting stance of the government and the nature of the healthcare organisation in the country, which are conducive to progress and introduction of newer IT concepts and technology for better healthcare delivery in the future. To seek the appropriateness of pay-per-use for Kuwait, it is necessary to have a background of the country and hence this chapter.

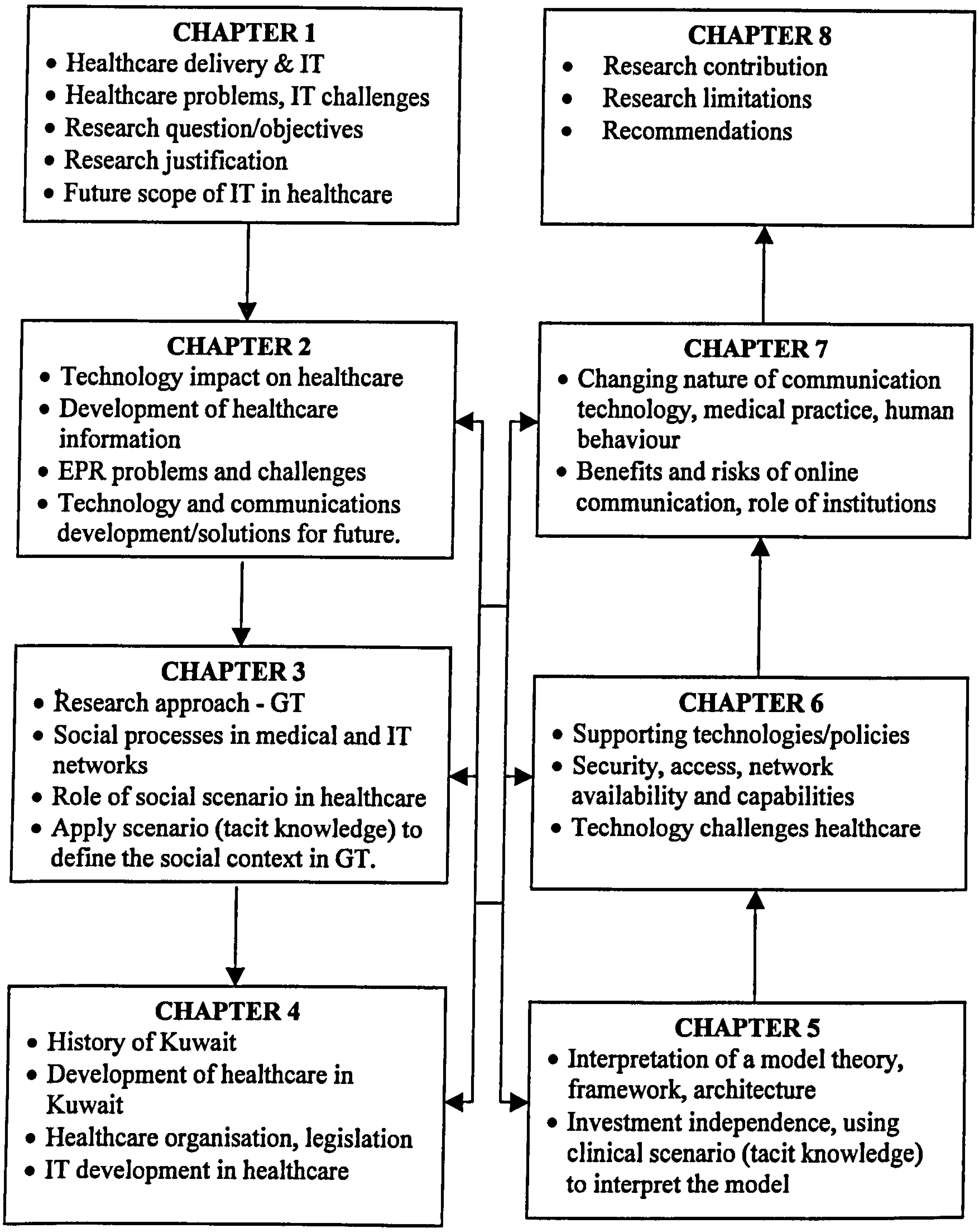
Chapter 5: Interpretation of a Model. In keeping with the research design in Chapter Three, this chapter describes the integrated model architecture for implementing the 'pay-per-use' concept. It presents a model theory that enables global accessibility of information due to the independent nature of its operation, delineates a model framework that efficiently revolves around the patient health record and related information, recommends a model architecture that advocates an 'open' and integrated system, and finally, suggests model standards that establish uniformity of operation, information storage and global usage.

Chapter 6: Network & Communication Technologies in Healthcare addresses the qualitative side of the supporting technologies and policies that can enable implementation of the pay-per-use concept. Emphasis on the choice of quality technology is made because of the need to use the best of breed within pay-per-use in an ever evolving IT environment. The great challenge for healthcare in modern times is to keep up with the quality of technology in healthcare, an essential concern raised in the research question and for the successful functioning of pay-per-use.

Chapter 7: A New Paradigm in Healthcare refers to the modern changes that have been undergone in the concept and delivery in healthcare and also in communications technology. Just as Grounded Theory emphasises human relations, behaviour and interactions, similarly, communications technology can be complete only when the target on the receiving line is reached, that is, when the goods are delivered to the beneficiaries, human beings. In recent times, tremendous changes have been observed in the thinking, behaviour and demands of healthcare delivery beneficiaries. Such changes have implicated the need for further changes in a fast evolving technological and modern world. This chapter also dwells on the pros and cons of online communication technology in healthcare and discusses the role of healthcare providers (also with reference to Kuwait) in working towards the development of healthcare delivery for the benefit of the people.

Chapter 8: Conclusion and Future Work summarises discussions maintained so far and provides the contributions and limitations of the research as well as some useful recommendations for future work.

Figure 1.1: Research Organisation & Linkages



Chapter 2
Technology Revolution & Healthcare Industry: A Literature Review

2.1 Introduction

Healthcare institutions world-wide have undergone major adjustments to meet the demands for enhanced health services, accessibility and quality, as well as lowered cost (Bazzoli et al, 2000). One of the most important means to accomplish this goal is by improving the effectiveness and efficiency of the patient information system for national healthcare, using the patient health record as a major entity. A healthcare record should ideally be a repository of data, describing an individual's health and how it is being supported; and not just a descriptive piece of information about an individual's diseases and treatment alone (Dick et al, 1997).

This chapter focuses, through literature survey, on the technology reforms that have taken place in the healthcare industry. Reform has taken place not only in the concepts of network and communication technology and paved the way for improved future systems in global accessibility, but also in the medical organisational structure, services and health information. The chapter further discusses the argument that standardised procedures will enhance the future prospects for an 'open' electronic patient healthcare information system using the Internet / Intranet architecture, object, Java, and XML technology (Murphy et al 1999).

2.2 Impact of Technology on Healthcare

2.2.1 Organisational Reforms

In an endeavour to respond to the market's desire for more efficient delivery of service, the healthcare industry is undergoing drastic reconstruction. Mainly large health institutions have tried 'vertical' integration of their IT first, between affiliated hospitals and medical offices/ health centres (Griffith, 1996). This supports the key function of a hospital, it is efficient, reliable and provides a coherent information system where integrity is secured. However, it requires very expensive hardware and it ties a hospital to a single supplier, thus placing the hospital in a weak position when dealing with this supplier over subsequent years. (Mousin, 1999; Friedman et al, 2001). This type of system is quite massive and is difficult to customise to a particular situation, the precise needs of a group of users, and to evolve with time, and change with techniques and practice. As a result the value in terms of money is often poor (Frandji, 1997).

In the 1980s, another approach was tried, called 'horizontal' integration, among associated hospitals, clinics, and community health and welfare support groups (Griffith, 1996; Grobman, 1997). A lot of departmental systems were formed for supporting the needs of groups of users. Such systems are cheap to start with, they are customised for specific user groups, they evolve easily, and they do not tie a hospital to a single supplier (Mousin, 1999; Keil, 2000). However, these departmental systems typically cannot communicate with others, and the cost of integrated systems based on such an approach has proven to be even more expensive than with the vertical approach. The value for money is a little better, but still poor (Frandji, 1997).

As a result, many moves into using computers, involving significant investments, have been through different and separate methods of tackling the same problem, with relatively high risk and no common strategy (Friedman, 2001). At the beginning of the 1990s, some advanced groups had attempted a distributed approach, enabled by a distribution platforms providing location transparency both for services and data. These groups filtered their existing departmental systems according to the new architecture, thereby supporting the various user requirements, in an integrated system, easy to evolve and able to deal with heterogeneous hardware and operating systems (McNamara, 2000).

However, such an architecture is artificial, based on existing systems, and not derived from user desires, with potential conflicts, redundancies of data and services, and the system remains proprietary and ties the user with suppliers (Friedman, 2001). Many healthcare institutions that worked in isolation could afford to build their own integrated system, however they often have no migration path from their existing situation and legacy system towards a future (Friedman, 2001).

Integrated Delivery Networks (IDNs) started to emerge consistently throughout healthcare institutions in the early 1990s. There is still no unanimous definition of an IDN, but it can be generally described as a collection of healthcare institutions that have merged, aligned, or affiliated in order to deliver broader clinical services at lower cost (Lohman, 1999; Friedman 2001). Precisely, we can define it by breaking down the term. 'Integrated' suggests a harmonious whole greater than the sum of its parts, which is based on the conventional thinking about profit centres or revenue makers. 'Delivery' focuses on the end user, who can be a patient or a healthcare professional.

Delivery of care is no longer dispensed simply to those who show up at the door; care must be proactively delivered along the continuum in a harmonised and integrated manner, focusing aggressively on wellness and prevention. 'Network' refers to the array of services that make the healthcare continuum complete (Widmer and Hovhanesian, 1999).

Historically, acute care settings were integrated locations in which many types of care, therapies, and administrative responsibilities were coordinated for the patient within a single incidence of care. The patient's clinical history (including the medical history, physical examination, types of therapy practised, and progress notes) had always been accessible within a single institution. Administrative tasks ensured that the patient was registered, was given a healthcare record number, and the needed information was retrieved when required. Internal processes, developed over the years, guaranteed the communication of relevant clinical information. Rounds, notes, and discharge summaries were all developed with the intention of 'communicating' the status of the patient to the appropriate healthcare professionals (Coddington et al, 2001).

IDN is similar to the acute care settings of the past, in that care is conveyed across a variety of settings. However, IDNs incorporate vertical and horizontal integration (Bartling, 1995). The new delivery models extend and spread out beyond the episode of care into the entire continuum of care, and they necessitate coordination and integration among all components of the IDN (may include homecare, long-term, and other welfare services). At the same time, redundant services and functions must be consolidated and streamlined to gain efficiencies. An IDN must transform itself from simply a group of healthcare professionals, by making major changes to operational, structural, clinical, and informational levels among the healthcare professionals who focus on providing coherent patient care (Bazzoli and Shortell, 1999). The new delivery model forces the healthcare institution to offer sufficient healthcare services under a single umbrella, and consolidate and manage those services. If this developing delivery model is to thrive, then people, processes, services, and long-established routines must dramatically change. (Keil, 2000; Burns et al, 2001).

Turning to the practice of healthcare today, it is clear that there is a change being experienced throughout the world. The provision of healthcare to the individual patient is no longer the sole responsibility of a single health professional, but rather is shifting to a team-based, or shared-care approach. Rienhoff (2000, p. 14) argues the definition of the two terms,

> "The term 'managed care' is not used so much in Europe; we use 'shared care'. This is due to the fact that Europe's political and social background differs from that of the United States of America. Since managed care sounds a bit too commercial to us, we rather talk about shared care".

Under shared-care (the term favoured in the present research), the patient's healthcare is directed by a group of health professionals representing all sectors, including primary, secondary, and tertiary levels, all collaborating together. Such seamless healthcare depends crucially on the ability to 'share information' efficiently between healthcare professionals within and between healthcare institutions (Blobed and Holena, 1997).

Essentially, what is required is that everyone concerned in the provision of healthcare to an individual patient has access to all relevant information about that patient's health records (Mousin, 1999; McNamara, 2000; Bacus and Zunke, 2001). To be successful, integrated delivery networks (IDN) require streamlined information integration across the continuum of care. Having this capability enables IDNs to administer care and costs efficiently, provide physicians with enterprise-wide access to information, and respond to the communication and quality demands of patients (Lohman, 1999; Coile, 2000). For most IDNs, the swiftest and most cost-effective way to achieve overall information system integration is to implement a health information network (HIN) based on Internet technologies (Dick et al, 1997). HIN enables IDN healthcare professionals and administrative staff to access requisite administrative and clinical information from every healthcare institution using a Web-enabled browser (McNamara, 2000).

Finally, achieving long-term success will not be easy for integrated systems, even for the best known systems. The leaders of these systems are concerned about positioning their heathcare institutions for a future increasingly dominated by the patient's needs and technology (IT, the Internet, medical advances, application of the results of genetic research, and new drugs, etc.) (Dick et al, 1997; Friedman et al, 2001).

2.2.2 Transformation in Medical Services

The 20th century was distinguished by a revolution in the provision of healthcare services. Advances in medical science and management have created an exclusively new system of healthcare. People are not cared for by a single general practitioner any longer. Instead, it is increasingly a collective process that includes nurses, a variety of specialist medical practitioners, laboratory technicians, diagnostic technologists and administrative staff. Moreover, people are no longer treated by one healthcare centre(Burns, 1998). For example, a person can be admitted to one facility, transferred to another for treatment, and then offered extended care in the community or at home. In these circumstances, it is necessary to be able to identify patients carefully across multiple care settings, and to collect relevant information on them from multiple sources in order to provide continuity of care (Burns, 1998; Lohman, 1999; Savage and Roboski, 2001).

Furthermore, healthcare professionals increasingly perform a wide variety of responsibilities, including rapidly changing combinations of 'hands-on' care, inductive and diagnostic thinking, detailed record keeping, patient education, and communication with colleagues. Although 'high-tech' equipment is increasingly common in clinical practice, automated information systems are not so. Thus, computers are not yet as practical, ubiquitous, and handy as the stethoscope and other common medical technologies. In addition, medical practice is extraordinarily complex and can change rapidly (Bucci, 1997). Systematising even the process of performing medical procedures is therefore a massive challenge (Donaldson, 1996; Lock, 1996;).

Moreover, there is a genuine explosion of individuals in search of medical information from sources other than their general practitioner. This is a sign of the information society in which individuals routinely look for information to address issues in their daily lives (CSTB, 1995). More generally, information and communication technologies are significantly transforming many aspects of economic and social life, such as working methods and relations, structure of healthcare institutions, the focus of training and education, and the way people communicate with each other (Nauenberg et al, 1999). They are resulting in major gains in productivity in industry, and in the quality and performance of services. A new 'information society' is emerging, in which management, quality and speed of information are key factors for competitiveness as an input to industry as a whole and as a service provided to individuals. Information and communication technologies (ICT) influence the economy at all stages (CSTB, 1999). The health sector is not, and will not in the future, be immune from such trends (Coiera, 1998; Department of Health, 2001).

2.3 Development of Healthcare Information

Healthcare information systems, like most other large computer applications, were dependent for many years on the capabilities of powerful mainframe computers (Audit Commission, 1995). Users gained access to information stored in the large databases of a central computer by means of slow text-based terminals. Although the central computer was relatively powerful, it had to perform many tasks, so that its performance in responding to a user's application for a patient's admission records, for example, would be slow if it were occupied with other calculation-intensive queries. As the speed and capabilities of desktop computers and networks increased, the centralised, hierarchical structure related with mainframe computers was gradually replaced with distributed computing using the client-server architecture (Dogac et al, 1998).

Under this approach, many tasks previously performed by a monolithic central computer were scattered among a series of programs running on a set of smaller computers, or servers. Each server handled a specific mission, according to requests made by other programs, or clients, on the network. Typically, users interacted with client programs running on desktop computers with relatively complicated graphics capabilities (Dogac et al, 1999).

A client program for scheduling surgery, for example, would issue requests for information to servers throughout a hospital. The client program assembled the necessary information from the various sources and displayed it to the user in a way that the user required. The data and the computational resources of the information system were distributed right the way through the institution rather than being localised in a central computer. In these circumstances, failure of any one computer would not bring down the whole system. In addition, if one server came under intense use, some of the load would be passed to another, less busy server (Michel et al, 1997).

Another advantage for a client-server network was that storage and computing capacity could be added incrementally. Thus client-server computing replaced large, central computers with interacting networks of servers, each accomplishing precise tasks and communicating with standardised messages. These technologies were widely used for collecting, storing, protecting, and communicating data throughout most of the world (Dudeck, 1997; Raghupathi and Tan, 1999).

In the healthcare sector, however, its application was restricted to scattered islands of automation - often limited to discrete departments within major teaching hospitals, for example (Healthfield et al, 1998). Computers were broadly deployed in parts of the health sector, but were not widely connected by means of any kind of network. The consequence was that the health sector was lagging badly behind other aspects of the economy in its use of computers and online technologies. Compared to, say, the financial sector, health was largely trapped in a world of the pen, paper and post when it came to health records (Ferrara, 1997).

Information technologies started to have profound impact on a variety of business and social applications. These technologies both enhanced the quality and lowered the costs of business processes. Healthcare was no different in this respect. As an example, the increased mobility of the patient populations and changes in healthcare professionals (hospitals, clinics and doctors' offices) resulted in a patient's medical information being collected in a variety of locations with little or no association between them (Ohly, 1995; Armoni, 2000).

Because of these multiple points of entry of patient information into the healthcare system, the healthcare professional got a fragmented picture of the health history of a patient, particularly in the case of chronic illness, such as diabetes. This fragmented view could occur over a regional network of clinics as well as over the entire country. This requirement for multiple entry points into the healthcare system can be described as 'distributed healthcare' (Dogac et al, 1998). In addition to the trend towards distributed healthcare, there was a quick movement to computerise patient records within hospitals, clinics, and even over CHIN's (Community Health Information Networks) (Chin, 1998) However, even electronic access over a region might not be sufficient to follow a significant number of patients as job mobility increased. This increasingly broad diffusion of the population required patient data to be accessible in an organised manner on a national and even global scale, independent of the healthcare professional or payer (Murphy et al, 1999; Armoni, 2000).

What healthcare institutions want (for example, see Dick et al, 1997) are clear healthcare information systems strategies, with a clear migration path to the future. They require to open up 'closed' information systems, to protect their investment in information systems, to concentrate focus on the patient, and on clinical work across a multi-health institution environment (Murphy et al, 1999). To deal with this IT explosion, there are a number of organisations working to standardise healthcare information and communication, including the CEN (European Committee for Standardization), UN/EDIFACT (United Nations Rules for Electronic Data Interchange For Administration, Commerce and Transport), JWG-CDM (Joint Working Group for a Common Data Model), the Health Level 7 (HL7) group, the CPRI (Computerized Patient Record Institute), and recently, the Object Management Group (OMG) (Schulte and Lordieck, 1997; Grimson et al,2001).

Certainly, IT possesses a unique and indisputable capacity for enabling the transformation of healthcare delivery. However, knowing how to apply the right technology at the right time in the right way is challenging (Gibbs, 1997; Borowitz and Wyatt, 1998). The tangle of technologies, buzzwords, vendor claims, and vendor failures makes the use of IT complicated and annoying (Beynon-Davies and Lloyd-Williams 1999). To make matters worse, organisations simply do not have the time to linger over difficult IT decisions. As the stakes go up, so does the need for investment of dollars and time (Keen and Wyatt, 2000). Moreover, information and communication technologies have a tendency to flatten healthcare institutions and may not mesh well with the rigidly defined job roles and hierarchical structure of current medical practice (Dick et al, 1997; Armoni, 2000).

Historically, healthcare institutions have sidestepped this problem; through avoidance, they have not been able to grasp how IT contributes to the end product and have not relied on IT to help transform and manage the healthcare services, as have other sectors (Burns, 1998). Many types of organisational changes will materialise throughout the healthcare system if information technologies are broadly adopted. In other industries, for example, changes associated with the introduction of information technologies have included large reductions in the demand for some types of workers (e.g. mid-level managers and bank tellers), increased responsibilities for workers in jobs that traditionally involved little decision-making (e.g. line workers in manufacturing industries), and an increase in competition for local experts from non-local sources. Similar changes are likely to take place for health professionals, along with a redistribution of status, responsibilities, and remuneration associated with the various health disciplines (Weed, 1997; Muir, 1998).

On the other hand, deploying information and communication technologies also facilitates alliances between geographically disconnected parties (e.g. Tele-health), and can be expected to not only redefine jobs but to exercise more subtle influences as well (Kidd and Purves, 1998). Also, the widespread adoption of integrated information systems will challenge the legal system (e.g. who 'owns' an electronic health record - and is possession still a relevant concept when the record may be constructed from the contributions of various care providers, and may not in fact even 'exist' in its entirety at any one location) (Murphy et al, 1999). Nevertheless, if past trends continue and the experience of other sectors of the economy is any guide, there will be an increasing imperative for all aspects of healthcare documentation and clinical communication among healthcare professionals to be maintained by electronic means (Godlee, 2000).

Therefore, the impact on the healthcare industry of making healthcare information accessible over wide areas in a secure manner will be quite profound (CSTB, 2001). Such accessibility could potentially allow for 'data mining' of information. This information could then be used to discover and analyse associations between disease entities and previously unknown risk factors (recorded in the patient history), to test hypotheses regarding putative risk factors, or to study disease distribution using demographic data (Lloyd, 2001). Applications of 'data mining' could also include enabling a physician to do a comparative analysis of a particular patient's symptoms with the symptoms of other patients with similar or different diseases (Murphy et al, 1999).

Furthermore, having wide area access to healthcare information would allow for more intelligent video consultations. During these consultations, along with the video, specialists in multiple locations could simultaneously see and annotate a patient's record. Healthcare institutions could do a better job of outcome analysis, physicians would have access to better decision support information, and patients could be better educated to manage their health (Armoni, 2000; Wong et al, 2000). All of these applications require advanced pattern matching techniques beyond simple database searches. Thus the management of information, produced across the continuum of care, and associated information system functionality, cannot be provided by data interchange to and from a monolithic application. A user-friendly web browser enables users who do not need to be a computer expert to access this information, to retrieve various types of information, including text, pictures, graphical displays of findings, and in some cases even audio and video clips, regardless of their setting (Anderson and Colin, 2000; Murphy et al, 1999).

However, information and communication technologies tend to be expensive to implement and their benefits may be hard to measure directly, even when all parties are happy with the results (Westberg and Miller, 1999). This may delay their deployment in an industry whose complicated technological base is seen by some to be a driving force in making healthcare more expensive and requires a huge investment in the network infrastructure. The inability to demonstrate return on investment, the cost of IT, and rapid obsolescence of technology present very difficult obstacles to the new delivery model (CSTB, 2000).

The major restructuring and adjustments which healthcare institutions worldwide have undergone in recent years have been to meet the increasing demands for improved healthcare access and quality, as well as lowered cost. In addition, the uses of IT to process medical data continue to expand, and much of the critical information necessary to meet this challenge is being stored digitally in a variety of formats, often at multiple locations. As a result, open network architecture to support data access and integration from a multitude of internal and external sources has become crucial. A major trend in healthcare computing involves the use of Web-enabled information technologies to address the complex information-processing requirements, such as access to electronic patient health records globally, that are emerging in this transforming industry (Chin, !998; CSTB, 1997).

Recent years have seen an explosive growth in the number of network users and the development of multiple physical networks composing the Internet. It is clear that the Internet is becoming entrenched as a common business tool, with a focus on attracting consumers to use the network (CSTB, 1994; Coile, 2000). An integrated network supporting electronic health records can be expected to break down the organisational barriers that tend to grow between care providers, medical researchers, and health administrators. The Health Information Network (HIN) is the construction of what is commonly called a virtual private network, an Internet-based network with in-built security measures to protect privacy and thus overcome the otherwise insecure nature of communications over the Internet. Without such security features, users will not accept HIN, and no virtual private network will be used unless users are comfortable with it. Despite the incorporation of high technology into almost every other aspect of clinical practice, information technologies have not, so far, been fully embraced by the health sector (Murphy et al, 1999; CSTB, 2000, Deluca 2000a).

2.4 Standard Guidelines for Technology Usage Across Networks

Increase in network handling in recent years has called for standardisation in technology usage across networks. The need for standardisation has become obligatory. Strict adherence to certain guidelines by all users is necessary to ensure security of information as well as effective use of available technology (as will also be seen in Chapter Six which discusses on extended conceptual solution for deploying the 'pay-per-use' concept within an 'investment independence' strategy for networks and communication).

2.4.1 Authentication

Authentication guarantees the identity of all communicating parties. Without well-built authentication procedures in place, network access may be effectively insecure, allowing an intruder to access private information stored on the network.

Having to authenticate one's identity has become a routine activity in daily life and certificates of various kinds are a way of doing this. Thus a birth certificate is valid for a lifetime, and a driver's licence can be used for authentication as well as for its main intention. Yet any certificate has its restrictions: certificates expire and have to be renewed; and there is always the issue of the validity of any certificate. Mechanisms for verifying the validity of a certificate are essential. In the electronic world, authentication is regularly based on passwords (shared secrets) or 'digital certificates'. Password authentication is the most widespread form of user authentication employed in computer systems today, but it is also one of the weakest because passwords can be guessed or stolen (Chadwick et al, 2000).

Digital certificates are also becoming more prevalent as an authentication mechanism for virtual private networks (VPN) and many more applications. A digital certificate is an electronic document that is issued to an individual by a 'Certificate Authority' that can vouch for an individual's identity. It fundamentally ties the identity of an individual to a public key. A digital certificate will contain a public key, information particular to the user (name, organisation, etc.), information precise to the issuer, a validity period, and additional management information. This information will be used to establish a message digest, which is encrypted with the Certificate Authority's private key to 'sign' the certificate. The digital signature guarantees that the message came from the reputed sender and that the message content, encrypted or in plain text, has not been distorted during network transmission (CSTB, 1997b; CSTB, 2000). Authentication typically take places when a user first logs onto the network. Once accepted as a legitimate user, frequent authentication during the course of a logged session may be enforced to verify that the user continues to be the same as originally authenticated. Additional authentication may also be required if a user requests access to increasingly sensitive information. The most significant aspect of authentication certificates is that they are issued by a trusted authority - usually a third party trusted by both issuer and user (Keen, 1998).

2.4.2 Authorisation

The dissimilarity between authentication and authorisation can be ambiguous. Authorisation is generally the next step after the authentication procedure is complete (or the first step, if authentication is not required). For example, if doctors were not required to authenticate themselves in order to access to certain information, the authorisation process would merely establish entitlement to access to that part of the network where freely available information is held (CSTB, 1997b).

Authorisation is typically accomplished by associating users with lists of access rights. Access rights grant or deny healthcare professionals permission to read, write, delete, modify or create information held on various parts of a healthcare network. Because access rights can be granted or revoked by an appropriate authority, coordinating and maintaining them can consume a lot of network administrator time (CSTB, 1997b).

If restrictions are inadequate, confidentiality, security, and privacy are jeopardised. If restrictions are too severe, not everyone can access the information they need to perform their responsibilities effectively. In the case of very sensitive information, even a particular field in a record (or the entire record) might be accessible only to users with the highest levels of authority (CSTB, 1997b; CSTB, 2001).

2.4.3 Quality-of-Service

The need for quality-of-service (QOS) is based upon design characteristics of networks, whereby resources are normally shared and surrounded by many users who are running applications simultaneously. Network engineers employ this term to refer to the ability of a network to offer a range of assured levels of performance. Performance is considered by metrics such as the bandwidth obtained between two points in the network (CSTB 2000). Thus, the network must have sufficient bandwidth for the application and deliver information across the network with minimal (or at least acceptable) delay. Bandwidth and delay can vary from network to network (and within a single network as the volume of traffic varies); however, if bandwidth for the application is insufficient or if users must wait too long for information, then the application will not run effectively on that network (CSTB, 2000).

The critical factors are therefore bandwidth and delay. Other quality-of-service parameters can be added to improve the network, but there is discrepancy of view on the next most important attributes. For example, as applications increasingly feature voice and image/video support aspects like stable delays, reliability and information loss become important - since stable delays avoid distortion of audio and video sequences, reliability indicates network availability, and the likelihood of breakdown and information loss reflects the percentage of bits sent across a network that fail to arrive at the destination (because of errors or dropped packets on the network) (CSTB 2000).

Security is another quality-of-service feature that is critical for virtual private networks, comprising network privacy and authentication (in addition to creating and adding counter-hacker devices). Thus the quality-of-service parameters that are needed for trusted networks can be categorised as:

- Essential - adequate bandwidth, minimal delay;
- Highly desirable - stable delays, reliability and integrity of information.

2.4.4 Bandwidth Considerations

There is a pervasive recognition that the market conditions for bandwidth are likely to be a key factor of production for the emerging information economy (Kidd, 1998, CSTB 2002). The bandwidth requirements of data network applications vary significantly, from a few bits per second for text-only e-mail messages to megabits per second (Mbps) for complex graphics file transfers such as X-ray. Many data network applications (and many new voice or video applications) are 'burst' in nature, producing different numbers of bits per second, and may be able to work for long stretches without transferring any bits between origin and destination - a further complication. However, it should be noted that bandwidth alone can not address the quality-of-service requirements of all network applications today (CSTB 2000).

2.4.5 Privacy and Security

Virtual private networks permit electronic transactions with at least some measure of privacy and security. But there will always be some risks to privacy and security on networks, whatever measures are considered. The key is to integrate sufficient measures so as to offer a level of privacy and security that people recognise as appropriate under the circumstances. What is measured as appropriate and acceptable in the circumstances may change over time. Adding privacy and security to a public network such as the Internet will usually entail making hardware and software modifications in order to achieve the added level of security. (CSTB, 1997b; Epstein et al, 1998).

2.4.6 Cryptography

The cornerstone of many forms of security, even authentication, is using some form of encryption. Encryption is the goal of network cryptography, a term that has been extended from its root of secret writing to indicate any use of encryption techniques. The Computer Science Telecommunication Board (CSTB, 2000) stated,

> "Encryption technologies commonly are classified as either symmetric key systems (also called private key cryptography) or asymmetric key systems (also called public key cryptography), both of which may be used during the course of a single session between communicating parties".

The two technologies contrast together with the time it takes to encrypt and decrypt communication transaction and alleviation of administration. As a result, they tend to be more appropriate to different categories of applications. Symmetric encryption, for example, are apt to work better when communicating entities have a preexisting relationship. While, asymmetric systems, in contrast, work well between parties that have not communicated before, as in many electronic commerce applications. However, in asymmetric encryption revocable transaction can be more complicated than with symmetric encryption systems.

Symmetric encryption employs a single key to encrypt and decrypt data. Parties wishing to swap over information securely must guarantee that they both have access to the key. While, asymmetric (public key) cryptography is significant element of Internet security because it offers a way in which aliens can institute the necessary set of shared information to sustain authentication and encryption. This means it could be helpful in exchanges of patient health records between two unaffiliated hospitals (CSTB, 1997a, 2000, 2001).

Data encryption refers to the storage of data in an encoded form to prevent unauthorised access to information stored in a server or database. While, network encryption refers to encoding message or tranasction prior to transmitting the message on the network to prevent unauthorised access during network transmission. Thus, because current cryptographic techniques in use are complex, it is only in recent years that their use has become standard for networking (Dam and Lin, 1997).

2.4.7 Firewalls

Many institutions find that the value of the Intranet and Internet technology is maximised when they work together across a firewall. A firewall is the cornerstone of most security approaches. The firewall is a device, typically a router or server, that provides secure communication between private, trusted networks (such as Intranet), untrusted networks (such as Internet), and public. If a healthcare centre's internal network is spread throughout several locations, a firewall may be in place to establish the security of the intervening links. Firewalls separate the inside of a network (Intranet) from the outside of the network (Internet), while allowing access to authorised users. They are also used to limit employees' activities on the Intranet and screen downloads for viruses. Two primary firewall architecture exists in practice today: packet filtering, and application level gateways (Schneider 1999).

2.5 Electronic Patient Health Record

Patient health information permits patients to better understand their health records and be in a better position to assume greater responsibility for making health-related decisions for themselves or on behalf of members of their families. This should therefore embrace information supporting patient and community-based health promotion and enhancement, self-care, shared (provider - patient) decision making, patient education and rehabilitation, using the healthcare system and choosing whether to take private health insurance (Peifer et al, 1998). The electronic patient health record lies at the heart of this health information exchange.

There are various definitions of just what comprises an electronic health record. However, for this thesis, the following description of the term, appears quite acceptable by the researcher:

> "An electronic longitudinal collection of personal health information usually based on the patient, entered or accepted by healthcare professionals, which can be distributed over a number of sites or aggregated at a particular source. The information is organised primarily to support continuing, efficient and quality healthcare. The record is under the control of the patient and is stored and transmitted securely" (Murphy et al, 1999)

The following are other definitions:

US Institute of Medicine: -

> " ... Electronic consumer record that resides in a system specifically designed to support users through availability of complete and accurate data, practitioner reminders and alerts, clinical decision support systems, links to bodies of medical knowledge, and other aids" (Murphy et al, 1999).

US Work Group on Computerisation of Patient Records:

> "Computer-based patient record (CPR) systems: computerised information systems maintained by providers to capture, store, retrieve, transmit, and manipulate consumer-specific health care-related data, including clinical, administrative, and payment data. Using standard definitions, codes, and formats that enable data to be universally recognised and processed, CPR systems would be linked (with appropriate mechanisms allowing consumers and their providers to control access to information) through high-speed communication highways capable of transmitting multimedia data (including voice, image, and text) electronically. We distinguish the computer-based patient record which would consist of all the information necessary for managing that consumer's care from health information infrastructure which would also include decision support applications, reference data bases and linkages between CPR systems" (Murphy et al, 1999),

US Computer-based Patient Record Institute (CPRI):

> "A computer-based patient record is electronically maintained information about an individual's lifetime health status and health care. The

computer-based patient record replaces the paper medical record as the primary source of information for health care, meeting all clinical, legal, and administrative requirements" (Murphy et al, 1999).

The above definitions of the electronic health record invariably feature the following properties as valuable aspects of the electronic health record (Murphy et al, 1999):

- Patient/individual/consumer-centric focus in support of personal healthcare.
- Longitudinal nature.
- Flexibility for users.
- Timeliness for decision support.
- Source material for various kinds of studies (e.g. epidemiological).
- Confidentiality of stored information (apart from authorised uses).
- Record stored and transmitted securely.

Depending on the level and complexity of a patient's encounters with the healthcare system, the medical record may contain lengthy contributions from a multiplicity of healthcare providers (e.g. general practitioners, specialists, dentists, nurses, and a variety of allied heath workers - such as physiotherapists, dieticians and social workers), what medications have been taken, as well as the results of diagnostic tests (radiology, pathology, electro-cardiology, etc.). Therefore, the 'content' of an electronic health record encompasses personal health information - information that has significance in the context of the developing health status of a particular patient/ individual. The value of such information in turn reflects the value-added nature of the healthcare delivery system: it is result-oriented, with the desired outcome being the continued health of the patient, or the restoration of health (Dick et al, 1997).

The primary reason for accumulating patient-specific health data is to facilitate maintenance of a person's health in as good a condition as possible, and the value of the data is in their derivative capacity to serve that end. The implication of this is firstly that consideration should be focused on accumulating personal health information that patients and healthcare professionals find most useful, and secondly, to present that information in a structure that the patient and the provider find most convenient (Dick et al, 1997; Murphy et al, 1999).

2.5.1 Problems and Challenges of Patient Records

Most of the clinical and administrative information that currently runs through healthcare systems is paper-based, although some information is captured and disseminated electronically (e.g. some diagnostic tests). In most cases, healthcare professionals and institutions are free to decide what information is significant and what structure it should take. As a result, paper records tend to be individualistic because much of the information is handwritten and individual providers may express entries using their own terms and standards (Murphy et al, 1999).

Different types of healthcare professionals might gather records with different content. For example, ambulatory care records generally have fewer categories of information than hospital records, but they may extent over a much greater time period because they are historical records documenting many encounters. Patient records also include administrative records such as letters, although these may be accumulated separately from clinical records. Paper records within a single folder have traditionally been reserved either in the chronological order of compilation or in source-oriented or problem-oriented formats. Source-oriented records are structured with forms from nurses, physicians, laboratories, and other sources in separate sections. Problem-oriented records categorise the various notes into a brief database of information identifying the patient, a problem list of the aspects of the patient's condition that require treatment, an initial plan for treating the problems, and progress notes detailing actions engendered by the problems and plans (Murphy et al, 1999).

This non-standardisation of patient records is not necessarily an indication of poor design; instead, it is a reflection of the main mission that patient records once served. They were a highly detailed, patient-centred documentation of the care process and a record of everything that happened with respect to a patient during a particular incident of care. In ambulatory care settings, they were also repositories of historical information about a patient's previous care, the records sent across, the instructions transmitted and responsibilities undertaken by the medical team. In this context, designing a standard format for documenting patient-provider encounters made about as much sense as trying to impose a standard format for phone exchanges or diary entries (Murphy at al, 1999).

The dilemma is that the functionality required of patient records has developed far beyond the bounds of record keeping and communication within a limited team because of changes to both the 'delivery system' and 'clinical practice'. Patient records are now broadly used for legal, administrative, and research purposes. They have become sources of information for shaping eligibility for insurance payments and for documenting the degree of injuries or the quality of care for use in legal proceedings. They may be used to offer data for evaluating the quality and appropriateness of care for peer review, accreditation, or other quality-assurance programms, and for coveying communicable diseases and other essential data to relevant authorities (Dick et al, 1997; Iakovidis, 1998).

Thus paper records are becoming progressively more insufficient for the information demands of modern healthcare systems. A number of disadvantages of paper records have been noted, such that paper-based patient records document the care-giving process inefficiently, and they delay the free flow of information and slow down the integration of health care delivery, research, and administration. In many settings, the traditional paper record has become bulky, unmanageable, illegible, and frequently unavailable (Murphy et al, 1999).

2.5.2 Complexities of Electronic Medical Records

Many centres for R&D in the world, relating to academic institutions or the software industry are in search of technological and methodological solutions to implement their computerised health / medical records (Kohane et al, 1996; Yamazaki and Satomura, 2000). The variety of ideas is expressed by the myriad terms used to name such projects: clinical information system, electronic medical record, computerised medical record, computer-based medical record, electronic patient record, electronic health record, digital medical record, automated record, etc. (Dick et al, 1997; Murphy et al, 1999).

Many organisations, including the American Institute of Medicine, the Medical Records Institute (MRI), the American Medical Informatics Institute (AMIA) and the Canadian Institute of Health Informatics (CIHI) have devoted interest and considerable investment in research on an electronic medical record system. Research on a computer-based medical record is a long-term process (Dick et al, 997). In certain places, such as Duke University in the USA, research has been ongoing since 1968. The initiative resulted in what was claimed as the premier computer-based medical record system in the USA (Abdulkarim, 2000). Although much effort has been undertaken in this area, many research challenges remain before complete practical and flexible systems can be commenced. The development of automated records is riddled with issues concerning standardisation arising from the complex nature of medical data, uncertainity in the observation of data, and dissimilarity in terminology.

The two nomenclatures 'computer-based-patient record' (CPR) and 'electronic medical record' (EMR) are used interchangeably, although there are slight differences between them. CPR refers to medical records that usually reside in a central computer system, such as a desktop or Intranet server. EMRs, on the other hand, are inherently distributed over the network and can be accessed by a variety of databases (in this thesis we will use electronic patient health record (EPHR) without intending to resolve the debates that surround the use of each term). In order to classify the nomenclature, the Medical Record Institute (MRI) defined five phases according to their characteristics and functionality. The five phases are automated medical records, document imaging, electronic medical records, electronic patient record systems, and electronic health record (Waegemann, 1998).

In spite of the nomenclature used, there is a consensus that the implementation of an electronic patient health record is a project to be managed in the perspective of a dynamic process of continuous evolution. It is envisaged that the implementation of these five phases will result either in the complete dissipation or entire clarification of the distinction between CPR and EMR It is a fact today that most systems are only at the first, second and third phases of development (Gordon et al,1998; Amaral et al, 1999).

The construction of a generic model for the electronic medical record is a subject that generates some debate among experts in the field. "In reality, the electronic medical record is much more an evolving concept than an artefact or a turn-key solution ready to be bought from the software industry" (Amaral et al, 1999, p. 37). This does not mean that there are no good packages or that there are partially functional ones of restricted use on the market. Therefore, for the sake of simplicity, it is useful to think of the electronic patient health/medical record as an entity that exists on the network in its aggregate form, simultaneously populated from multiple locations.

A patient's medical record has always been a distributed entity. Literally defined, it is the accumulation of medical information concerning the patient. Ideally, this information is bundled in a single folder with the patient's identification data on the cover. In real life, this information would be scattered between several health bodies (computerised and paper-based) in various locations, often under different identifier numbers. Much of the information in the records is obsolete, redundant, duplicated, or indecipherable, to the extent that it does not benefit the patient at the point of care. The content of the medical record is extremely heterogeneous. Information is gathered over time from various sources that use different formats and standards (which also change over time), making the record difficult to follow. In addition, medical terminology and diagnostic techniques change over time, so that the record becomes an aggregation of loosely related documents. The latest electrocardiography results of a patient with coronary artery disease would be useful for emergency care, but not the numerous archived results typically found in the record. This vital information is not cumulative but cross-sectional in nature. It explicitly does not cover a patient's medical history but should reflect information that is pertinent for future (emergency) care (Kay and Purves, 1996; Dick et al, 1997).

On the other hand, an electronic patient health record is built up as a collation of particular digital data captured each time a patient interacts with the healthcare system. Typically, one entry (or more) for the record is created for each interaction with a healthcare provider (van Ginneken et al, 1996). Examples of patient entries would be a general practitioner prescribing a drug for a patient, and a pharmacist dispensing the prescription. To be able to assemble the record, each entry needs to include an agreed set of information (e.g. time and date, identification of the provider, the patient and the location of the healthcare service; any coding system(s) used; and who is permitted to access the entry). Authorised people must be able to update the record, but it must be impossible to amend or erase previous entries. Computer recording requires not only behavioural changes, as users have to give up traditional hand-written/dictated input methods to which they are familiarised or trained for direct interfacing with the computer, but it also requires compliance with legal and system requirements. The inclusion of access control systems that clearly identify and authenticate the user, incorporation of an electronic signature, and appropriate system security features are necessary when patient information is entirely stored on the computer (Murphy et al, 1999).

Today, it is possible to automate sections while maintaining the paper-based patient record or to move to a computerised medical record system through document imaging. As many users claim to be implementing an electronic patient record system and some vendors indicate that they sell current computer-based patient record systems, none of them clarifies the definition. Moreover, electronic patient health records must be secured against such things as unauthorised use, tampering or destruction. The notion behind these records is simple enough: changing the form in which the health record is held from paper to electronic means. But building useful systems to support them is quite challenging (Porth et al, 1999). This not only reflects the complexity of having to deal with many contributions to the record (both from multiple providers and over time) in a way that will prove valuable to others, but also the necessity of incorporating into systems design aspects such as a safe way of identifying the patient, standardisation of messages and codes, secure means of transmission and storage of what is highly sensitive personal information, and mechanisms to guarantee that access to records is confined to authorised users. Otherwise, such systems will simply not be used (Dick et al, 1997)

Finally, therefore, achieving desired health outcomes depends on having the right information available when and where it is needed. This means that health information should cross the boundaries to do with one's profession/ discipline/ speciality, something a truly integrated electronic health record system would achieve.

When patients see multiple providers in different settings, none of whom has access to complete information, patient safety is more likely to be put at risk than where care is better co-ordinated (e.g. via electronic health records). Unsafe care is one of the prices we pay for not having structured systems of personal health information (which can mitigate a major source of medical misadventure) (Kohn et al, 2000).

The electronic health record and supporting infrastructure will be significant tools in supporting the delivery of high-quality care by means of informed decision-making on the part of both providers and patients. Just as there can be expected to be many different healthcare settings in which the electronic health record is accessed (ranging from hospital to home), an electronic health record system will play many roles in the provision of care both at the patient and community level. Consequently, healthcare administrative institutions would like to have medical information accessible for questions about eligibility for treatment (Kohn et al, 2000).

Delivery networks (such as hospitals) would like it to be accessible to the services within the system (clinical, administrative and financial) (Murphy et al, 1999). Healthcare professionals would like the record to be accessible to them as the patient enters their practice. Patients will want their records to be accessible wherever they present themselves to get care. For example, a patient with haemophilia who is involved in a car accident and is taken by ambulance to the nearest hospital would need her records to be available there. Evidently, any system that attempts to provide the 'correct' scope of access should be able to cover all of the above simultaneously. In conclusion, such a system should focus on a flexible delivery mechanism rather than on specific delivery end points. As the location of the point of care cannot be predetermined, global availability is needed. The World Wide Web could fulfil this requirement (Dick et al, 1997; Murphy et al, 1999).

2.6 Approaches to Electronic Health Record Concept

2.6.1 Virtual Patient Record Concept

Healthcare providers and end-users, such as the doctors and patients around the world, have recognised the real value of the virtual patient record. Forslund and Kilman (1996) define the virtual patient record as "virtual in that it is a view of the data that might be configured differently at different locations, but that is mapped into a common format at the time the record is required". The principle of the virtual patient record makes data available to all, whenever and wherever needed, through the distributed technology. The major focus then is the security and integrity of data transmitted while maintaining high accessibility. Hence, the virtual patient record serves as an integrating application, and its functionality is defined from the collection of information from any existing information system.

Nowadays, improved facilities and services such as CORBA and OMG have showed that access to records by multiple users can be made while at the same time maintaining the integrity of records. Here, high bandwidth is necessary only when video or images are passed on. Recent developments in electronic commerce and security have improved record accessibility to larger users and distant places. The virtual record is no longer a far-fetched idea but can turn into a reality with the cooperation of everybody in the health sector. The trend towards larger networking systems, shared information and standardisation has enabled wider access, and a cost-effective and quality-oriented approach to the virtual patient record. The value of the record can be enhanced if health communities come together to utilise it and demonstrate its importance and benefit to those who need it (Forslund and Kilman, 1996).

2.6.1.1 Some Projects on EPHR

The European Standards Organisation took practical steps to assist in healthcare development by providing several useful standards that enable compatibility and interoperability between independent systems in healthcare. The European standardisation programme provides an important channel to use the results of the R&D programme in health telematics. Technical Reports and projects in health informatics were released in parts for providing guidelines on standards to those who need them (Dixon et al, 2000).

The *Good European Healthcare Record* (GEHR) project set up a telematics programme, with a comprehensive and widely applicable common data structure for using and sharing electronic healthcare records within Europe. This brought together a large number of healthcare-related professional project teams. The *Prestige* environment deals with the clinical guidelines management and protocols aimed at improving the healthcare process in terms of quality, efficiency and outcome. Guidelines include support for architectures for multimedia patient records which allow all healthcare professionals involved in the care of a patient to have access to information. The *RICHE* project defines a framework for open patient-based healthcare information systems for effective coordination within healthcare delivery. The *STAR* project further enables a cooperative environment within healthcare organisations in a region. *Synapses*, another project in health telematics, supports improvement of patient care by enabling healthcare professionals to access clinical record information more readily at their computer workstations across Europe. The approach is a generic one for combining healthcare records systematically and securely to enable the sharing of data between different information systems in different places. Attempts were thus made to develop healthcare information systems in different stages and through different channels (Dixon et al, 2000).

2.6.1.2 United Kingdom perspective

National Health systems (NHS) must balance two purposes. In the short term they must respond to the demands of the population for access to existing services. At the same time they must try to improve the health of the whole population (get the waiting list down) (Wanless, 2002). The Department of Health (DoH) in the UK has responded with a new national strategy to deliver the benefits of working practices supported by information technology and computer based records across the NHS (DoH, 2003). Concern is not limited to Britain: in 2001 the US Institute of Medicine stated that IT must play a central role if a substantial improvement in quality is to be achieved. While noting that to date IT has barely touched patient care, it describes the computer based patient record as an essential technology for healthcare (IoM, 2001).

The NHS is a nationalised business, paid for from taxation, and the government has a dominant role as both owner and paymaster. The Public Accounts Committee of the House of Commons is the most powerful parliamentary watchdog and has issued a long series of negative reports about information technology in healthcare, including the projects at Kings College Hospital, Hospital Information Support Systems, and the

Read codes. The committee reports were used as excuses for closing down the experimental programme in the late 1970s, regional computing initiatives and centrally funded computer projects in the early 1990s and the NHS Centre for Coding and Classification in 1999 (Royal College of General Practitioners, 2000).

In 1972 the Department of Health decided to treat information technology as a management and administration cost. One result was to grade hospital information technology staff on administration and clerical scales. Since then, NHS staff have been an underclass of the information technology world, with salaries typically running at 40% less than the going rate for the job outside the NHS. As a result, the health service is chronically short of information technology skills and increased resources need to be devoted to education and training in health informatics. At the same time investment in information technology was reduced in the years prior to the 1997 General Election (DoH, 2001, 2002).

In 1998, the NHS recognised that IT had a major role to play in healthcare, and *Information for Health* (IFH) (DoH, 2001) defined the strategic approach for the use of IT. Since the advent of IFH, there have been improvements in the level of IT funding and in the uses that are made at local, regional and national levels. However, there remain a number of critical barriers to the effective use of IT as a strategic tool in the delivery of healthcare by the NHS. These include, the lack of a cohesive, nationally-led IT architecture for data and system standards that allow information and processes to follow the patient's journey through the NHS seamlessly, and the need to improve coordination of IT resources and procurements to increase the pace of implementations and provide fast, better value for money IT projects (DoH, 2001).

While there were good, usually local, IT initiatives sponsored by enthusiastic visionaries, these were outweighed by the overall lack of funding and development priority given to IT at all levels. Good experiences were not captured, and successful implementations were not scaled from their local beginnings to NHS-wide application.

In 2001 the government announced a rise in capital expenditure on computing from £65m in 2000-1 to £317m in 2002-3 (DoH, 2001). The NHS is now planning to deploy integrated patient record systems across both primary and secondary care. The examples of Kaiser Permanente and the Veterans Administration in the USA suggest that such systems may play a critical part in improving effectiveness and efficiency. However, such a project faces several technical obstacles, mainly associated with scalability (Feachem et al, 2002). It is much easier to computerise small general practices than large complex hospitals, let alone provide integrated services across an organisation as large as the NHS. These technical issues (including patient record architecture, terminology, interoperability standards, security, and developments in computer technology) are the main issues in deploying integrated health information systems. Therefore, these issues, which are all related to scalability, present a major challenge to those responsible for delivering the new vision of integrated 21st century information technology support for the NHS.

Recently, Department of health (DoH) recommended five options to be considered to deliver the new vision. The first and second options overlap significantly with the content of this thesis (although the focus of this work is very much smaller scale problem in the State of Kuwait) (DoH, 2002 p 7).

Option 1 - 100% Private Sector dependence: *Outsource the whole of the NHS IT strategic programme (including local implementation arrangements).*

Option 2 - Strategic outsourcing: *Selectively outsource major components of the NHS IT Programme, e.g. networks; Deliver some components at a national level via the NHS Information Authority, e.g. National Health Authority Information System; maximise the use of national framework contracts for commodities; set national standards for local use; Strategic Health Authorities to be performance managed to ensure implementation.*

The other three options, which are less relevent to this thesis are:

Option 3 - National NHS solutions for the NHS: *NHS to run all major components of the IT strategic programme at an national level.*

Option 4 - Strategic HAs Lead: *Decentralise the management of IT toStrategic Health Authorities (HA).*

Option 5 - 100% Local NHS Provision

Thus, the key element is to create an IT management capability that provides greater leadership, competence development, co-ordination and direction, allowing the NHS to capitalise on the power of IT to integrate data and processes across organisational and physical boundaries.

2.6.2 Computing Technologies and Communication Network

Software and computing technologies provide the capabilities that define 'next-generation' information systems. Proper application of these technologies within Computer-based Patient Record (CPR) and Electronic Patient Health Record (EPHR) systems can provide such systems with tremendous flexibility, capability, and longevity. This section contains a brief reference to the state-of-the-art in distributed objects, and addresses the application of these technologies to the creation of EPHR systems (Dick et al, 1997).

The global communications industry is undergoing major changes, the most significant of which are the shift from voice to data and a spectacular growth in the demand for services and the capacity of networks to provide them. The fact is that we live in an increasingly networked society. This change is underpinned by significant developments in communications technology to reduce the unit cost of carrying information; commercial and financial arrangements to facilitate e-commerce/e-transactions; and regulatory structures to promote competition. The practice of medicine is information-intensive, and therefore an obvious candidate for utilising modern information and communication technologies (Murphy et al, 1999).

2.6.2.1 Distributed Technology

Today, most IT organisations are under a considerable amount of pressure to deliver higher value products at lower costs, and within much shorter time to market schedules, adding to the ever increasing burden on organisations. Most are struggling to manage complex, heterogeneous environments that have different hardware, software, applications, networks and database systems. Many new systems that are developed today using the latest Internet or client/server technology must integrate with legacy systems that were originally developed ten or twenty years ago. Driven by increasing demands on an organisation to bring products to market quicker, this has resulted in many organisations adopting a tactical short-term approach to satisfy increasing customer demands. This has resulted in the lack of organisations setting a long-term technical direction, and just settling for the quick fix (such as the case of London ambulance services (LAS) where management clearly undersestimated the difficulties involved in changing the deeply ingrained culuture of LAS) (Beynon-Davies, 1995) .

The past two decades have seen many transforms in the way enterprise information systems get designed, developed and maintained. It all started with the monolithic mainframe systems. Each of these systems contained all of its own presentation, business and data access logic. These systems could not share data with other systems, which meant that each system had to retain its own private copy of the data. Since different systems required access to the same data, organisations had to store redundant copies on multiple machines. These monolithic applications were inefficient and costly, they were shortly replaced by relational database technology and the client/server model (Ohly, 1995).

Client/server computing guaranteed to simplify large and complex systems by separating centralised systems into components that could be developed and maintained with ease. The client component would characteristically implement the presentation logic, whilst the server would contain the business logic. Either the client or the server, depending on the strategy of the organisation, would handle the data access logic. In the end, many of these solutions were just two separate monolithic systems. One of the key problems with these types of system was that developers found it very difficult to reuse code. Development teams would build modules of similar functionality over and over again, to be used in different parts of an enterprise system. The problem occurred that if a change was required in one module, that change would have to be propagated to all other modules containing the changed functionality, throughout the enterprise. The problem of managing the changes in an effective way arose as functionality inconsistencies crawled into the enterprise information system (Barnes and Shimberg, 1997).

Distributed object technology, tied with a powerful communication infrastructure, fundamentally changes the problems inherent in client/server computing. The idea is to change monolithic client/server applications into self-managing objects, which can interoperate across different networks and operating systems. The concept of objects is that they must be self-contained. They are packaged to contain both processing logic and information in their structure, so that conceptual entities can be isolated. For example, in health informtion systems, patient information tends to be contained in isolated systems, pertaining only to the requirements of a particular community, such as radiology, pharmacy or dietetics. A hospital could build a set of applications in which a 'patient' object moved from department to department, depending on the inquiry or information needed. It would present a different view of its information to different requestors, and could be used to track any information update and to provide consistent information to all requestors. A distributed object computing model enables IT organisations to build an infrastructure that is more adaptive to ongoing change and responsive to market opportunities, making it easier for an organisation to establish and maintain a competitive advantage (Balen et al, 1999).

The integration of large-scale distributed information systems needs interoperability along with interconnectivity. Interconnectivity provides communication so that systems can exchange messages amongst themselves. For example, in early days client-server models organise a distributed system as server and client processes. The server processes offer services to client processes across the network. The client can access the server processes through interprocess communication mechanisms such as remote procedure calls (RPC), but there is no cooperation in executing these processes, while interoperability means that the client and server can interact to execute a process jointly (Huange, 1999; Douglas et al, 1996).

Therefore, the International Standards Organisation (ISO) proposed architecture for addressing these complexities, known as the Open System Interconnection Reference Model (this standard description or reference model describes how information from one application moves through a network medium to another application). However, with this new model came new requirements: distributed business applications must be able to operate in a heterogeneous environment, being able to operate on different hardware and software platforms. They must also integrate old and new technology and make use of existing infrastructures. The integration and evolution of existing systems represents one of the most urgent problems facing those responsible for healthcare information systems so that the needs of the whole organisation are addressed. The management of the healthcare record represents one of the major requirements in the overall process; however, it is also necessary to ensure that the healthcare record and other healthcare information are integrated within the context of an overall healthcare information system (Murphy et al, 1999).

2.6.2.2 Java Technology

Java language is an example of a tool that can play a role in the 'platform and application independence'. An information space is not confined to one type of computer, one type of application or one geography. The Web is handling the data side of this information space. The applications to take advantage of this universal information space are left to the software industry. This is where Java becomes the most obvious choice due to its platform-independent capability. Java was designed to be a network-centric universal computing platform. Thus Java combines well with XML in bringing the complete portability to both code and data. However, there are technical limitations in using platform, application independence on top of Web technology. The slogan of Java is "Write once and run anywhere". Java is a framework for the network-centric computing (Hamilton, 1996). Java programs can be developed in two patterns: applet and application. An applet is a Java program that is downloaded over the Internet and run on the client side using a Web browser, while an application is a stand alone program and resides and runs on the client side using a Java Interpreter (Budd 1997). The main attraction in Java is that Java programs are completely portable; they are written once and run anywhere. The Java compiler produces machine-independent instructions, called byte-codes, instead of machine-dependent code like other languages. The Java runtime environment (Java Virtual Machine (JVM)) interprets the byte-codes into machine-dependent instructions at execution time. However, execution of byte-codes is slower than the execution of compiled software and this is one of its drawbacks (Lewis and Loftus, 1998).

2.6.2.3 Middleware-based Architectural Approach

The organisational structure of healthcare is distributed, being an environmental spread of centres at different levels of complexity - from general hospitals and clinics to individual GPs. From the IT point of view, delivery of healthcare is usually supported by a number of different, heterogeneous, and often mutually incompatible applications, which are installed and operational in individual centres, meeting the specific needs of particular groups of users. Generic middleware components like DCOM and CORBA provide potential solutions for the technological interconnection of distributed systems, but do not address inter-operability and inter-working of the systems from the point of view of application-oriented support meeting a range of users' needs. In other words, the semantic aspects of inter-working need to be the key focus once the technical problem of distribution is solved. In passing, it can also be noted that the exchanging of messages is not sufficient, since this approach can only lead to a loosely coupled inter-working among the different sectors in an organisation, without meeting the needs of the healthcare organisation as a whole (Kramer et al, 1998).

The overall healthcare organisation can be considered as a set of users, individually different and doing specific jobs, but all needing to rely on and to share a set of common fundamental data, exploiting a common set of services. Such common data and facilities ideally should not be under the ownership of individual applications and/or suppliers, but must be accessible to all applications (under controlled conditions) through public and stable interfaces which should not depend on any specific technical characteristic or system configuration. These objectives and requirements may be effectively satisfied and supported by structuring the architecture (Davidson, 2000).

In this architecture, an information system is modelled as three co-operative layers (application, middleware, and bitways), individually responsible for addressing specific design and operational aspects of the information system. The 'bitways' refer to the technical infrastructure providing distribution and connectivity in the generally heterogeneous environment, and are not specific to the healthcare domain. The 'middleware-layer' (usually just referred to as middleware) represents therefore the central element of the system, providing a holistic infrastructure where all applications may be connected. The middleware, through its services, facilitates the management of the information common to the whole organisation through stable and technology-independent interfaces. The 'applications' refer to the software component identified and associated directly with the user activities, and in very general terms, include data operations, the use of embedded knowledge, and presentation of information on computer screens and other devices. It is the choice of splitting the location of these software applications that is crucial to the development of a middleware approach. The reasoning used is that applications providing services to more than one user or category of users point strongly to positioning such services where they can be made available to users - and the middleware-layer is the appropriate location (Spahni et al, 1998; Davidson, 2000).

In addition to these common services, other components offering generic support are ideally placed in the middleware layer too, security being one example. The essence of this architecture is that information represents a common heritage and must be clearly separated from the client applications; and that the information should be made available to other components of the information system (Davidson, 2000)

2.6.2.4 XML Technologies

The World Wide Web Consortium (W3C) approved Extensible Mark-up Language (XML) as a Recommendation in February 1998. W3C is a consortium bringing together representatives from many of the leading IT companies, academic institutions, and public bodies (World Wide Web Consortium Member, 2000). As a result, all key software companies refocused their development strategies to include XML, and numerous companies are now offering their applications with the recommendations implemented. These software applications from XML parsers implemented in different programming languages to sophisticated XML-oriented database applications. XML is a markup language used to identify types of information enclosed in an interchangeable structured document. Structured documents enclose content, including texts and pictures along with identifiers as to what function each piece of content plays. The basic rules behind this are to define what the content of a document is, rather than what the document looks like. The division of the content and structure of a text from the style of information used for its rendering in an output device is an essential precondition for the document not only to be accessible with heterogeneous software systems, but also to continue to exist in an environment of constantly changing software tools. As a result, this separation of the content and structure of a text has made it possible to use it for data in general (Alschuler, 1998).

XML is a variation of the Standard Generalised Mark-up Language (SGML). SGML is an ISO standard that defines how the structure of documents should be described so that they can be seen over a whole variety of applications and platforms without the need for further conversion. The method of doing this is to produce a document type definition (DTD) that describes the structure of the document. The elements of the structure are achieved through tagging based on the rules set by the DTD. For each type of document, there is a DTD. These DTDs can be nested so whole rafts of documents can be seen together as a single entity (like Lego bricks all fitting together irrespective of size, colour and shape). The DTDs allow security to be included, thus a viewer who does not have security clearance will not be able to see parts of the document requiring that clearance. Thus, the SGML document is secure and can be viewed over all computer systems that have SGML viewer software (Alschuler, 1998).

The limitations of HTML (it only prescribes the look / layout of document) means that the type of applications increasingly required over Internet and Intranet could not be implemented. A more sophisticated document-structuring approach was demanded. Thus a halfway form was proposed called XML to replace HTML as the standard document mark-up language for the Web. It improves over HTML in providing data semantics and data independence. The latter is achieved because XML documents are specified independently from their presentation. Document presentation is the subject of a companion standard (XSL) which dictates how a style sheet can be associated with an XML document in order to be presented on a Web browser (Flynn, 2002).

Healthcare is to a large extent an information-processing activity. Data about the patient's physical condition are gathered by the healthcare provider through various diagnostic techniques, and evaluated within the framework of his or her medical knowledge to make suitable decision for treatment or further diagnostic procedures. If this information processing path is to be effectively enhanced by electronic clinical support systems, it is inevitable that data be structured at some time point. For this structuring to be constructive, however, it requires a standard syntax and terminology that is commonly used by all healthcare professionals. The lack of such a commonly standard electronic language has so far been a major impediment for rapid development in this field (Dudeck, 1997). EDI (Electronic Data Interchange) standards like HL7 (Health Level Seven) or EDIFACT (Electronic Data Interchange for Administration, Commerce and Transport) have found a certain application, but mainly in the administrative and financial areas of healthcare. Dudeck (1997) calls for harmonisation of all available standards: " Since the cost for developing, maintaining, are increasing, the awareness is growing that the available standards have to be harmonised".

Therefore, communication standards are getting more and more important in medical information processing. Several standards development organisations are developing and maintaining standards for different medical domains. Most of the already available standards are now well accepted and widely used. Thus, for the first time, XML presents a concept and technology that promises to offer a flexible, open and standardised solution to the problems of structuring, storing, and exchanging patient data. The independence of XML from particular software vendors, its self-describing nature, and not least, the fact that XML can be read by human beings as well as by computer programs, makes XML particularly suited to storing and handling documents and data over a long period of time, as is needed for patient records (Dudeck, 2001).

2.7 Summary

While it is apparent that the healthcare industry is in the midst of some of the greatest changes in its history from a business point of view, as well as from a delivery perspective, it is not clear how the industry will look in the near future. One thing we can learn from a general perspective is that technology certainly has the potential to provide some solutions for the major challenges facing the business of healthcare delivery. Whether or not technology will drive these changes is not the question. What is important is how the technology can help facilitate the changes and how obstacles can be removed in the deployment of the technology.

A careful review of several revolutionary changes that have taken place in recent times within the health industry has revealed an entirely new phase of development in healthcare informatics through information and communication technologies. There have, undoubtedly, been concerted efforts towards the development of well-defined automated healthcare information systems, systematised processes, quality, and secure data. One of the vital requirements in healthcare informatics is the need for standardised regulations that control the electronic patient record, with well-defined properties and entry format. This, in turn, will also address the prevailing challenges of patient records and pave the way to replace the traditional patient paper records. The electronic patient record should be supported by practical, flexible systems that simplify complex medical data and at the same time maintain the quality and security of data. The virtual patient record, the result of research initiatives, sets a generic and open means to transmit data across systems and locations. On the other hand, computing and communication technologies now provide tremendous flexibility and capability to systems. Distributed object technology, with its powerful communication infrastructure, enables adaptability to changes, while language such as Java support system interoperability, independent of hardware and software. Middleware applications pave the way for solutions to problems of interconnectivity, with focus on an architecture that allows information flow between several components. XML sets the syntactical standard for data exchange, and support standardisation for electronic interchange of medical information, and SGML can also be integrated into medical informatics. Distributed systems enable greater accessibility and global interchange of data. Communication standards in medical information processing play an important role in enhancing healthcare information delivery, and future researches can establish this view and introduce greater beneficial changes within the healthcare industry.

The next chapter dwells upon the 'social' element of healthcare delivery and IT, using the Grounded Theory approach to explain the evolution of a new paradigm.

Chapter 3

Research Methodology:

Social Process in Medical and IT Network

3.1 Introduction

The increased complexity of current organisational environments, changes in organisational forms and work practices, and the increased sophistication of applications have resulted in the realisation that "research is therefore needed which would investigate the true nature of the current systems development environment in real organisational situations and on real development projects" (Baskerville et al, 1995, p. 237). Researchers have examined the complex and problematic processes of conceptualising information requirements or expert knowledge from raw data accumulated from interviews or observations. Jones et al (1996), for example, propose an approach to eliminate unnecessary detail from interview transcripts to facilitate analysis, while Pidgeon et al (1991) propose the use of social science methods in analysing qualitative data, in particular the Grounded Theory (GT) approach, in order to transform raw transcripts to a core set of interrelated concepts, memos and models. Grounded Theory is a qualitative research method from the social sciences that has also been usefully applied in the field of information systems (IS). It is a method that provides practical strategies and procedures for the collection and analysis of qualitative data. Great appreciation of the essentially social nature of IS in practice has led some researchers to adopt research approaches which focus primarily on human interpretations and meaning (Walsham, 1995; Myers, 1997). Consequently, interpretive approaches are being employed to an increasing extent (Klein and Myers, 1999). There is also increasing evidence of this debate in the field of IS evaluation (Serafeimidis and Smithson, 2000; Irani and Love, 2001).

Therefore, arising from this, an issue of concern for many interpretive researchers, is that when presented with unstructured, non-numeric data derived from a qualitative research study, there is a clear absence of practical direction for the coding and analysis of data. An element of relief can be instituted, however, with Grounded Theory (Glaser and Strauss, 1967), one of the practical methods that is prominent amongst the various research strategies recommended for conducting interpretive research (Myers, 1997).

This chapter establishes the sociality element that exists in both medical work and in communication theory and networks. Because of their relevance to the research findings, we will review medical work, and communication theory introduced by the literature. The use of scenarios will then be incorporated into these two structures on the basis of the GT argument. The use of a scenario is as a means to acquire and represent tacit knowledge (which is a form of knowledge that is deemed extremely abstract, intangible, and difficult to formalize as it is embedded within the expert's explicit knowledge) (Cheah and Abidi, 2000). This chapter emphasises the importance of a social scenario in medical environments, which enables interpretation of concepts on the abstract level, not on the data level. The core of the study is to address the research question, which investigates the pay-per-use concept, and accessibility of electronic patient health records globally, the need for which has evolved mainly on the basis of social grounds, that is, the human need for a developed healthcare delivery system.

3.2 Social Aspect in Medical Work

Discussions on the computer-based-patient record (CPR) often criticise the poor state of current paper-based medical records. Information is difficult to recover from these disordered documents full of illegible notes for the healthcare providers themselves, but also for researchers, administrators, insurance companies, and all those other third parties who could benefit from having more direct access to patient data (Ball and Collen, 1992). More often than not, it is argued, the current medical record is messy, incomplete, and the terminology used is vague and non-interpretable in many ways. In the words of Bleich,

> "the medical record is an abomination ... it is a disgrace to the profession that created it. ... The charts confuse rather than enlighten; they provide a forbidding challenge to anyone who tries to understand what is happening to a patient"

(Bleich and Lawrence, 1993). Ideally, it is argued, a medical record both supports the physician's clinical problem-solving and serves as a 'repository of information' for use by multiple parties. It should guide the physician's thought processes towards an efficient, scientific problem-solving method, and allow for quick, efficient access according to widely diverging needs (Dick et al 1997). To satisfy these requirements, many authors discuss the necessity to standardise terminology, to restrain the use of 'free text', or to automatically code the free text portions. In this way, the building blocks of medical thinking can be delineated and ordered. The record needs to be structured so that bits of information can be recognised by the computer as belonging, for example, to a single class or as standing in a distinctive type of relation (e.g. 'request' and 'response') (McDonald and Barnett, 1990; Rector et al, 1991, 1993; Shortliffe and Barnett, 1990).

In such discussions, medical work is, implicitly or explicitly, depicted as a cognitive process, in which 'observations' are gathered, diagnostic hypotheses are tested, and treatment decisions are reached according to, more or less adhered to, rules of logic. It is a model in which data are conceptualised as given entities, and in which medical criteria are ideally explicable as 'if ... then ...' statements (Bell et al, 1988; Berg, 1994).

In this process, historical information, examination results and medical criteria are not so much 'uncovered' or 'given' but are continuously (re)constructed (Silverman, 1987; Clancey, 1995). Diagnostic technologies have too many 'ifs' and 'buts' attached: an X-ray will miss a small focus of infection, a rising temperature can be an artefact of two slightly differently performed measurements, and so forth. In medical work, moreover, such a true picture is not the prime interest, even if it could be produced. Medical work is directed at finding an answer to what Garfinkel (1967) has called the "practical problem par excellence: What to do next?" (p.12). In conjunction with nurses, their tools, and organisational routines, physicians do not attempt to create a 'true' image of nature, but a 'meaningful difference for the purpose at hand', a result sufficient to direct the immediate course of action (Clancey 1995).

In the light of the perspective outlined above, however, the medical record takes on a different status. The medical record is a tool, and a crucial one at that, aiding memory, communication, and so forth, but it is not a 'mirror' of that work. It does not 'represent' the work, but it 'feeds into' it, it structures and transforms it in complex ways: it structures the communication between healthcare personnel, shapes medical decision making, and frames relations between personnel and patients (Berg 1997). Recent studies of 'thinking-in-action' have shown that what we often consider to be 'intellectual tasks' in fact often appear to be highly embodied activities, in which ongoing interactions with the immediate material and social surroundings play a crucial role (Clancey, 1995).

In this transformation of multiple sources of information into some curtailed sentences, the healthcare professional gains the opportunity to 'pull' the patient out of the ongoing stream of day-to-day events. A physician, confronted with a patient's problem (whatever a person or his/her environment perceives to be a problem for which a physician should be consulted), tries to 'transform' this into a 'manageable' problem: one which matches his/her work routines; which implies a limited set of actions (s)he perceives to be a sufficient answer (at this time and place). All heterogeneous elements mentioned (data, organisational issues, medical criteria, and so forth) reciprocally shape this transformation. Thus, the knowledge possessed by the physician is a tacit knowledge (knowledge about what really works) and is not marked as rules, rather it exist as the domain expert's skill, common sense of intuitive judgement whilst solving the problem (Cheah and Abidi, 1999). Therefore, as a result, the medical work is essentially a *social process* and interactive activity. The unit of the analysis is the process not the data (Berg 1997).

3.3 Communication theory and Network Perspective

As we discussed in the previous section 3.2 about the 'sociality context' in medical work, which considers a first assumption towards using scenarios as a means of data collection. This section describes communication theory and the use of networks as a means of sharing information among affiliated healthcare settings to explore the 'sociality context' in their action and behaviour and this is the second assumption in using a scenario.

3.3.1 Communication theory of Schramm (1954, 1971)

Schramm (1954) claims that "when we communicate we are trying to establish a 'commonness' with someone". All communication involves at least three elements: source, message, and receiver. The source encodes the message and transmits it, and the receiver decodes it. Both the encoding and decoding are grounded in the particular "fields of experience" of sender and receiver. If decoding matches the encoding, then a commonness with someone has been established.

Schramm (1971) updated his earlier work and he stated that "human communication seemed a simpler thing in 1952 than it does in 1970". He also noted that "communication had now come to be thought of as: a relationship, an act of sharing, rather than something which someone does to someone else". Schramm advocated the end of what he called "The Bullet Theory of Communication". He stated that communication had been seen as a magic bullet that "transferred ideas or feelings or knowledge or motivations from one mind to another". Schramm has also acknowledged that "it is now necessary to think of the communication process as two separate acts, one performed by a communicator, one by a receiver". He redefined communication as "the sharing of an orientation towards a set of informational signs". Information in turn was broadly defined as "any content that reduces uncertainty or the alternative number of possibilities in a situation" (p.13).

Schramm (1971) claims that all communication, whether interpersonal or mediated, involved three elements and two kinds of action. The elements are the communicator, the message, and the receiver. Schramm observed that "the message exists as a sign or collection of signs with no meaning of their own except that which cultural learning enables a receiver to read into them". He saw the first act of the communication process as the construction by the communicator of the "signs which he hopes will call forth the desired responses". The second act is performed by the receiver in a way that "A receiver selects among the stimuli available to him, selects from the content of the message he chooses, interprets it and disposes of it as he is moved to do". He concluded that " communication is something people do; it has no life of its own, and there is no meaning in a message other than that which people put into it. The study of communication, therefore, is the study of people in relationship." The final element in the revised model is termed "social situation and relationships".

The Schramm (1954) communication model is basically a modification of the Shannon-Weaver model and incorporates some of its components and technical aspects of communication. Shannon and Weaver (1949) describe communication as a process which starts when an information source selects a desired message out of a set of possible messages. The transmitter changes this message into the signal which is then sent over the communication channel from the transmitter to the receiver. The receiver then changes the transmitted signal back into a message, where the message meaning is understood and an effect resulted.

Weaver, in Shannon and Weaver (1949), starts by defining communication as "all of the procedures by which one mind may affect another. This, of course, involves not only written and oral speech...and in fact all human behaviour. In some connections it may be desirable to use a still broader definition of communication, namely one which would include the procedures by means of which one mechanism... affects another mechanism."(p.3). Weaver presented communication problems in communication theory as being on three levels: "Level A. How accurately can the symbols of communication be transmitted? (The technical problem.). Level B. How precisely do the transmitted symbols convey the desired meaning? (The semantic problem.). Level C. How effectively does the received meaning affect conduct in the desired way? (The effectiveness problem.)".

Therefore, Schramm, in his 1971 modified model, introduced the notion that communication is more of a relation between the sender and receiver than being a message-bullet sent by the sender to the receiver and vice versa. Schramm claims that all communication necessarily functions within a broader framework of *social relations* which he identifies as comprising four elements: the physical /spatial relationship between sender and receiver, the situational context, role expectations, and social norms.

3.3.2 Network Perspective

In the case of a network (healthcare to healthcare exchange relationship of how dynamic health concerns are coordinated), the network perspective (using communication theory) has a theoretical underpinning: for example, social exchange theory. Cook and Emerson (1984) depict the primary focus of social exchange theory as "the explanation of the emergence of various forms of social structure, including networks and corporate groups".

Specifically, theories of social exchange are mainly interested in this operational explanation. When firms interact and exchange, the connection between them is contingent upon the interdependency between them and the other interdependent relationships that they might have. Therefore, the unit of analysis can move beyond the dyad, to the network of both direct and indirect relationships a firm might have (for example, shared care among a many-affiliated healthcare or under an IDN setting).

The network perspective sets greater importance on contextuality and time and incorporates two significant assumptions about social behaviour. Knoke and Kuklinski (1982) explain these assumptions as follows: firstly, "any actor typically participates in a social system involving many other actors, who are significant reference points in one another's decisions", and thus their relationship may affect each other's perceptions, beliefs and actions, and secondly, "by emphasising the relationship between actors, within which individual actors are embedded, allows social phenomena that have no existence at the level of the individual actor to be detected". Therefore, a firm's activities are not performed in isolation. They are more or less embedded in the wider web of business activities (Forsgren and Johanson, 1992). These clinical activities are co-ordinated through interactions between health centres. This interaction process develops over time with how to interpret each other's acts (Hakansson and Johanson, 1988).

Therefore, as a result of the above, the network and communication model assumes that business takes place in a network setting where different business actors are linked to each other through direct and indirect relationships. The network of relationships is the unit of analysis, not the individual firm (Forsgren and Johanson, 1992). Indeed the emphasis on connection is important, because networks emerge and develop as a consequence of interactions. Relationships form the context in which interactions take place. Thus, grounded theory explicates these relationships by adopting a process perspective (communication theory and network) as opposed to a unit perspective.

3.4 Significance of Social Scenarios

Scenarios are informal narrative descriptions. As Carroll (1999) claims, they are stories about human activity and they have long been used in the humanities and social science to describe and to analyze human behaviour. In analysing and designing systems and software, one needs to understand better how they can transform and be influenced in the context of human activity. This is the only way we can hope to accomplish control over the *materials* of design. A straight approach is explicitly to envision and document typical and significant activities early and continuously in the development process. Such descriptions, often called scenarios, maintain reasoning about situations of use, even before those situations are actually created (Weidenhaupt et al, 1998)

According to Carroll (1999), scenarios are stories about people and their activities. Scenarios highlight goals suggested by the appearance and behaviour of the system, what people try to do with the system; what procedures are adopted, not adopted, carried out successfully or erroneously; and what interpretations people make of what happens to them. Scenarios incorporate *agents* or *actors*. Every scenario involves at least one agent and at least one goal. In Carroll's (1999) view, scenarios have a plot; they include sequences of *actions* and *events*, things that actors do, things that happen to them, changes in the circumstances of the setting, and so forth. Particular actions and events can facilitate, obstruct, or be irrelevant to given goals. Scenarios can help designers and analysts to focus attention on the assumptions about people and their tasks that are implicit in systems and applications. Scenarios take into consideration the ambiguities of technology and provide a constructive framework for a design-based model of human-computer interaction (Carroll, 1999).

As a result of the above, a scenario, by itself, is a customised, goal-oriented narration or description of a situation, with a mention of actors, events, outputs and environmental parameters. In simple words, a scenario (1) depicts a sequence of distinct actions that might be taken to achieve a particular job; and (2) details the sequence of interactions (comprising exchange of messages and responses to intermediate outcomes) performed by entities to fulfill the purpose (Beeler et al., 1998).

3.4.1 Tacit Knowledge

The knowledge possessed by an individual or domain expert may be broadly distinguished as Explicit Knowledge and Tacit Knowledge. Explicit Knowledge can best be explained as canonical knowledge, i.e. knowledge formalised within databases, business rules, manuals, protocols and procedures (knowledge about how things should work) and so on. Tacit Knowledge is non-articulated knowledge, more appropriately, it can be referred to as non-canonical knowledge (knowledge about what really works) (Nonaka, 1994).

Tacit knowledge does not manifest as rules, rather it exists as the domain expert's skills, common sense and intuitive judgement whilst solving problems. So, a typical database is not necessary a good or complete carrier of an expert's knowledge about practice. The general belief shared by knowledge practitioners is that much of the strategic knowledge about how business processes work is stored tacitly within the employee's minds and is difficult if not impossible to reproduce in documents, databases, or sets of formal procedures. Much of the current research in the realms of knowledge management pertains to (i) the capture of tacit knowledge and (ii) its transformation to explicit knowledge (Frappaolo and Toms, 1997). In the next paragraph we define tacit knowledge.

The Merriam-Webster dictionary defines the word tacit as an adjective meaning "expressed or carried on without words or speech; implied or indicated but not actually expressed". Therefore, tacit knowledge is considered as knowledge that is unexpressed yet implied or indicated. The act of an expert imparting his or her knowledge is merely an external expression of the deep, experiential, intuitive and inculcated knowledge that make up his/her being. According to (Polanyi, 1974), there are three main characteristics of knowledge:

1. Knowledge is derived by true discovery.
2. Knowledge is public and personal.
3. An inherent, yet fundamental, knowledge that typically underlies explicit knowledge.

Based on the above classification, the third characteristic best signifies the nature of tacit knowledge, mainly suggesting that tacit knowledge leads to the manifestation of explicit knowledge as verified by individuals. Generally, tacit knowledge is characterised as follows: (Cheah and Abidi, 2000 p.3)

- *Tacit knowledge is fuzzy, subjective and less manipulatable.*
- *Tacit knowledge arises less from the mind and more from human experience. It includes emotional and contextual experience, dreams, belief systems, insights, and intuition.*
- *Tacit knowledge is highly personal and difficult to formalise and communicate.*
- *Tacit knowledge may be identified as 'patterns' used to classify symptoms and associate these with solutions.*

Having defined tacit knowledge, the focus may now shift towards the use of a scenario to represent the knowledge.

In traditional knowledge acquisition dialect, a knowledge engineer typically derives knowledge from reference materials, databases, and human experts. Although there are many methods to procure knowledge, a typical knowledge acquisition exercise involves the interviewing of domain experts, and subsequently observing and analysing their problem solving methodologies (VonKrogh et al, 2000). Generally, traditional knowledge acquisition approaches work well to procure explicit knowledge. However it is widely contended that traditional strategies are quite ineffective when it comes to acquiring an expert's tacit knowledge; although to some extent, we can infer, or more so derive, a domain expert's tacit knowledge by inquiring about his/her operative behaviour and values, i.e. asking how (s)he tackled a particular problem.

In this work we follow a tacit knowledge explication approach that involves the presentation of a scenario pertaining to hypothetical problem situations for domain experts and in turn to record their tacit problem-solving methodology and knowledge, as well as their explicit knowledge, to solve the given problem. The specialised knowledge extracting scenario is hypothetical but is designed to reflect problems whose solution may demand an interplay of formal, informal and ad hoc intuitive (or based on experience) judgements.

A scenario, (a) depicts a sequence of distinct actions that might be taken to accomplish a particular task; and (b) details the sequence of interactions (comprising exchange of messages and responses to intermediate outcomes performed or experienced by entities to fulfil the goal) (Beeler et al, 1998). In essence, a scenario is a collection or sequence of hypothetical (but imitating real) situations encountered by a domain expert, together with the intermediate responses/actions by the domain expert and henceforth describes one or more episodes or events of the scenario, as explained in Section 3.2.

This is based upon the belief that the explicit characterisation of the full context (i.e. a description of the social settings, resources and goals of the users) in describing a particular situation is an important consideration (Cheah and bidi, 2000). For that matter, the provision within the scenario representation to link contextual documents to the sequence of events is deemed as a crucial factor in distinguishing the scenario representation scheme from other knowledge representation schemes. Since tacit knowledge is both rich in content, such contextual information is imperative for the successful illustration of the bigger picture (i.e. the sequence of episodes and events). Therefore, we use the scenario to facilitate the understanding of the 'sociality context' of the Grounded Theory (GT).

3.4.2 Role of Scenarios in IT

Many research communities in IT areas have incorporated scenario-building design methods and tools into their agendas. Indeed, one of the roles that scenarios are playing in research on software and systems is to integrate diverse disciplinary views originating, for example, in human-computer interaction and software engineering. It appears that scenarios may provide a common, minimally structured description that various approaches can specialise and elaborate for their distinct purposes as interdisciplinary issues in scenario management (Carroll, 1999).

Scenarios of human-computer interaction help us to understand and to create computer systems and applications as artifacts of human activity-as things to learn from, as tools to use in one's work, as media for interacting with other people. Scenario-based design of IT addresses five technical challenges: scenarios evoke reflection in the content of design work, helping developers coordinate design action and reflection. Scenarios are at once concrete and flexible, helping developers manage the fluidity of design situations. Scenarios afford multiple views of an interaction, diverse kinds and amounts of detailing, helping developers manage the many consequences entailed by any given design move. Scenarios can also be abstracted and categorized, helping designers to recognize, capture and reuse generalizations and to address the challenge that technical knowledge often lags the needs of technical design. Finally, scenarios promote work-oriented *communication among stakeholders*, helping to make design activities more accessible to the great variety of *expertise* that can contribute to design, and addressing the challenge that external constraints designers and clients face often distract attention from the needs and concerns of the *people who will use the technology*. The researcher uses work-oriented to address these key words marked in italic in the scenario design (IDN, healthcare provider and patient) (Carroll, 1999).

Human-computer interaction work seeks to describe and direct the appearance, operation, and application of technology and its consequences on people, organisations, and their practices. As a result, scenarios emphasise qualitative descriptions of human activity, directly engaging the laws of the social and behavioural sciences, our knowledge of what people need to do and wish to do, what they are most likely to do, how they will go about doing it, what they are most likely to recall or forget, what sorts of performance errors they are most susceptible to make, and so forth. This can provide guidance on the design of tasks, functionality, and user interface metaphors. The researcher examines all related ingredients in the HCI to construct the scenario (Kuutti, 1995; Carroll, 1999).

Therefore, two assumptions have been introduced in Sections 3.2 and 3.3 of this Chapters, based on the literature review: - (i) medical work uses medical records and (ii) medical work is based upon networks and communication. These assumptions are used in order to derive a theory that is grounded in a social setting that is constructive and widely applicable to scenario-based concepts. The choice of scenario to describe the communication among all involved parties within HCI is to analyse and explain the relationship within the 'sociality context'. The researcher find this is the most appropriate means of exploration that could deploy such new concept of the 'pay-per-use' concept in the State of Kuwait and to use the GT method to address the research question. GT uses scenarios to study the action and the behaviour of the clinical setting that describes the tacit knowledge in Kuwait's healthcare delivery system. Kay et al (1999) used a generic scenario developed by a group of healthcare professionals for validating the electronic health care record architecture, using communication theory to exchange information. Thus the scenario is a reusable (some part of it can be re-used, if not all) approach (Key et al, 1999). Both assumptions emphasise the social process of the healthcare delivery, and that the unit is the process. The following sections will be about Grounded Theory and how we address the research question by constructing the scenario with the two assumption to explain the 'sociality context'.

3.5 Grounded Theory (GT)

Research strategies or methods provide the means to collect data. Data can be collected from several sources using different methodologies. The data required can be classified as qualitative if they come in word form, while they are regarded as quantitative if they come in the form of numbers (Neuman, 1997). The proper selection of quantitative and qualitative methods, and the understanding of their application to the research context are vital to the success of the research in presenting the phenomenon being studied in a scientific frame. However, the choice of either a qualitative or a quantitative approach as the most appropriate for a particular study has always been problematic, because a decision on its appropriateness cannot be made in isolation from the context in which the research problem exists (Neuman, 1997).

Quantitative research is used mainly to test a theory by testing individual hypotheses. These hypotheses are attempts to establish relationships between variables or concepts. Concepts in quantitative research are described by distinct variables. The primary data collection methods used are survey methods such as questionnaire and structured interview, which are quantifiable. Research analysis is performed by using statistics, tables, or charts, and link what they express to the hypotheses (Balian,1982; Neuman, 1997).

Qualitative research differs from quantitative research in its way of generating information. It concentrates on a particular situation where depth is more important than generalisation. In qualitative research, research questions are posed rather than hypothesised. Concepts take the form of themes, and data take the form of words of participants from actions, behaviour of people in observation or scenarios. Many methods are associated with qualitative research (Neuman, 1997).

3.5.1 GT Methodology

Grounded theory is a general methodology for developing theory that is grounded in data that are systematically gathered and analysed. The methodology was presented initially by Glaser and Strauss in *The Discovery of Grounded Theory* (1967). The method is concerned with discovering theory that is grounded in social settings. Glaser and Strauss had three declared purposes: firstly, to offer the rationale for theory that was grounded; secondly, to suggest the logic for and specifics of grounded theories; and thirdly, to legitimise qualitative research. Grounded theory is a method that has been used extensively across a variety of social science disciplines (Layder, 1982). Charmaz (1990) takes a social constructionist approach to grounded theory, viewing it as a method involving a dialectical and active process, and the outcome of any research using this method, "as a social construction of the social constructions found and explicated in the data" (p. 1165). Data collection is guided by theoretical sampling, or sampling on the basis of theoretically relevant constructs.

The method dates back to 1967, but its use in IS research is very recent. It is growing in popularity, particularly in the interpretative IS research paradigm, for enabling rich and context-sensitive analysis of social situations (Baskerville and Pries-Heje, 1999; Hughes and Wood-Harper, 1999). Useful summaries of the use of GT in IS research can be found in Hughes and Howcroft (2000) and Urquhart (2001). In the method, conceptual properties and categories may be 'discovered' or generated from the qualitative data by following a number of guidelines and procedures, where the aim is to indicate the importance of the actors in the social setting.

The 'sociality problem' in the information architecture model in the healthcare delivery system stems from its interdisciplinary roots. Components from different disciplines are difficult to integrate because they come encumbered with values, meanings and associations that often remain immiscible. Grounded theorists contend that the issue of the sociality problem can be addressed by focusing understanding and explanation on processes rather than on units. They believe that the grounded theory method is particularly oriented towards understanding processes and, as a result, only focus on social units to study the movement of social life through time rather than on units such as persons and their roles (Strauss and Corbin, 1994).

3.5.2 GT Approach

Selecting the most appropriate research approach to achieve the research aim depends on the specific research questions. The question is "Can 'pay-per-use' allow easy national and international access to electronic patient health records, and is it an appropriate approach for healthcare in a country such as Kuwait?". Neuman (1997) explains, "It takes skill, practice, and creativity to match a research question to an appropriate data collection technique"(p.30). Stern (1980) has highlighted several ways in which grounded theory differs from other methodologies:

1. The conceptual framework is interpreted from the data rather than from previous studies, although previous studies always influence the final outcome of the work.
2. The researcher attempts to discover dominant processes in the social science rather than describing the unit under study.
3. Rather than following a series of linear steps, the investigator works within a matrix in which several research processes are in operation at once.

All researchers approach their subject though explicit or implicit assumptions about the nature of the world and the way it may be investigated (Burrell and Gareth, 1979). Accordingly, it is necessary that these assumptions are spelt out clearly when deciding or making judgement on a particular research strategy. Thus, while one research strategy should not be emphasised to the exclusion of others, greater interest in the Grounded Theory method is warranted (Neuman, 1997).

Indeed, Charmaz (1990) views GT from a social constructionist viewpoint which assumes an active observer whose decisions very much shape the process and outcome. In Hutchinson's (1988) view is that, "Grounded Theory is qualitative in its philosophy of science, its data collection, its methods of analysis, and its final product offers a rich and complex explanatory schema of social phenomena .... [it] is a form of social criticism; it does make judgements about identified patterns of social interaction" (Hutchinson, 1988, p. 126). It allows for the exploration of a complex and multifaceted environment, this being an important aspect of any 'real world' scenario, such as healthcare institutions (Strauss and Corbin, 1994).

The selected *research design* (in our case constructing a scenario with two assumptions) should take into consideration the issue of the sociality problem, which can be addressed by focusing understanding and explanation on processes rather than on units in the scenario building. A scenario is very much similar to a *case*. Cases are simply 'frozen' snapshots of an episode and may lose whatever significant temporal elements they may possess. Whereas scenarios can manifest a temporal nature whereby they can capture the sequence of events as they may have occurred during a particular episode. Thus, scenarios can share the same structure as cases though temporal information and can be operated by reasoning strategies (similar to the ones used in case base and qualitative reasoning) to abstract tacit knowledge from them (Cheah and Abidi, 1999, 2000).

Basically, a scenario may be composed of four main parts (Potts et al., 1994;Schultz et al., 1997);

1. *Identification/context block*: Contains a scenario's unique identification number, contextual information, and the time frame in which the event occurred. Context refers to an environmental or situational description (within one discipline you may have many scenario) in which the scenarios were conceived and presented to the expert.

2. *Trigger event*: States the starting event of the scenario with various attributes and their values.

3. *Episodes:* Each episode consists of a sequence of events. Each event may consist of either a normative point, obstacle point or action. Normative points refer to events that are expected to happen on a normal basis. Obstacle points, however, refer to events that hinder the progress of the task at hand. Actions define a course of action undertaken by an actor. The above parts and events may also state the actor and object involved and are made up of various attributes and values.

4. *Concluding event*: States the event attributes and their values at the end of the scenario.

In essence, a scenario is a collection or sequence of hypothetical situations encountered by a domain expert, together with the intermediate responses/actions by the domain expert and henceforth describes one or more episodes or events of the scenario. Thus, for this research, we will use a *trigger event, episodes* and a *concluding event* for each healthcare discipline interaction.

The Grounded Theory method is particularly oriented towards understanding processes and, as a result, only focuses on social processes to study the movement of social life through time rather than on units such as persons and their roles. Grounded Theorists distinguish between the two as follows: researching units is generally concerned with developing a static description, whereas processes are conceptually developed to account for behaviour as it occurs over time (Strauss and Corbin 1998).

The choice of GT for this work is based on the research method being:

1. Inductive (that allows the authorities to implement healthcare systems incrementally).
2. Investigative not prescriptive (the solution therefore requires that the problem be analysed in such a way as to shed light on the organisation, its IT, and the way in which people use it). This approach is aligned with a socio-technical systems approach (Mumford and Beckman, 1994), which seeks to integrate the social, technical and organisational aspects of an open system.

The focus for the research is the relationship between the IS/ IT systems and the healthcare institution process which addresses the research question.

3.5.3 GT Process

Two analytical techniques, theoretical sampling and constant comparison are the means by which the GT proceeds. Theoretical sampling is an inductive technique that is used when the data (data could be observation of behaviour or from scenarios such as interactions and events) does not exhaust the theoretical category that is being developed (Strauss and Corbin, 1998). The constant comparative method is where bits of data are compared with other data, and where coded data are constantly confronted with new data for verification purposes. This general method of constant comparative analysis is a central feature of GT (Strauss and Corbin, 1998).

In this research, the researcher addresses the question of applying the new 'pay-per-use' concept that will facilitate the network communication between sender and receiver, and affecting the adoption of using the latest technology based on the Internet architecture in the State of Kuwait health environment. The research aims are to construct a scenario at the higher level (abstracted level, where data could be observation of behaviours, such as interactions and events) exploring the major key entities involved in exchanging health information using the 'pay-per-use' concept through access to electronic patient health records during several visits. For these purposes, the researcher will assume two situations (medical work and network communication) where 'sociality' is introduced. This research is primarily concerned with trying to understand the complexity of healthcare delivery and its relationships within the context of 'sociality'. It implies a relationship view of healthcare, which means that it is concerned with relationships between health institutions over time, rather than a single exchange episode and transactions. Assuming such a relationship view to be an important empirical phenomenon in a healthcare delivery system, GT explicates these relationships by adopting a process perspective as opposed to a unit perspective, by taking a social, psychological level of analysis and by defining the research problem from the perspective of the focal actor (Strauss and Corbin, 1998).

The following steps represent the systematic development of the research process, which seeks to answer the research question stated.

- At the outset, a relevant literature review related to advances made in healthcare delivery pertaining to medical network and IT provides the necessary background for the research, as well as the needed information (theoretical data) for further evaluation and analysis of the patient health record. Literature is only used as data to explain the theory, the theory is not derived from it (Strauss and Corbin, 1994).

- Following this, observation of a realistic clinical scenario in Kuwait, its coding and social implications, facilitates identification of the major requirements that form part of the access electronic patient health record (EPHR). That is, a scenario embedded with communication and network theory to identify the major key entity in a social context. In our situation, where information on the patient must be accessed electronically and globally, the healthcare professionals need a systematic method of content definition and a mechanism to transfer the meaning of the current information architecture flow process. A clinical scenario, developed for a variety of purposes, makes useful interpretation of explanatory phenomenon (see for example Cheah and Abidi, 1999, 2000; Kay et al, 1999,). This will enable stakeholders to judge whether or not the architecture is a socially embedded process by which actors make sense of their situation. The suggested scenario is outlined in Section 3.4 to derive the 'concepts' from each intervention (Visit No., Event No.). The information flow identifies 'categories' of information, and also identifies the 'relationships among concepts and categories'. The internal and external validity of these concepts are qualified by relationships among concepts and information categories.
- Further, comparative analysis of the various concepts (entities) within healthcare delivery and the organisation and emerging communication technologies in the IT network provides understanding of the EPHR content management for global access and the required independent infrastructure to support it in each health record

intervention. This interpretation allows information systems to be exchanged within the social context and norms (communication theory) (Saleh, 2002). The suitable, best of breed architecture and technology will prove an ideal system to be used with the pay-per-use concept as the research question stated.

The core of the research paradigm is the electronic health record and the major process attempted here is to ensure its quality and permit accessibility by all those who need it on the basis of pay-per-use. This should answer that the phenomena of technology evolution will not frighten a healthcare authority regarding investing in technology that may become obsolete. If health informatics is really to serve people and their health, attention needs to be given to the deployment of a national patient health information system. Only then, can shared information and recorded system linkage become a super-highway of knowledge between patients and their supporting professionals. The relationship between concepts and categories will be a template for any healthcare institution lacking an expert to develop such a system, in addition to a constrained budget. This overall research process is depicted in Figure 3.1 in Section 3.7.

3.7 Summary

The interpretation of an evolving theory, represented in a paradigm (pay-per-use), using a Grounded Theory approach, can be summarised and illustrated in the diagram Figure 3.1. In the figure, the core of the study is to address the research question, which investigates the pay-per-use concept, its feasibility in healthcare delivery, while preserving the quality and accessibility of the electronic patient health record globally.

At the outset, relevant literature related to advances made in healthcare delivery pertaining to medical networks and IT is reviewed. This provides necessary information (data) for evaluation and analysis of the process for secure access to EPHR. On the other hand, observation of a reusable medical scenario (Kay et al, 1999) and its social implications provides identification of the major requirements that form part of the EPHR.

Hence, a comparative analysis of relationships between healthcare delivery and social needs and a relationship view of health markets and emerging technologies promotes an understanding of the process and definition of the elements of the information architecture, which forms the baseline of the infrastructure for the pay-per-use concept.

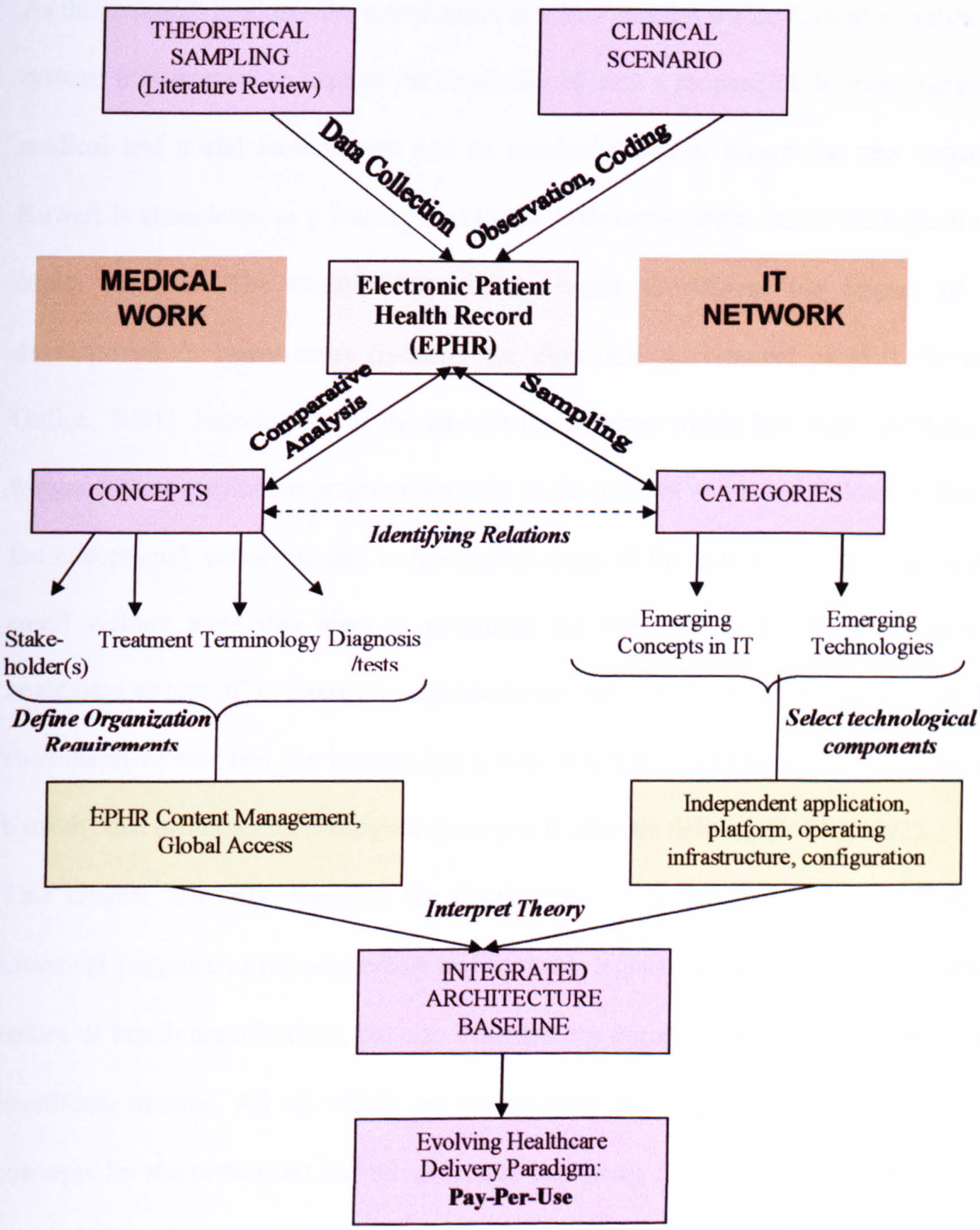
Interpretation of standards and rules for EPHR content management and global access, and selected communication technological components, provide the delineation of a theory for an integrated architecture model that can be used within a pay-per-use system.

The core of the research paradigm is the electronic health record and the major process attempted here is to preserve its quality and provide access to it by those who need it within the pay-per-use concept.

Having identified the basic features of a suitable architecture and conceptual solution for a healthcare information system, which promotes EPHR security, integrity and accessibility, and having considered its application within Kuwait's medical scenario. Therefore, further research on similar lines will be necessary to re-instate and establish the advantages of implementing the proposed system in healthcare.

The next chapter focuses on healthcare delivery in Kuwait and discusses the need for future developments in the health industry and enhancement of its services, facilities, operation and functioning. The current structure of the healthcare delivery system (Chapter 4) promotes the construction of a clinical scenario based upon several visits to the Ministry of Health and several informal meetings with medical and IT staff. The suggested scenario, which outlined and described in full in this Chapter addresses all necessary ingredients that are required to deploy the 'pay-per-use' concept in the state of Kuwait.

Figure 3.1 Conceptual Development of Healthcare Architecture Model Baseline using GT



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Chapter 4
Healthcare In Kuwait

4.1 Introduction

As this research proposes the introduction of a new concept within Kuwait's healthcare system, it is relevant to explore the feasibility of such a proposition by examining the medical and social environment and its conduciveness to accept the new concept. Kuwait is considered as a leading developed Arab nation with one of the highest per capita incomes. The country has already begun to witness the impact of IT development in many areas (recently the electronic government project) (Kuwait Online, 2001). Introduction of the pay-per-use concept within healthcare is likely to trigger further qualitative progress not only in the medical and social fields but also in the educational, economic and technological areas of the nation. The geographically small welfare state that aims at providing the best for its people and supports healthcare as one of its foremost responsibilities and seeks to boost its quality, can be considered as test bed for introducing a new conceptual paradigm (for the State of Kuwait) that promotes technological quality in healthcare delivery (MERI, !992).

This chapter not only describes the development of healthcare in Kuwait from a historical perspective (its supporting government, legislation, policies and conducive nature of health organisation), but also describes the current status and structure of the healthcare system. All of which are encouraging factors for introducing new IT concepts for the betterment and advancement healthcare delivery in the modern times. Therefore, we furnishing this knowledge in the scenario design (Chapter 5) to promote work-oriented communication among stakeholders (IDN or primary, secondary and tertiary care) and helping to make the scenario (tacit knowledge) more accessible to the great variety of expertise that can contribute to use the technology.

4.2 Kuwait's Background

The State of Kuwait, a princedom inherited from the descendants of the late Sheikh Mubarak Al- Sabah, is an Arab Islamic democratic state. The executive authority is vested in the Amir, the ruler, while the Cabinet of Ministers is headed by the Crown Prince, who is the heir apparent and Prime Minister. The Amir and the National Assembly of fifty members, who are elected through a direct secret ballot, hold the legislative authority (Lambert and Lambert, 1992). The courts in the name of the Amir exercise the judicial authority in Kuwait. The executive function of the government is carried out by the various ministries. According to the constitution, the number of ministers should not exceed one-third of the number of members of the National Assembly, which is fifty. The constitution of Kuwait guarantees freedom of religion and worship, individual liberties, and freedom of the press. The constitution protects all citizens against discrimination on the grounds of race, language, and social origin. Kuwait is a member of the United Nations, the Arab States League, the Gulf Cooperation Council, the Non-Aligned Movement and the Islamic States Conference Organisation (MERI, 1992). The State of Kuwait follows a free economy system, in which government fiscal policy plays an important role. However, the private sector makes a major contribution to the economy of the State. Certain essential consumption commodities, which are made available through cooperatives, are subsidised by the State. Examples include the supply of electricity and water. Likewise, the State ensures support of citizens with disabilities or illness, as well as the elderly, in addition to providing social insurance and social aids. Education and healthcare services are who typically require less healthcare support than the elderly members of the population, one cannot easily measure or evaluate the return of investment (ROI) in IT (Saleh, 2002), since the youth population requires preventive programmes as much as curative programmes. However, the rising trend in the influx of expatriates (Tables 4.1 and 4.3), and the rising costs of healthcare (Tables 4.4 and 4.5) have led to the imposition of health fees for expatriates by the Ministry of Health to modernise the healthcare delivery services (Ministry of Health, 2000; Ministry of Planning, 2000).

The population structure represents a rising number of citizens (Table 4.3) and expatriates in the country over the years (Table 4.1 shows a fall in expatriates due to the Gulf War in 1985 and 1995). The Ministry of Health faces the huge responsibility of catering to the medical needs of its citizens free of charge and providing good health facilities to all the residing expatriates for a nominal charge of fees.

The imposition of health fees is intended as an alternative revenue stream to help to cover rising costs. Note that a number of studies cite medical technology as a major, if not the predominant, cause of increasing health costs (examples are in Foote, 1992; Herdmann et al, 1993). The high costs associated with the adoption of new technologies have been justified by increased competition among hospitals for physician loyalty (e.g. providing continuous education and training programmes) (Coile, 1990), increased diagnostic and therapeutic effectiveness (Bautz et al, 1992), perceptions among patients and health professionals that equate new technology with high-quality medical care (Duncan, et al 1995), and the demands of healthcare consumers (James et al, 1991).

The acquisition of new technology can be one of the most critical decisions a senior hospital executive makes, and it can have dramatic effects on the healthcare institution.

provided free to all citizens. The country is divided into six governorates: the City, Hawalli, Farwania, Qurain, Ahmadi, and Jahra. Each governorate is headed by a governor and administered by a governorate council. The official language of Kuwait is Arabic (Abd-El-Bary, 1993).

4.3 Geography of Kuwait

The State of Kuwait occupies the north-western corner of the Arabian Gulf, which forms its eastern boundary. It is bounded in the east by the Arabian Gulf, in the south-west by the Kingdom of Saudi Arabia, and in the north-west by the Republic of Iraq. The total area of the State of Kuwait is 17,818 sq. km. The location of Kuwait, between latitudes 28', 30" and 30', 06" to the north of Equator and between longitudes 46' 30" and 48' 30" to the east of Greenwich determines the climate of the country, which is typical of the Sahara geographical region (Slot, 1998).

4.4 Demographic Characteristics

Demographic study has become one of the independent statistical sciences, and information related to the number, characteristics and distribution of population is of great importance for policy-making and the setting up of planning programmes. The census of the country states that almost 50% of the population belong to the youth category. The number of Kuwaitis, represented in the 1985-1995 censuses (Tables 4.1 and 4.2), in the age group 0-4, 5-9, 10-14, 15-19 totalled 360,719 individuals out of the total population of 653,616 and dependents, Among the non-Kuwaitis, about 75% of the population was aged 15-50, reflecting the significance of adult migration to Kuwait for work. Hence, given the fact that the major part of the population constitutes the youth for the years 1985-1995 (Table 4.1) and for the years 1998-2000 (Table 4.3), The high initial cost of a device, potentially large physical plant modifications, requirements for highly trained technical staff, and maintenance costs must all be considered before a new technology is acquired. Many facilities have instituted technology assessment and acquisition protocols in an attempt to standardise the decision-making process (Hoppszallern et al, 1991).

Table 4.1 Population by Age Groups, Sex & Nationality Census 1985-1995

Age, Sex Group	1985			1995		
	Kuwaiti	Non-Kuwaiti	Total	Kuwaiti	Non-Kuwaiti	Total
0-4 M	42,247	81,010	123,257	55,281	31,236	86,517
F	41,288	77,655	118,943	52,075	29,573	81,648
Total	**83,535**	**158,665**	**242,200**	**107,356**	**60,809**	**168,165**
5-9 M	37,014	70,077	107,091	49,883	33,925	83,808
F	36,255	67,041	103,296	48,300	31,896	80,196
Total	**73,269**	**137,118**	**210,387**	**98,183**	**65,821**	**164,004**
10-14 M	32,264	55,600	87,864	42,751	28,316	71,067
F	31,653	52,981	84,634	41,257	27,003	68,260
Total	**63,917**	**108,581**	**172,498**	**84,008**	**55,319**	**139,327**
15-19 M	27,082	45,617	72,697	35,916	20,078	55,994
F	26,375	46,124	72,499	35,256	19,342	54,598
Total	**53,457**	**91,739**	**145,196**	**71,172**	**39,420**	**110,592**
20-24 M	22,293	54,607	76,900	30,692	38,602	69,294
F	22,063	49,425	71,488	29,879	33,972	63,851
Total	**44,356**	**104,032**	**148,388**	**60,571**	**72,574**	**133,145**
25-29 M	16,893	98,102	114,995	25,893	99,389	125,282
F	18,408	53,853	72,261	25,415	52,606	78,021
Total	**35,301**	**151,955**	**187,256**	**51,308**	**151,995**	**203,303**
30-34 M	12,654	98,323	110,977	20,997	103,567	124,564
F	14,350	48,396	62,746	21,503	49,543	71,046
Total	**27,004**	**146,719**	**173,723**	**42,500**	**153,110**	**195,610**
35-39 M	9,198	79,268	88,466	15,758	88,677	104,435
F	11,383	37,712	49,095	18,620	38,976	57,596
Total	**20,581**	**116,980**	**137,561**	**34,378**	**127,653**	**162,031**
40-44 M	8,578	56,230	64,808	12,039	62,695	74,734
F	8,887	24,385	33,272	14,896	23,587	38,483
Total	**17,465**	**80,615**	**98,080**	**26,935**	**86,282**	**113,217**
45-49 M	8,731	40,217	48,948	8,499	38,909	47,408
F	6,932	16,558	23,490	11,875	12,360	24,235
Total	**15,663**	**56,775**	**72,438**	**20,374**	**51,269**	**71,643**
50-54 M	6,478	24,890	31,368	7,684	20,918	28,602
F	4,999	9,857	14,856	8,993	6,166	15,159
Total	**11,477**	**34,747**	**46,224**	**16,677**	**27,084**	**43,761**
55-59 M	5,114	13,123	18,237	7,300	11,996	19,296
F	3,376	5,710	9,086	6,887	3,574	10,461
Total	**8,490**	**18,833**	**27,323**	**14,187**	**15,570**	**29,757**
60-64 M	3,460	5,580	9,040	4,844	4,682	9,526
F	2,434	3,697	6,131	4,658	2,123	6,781
Total	**5,894**	**9,277**	**15,171**	**9,502**	**6,805**	**16,307**
65+ M	6,175	4,474	10,649	7,892	2,996	10,888
F	3,889	6,318	10,207	6,883	2,884	9,767
Total	**10,064**	**10,792**	**20,856**	**14,775**	**5,880**	**20,655**
Non-stated M	-	-	-	872	1,115	1,987
F	-	-	-	818	1,248	2,066
Total	-	-	-	**1,690**	**2,363**	**4,053**
Total M	238,181	727,116	965,297	326,301	587,101	913,402
F	232,292	499,712	732,004	327,315	334,853	662,168
Total	**470,473**	**1,226,828**	**1,697,301**	**653,616**	**921,954**	**1,575,570**

Source: Public Authority for Civil Information (31/12/ 1997, 1998 and 30/6/2000)

Table 4.2 Percentage Distribution of Population (1985-1995)

Age Sex Group	1985			1995		
	Non-Kuwaiti	Kuwaiti	Total	Non-Kuwaiti	Kuwaiti	Total
0-4 M	11.1	17.7	12.8	5.3	16.9	9.5
F	15.5	17.8	16.2	8.8	15.9	12.3
Total	**12.9**	**17.8**	**14.3**	**6.6**	**16.4**	**10.7**
5-9 M	9,6	15.5	11.1	5.8	15.3	9.2
F	13.4	15.6	14.1	9.5	14.8	12.1
Total	**11.2**	**15.6**	**12.4**	**7.1**	**15.0**	**10.4**
10-14 M	7.6	13.5	9.1	4.8	13.1	7.8
F	10.6	13.6	11.6	8.1	12.6	10.3
Total	**8.9**	**13.6**	**10.2**	**6.0**	**12.9**	**8.8**
15-19 M	6.3	11.4	7.5	3.4	11.0	6.1
F	9.2	11.4	9.9	5.8	10.8	8.2
Total	**7.5**	**11.4**	**8.6**	**4.3**	**10.9**	**7.0**
20-24 M	7.5	9.4	8.0	6.6	9.4	7.6
F	9,9	9.5	9,8	10.1	9.1	9.6
Total	**8.5**	**9.4**	**8.7**	**7.9**	**9.3**	**8.5**
29-25 M	13.5	7.1	11.9	16.9	7.9	13.7
F	10.8	7.9	9.9	15.7	7.8	11.8
Total	**12.4**	**7.5**	**11.0**	**16.5**	**7.8**	**12.9**
30-34 M	13.5	5.3	11.5	17.6	6.4	13.6
F	9.7	6.2	8.6	14.8	6.6	10.7
Total	**12.0**	**5.7**	**10.2**	**16.6**	**6.5**	**12.4**
35-39 M	10.9	3.9	9.2	15.1	4.8	11.4
F	7.5	4.9	6.7	11.6	5.7	8.7
Total	**9.5**	**4.4**	**8.1**	**13.8**	**5.3**	**10.3**
40-44 M	7.7	3.6	6.7	10.7	3.7	8.2
F	4.9	3.8	4.5	7.0	4.6	5.8
Total	**6.6**	**3.7**	**5.8**	**9.4**	**4.1**	**7.2**
45-49 M	5.5	3.7	5.1	6.6	2.6	5.2
F	3.3	3.0	3.2	3.7	3.6	3.7
Total	**4.6**	**3.3**	**4.3**	**5.6**	**3.1**	**4.5**
50-54 M	3.4	2.7	3.2	3.6	2.4	3.1
F	2.0	2.2	2.0	1.8	2.7	2.3
Total	**2.8**	**2.4**	**2.7**	**2.9**	**2.6**	**2.8**
55-59 M	1.8	2.1	1.9	2.0	2.2	2.1
F	1.1	1.5	1.2	1.1	2.1	1.6
Total	**1.5**	**1.8**	**1.6**	**1.7**	**2.2**	**1.9**
60-64 M	0.8	1.5	0.9	0.8	1.5	1.0
F	0.7	1.0	0.8	0.6	1.4	1.0
Total	**0.8**	**1.3**	**0.9**	**0.7**	**1.5**	**1.0**
65+ M	0.6	2.6	1.1	0.5	2.4	1.2
F	1.3	1.7	1.4	0.9	2.1	1.5
Total	**0.9**	**2.1**	**1.2**	**0.6**	**2.3**	**1.3**
65+ M	-	-	-	0.2	0.3	0.2
F	-	-	-	0.4	0.2	0.3
Total	-	-	-	**0.3**	**0.3**	**0.3**
Total M	100.0	100.0	100.0	100.0	100.0	100.0
F	100.0	100.0	100.0	100.0	100.0	100.0
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: Public Authority for Civil Information (31/12/ 1997, 1998 and 30/6/2000)

Table 4.3 Population by Age Groups, Sex and Nationality (1998-2000)

Age, Sex Group	1998		1999		2000	
	Non-Kuwait	Kuwaiti	Non-Kuwaiti	Kuwaiti	Non-Kuwaiti	Kuwaiti
0-4 M	41,877	64,582	41,013	64,759	41,151	66,403
F	40,215	61,839	39,636	61,719	39,598	63,177
Total	**82,092**	**126,421**	**80,649**	**126,478**	**80,749**	**129,580**
5-9 M	40,332	57,572	37,988	59,988	36,144	60,296
F	38,212	55,417	35,951	57,393	34,303	58,029
Total	**78,544**	**112,989**	**73,939**	**117,038**	**70,447**	**118,325**
10-14 M	39,891	50,238	39,184	51,864	37,555	52,773
F	36,956	49,398	36,377	50,934	35,016	51,626
Total	**76,847**	**99,636**	**75,561**	**102,798**	**72,571**	**104,399**
15-19 M	34,789	41,867	35,363	43,819	34,578	44,414
F	30,226	41,189	30,617	43,140	29,782	43,836
Total	**65,015**	**83,056**	**65,980**	**86,959**	**64,360**	**88,250**
20-24 M	150,685	31,356	150,868	32,079	142,744	32,581
F	67,328	31,133	64,279	32,369	60,339	33,057
Total	**218,013**	**62,489**	**215,147**	**64,448**	**203,083**	**65,638**
30-34 M	189,432	26,955	181,786	27,861	177,822	28,220
F	71,499	28,140	72,388	29,216	69,891	29,821
Total	260,931	55,095	254,174	57,077	247,713	58,041
35-39 M	155,311	21,004	147,547	22,385	144,971	23,047
F	63,253	23,309	59,753	24,587	56,395	25,323
Total	**218,564**	**44,313**	**207,300**	**46,972**	**201,366**	**48,370**
40-44 M	123,776	15,844	117,268	16,457	116,465	16,725
F	42,295	19,770	40,660	20,566	39,567	20,835
Total	**166,071**	**35,614**	**157,928**	**37,023**	**156,032**	**37,560**
45-49 M	80,416	11,007	77,251	12,264	76,372	12,544
F	23,043	14,616	22,654	15,839	22,109	15,955
Total	**103,459**	**25,623**	**99,905**	**28,103**	**98,481**	**28,499**
50-54 M	45,993	8,293	44,413	8,502	44,509	8,623
F	11,544	11,648	11,363	12,224	11,335	12,342
Total	**57,537**	**19,941**	**55,776**	**20,726**	**55,844**	**20,965**
55-59 M	23,996	7,578	22,291	7,725	22,023	7,670
F	5,886	8,699	5,797	9,199	5,740	9,353
Total	**29,882**	**16,277**	**28,088**	**16,924**	**27,763**	**17,023**
60-64 M	12,348	6,755	11,522	6,896	11,375	6,995
F	3,452	6,594	3,397	6,871	3,386	7,099
Total	**15,800**	**13,349**	**14,919**	**13,767**	**14,761**	**14,094**
65+ M	7,101	9,923	6,951	10,424	7,003	10,589
F	4,690	9,672	4,666	10,177	4,588	10,806
Total	**11,791**	**19,595**	**11,617**	**20,601**	**11,591**	**21,395**
Total M	1,002,718	388,687	970,865	401,433	946,986	407,871
F	482,137	397,323	471,834	410,822	455,294	418,212
Total	**1,484,855**	**786,010**	**1,442,699**	**812,255**	**1,402,280**	**826,083**

Source: Public Authority for Civil Information (31/12/ 1997, 1998 and 30/6/2000)

The historical development of healthcare facilities in the country can be traced as follows. Most of the historical information has been taken from Ministry of Health (MOH) either in Arabic documents (translated) or in the English language.

4.5 Development of Kuwait's Healthcare Delivery

The State of Kuwait has developed a comprehensive and responsive public health system for its people. In fact, the availability of health services is a constitutional right accorded to all Kuwaitis. Although the concept of modern healthcare dates back to the year 1912, the year in which the first clinic was established, the health delivery system entered a new era with the independence of Kuwait in 1961, the year when the Ministry of Public Health (MOH) was established. The period since independence saw significant development in health services (Ministry of Health, 1984). The history of health services in Kuwait can be traced in distinct phases: the pre- and post-independence period, and the post-liberation period (after the Gulf War in 1991).

Prior to 1912, the health needs of the population were met predominantly on the basis of traditional medical practices. At that time, mainly herbs and plants were used to meet both preventive and curative needs. Considerable experience and substantial knowledge were gained during this time, which resulted in the establishment of the Centre of Islamic Medicine. The benefits of research could be felt in the overall system and in medical specialities. The first clinic in Kuwait was set up by an American mission in 1912, at the invitation of the ruler of Kuwait, Sheikh Mubarak Al Sabah. It provided primary care services, and later, in 1917, the first government clinic for women was established (Ministry of Health, 1984). During the same year, the first dispensary in Kuwait was also set up. In 1936, the Department of Health was established to provide various health services, vaccination and curative treatment.

Medical staff in the department, however, was very limited. The period between 1949 and 1960 witnessed a sharp expansion of medical services. The cornerstone in the foundation of the health delivery system in Kuwait was the establishment of the first hospital, the (old) Amiri hospital, in 1949. An annexe to that facility was built in 1956 and was used for a number of years as an outpatient department. Over the years, new service departments were added to the Amiri hospital. Several clinics were established to meet the needs of the population in different areas. By 1960, there were 16 clinics in Kuwait. The first Maternal and Child Health (MCH) centre was opened in 1955. By 1960, three more centres were added, and the number of MCH centres rose to ten. The Psychiatry hospital was opened in 1958. Another important event was the establishment of the Chest Diseases hospital, which became operational in 1959. Development of school health programmes and emergency medical services further triggered progress (Ministry of Health, 1984).

Kuwait entered a new era when it gained independence in 1961. In the same year, the Ministry of Public Health was established. It consisted of two major departments, in addition to administrative and supportive services, the department of preventive medicine and the department of curative medicine. Two significant developments during the period were the establishment of the (old) Maternity hospital in 1961 and the Sabah hospital in 1962. From 1975 onwards, the progress in the health sector was significant. The number of hospitals increased to 11 by 1980, and later to 16 by 1989. The number of primary healthcare centres were increased from 12 to 68. Various facilities such as dental clinics grew from 94 in 1980 to 222 in 1989; maternal care centres rose in number from 18 to 24, while child-care centres rose from 28 to 43; and preventive care centres increased from 23 to 30. This expansion necessitated major organisational changes and led to a new era. However the linear progression, seen until 1989, suffered a setback in 1990 in all aspects of healthcare due to the Iraqi invasion of Kuwait. The number of clinics, hospital beds, doctors, dentists, nurses, pharmacists, etc. showed a significant decrease as compared to 1989 levels. Though the progress after the liberation of Kuwait was slow, it grew steadily and once again showed the same momentum as in the early 1980s (Ministry of Health, 1998).

In terms of organisation and administration, healthcare delivery demands an organised networking environment, where different healthcare delivery units are inter-linked and working in co-ordination. Kuwait's reputation of a welfare state is evident by the contributions made by the State and the MOH's cost allocation for medical facilities. Details of the current set-up will be giving in Section 4.8

4.6 Healthcare Costs

In the year 2000, the MOH in Kuwait employed a total of 28,275 individuals, who worked for the provision of healthcare services and the management of supporting programmes and organisations. Of these, 44.5% were males and 55.5% females, 49% Kuwaitis and 51% Non-Kuwaitis. Doctors, nurses, and dentists constituted approximately 42% of the total work force of the MOH (11%, 29% and 1.8%, respectively). The rest (58%) were pharmacists, paramedical technicians, administrators, and others. The Minister for Health, who is assisted by a number of top assistants and officials, heads the MOH. The various services of the MOH are provided in accordance with norms and standards that were devised almost forty years ago. Experienced experts and consultants from various countries provide the necessary assistance in providing specialised medical services. While surveying the costs by MOH, it can be observed that around 79.3 % is expended for salaries and medicine and less than 8 % is spent for training the staff, while the amount spent on IT was a very small fraction due to the lack of use of IT in the healthcare delivery (Tables 4.4, and 4.5).

Healthcare Expenditure (KD)	Years				
	1995-1996	1996-1997	1997-1998	1998-1999	1999-2000
Government expenditure on health (Thousand KD)	275,720	281,777	297,231	297,150	282,552
Expenditure (% of total budget)	6.6	9.6	6.8	7.0	6.8
Cost Per Capita (in KD)	141	124	123	124	126

Table 4.4: Healthcare Expenditure by Government (KD)

Source: Ministry of Health (30/06/2001)

Table 4.5: Healthcare Expenditure by MOH (KD)

Expenditure Type	1998-1999	%	1999-2000	%
Salaries(KD)	174,729,727	62.1	175,933,050	62.9
Purchase of Goods/Services	39,361,893	14.1	45,930,466	16.4
Unclassified Expenditure	23,171,075	8.3	23,847,787	8.5
Projects	27,527,665	9.8	17,555,675	6.3
Consumption Expenditure	16,415,790	5.8	16,479,220	5.9
Total (KD)	**281,206,150**	**100**	**279,746,198**	**100**

Source: Ministry of Health (30/06/2001)

4.7 Healthcare Legislation

The State of Kuwait, until recently, provided healthcare to its population free of charge. The legitimacy of the healthcare delivery system stems from the constitution, which contains four articles that provide the foundation of the country's policy towards healthcare (this is a direct translation from Ministry of Health, 1984 documents).

Article 9: *The family is the cornerstone of the community. Religion, morality and patriotism of the homeland form the foundation for the family. Its existence is preserved by law, which strengthens its ties and consequently protects the mother and child.*

Article 10: *The state provides care to youth and protects them from exploitation and from moral, physical and spiritual neglect.*

Article 11: *The state ensures aid to citizens in old age, illness or inability to work, and provides them with services of social security and healthcare.*

Article 15: *The state is responsible for public health and the means of prevention and treatment of diseases and epidemics.*

Review of the above four articles reveals the country's policy governing the healthcare system is all-encompassing and comprehensive. In other words, it is not restricted to the preventive and curative services only, but extends to the social, moral, and ethical development of its population. Community participation is viewed as an essential element of the healthcare delivery system. Therefore, the community is encouraged to participate in the formulation of health service policies and in the delivery of health services. The overall objective is to maintain a health delivery system that is effective and efficient. Health personnel are to be trained in such a way that they meet the highest professional standards. It is the MOH that devises, tests, and implements standards in all spheres of health activities and collaborates with countries, as deemed necessary, for the exchange of resources for the advancement of the healthcare delivery system (Ministry of Health 1986).

Health services in Kuwait, as mentioned earlier, were provided free of charge to all citizens in Kuwait. The MOH started the Health Registration System in 1962. Under this system, all persons living in Kuwait were required to register themselves with the dispensary nearest to their home. This registration made them eligible for the use of preventive and curative health services. Each individual applying for registration in the system was issued with an identification number and a card. Each time an individual visited any of the healthcare facilities, the card would be presented. The receptionist prepared the necessary papers to be handled by the health provider. All papers on each individual got filed into a Medical Record File. If any citizen required specialised medical care, not available in the country, the MOH, at its own cost, would make arrangements for treatment of the patient abroad. In 2000, the number of patients treated abroad (as well as the number of attendants accompanying them) showed a considerable decline compared to previous studies (Ministry of Health, 1998 ;Ministry of Health, 2000). This reflects a desire on the part of the Health Ministry to place greater reliance on local clinical expertise as well as on some, internationally recognised consultants, invited to Kuwait, thus limiting the flow of people abroad for treatment.

4.8 Healthcare Organisation

Health services in Kuwait are provided through a three-level system of Primary, Secondary and Tertiary healthcare. Kuwait has, over the years, developed an extensive network of clinics and polyclinics. There were only two clinics/polyclinics in 1949, which increased to 38 in 1969, 71 in 1999, and 75 in 2000 (Ministry of Health, 2000). All residents in Kuwait have to register at the nearest primary healthcare facility (a clinic or a polyclinic) to avail themselves of these facilities. The clinics and polyclinics are located geographically in such a way that they are easily accessible to the residents. The farthest distance from the residence of a registered user is generally not too great (Section 4.3 shows that Kuwait's size make this possible). Primary healthcare is provided at the health facilities, each serving approximately 10,000 citizens, who are registered through the national health registration system (NHRS). The services include general practice, maternal, child health and dental. Simple laboratory tests and X-rays are provided by some of the centres. The centres refer patients to general hospitals and specialised clinics and hospitals (Ministry of Health, 2000). Furthermore, they provide services to the geriatric patients at their homes, in addition to social and rehabilitative care for needy individuals and families.

Additional services offered by some centres include: diabetic clinics, preventive services, school health section, and some speciality clinics (dermatology, general surgery, orthopaedics, ophthalmology, ENT). Laboratories in specialised centres provide more advanced laboratory tests and ultrasound examination.

Secondary healthcare is provided through six regional general hospitals, namely:

1. Al-Amiri Hospital.
2. Mubarak (Al-Kabir) Hospital, *(Hawally health region)*.

3. Al-Sabah Hospital.
4. Al-Farwaniya Hospital.
5. Al-Adan Hospital (*Al-Ahmadi health region*).
6. Al-Jahra Hospital.

These hospitals are distributed organisationally not geographically (note two hospital names are different from the region names). Each hospital has inpatient, outpatient and casualty departments. Each hospital provides internal medicine, general surgery, paediatrics, and orthopaedic services. Some hospitals also provide trauma, ENT, psychiatric, dermatology, physical medicine, and dental services. Obstetrics and gynaecology services are provided by three general hospitals: Farwaniya, Adan and Jahra (Ministry of Health, 1986).

The healthcare services provided through the six general hospitals are supplemented by speciality clinics. The rationale behind the establishment of these clinics is to minimise the patient load on the hospital's outpatient clinics, making speciality services more readily available, and providing an important link between the primary and secondary healthcare. Twenty-two specialised hospitals and centres provide this tertiary care. Most of the tertiary care specialised health centres and hospitals are located in the Al-Sabah health region (Ministry of Health, 1986).

4.8.1 Services Provided by Private Sector

The bulk of health services in Kuwait are provided by the Ministry of Health. However, some curative services are provided by the private sector as well, Kuwait has five private hospitals and three hospitals belonging to oil companies (Ministry of Health, 2000). All operate outpatient clinics during morning, afternoon, and evening hours. They also provide emergency treatments twenty-four hours a day. On the first visit, a patient pays a fee to receive an ID card and to see a doctor. Medicine and laboratory fees are additional. Private general practitioners and specialised doctors have their own surgery and they use private hospital facilities for their operations. In general, the private sector role lies outside the scope of this thesis.

4.9 Healthcare Regions

Kuwait is divided into six health regions, namely:

- Capital Health Region, primary and secondary levels.
- Hawally Health Region, primary and secondary levels.
- Al-Jahra Health Region, primary and secondary levels.
- Al-Ahmadi Health Region, primary and secondary levels.
- Al-Farwaniya Health Region, primary and secondary levels.
- Al-Sabah Speciality Medical Region, tertiary level.

Each region also includes a comprehensive preventive health programme and the requisite programmes for health promotion. Therefore, the term 'regional' represents a community or region that should share the responsibility for solving its health problems as opposed to a strict geographical region. A general hospital with a specific number of clinics (dispensaries and speciality clinics) under it fulfils such a purpose. MOH identified six health regions, each region having the potential capacity to provide comprehensive medical services to a population of 250,000 to 300,000 (Ministry of Health, 1986). The services can, however, be expanded to meet the health needs of a population of up to 500,000. The service delivery system in each region rests on a combination of Primary Health Clinic, Speciality Clinic, General Hospital, and referrals to Specialised Care Units in the Sabah health region.

The major functions (Ministry of Health, 1984) of each health region are to provide the operational parameters within which the health needs of the residents of each region will be met, as follow (this is a direct translation from Ministry of Health 1984):

1. *Defining and studying the health problems facing each region in co-operation and co-ordination with other services within the region, together with the help and participation of members of the community, institutions and national associations.*
2. *Encountering health problems and implementing a proper health plan to deal with them according to the standard set by the ministry, while simultaneously seeking the help and support of responsible members of the community.*
3. *Continuously providing the necessary primary healthcare services for each region and, by making them accessible, implementing the region's plan and keeping them under constant review.*
4. *Services within each region include creating awareness of the region's health problems, working towards disease prevention and control, encouraging proper nutrition, family planning, mother and child care, inoculation against diseases, their prevention and early diagnosis, treatment of diseases and injuries, and caring for emergency cases by means of suitable medical technology and drugs.*
5. *Providing necessary services to ensure home visit and healthcare for individuals as well as families in each region in so far as psychological, social, and rehabilitative care may require.*
6. *Each health region provides a system of effective procedure for referring cases as quickly and effectively as possible. These procedures are supervised and*

regularly evaluated in the case of referring difficult cases to the proper facilities and following them up.

7. *Each region provides backup services to primary healthcare in its hospitals, which include general medical specialisation.*
8. *Providing paramedical services and technical and administrative assistance as necessary for each health region.*

4.10 Healthcare Information System

Up until the year 2000, most of the medical and non-medical functions were based around paper work, and the use of personal computers to manage the information was minimal or was in an isolated manner, with little relation to the functions performed. So each department or healthcare discipline worked as a 'closed' system. Despite having such an inadequate core information system, the healthcare delivery system has continued to function under overloaded pressures, probably because of the dedication of the professionals involved. They work at the problems, using their memory to recall facts that may be lost in the chart, making telephone calls to locate other missing data, and keeping 'shadow charts' in their desks in anticipation of the inevitable occasion when the official chart fails to arrive in time for a patient encounter (based on several informal meeting with some doctors). Recent demand for quality and outcome-oriented information has finally proven that the electronic patient health / medical record is an essential part of every healthcare provider's strategic plan (Murphy et al, 1999). To improve information flow and attempt to gain further productivity in the delivery of healthcare, it is now becoming accepted that IS / IT strategy should move from simply departmental information to better reflect the overall delivery of care (Alshawaf, 2001).

In the year 2001, the MOH embarked on the development and application of a number of important information systems. Primary Health Information Systems in all health centres in Kuwait will have LANs and run applications designed in Oracle. Tenders for equipping these centres with servers and PCs and other relevant machines have already been processed and were delivered by early 2002. Secondly, the Health Insurance National System (HINS) will come into effect by the end of 2002 and will cover all legally resident non-Kuwaitis. Non-Kuwaitis are expected to pay a yearly premium to enable them and their dependent family members to receive medical and health services. Eligible recipients must have a valid visa and / or residency to be covered by the umbrella of HINS and MOH facilities and services.

The total population of eligible expatriates is approximately one and half million persons. The amount of the premium will vary according to a specified set of rules and regulations. HINS has three classes of premium values depending on the beneficiary's nationality, work and income and the size of his/her family. One reliable company (one bidder as the *main* contractor) is expected to undertake the task of equipping and furbishing an Integrated Information System (IIS) on the basis of a turnkey contract to supply, customise, implement, operate and train MOH personnel. The desired system must cover all the requirements of the Department of Health Insurance. It must include registration of data / information of treatments and examinations, and analyses, and all health insurance materials. Consequently, this system will produce claims to Medical Insurance companies as well as the various reports and statistics that serve MOH. On the other hand, the system must allow for a Health Insurance card production facility as well as card renewals, card replacements and expiry. Also, the insurance cards must identify the insurance category and the ratio of payment the holder will undertake and that which the insurance company will pay. The system will specify and handle all other insurance accountancies (Ministry of Health, 2001).

As a result, in the researcher's opinion, these new IS/ IT technologies and applications (Aladwani, 2000, 2001) would not achieve an integrated view of patient-oriented information if they were not intended to improve the quality of care, directly or indirectly, to help in cost-containment and better management of the health sector, and to increase the competitiveness of the healthcare delivery system. Consequently, we should not forget that the health information infrastructure cannot be seen as an objective in itself but as an enabling mechanism for continuity of care. Here the expression 'continuity of care' means continuous provision of healthcare through all the stages of prevention, diagnosis, treatment and rehabilitation, as well as continuity and collaboration across all the points of care such as hospitals, primary care centres, rehabilitation centres, labs, pharmacies, health authorities, homes, etc., with the patients at the centre, using the latest technology (Brennan et al, 2000).

This patient-centred care is a result of a growing trend for more effective management and the need for collaborative work of health professionals or, in other words, shared care. Shared care builds on a health information infrastructure linking hospitals, laboratories, pharmacies, primary care and social centres (Murphy et al, 1999). Such an infrastructure has to accommodate not only the health professionals in the State of Kuwait, but also the total population. Of course, all the health-related information shared by all of the care providers, managers and patients must be comprehensive, reliable and confidential.

4.11 Summary

The conducive geographical feature, the demanding demographic structure, the favourable constitutional and legislative set-up, the supporting stance of the Ministry of Health, and the pressing need for automated operational functioning are various factors that provide ample reasons for the need of a new, affordable, scalable flexible and low risk IT concept for healthcare.

The current situation in Kuwait (bidding for turnkey IS/IT solutions) favours an efficient healthcare delivery system and cost effective information setup, which replaces manual tasks with automated procedures, and provides easy and uncomplicated access to medical services (Ministry of Health, 2001). However, learning from other experience this project may not bring what all stakeholders needs as Saleh (2002) in his research views the failure of IS/IT in the state of Kuwait and attributed this to the lack of research investigation in this area which need to include suitable IS/IT success and level of readiness evaluations. He attributed this frequent failure to shortcomings in needed staff and skills, lack of suitable work environment (leadership, culture, structure), shortcomings in IT systems and infrastructure, and shortcomings in business process practices. He provided some cases which presented the failure of outsourcing involving some reputable international vendors where one of the cases is still in the court.

The MOH is expected to take the upper hand and initiate implementation of effective solutions to contemporary problems in healthcare. Kuwait's healthcare legislation also provides an optimistic note of support and promotes quicker solutions to existing problems by using an infrastructure that adapts to evolving technologies and concepts. Policy regulations in support of technical novelties for the betterment of healthcare provision will enable and ensure better functioning and operation in the future. The

Ministry of Health plays the leading role in establishing policies and regulating the operational network for healthcare. The administrative and organisational structures within the healthcare network should co-ordinate and work with shared responsibilities, and thus promote revolutionary changes within the healthcare industry. Having discussed Kuwait's requirement for such a concept, the next chapter delineates a feasible model framework architecture that can be co-ordinated or correlated to suit Kuwait's healthcare needs. From what has been furnished in this chapter, a scenario design (as motivated in Chapter 3) can be viewed as a process perspective using current structure of Kuwait's healthcare delivery system to focus on actions and events rather than individual acts to validate the model framework architecture. This architecture consists of two important technologies: (i) application technologies that enable human-to-computer interaction (pay-per-use concept within investment-independence), and (ii) networking technologies that enabled computer-to-computer connectivity (a networking infrastructure) (details are in Chapter 5 and 6). The advantage of that concept (renting software application) over the internet include relatively low capital expense, quick upgrades and consistent cost, and organisation need not to pay huge consulting fees, or make huge capital investment in hardware and software (Dewier, 2000). Furthermore, the 50% of population which they are under age 19 promote better planning for preventive behavioural education, and delineate the doctor-patient relationship in the form of cultural change and socio-technical issues (Chapter 7).

PAGE

NUMBERING

AS ORIGINAL

Chapter 5

Interpretation of a Model

5.1 Introduction

To escort a healthcare institution into this century successfully, healthcare professionals will be required to adopt modern and innovative ways of thinking about and using information technologies. Several trends are making information systems (IS) and information technology (IT) a critical factor in the healthcare environment. Debates over cost, access and delivery will persist. As solutions are put in place, there will be greater endeavours to manage quality, affordability, and longitudinal care will present new challenges. At the same time, there is an escalating demand for information to manage wellness, determine case-by-case costs, and allow healthcare professionals to compete for the highest-quality treatment at the lowest cost. The goal is to construct an integrated system that enables seamless patient care. This means that from birth to death, the patient's information follows him or her throughout the system. Furthermore, the patient is treated more effectively and more cost-effectively, because more and better information about that patient is accessible to the healthcare professional at the point of service. This aim is often realised in an electronic patient health record (EPHR). Hence, it is evident that the Internet-based architecture presents many technological solutions to an industry seeking broader access to manageable information.

In this chapter we use scenario-based approach the basis for discussing a model-architecture for 'pay-per-use' and attempt to interpret the governing theory that underlies the 'pay-per-use' concept. In order to do this, it is important first to describe this concept in detail, delineate its functions and role in healthcare, understand its underlying relationships, and evolve a model theory, framework, and architecture, which is interpreted within an investment-independent strategy. This strategy allows the organisation to have choice, and to gain access to all relevant services (Applications, Data, Communications, etc.) from respective vendors on a pay-as-you-go basis . The basic requirements for 'independence' are:

- EPHR must be available anywhere in order for Health Service providers to offer the best health care.
- Health care organisations must be able to choose information systems to manage patient records from the best-of-breed solutions available for health record information for various services, and on a 'pay-per-use' basis, instead of getting locked up with IS investments. In other words, IS systems must become 'platform independent', and the EPHR information asset becomes 'application independent'.
- Patient record information must remain alive with any active information systems chosen for use. In other words, organisations' choice of applications does not bind a specific format of data to process. The newly chosen application is able to process the existing and new EPHR information in the specific health care area without any data conversion constraints. Old and new EPHR data are processed consistently. In other words, applications available for choice become 'data independent'.

- Data storage of EPHR can be distributed and de-centralised but the applications chosen for EPHR management for various health care services can be configured to access data from various available data storage locations and be able to merge them logically. The end user can access the EPHR for a patient to view the patient health profile in a time frame seamlessly, although the profile EPHR for the client could be distributed across multiple data storage locations. In other words, the application and the EPHR become 'configuration independent'.

5.2 Application Service Providers (ASPs)

In the current dynamic business and technological environment, it is imperative for organizations to stay competitive through the use of new information technologies (IT) and tools. However, the development and maintenance of these new technological infrastructures are both costly and time consuming (Holohan, 2000). The shortage in the IT labour market is also putting pressure on organizations, which are aggressively expanding their technological infrastructure. In addition, the increasing popularity of enterprise resource planning (ERP) and e-commerce technologies over the last few years is presenting new challenges to IT departments. In recent years software has evolved from custom-coded, proprietary applications to pre-packaged off-the-shelf offerings and now to the development of net-centric applications. Likewise, IT infrastructure has emerged from a closed mainframe environment to distributed computing and now towards a net-centric infrastructure with the potential to link customers and suppliers. While businesses are eager to take advantage of these new technologies to create new business value and stay competitive, IT departments are finding it more and more difficult to manage the increasing number of new technologies effectively (Khalfan and Gough, 2000).

Given limited internal resources, outsourcing applications have become a viable option. As McFarlan and Nolan (1995) predicted, organisations are increasingly dependent on outside expertise to provide and maintain organizational data-processing resources. Throughout the 1990's, information system (IS) sourcing evolved into four distinct types: total outsourcing (where a company would outsource more than 70 per cent of its IS facility); selective sourcing (often using multiple suppliers); joint venture sourcing (where a company would set up or partner with another company to provide system and applications); and insourcing (where a company procures, manages and develops its own IS function) (Currie and Willcocks, 1998).

As outsourcing continued to gain momentums in the 1990's, there were concerns that small and medium companies, with low IT budgets, were unable to reap the benefits afforded to their larger counterparts (McLellan et al, 1995). Delivering information services over the Internet, application service providers (ASPs) have been set up as the answer to many organisations needs when it comes to outsourcing applications. The growths of the Internet and its acceptance among both organisations and end users have paved the way for the rise of ASP vendors (Currie and Seltsikas, 2001a).

Currie and Seltsikas (2001b) explained that an ASP is a firm which "manages and delivers application capabilities to multiple entities from data centres across a wide area network". An ASP may be a commercial entity, providing a paid service to customers or a not-for-profit or a government organisation supporting end-users. To some extent, the ASP concept revisits the service bureau model of the 1960s and 1970s, which paved the way for the large-scale IT outsourcing contracts of the 1980s and 1990s. But the service bureau model was limited in the scale and scope of software applications it provided for customers, and proved to be relatively expensive to small and medium companies with limited IT budgets and infrastructure capabilities (Currie and Seltsikas, 2001a).

ASP solutions, on the other hand, are applications-centric, which means that the core value of ASPs is to provide access to, and management of, an application that is commercially available. ASPs sell application access to customers. Through application hosting, ASPs claim to remove the burden of day-to-day IT management by assuming total responsibility for application delivery, updates and ongoing maintenance and support. This "third wave IT outsourcing" (Ekanayaka et al, 2002) typically means that the end user organizations are charged a fixed, monthly fee based on application usage and services offered. These applications are managed in a central location rather than at the customer site. Customers, therefore, access the applications remotely through the Internet or via leased lines (Currie and Seltsikas, 2001b).

ASPs are third-party service firms, which deploy, manage and remotely host software applications through centrally located services in a rental or lease agreement. ASPs are important for those researching into IT strategy and outsourcing practice, since they potentially offer a new value proposition to the customer, moving away from a product-based approach for software procurement to software-as-a-service. Thus, "in contrast with traditional outsourcing, the ASP model involves renting access to core business applications over the Internet or some other network - not simply handing over operational control of your existing data centre" (Lauchlan, 2000, p. 29). But, for the model to work, the ASP must achieve economies of scale by offering a one-to-many service rather than the one-to-one relationship found in traditional outsourcing (Ekanayaka et al, 2002).

ASPs currently procure and implement software systems for their customers, many of which are non-mission critical business-related packages (e-mail, calendaring, travel and expenses modules, etc.). However, ASPs have ambitions to provide customers with a comprehensive alternative to building and managing internal information technology operations through the provision of complex enterprise resource planning (ERP) systems (Sushil and Jatinder, 2002). The main advantage for the vendor will be to develop new business opportunities with small and medium-sized companies. For the customer, access to enterprise software at an affordable rate will, it is claimed, enhance efficiency through re-engineering business processes and operations (Currie, 2000).

ASPs offer a wide variety and range of applications. Depending on the kind of services offered, the types of services offered by ASPs can be classified as: collaboration services, electronic commerce, content services, corporate systems/ knowledge management, interfaces, network smart products, and infrastructure outsourcing (Ekanayaka et al, 2002).

Many ASPs offer solutions for business applications customised for a particular industry segment such as health care, telecommunications, or banking. Other ASPs are taking a more horizontal approach by offering hosted applications that are useful to businesses in a wide array of industries. ASPs can be categorised based on the types of applications they offer. There are four major categories of ASP: enterprise, general business, specialist, and vertical (Dewire, 2000). Each of these is briefly described below.

The enterprise ASPs usually offers high-end applications that require customisation. This category of ASPs offers application solutions such as enterprise resource planning (ERP), customer relationship management (CRM), supply chain management (SCM), or workflow and imaging software services. The various ERP and SCM vendors like SAP, Baan, PeopleSoft, Oracle, and Siebel, etc. fall into this category. Corio, through partnerships with software giant Siebel Systems and other application developers, offers hosted customer relationship management components such as sales-force automation, customer service, and e-marketing applications to customers in numerous industries (Currie and Seltsikas, 2001a).

The general business ASPs focus mainly on the needs of the small to mid-sized companies. Thus, they primarily deal with general business applications that require little or no customisation. The specialist ASPs, on the other hand, focus on a particular type of application. The fourth category of ASPs is known as vertical ASPs. These ASPs provide packaged or specialized applications for a vertical market segment such as medical practice management software or claims processing for insurance companies. All categories of ASP provide services such as managing the application environment, monitoring the application, network support, and providing upgrades, etc (Currie and Seltsikas, 2001b).

The ASP has progressed from traditional co-located, hosted offerings to include client/server collaborative and enterprise solutions and have migrated to application nuteral, distributed models based on Web services. Today most ASPs provide 'plug-and-play', type solutions and can offer solutions for all applications such as CRM, sales force automation (SFA), and ERP, etc. (Gurin, 2001). ASPs develop, manage and deliver software application capabilities to multiple entities from a data centre across the Internet (or other wide area network). ASPs can put the processing power of their software into virtually any personal computer (PC) that is hooked to the Internet. As mentioned before, instead of buying software, organisations essentially lease computer applications from ASPs. The ASP architecture has three layers: a back-bone service provider (BSP) layer, storage and Internet service provider layer, and a software layer (Dewire, 2000).

At the BSP layer, ASP has connectivity with backbone service providers. BSPs provide high-capacity, long-haul connectivity. The storage and Internet service provider layer involves alliances with Internet service providers (ISP), storage service providers (SSP) and commerce service providers (CSP) (Dewire, 2000). ISPs provide access between the Internet gateways and the BSPs. SSPs provide remote data storage locations. CSPs provide delivery, Web design, and ISP service. Management service providers (MSPs) are closely related to ASPs, offering system management services tailored for corporate IT departments. MSPs differ from traditional ASPs in that they deliver applications designed for technology management rather than applications used as business productivity tools. MSPs manage entire IT projects for their corporate customers. Some MSPs will even position themselves as complete outsourced IT departments for small and mid-sized businesses that elect not to staff an internal IT group (Fairchild, 2001). Partnerships are becoming common and ISPs, BSPs, CSPs and MSPs are becoming commodities that need strong coordination within themselves to provide better solutions through a single vendor. Usually, ASPs partner with other organisations to leverage expertise, as one partner might be providing data storage, another Web hosting services, and another the application itself (Dewire, 2000).

The third layer in the ASP architecture is the software layer that forms the front (or the client) end. The client organisation rents the software to access the application via the Internet or leased lines. Any standard Web browser can be used to run the software application from the client end. Basically, there are two approaches to engage ASPs. In the first approach, ASPs own the software and allow the clients to use the software by paying a license or monthly subscription fee. Clients have to pay an upfront contract license fee for a minimum of one year, after which they can pay a subscription fee on a monthly basis. There could be independent arrangements with MSPs, ISPs, etc. for Internet connectivity as well as for managing the entire IT set-up (Turner, 1999).

In the second approach, the entire responsibility for running the applications as well as managing the entire IT infrastructure rests with the ASP vendor. In both approaches, customers gain access to the environment without making investments in application license fees, hardware and staff. The application is managed from a central location (the ASP site) rather than the customer's sites. The ASP is responsible for delivering on the customer's contract regardless of its structure, e.g. sole provider or partnered (Dewire, 2000).

Usually, organisations prefer the second approach in which the entire application from the beginning to the end is managed by a single vendor, who in turn has partnerships among several vendors. A single-source vendor controls everything from implementation to ongoing operations and maintenance of the application.

Currently, wireless technologies are enabling consumers and business people to shop, bank, close business deals, and even pay for vending machine goods with portable Internet devices. Because of these advances in the wireless technology, companies are eager to make key applications accessible via a host of wireless devices including handsets, personal digital assistants, and Internet appliances. As the world moves towards the wireless technology, the ASP model has to equip itself to deliver applications, which can be accessed by wireless devices. Therefore, it is worthwhile to look at the emerging W-ASP model. Architecturally, the W-ASP model has the following additional features in an ASP model to provide various services through wireless devices (Sushil and Jatinder, 2002):

Translation services. Porting or translating Web content to wireless networks including initial set-up and maintenance.

Wireless application services. Data applications delivered for a fee.

M-Services (Mobile-services) content. Internet content translated and delivered through the wireless network.

Wireless infrastructure technology and services. Including software, hardware, consulting, and customer implementation delivered to the wireless carrier, content provider or wireless ASP.

The majority of ASPs have started to incorporate wireless applications protocols (WAP) features in their software to make their applications accessible through wireless devices. Therefore, W-ASP model features will become part of any ASP business model (Cox, 2000).

Finally, like most technological solutions, ASPs are subject to security issues involving data protection, privacy and communications. In many ways, modern Internet technology provides high levels of security. However, it does so in ways that are new and unfamiliar to many organisations. Even though the Internet can transmit data in a safe and secure way, there is no guarantee that every ASP uses proper security procedures and protocols (Tiernan, 2001). Organisations are often reluctant to use the Internet to routinely transmit sensitive data or to allow Internet - based technology to interact with their in-house systems. Organisations prefer interacting with the outside world for sensitive information via dedicated communications circuits (Jordan, 2001).

Moreover, one of the challenges (for ASPs) is the ability to provide not just the application but the ability to integrate it with other applications on which the customer relies (Tiernan, 2001). Organisations have legacy systems implemented in heterogeneous environments. Organizations expect the ASPs to integrate their solutions with their ongoing legacy systems that are in different formats and standards. The ability to integrate with other applications at the remote site may be one of several things that distinguish traditional remote computing solutions from those that fall under the ASP umbrella (Feurer et al, 2000). Therefore, ASPs still lack technology infrastructure that will allow them to quickly and economically connect to any and all marketplaces regardless of data and format demands.

5.3 Pay-per-use concept

The growing popularity of the outsourcing concept is fast catching up in the Middle East as a promising trend, with positive features such as minimal capital investment for hardware, software, and IT staff, and its capability of accelerated software installation, thus setting the ground for the build-up of an electronic government (Khalfan and Gough, 2000, 2001, 2002). Healthcare enterprises have outsourced entire IT departments as well as selected applications for years. The market introduced a new form of outsourcing called Application Service Providers (ASPs) developed in response to the needs of small and mid-sized institutions that have limited resources to devote to IT investments and staffing but need the capabilities to grow their services and businesses.

However the 'pay-per-use' concept, whilst similar to the ASP market, is in its infancy and remains immature and unpredictable (IBM Global Services, 2000). Thus, the 'pay-per-use' concept poses some significant risks (Glick, 2001). This immature business model has yet to be time tested and evaluated. It is important that healthcare executives understand this concept within an investment-independence strategy so that they can use it appropriately for the benefit of their organisation. 'Pay-per-use' is not a healthcare-specific IT solution. The 'pay-per-use' concept and solutions prevail over the in-house developed solutions mainly because of the shortage of skilled professionals, increasing complexity of communication and network management, rapid evolution of technology, and the need to monitor on a 24 x 365 basis. This fast implementation contrasts sharply with the long implementation times required for an organisation to host a solution in-house (Currie and Seltsikas, 2001).

The advantages of renting software applications over the Internet include relatively low capital expenses, quick upgrades, consistent costs, and versatility (Dewire, 2000). Thus, the 'pay-per-use' concept reduces the risk associated with buying software. Organisations need not pay huge consulting fees, or make huge capital investment in hardware and software. It allows organisations to focus on their core competencies of business and frees them from the need to manage the technology complexities involved in installing software, hardware, network, and related support functions (Dewire, 2000). Since the 'pay-per-use' concept is about leasing their ICT services, the clients can access these services over the Internet or through a private network. Thus, the client no longer has to maintain or upgrade the software, hardware and networks that it uses (Dewire, 2000). The researcher, in order to describe the new born concept for the scope of this research, assumes that the 'pay-per-use' concept allows the entire responsibility for running the applications as well as managing the entire IT infrastructure to rest with the ICT software services vendor. In this assumption, customers gain access to the environment without making investments in application license fees, hardware and staff (clients have to pay upfront contract license fee for a minimum of one year, after which they can pay a subscription fee on a monthly basis) (Booker, 2000).

The application is managed from a central location (the ICT service provider site) rather than the customer's sites. Usually, this assumption is preferred by most of organisations (including the MoH in Kuwait as mentioned in Chapter 4) in which the entire application from the beginning to the end is managed by a single vendor, who in turn has partnerships among several vendors. A single-source vendor controls everything from implementation to ongoing operations and maintenance of the application. This assumption has raised a number of unresolved issues to be carefully considered in order to understand the 'pay-per-use' concept within 'investment-independence' strategy:

- Data control: The concept does not require an application to be run on an organization's server or desktop. It can be run entirely on the ICT service provider server and can be browsed using a standard browser at the organisation end. This means that sensitive data of various organisations are stored on remote servers outside the organisations' control. The organisations are therefore forced to rely on the ICT service provider integrity and reconcile themselves to a loss of control over valuable data. Therefore, many organisations would be hesitant to let ICT service provider have control over their data privacy, so that the value of their data does not diminish, especially when a conflict arises (Kearney, 2000).
- Pricing strategy: From ICT service provider perspective, pricing strategies vary greatly depending on several variables such as application features, customisability, number of users, and transaction volumes. There may even be added implementation fees which depend on how much work the

implementation process entails. Usually, the ICT service provider asks customers to pay up-front for the first year of service and then ask customers for a monthly payment for succeeding years. Users are also asked to commit to ICT service providers for a longer-term contract, generally about five years (to ensure the ICT service providers viability in doing its business while carrying their customers' costs and to avoid the bankruptcy or going out of service) (Booker, 2000; Keamey, 2000).

- Inter-alliances problem: An ICT service provider delivers applications through its efficient client/server architecture. Users access the application via their browsers using a portal site. The ICT service provider manages the browser application and the individual desktops. Client/server architectures typically consume large amounts of bandwidth between PCs and servers. Since remote run applications are fully dependent on telecommunication connectivity, an ICT service provider has to partner with several other vendors to deliver solutions for broadband connectivity and storage of data. Such vendors include the telecommunications providers and storage service providers. These alliances are to be managed effectively, because a break in any of these alliances can cause considerable loss to the ICT service providers business (Booker, 2000; Dewire, 2000).
- Long-term viability: Customers are looking for more than software; they are seeking a single-vendor managed application with the right kind of people and expertise. Historically, organisations have bought software solutions as products and then customise this software to their internal needs themselves

or with the help of outside vendors. Now organisations are experiencing the shift from software as product to software as service. Organisations are interested in spending more of their time on their core competencies and are keen to outsource to get services. Hosting applications is the easy part but ICT service providers must have the resources and commitments to keep systems running smoothly (Dewire, 2000; Kearney, 2000).

- Internet connectivity - security and bandwidth: Internet connectivity directly affects the way an ICT service provider can provide access to the hosted application. Internet connections can vary from dial-up to T1 lines. The ICT service provider applications frequently work best with higher speed Internet connections. Potential customers must be convinced that their application and data will be available to them 24 x 7 and will be secure from outsiders. As Internet traffic continues to grow, potential customers must also be convinced that their access will not slow down. Many organisations that do not have higher bandwidth connectivity may find some ICT service provider solutions inappropriate. On the other hand, if these organisations use dedicated circuitry to run an application, it is secure and reliable but expensive. Also, using the Internet is cheaper than installing and maintaining private lines (Tieman, 2001).

By adopting the pay-per-use model within the frame of investment-independence theory, clients gain access to the best-of-breed software applications at affordable prices (depends on how you form the contract with the healthcare organisation or with the ICT service provider). Advancements in network technologies that permit high-speed connections from virtually anywhere have been one of the key enablers of this new form of investment-independence theory deployment. In addition to offering access to an application, pay-per-use contracts include the management of the application. Since true investment-independence runs standard software without client-specific customisation, the maintenance is easy and economical. In the next section, a comparative analysis can be made between the pay-per-use concept and other outsourcing facilities.

5.3.1 Outsourcing Versus ASP / Pay-per-use

Before starting comparative analysis, it is worthwhile observing that the pay-per-use concept may be viewed as a type of ASP provision. The key component being that it should be delivered in such a way that it is possible to switch to other applications / providers within the investment-independence framework.

In a traditional outsourcing arrangement (also referred to as facilities management), full responsibility for an IT function is usually transferred to the outsourcer and often includes the transfer of staff. Essentially, part or all of a company's IT facilities are sold to an outsourcing company. In an ASP / pay-per-use environment (a form of outsourcing) relationship, only the application is transferred. If the ASP provides a new application, the client can gain access to it for a slightly higher fee, just as if it had purchased and installed the software package (Dewire, 2000), while in 'pay-per-use', one can access the specific application with different providers, based upon requirements and also switch to other application(s) / provider(s) within the investment-independence approach. Thus, there is no restriction to one specific application or provider as in the ASP.

Table 5.1 summarises the respective benefits of services by different providers. Since 'pay-per-use' is a subset of ASP their arrangements are similar in delivery method, model and location in their offering of applications or services. They should deliver an application into an organisation from a remote location as a method, with a one-to-many relationship (rent access to applications and a shared single copy of the software among numerous customers to achieve economics of scale) as a model. Both can also deliver services over virtual private networks (VPN), and they are able to use the Internet and Web browsers to run an application. The application architecture is the same multi-tier client server or Web architecture technology. However they contrast on hardware and software ownership: ASP clients gain access to both a data centre and hardware as part of the ASP service package, thereby avoiding the need to invest in these elements themselves, while 'pay-per-use' will gain access to a multiple service provider under a *standardisation concept* and best breed of technology evolution within the investment-independence framework . There will be no long commitment to particular providers with 'pay-per-use' because the organisations now have latitude to switch their vendors for applications as required. This means one may either link with the main vendor (e.g. Oracle) (rather than third party provider) or to the healthcare institution as a new node of communication to their services.

On the other hand, outsourcing requires initial software licensing fees and a one-to-one relationship. Since the software is owned by the client and merely run by the outsourcer on behalf of the client, the delivery method is on-site or remote. Outsourcing arrangements are typically delivered over private networks. Finally, in outsourcing, hardware and software ownership, application architecture and proprietary customised application may not be located at the client site. Depending on the contract, the outsourcer takes over the operations of the client's data centre or transfers existing data to what are called proprietary systems (Curtis and Alphonso, 2000).

With the current competitive labour market, many healthcare institutions have difficulty in recruiting, hiring, training, and retaining qualified IT staff. Since the pay-per-use concept currently relies on web browsers, healthcare institutions can train Internet (limited experience) users more quickly with minimal technical expertise than would be possible using a new software application (Chen and Soliman, 2002). The comparison, Table 5.1 is on the next page.

Table 5.1 Comparison of Outsourcing and ASP / Pay-per-use

Model Characteristic	Outsourcing	ASP / Pay-Per-Use
Delivery Model	One-to-One	One-to-Many
Delivery Method	On-site or Remote	Remote
Delivery Location	On-Site=N/A Remote: Dedicated Network	Internet or VPN
Hardware Ownership	Client or Service Provider	Service Provider / Multiple Service Provider
Software Ownership	Client or Service Provider	Service Provider / Multiple Service Provider
Application Architecture	Client Choice	Multi-tier c/s or Web Technology
Proprietary, Customised Application	Yes	No, standard package software / No, standard best-of-breed package software

Healthcare institutions that have recently merged under Integrated Delivery Services / Network (IDS/IDN) or operate in geographically dispersed locations can benefit from sharing and centrally managing a single patient health record under the pay-per-use concept, and all stakeholders can save both time and money by avoiding duplicate tests and examinations for a patient in multiple locations. Since data are consolidated in one central (virtual) location, better decision-making and analysis are possible. Thus, a large IT department is not needed to use this concept, and the healthcare institution can focus its resources on 'core business' issues rather than on building and managing infrastructure (Chen and Soliman, 2002). The following are some of the advantages:

- Reduced need for capital investment (no up-front licensing/implementation fees).
- Application up-time.
- Universal access via the Internet.

While considering the comparative merits and demerits of available IT sources, it is practically useful to describe the basic standards which can be set for uniform usage by users. A model theory is interpreted here, which can set the stage for standardisation and globalisation in IT utility.

5.4 Model of an Investment Independence

The core objective of national healthcare organisations, including Kuwait's Ministry of Health, is to deliver the best possible healthcare to its residents. Having established the fact that one of the central initiatives of the organisations is the creation and upkeep of EPHRs, which serve as the central clinical repository of information pertaining to patient care, it is important to underline a theory that enables an information framework and system for effective healthcare (Dick et al, 1997).

EPHR is a critical information asset for all stakeholders in healthcare delivery. An effective information system infrastructure is vital for the set-up, maintenance, management and access of the EPHRs (Murphy et al, 1999). The capital investment, in terms of time and money, required to build this dedicated infrastructure is phenomenal, and is subject to the great risk of fast technology obsolescence and the resultant loss of the information asset and its access. The healthcare delivery industry needs to develop an infrastructure that is based on a model theory, that is, the 'investment-independent' theory, with respect to the EPHR information asset management.

Investment-independence allows the organisation to procure all the relevant services, namely the technology services, application services, data storage services and communication services from the respective vendors with relatively minimal capital investment. This infrastructure would facilitate the organisation to procure these services on a 'pay-per-use' basis.

Today's Internet computing architecture and the Word Wide Web have laid the foundations for enabling the 'investment-independent' information infrastructure for the healthcare industry. Distributed database and data management services are available from service providers. Various applications are available on-line on a 'pay-per-use' basis. These applications also use software technology, like Java, that can run on all hardware platforms under various operating systems. This enables 'platform-independence' for the healthcare organisations. The applications also share data among various distributed databases using database connectivity standards, like ODBC, and IIOP (Grimson, 1998). All these applications are now available to run from a simple 'web browser' from anywhere on a personal computer that connects to the Internet (Deluca, 2000).

Communication and Internet services are available on a subscription basis. This provides the stepping-stone towards 'database independence' and the 'communication technology independence'. The vendors for the 'enabling software' and applications are now supporting 'application-independent' data formats (XML). Industry standards have been set to define 'application-independent' data and manipulation needs (Deluca, 2000). With this, an application for a specific purpose, from vendor A, will be able to read/write data in a common format. Another application of the same tribe from vendor B can also access the same data processed earlier by vendor A's application. Data become interchangeable among applications that cater to a specific need. The information is hence safeguarded against loss when the organisation chooses a new best-of-breed application for a business purpose. This enables both 'data-independence' and 'application-independence'. The organisations now have a latitude to switch their vendors for applications for a business need, as required. The healthcare service is then not bound by the application system and its vendor. This drives competition among application system developers and service providers for better information management.

Platform independence, database independence, application independence, data independence and communication technology independence are the major building blocks to establish the required 'investment-independent information infrastructure' for the healthcare organisations. The complexity and the wide spectrum of healthcare areas require specific application systems for each area to record EPHR diagnosis and results. Therefore, 'investment-independence' presents a 'conceptual architecture' that allows health organisations to deploy this infrastructure for effective and efficient healthcare delivery, which is its core function. As part of this architecture, it also opens up a need among healthcare EPHR information application system vendors to develop applications that will maximise the benefits for both the supply and demand domains of healthcare services. The infrastructure that forms the basis of this architecture also drives the healthcare information system service producers towards an 'industry standards definition' for the ways and means of acquiring, processing and storing the EPHR information for the countless areas of the medical field domain.

Nowadays, health organisations have invested or have to invest heavily to build an information infrastructure covering various software applications, databases and hardware platforms to manage the EPHRs of their clients. The information asset, EPHR, managed with the help of vendor-specific applications becomes locked with proprietary solutions of the application vendor, and proprietary data storage formats of the database vendor and the hardware platform vendor. This puts the health organisations at great risk in terms of technology obsolescence or loss of access to the information asset, and does not allow them to take advantage of the continuously improving technology and healthcare delivery software applications.

Therefore, ideally, the health organisations need an 'information infrastructure' in which they should be able to procure all or most of their infrastructure and information service needs on a 'pay-per-use' basis to manage the EPHR of their clients, rather than trying to 'own' the complete infrastructure suite. This information infrastructure availability provides the health organisations with investment-independence or complete freedom to manage effectively the information asset, EPHR, without the heavy IT investments and expensive on-going support of the IT infrastructure, to be able to choose the 'best-of-breed' applications from the market (vendor independence) without losing any of the EPHR information asset (application independence, data independence), and to be able to choose the 'vendor of choice' to store the EPHR data (hardware and data storage independence).

5.5 Scenario Definition – Kuwait Perspective

5.5.1 Information Architecture Model

Real life situations are observable phenomena in healthcare delivery that enable a better understanding of the information flows and processes within medical works and information networks (Kay et al, 1999). The following is a typical case (tacit knowledge) of a clinical scenario in Kuwait, which provides a comprehensive insight into the processes of medical practice and computer-human interactions, which form the basis for setting up a framework of an information network architecture. A scenario is developed to derive a domain expert's tacit knowledge by inquiring about behavior and value.

- Bader Akber, a Kuwaiti football player, visits his local clinic at Farwaniya when he develops a pain in his leg. The clinic receptionist checks his Health Record using his civil-identification card number to verify. The receptionist records the visit details and asks Bader to wait for his turn (Visit No. 1, Event No. 1).
- Dr. John Sullivan is the attending physician. Bader explains the problem. Dr. Sullivan retrieves Bader's medical records on-line. Dr. Sullivan examines the patient's leg and records his inferences in the system using the 'General Medicine Service' function available in his System Menu on his computer screen. Dr. Sullivan 'orders' X-rays be taken from the Radiology section (Visit No. 1, Event No. 2), and records this order.
- Bader (patient) goes to the X-ray section, where the radiographer verifies Bader's medical records. He sees the order for X-ray from Dr. Sullivan. He takes X-rays of Bader's left leg - tibia and fibula. He scans the X-ray image from his specialised scanner computer, records the X-ray event against the 'order' Dr. Sullivan has made, and saves the X-ray image scanned against the order (Visit No. 2, Event No.3).
- Bader returns to his local clinic for review with Dr. Sullivan of his X-ray results (Visit No. 3, Event No. 4).
- Dr. Sullivan verifies medical record diagnosis against Bader's medical records (Events 1-4 from Visits No. 1, and 2). He views the X-ray image on his computer by clicking the Image link against the medical record diagnosis of Visit No. 2, Event No. 3.

- Dr. Sullivan refers Bader to the Orthopaedic Specialist at Mubarak Al-Kabir Hospital (university teaching hospital) near Jabriya for treatment (Visit No.3, Event No. 5).
- Bader visits Mubarak Al-Kabir where his identification is checked (Visit No.4, Event No.6), and he is requested to wait for Dr. Musa Akbar, the orthopaedic specialist. Dr. Akbar checks Bader's referral from Dr. Sullivan and arranges for minor surgery at the hospital at a later hour on the same date (Visit No. 4, Event No. 7).
- The operation is conducted to align the tibia with the fibula in the operating theatre at the M.A.K Hospital (Visit No.5, Event No.8).
- Dr. Musa records all operation results and prescription drugs for Bader during the post-operation period (Visit No.5, Event No.9).
- Bader is discharged on the evening of the same day and is requested to return after 10 days to confirm his well-being after post-operation rest. Bader collects drugs from the pharmacy (Visit No.6, Event No.10).
- Bader visits Dr. Akbar (Visit No.7, Event No.11), where Dr. Akbar checks and confirms that Bader's leg is now back to normal (Visit No.6, Event No.10). Bader's case from Farwaniya is closed (Visit No.7, Event No. 12).

On examining the sequence of actions and interactions within the scenario, one can identify the various entities in the scene and also determine the fundamental concepts that govern the electronic patient information record or system. An infrastructure to access patient health record globally requires a clear architecture baseline definition and a methodology. The architecture baseline is structured to define, select, validate, and operate major technology components across the organisation of the healthcare information system. The technological components cover: (i) packaged applications, (ii) customised applications, (iii) distributed applications services, (iv) complementary packaged software, (v) complementary customised software, (vi) data processing and communications hardware, (vii); and operational infrastructure. The Authority (i.e. who adopts the architecture) uses this baseline definition to create a framework for a stable, contemporary computing environment for applications that provides access to patient health record anywhere globally with centralised security. The scope of the Baseline covers all the stakeholders in the patient health record information system - patients, physicians, authorities, laboratories, different levels and types of healthcare centres, specialists. The baseline is used to create an integrated architecture model that takes into account the technological needs of the information system as a whole.

The following Figure 5.1 depicts a patient health record update process scenario. The Figure 5.1 provides an analysis of how each piece of information requires application access to the patient health record, using Internet an Intranet communications networks. Every access to an information item may invoke the 'pay-per-use' within the 'investment-independence' strategy. From this scenario (information model), we developed two concepts, one for the content management and the other for the access anywhere globally. As a result, an application architecture for this scenario is developed to reflect both concepts.

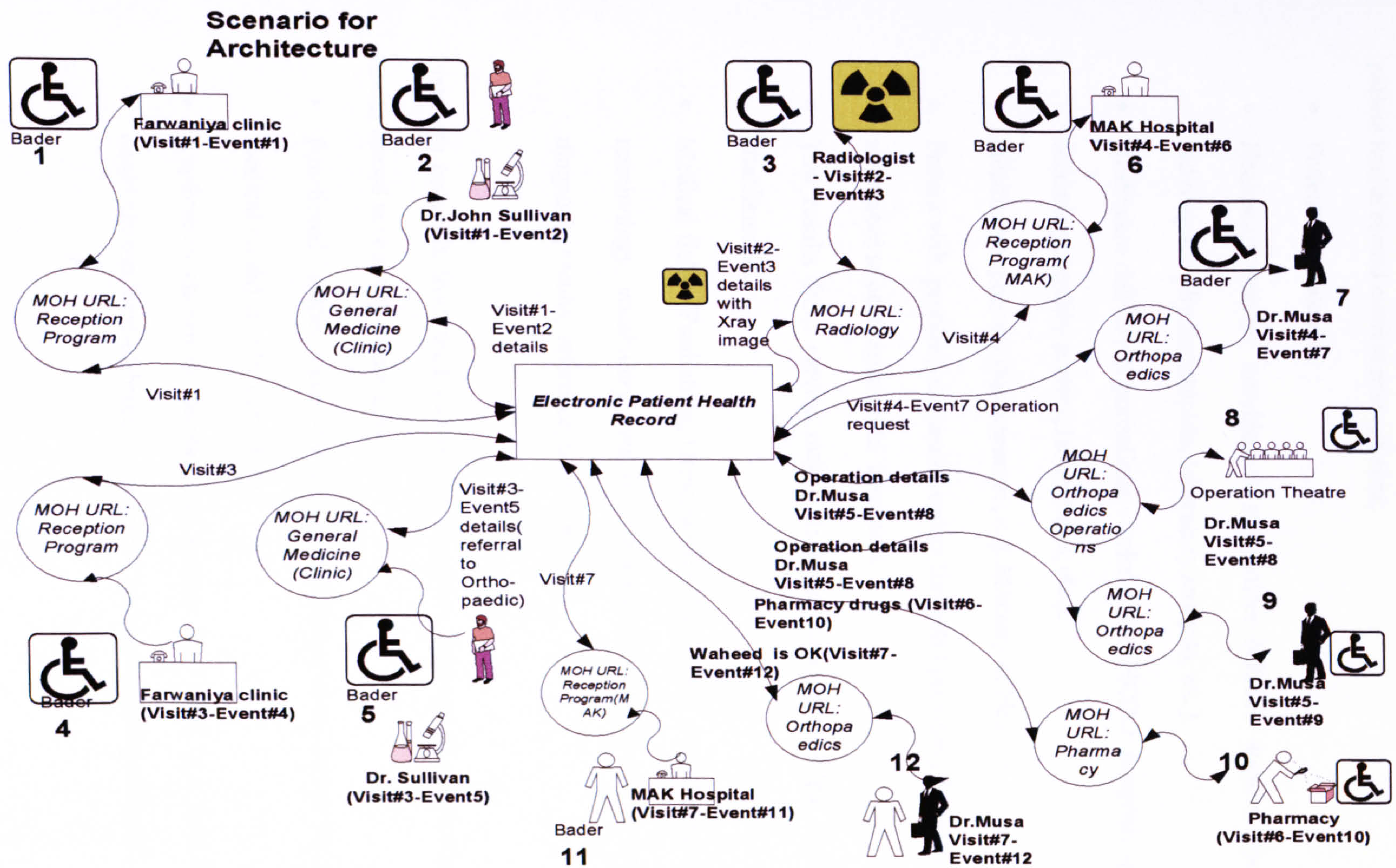


Fig 5.1 Scenario for Architecture (Health Record Update Process)

The following are the concepts from tacit knowledge (entities) that drive electronic patient health record content management:

- Patient - stakeholder.
- Healthcare service providers - stakeholder (HCSP: doctors, specialists, radiologists, physiotherapists, laboratory analysts, etc.).
- Healthcare delivery organisations - stakeholder (HCDO: hospitals -primary, secondary, tertiary centres, laboratories, etc.).
- Healthcare sponsors (Government , e.g. Ministry of Health).
- Patient visit, problem, diagnosis, orders for tests / pharmacy / operations etc., references to other specialists, treatment.
- Test results from service orders (images, audio/video clips, multi-media attachments).
- Medical fields (Paediatrics, Orthopaedics, Radiology, etc.) that have unique terminology, vocabulary used in health record management for problems, diagnosis, results, inference, treatment.

Next are concepts from tacit knowledge that drive delivery of electronic patient health record access any where globally:

- Functional independence (different record management nature for different medical fields) is to be considered.
- Application chosen to manage data content for EPHR in a field. Sponsor could choose 'best-of-breed' to promote 'application-independence'.

- Universal data manipulation format used by an applications to facilitate 'data-independence'.
- Data storage definition to be used by applications to promote 'data-storage-independence' (able to store data at locations of choice).
- The above three promote platform/configuration/machine Independence.
- Application access definition to allow secure access to authorised persons to access secure data of a EPHR from all storage locations.
- Data presentation to healthcare service provider (HSP) to access and record data in different accessible formats (text, images, audio, video, charts, numbers) using simple browser clients.
- Merging of patient health data (PHD) from various visits for various illness, in different medical areas, stored in distributed storage locations.

5.5.2 Information Architecture Model Baseline

Relationships (categories) among concepts, mentioned in the previous section, that ground the information architecture within the healthcare scenario, provide an interpretation of a baseline of an architectural model for healthcare information, the basic features of which may be summarised as follows:

- For healthcare organisations (sponsors), healthcare delivery is the 'core' business and not healthcare systems development/maintenance. Hence health organisations demand application investment-independence.
- Easy-to-use patient health record management (PHRM) software in each specific healthcare area is deployed on a 'pay-per-use' basis.

- Processed health record data are stored at an information service provider's facility in a 'portable format' on a 'pay-per-data storage' basis, and are always accessible.
- Health service providers access patient health record management using a simple workstation with a browser.
- Healthcare sponsor selects the application software to be used for each area.
- Healthcare sponsor defines a 'portal' through which authorised healthcare service providers (HSPs) can manage patient health records (PHR).
- The portal authenticates each user and control access with a firewall, deploys all applications currently in use for various lines of medical areas.
- When authorised practitioners access the portal, they are directed automatically to use the relevant software to record/access/store PHR information.
- The selected application aided by the portal provides a single logical collection of all components of the PHR covering the patient's complete medical history by visit and allows additional updates to the PHR.
- The selected application software saves the PHR details in a universal format, namely XML, in storage areas directed by the set-up established by the healthcare sponsor (HCS). This establishes the 'data independence' and 'data storage or configuration independence'.

5.6 Framework & Solution Validation using Scenario walkthrough

The next step is to present a model framework and solution validation by correlating the functions of 'concepts' and 'categories'. By doing so, the basis for a model architecture for an ideal information system can be elucidated. The relation between the basic concepts that were identified from the scenario and the patient health record can be explained. Developing a baseline to build an integrated architecture model is composed of multiple intertwined processes. Each process focuses on a different aspect of the technological components of the information system. Information architecture specific to the patient health records (scenario walkthrough), application architecture (data model), distributed services architecture, and architecture component selection (application architecture). The milestone deliverables from each of the process provide an incremental approach towards Architecture Integration.

The next two diagrams (Figure 5.2 and 5.3) present an 'Application Architecture' for the electronic patient health record (EPHR) data model as a result of using and analysing previous scenario information architecture (tacit knowledge) by simply defining an entity relation diagram. Furthermore, Table 5.2 'Data and function model definition' is the interpretation of the previous Figures 5.2 and 5.3 which show how we explain and derived these models.

Figure 5.2 Application Architecture – Electronic Patient Health Record Data

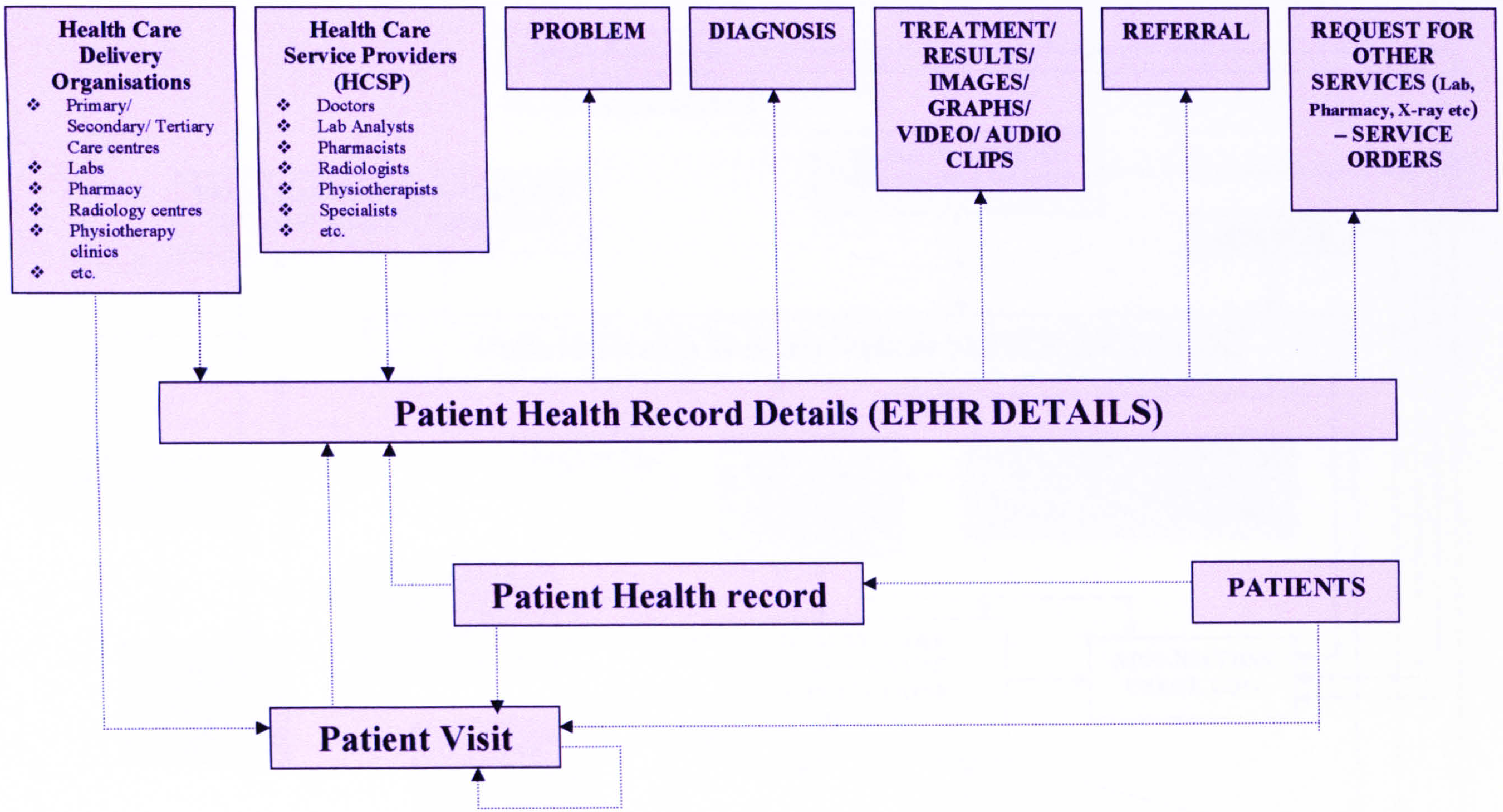


Figure 5.3 Electronic Patient Health Record Access & Management - Application Architecture - Data Model

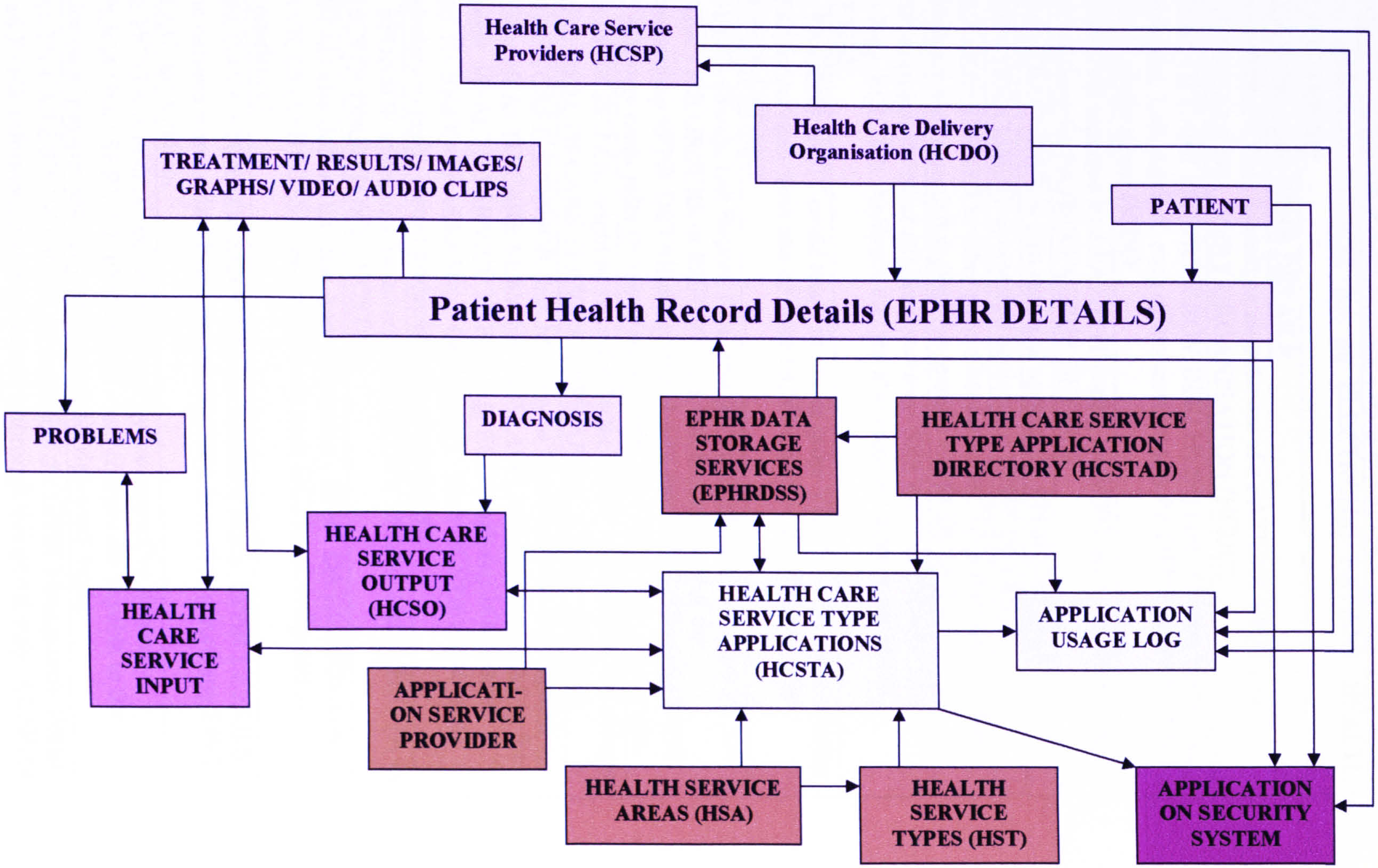


Table 5.2 Application Architecture - Data & Function Model Definition

1	Every authorised PATIENT has an ELECTRONIC PATIENT HEALTH RECORD (EPHR).
2	An EPHR has many EPHR DETAILS.
3	Many EPHR DETAILS could be an outcome of a PATIENT VISIT to a HEALTH CARE DELIVERY ORGANISATION (HCDO).
4	A HEALTH CARE SERVICE PROVIDER(HCSP) (viz., Doctor, Specialist, Radiologist, Lab. Analyst, etc.) offers services to a PATIENT on a PATIENT VISIT to his/her/their HCDO
5	PROBLEMS reported by a PATIENT during his VISIT are recorded by the HCSP against the PATIENT's EPHR DETAILS
6	HCSP's DIAGNOSIS is also recorded against the EPHR DETAILS
7	HCSP's TREATMENT is recorded against the EPHR DETAILS
8	HCSP's REFERRALS to other specialists (other HCSP in the same or other HCDO) are also recorded against the specific EPHR DETAILS.
9	HCSP's request for other auxiliary services- SERVICE ORDERS- like radiology, ECG, lab. Analysis, etc. are also recorded against the EPHR DETAILS.
10	One PATIENT VISIT could result in one or more VISITS to the same or other HCDO for services from one or more HCSP based on REFERRALS or SERVICE ORDERS.
11	RESULTS (X-ray, Lab Report, ECG images, audio clips, video clips, etc.) of the SERVICE ORDERS or REFERRALS will become part of the corresponding EPHR DETAILS associated with that VISIT. Thus one EPHR DETAIL may cross-refer to one or more EPHR DETAILS from other visits.
12	Each EPHR DETAIL might be recorded by the HCSP in the HCDO by using a specific HEALTH CARE SERVICE TYPE APPLICATION (HCSTA)
13	HEALTH CARE SPONSOR (e.g. Ministry of Health) selects and deploys different HEALTH CARE SERVICE TYPE APPLICATIONS (HCSTA) for different HEALTH SERVICE TYPES (e.g: ECG Analysis) in different HEALTH SERVICE AREAS(e.g. Cardiology). Each HCSTA is rich in its vocabulary to easily record problem/diagnosis/treatment.
14	The SPONSOR maintains the active DIRECTORY of the available HCSTA in the HCSTA DIRECTORY - HCSTAD.
15	HCSTAD also defines the data storage location - EPHR DATA STORAGE SERVICES (EPHRDSS)- associated with each HCSTA (Configuration independence).
16	EPHR DATA STORAGE SERVICES (EPHRDSS) stores EPHR DETAILS in the defined storage data base when the HCSTA is used to record any EPHR DETAIL for a Patient.
17	Each HCSTA is maintained and managed by the respective Vendor - APPLICATION SERVICE PROVIDER - and charges are payable to the vendor on a 'pay-per-use , pay-per-storage service-used' basis.
18	HEALTH CARE SPONSOR (HCS) maintains the EPHR Management Portal and all EPHR Information system access is through this portal only. All EPHR Applications are launched from this portal.

19	HEALTH CARE SPONSOR provides health care to all its registered PATIENTS. All PATIENTS are first registered using Patient Registration Application. The Patient Identification Number , e.g. CIVIL-ID NUMBER, is the main key. Patient's personal particulars form part of EPHR
20	The SPONSOR also dynamically maintains the 'access security' on HCSTA and EPHRDSS, and assigns user-access to the HCSP in different HCDOs whenever a patient needs health care services from them. This security information is maintained on a continuous basis using the APPLICATION SECURITY SYSTEM (ASS). It maintains access privilege for HCSP on applications (HCSTA), and which Patient records are allowed to be accessed and for what time-frame.
21	When an authorised HCSP logs in to the portal using his/her user-access, he /she will be guided to access only those Patient records. Also, the HCSP will be able to record the EPHR DETAILS using the authorised HCSTA.

The above table shows how the two figures are derived using the scenario walkthrough analysis for 'pay-per-use' within investment independence.

Next, Figure 5.4 is the application architecture which is another depiction of scenario walkthrough. If the Figure 5.1 scenario is compared with Figure 5.4 it can be seen how all steps can be represented in this application architecture. The 'data' asset resides in a database that can be configured for access by the application that handles a specific health care service health records. The 'database' is independent of the 'application'. Both can be stored in different locations for time zone purposes (UK, USA, etc.). The application may have the stored procedures for business logic, and these can reside in a database that is local to the application. However, the data asset pertaining to the health record itself sits in a 'data repository' that is independent of the application. The application runs the application specific to a request for a health care service to manage the health record. The application may have various components – Java components to handle the user interface, application logic, data access from the database server (HCSTAD, ASS).

The applications server acts as a 'central authority' to decide which application should run for a requested service, its location, and the location where the data asset resides. The authorised application will use the authorised database to store or retrieve the health record. Figure 5.5 explains in general all steps necessary for Figure 5.4 (Kuwait case). The following Table 5.3 gives the 'distributed service components in the application architecture to explain what is in Figure 5.4

Table 5.3 Definition of Data and Functions Definition

HCSTAD	Healthcare Service Type Application Directory
HCSTA	Healthcare Service Type Applications for each specific healthcare area
ASS	Application Security System maintains the access to various Healthcare applications that are available on EPHR by various Healthcare service providers within a time range and on specific Patient Health Records. Healthcare Sponsor maintains this security.
EPHR DSS	EPHR Data Storage Service. EPHR Details are stored in universal XML format in the EPHR DSS defined in the HCSTAD. All attachments in various formats - images, audio, video, graphs, reports, etc. - are stored separately with reference pointers/links stored in EPHR
HCSTA99	Application that allows EPHR details to be displayed. The images, audio, video, reports, charts are displayed as links to the respective details that can be seen by using appropriate plug-ins, depending on the attachment file type. Plug-ins are loaded by the HCSTA99 when the respective attachment links are demanded (clicked by the requester).
Healthcare Sponsor's PORTAL	Front-end application which drives the entire application access and flow, aided by the HCSTAD, ASS, HCSTA, EPHRDSS. Users have to logon to the portal for access and authorisation to applications and patient records.

Delineation of a model framework for Kuwait's healthcare, leads to the next step, that is, explication of a model system architecture that is based on standards.

Fig 5.4 Application Architecture - Scenario Walk-through (see table 5.3)

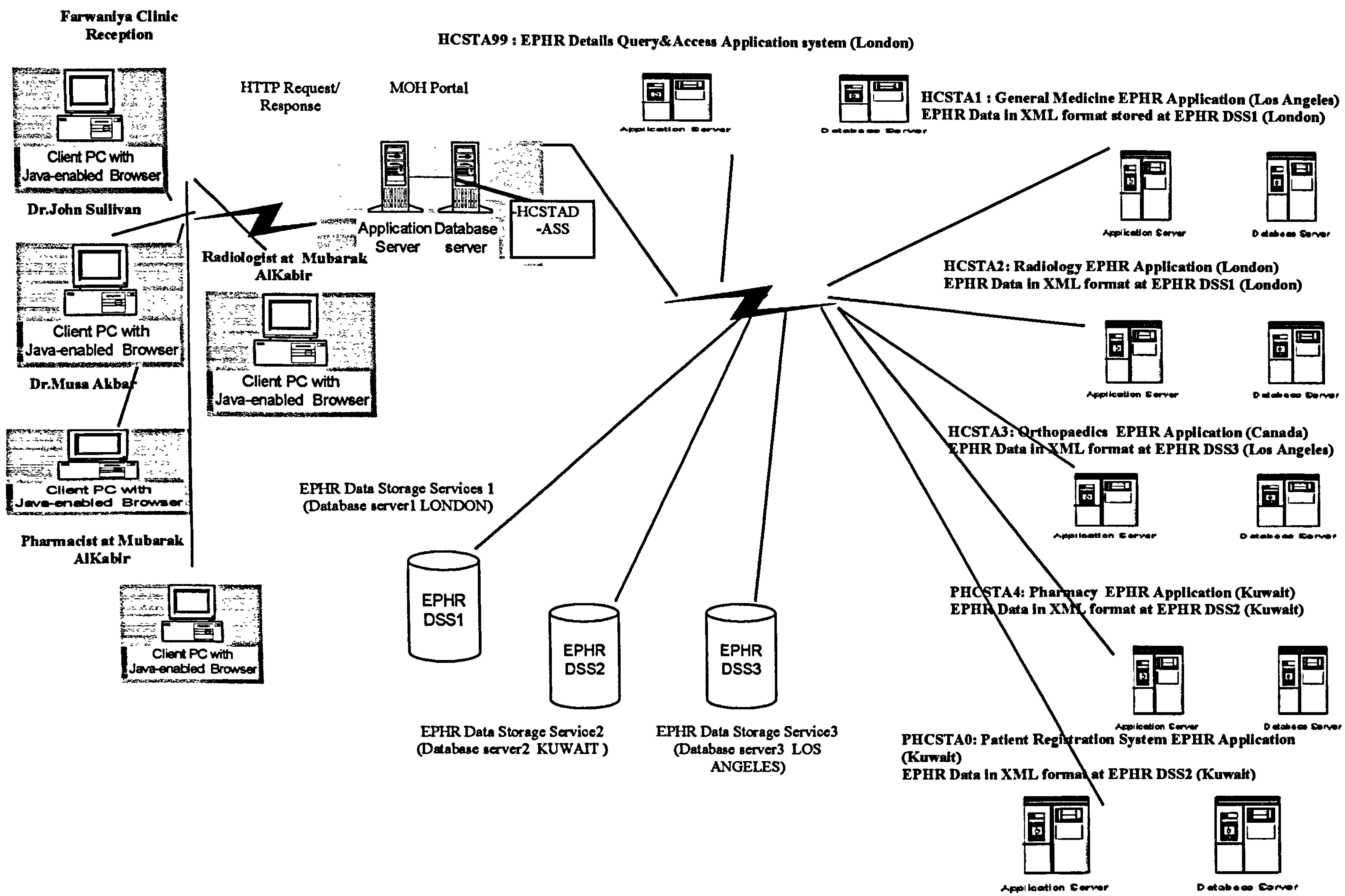
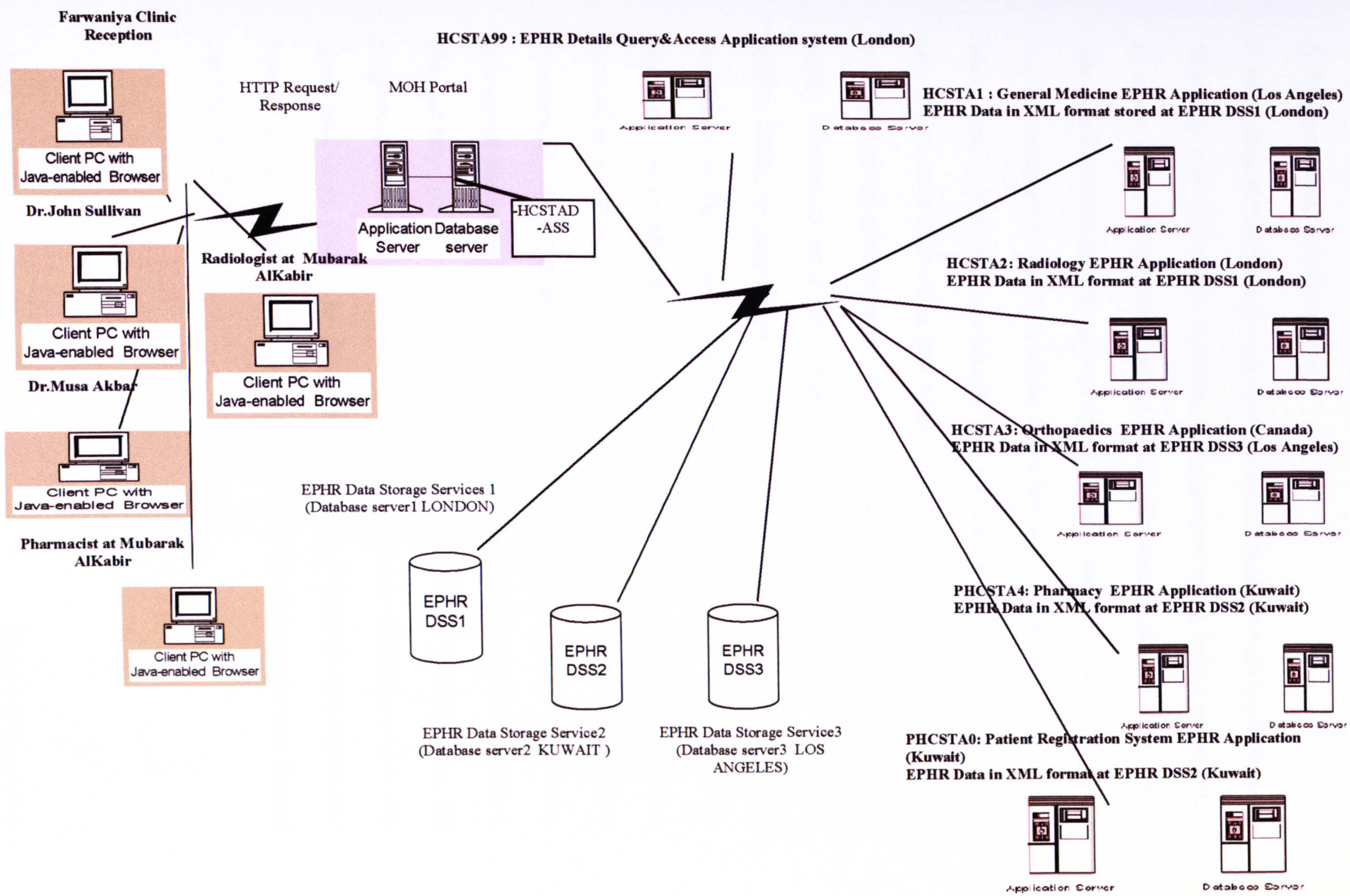


Fig 5.4 Application Architecture - Scenario Walk-through (see table 5.3)



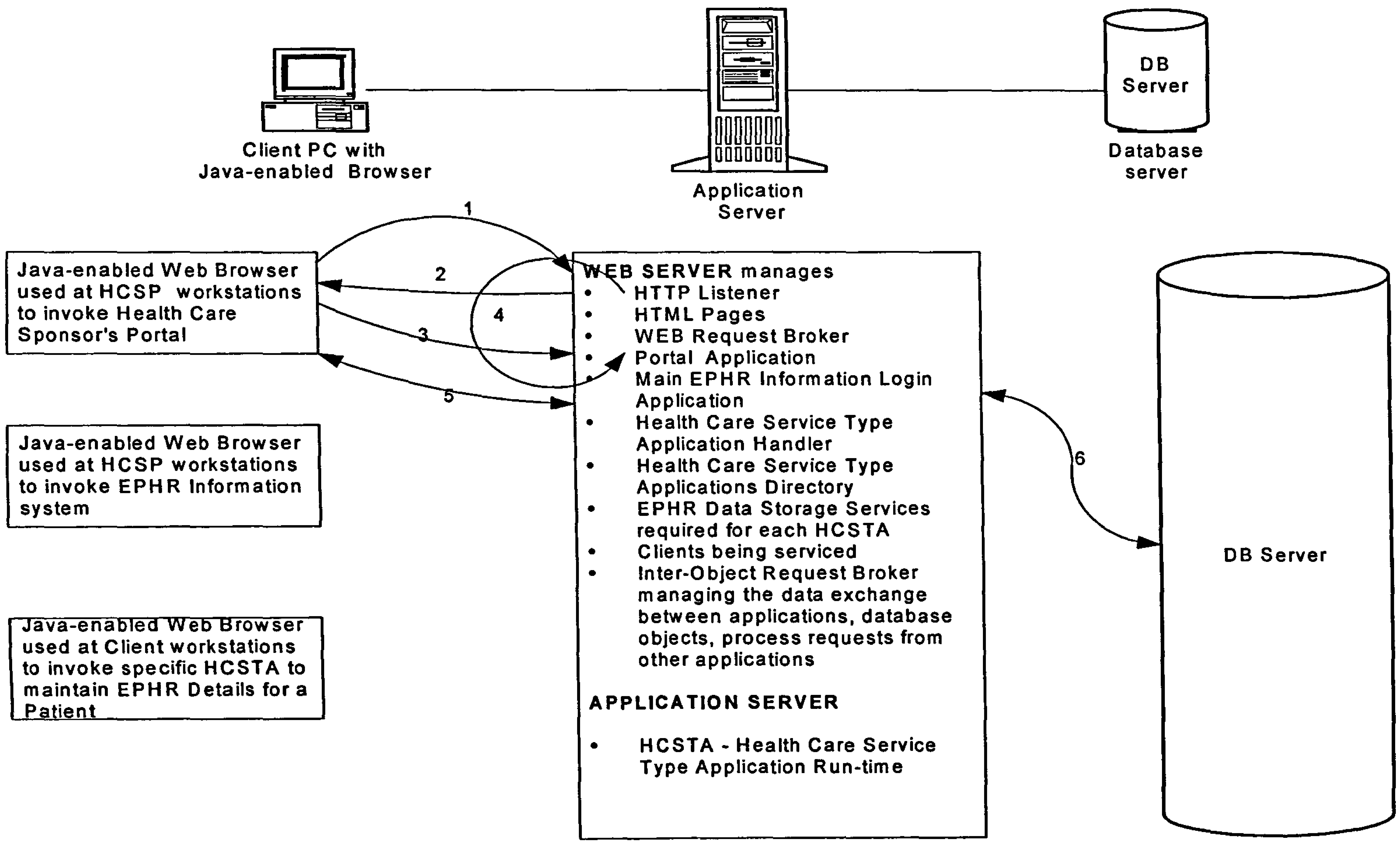
5.7 Conceptual Architecture

A networking platform can provide very valuable information resources to its users. Generally, these information resources can be accessed at any healthcare institution by means of the Internet, using various models (Bernstein et al, 1996; Chin, 1998). The simplest model requires no more than a PC with reasonably priced software, a way of communicating outside of the institution, and a relationship with an ISP. Many organisations now have intranet web sites for internal business and Internet web sites to share information with health centres partners and consumers. Intranets provide an information infrastructure link for organising and presenting private and public information using the standard technologies developed on the Internet (CSTB, 2000). An intranet model usually requires the institution to install a local intranet server. This server is functionally identical to an Internet server and can be the same machine physically too, except it services private information. Intranets are used to provide members of an organisation with access to internal information by means of web technologies. Internet technology is opening doors for healthcare information management by means of intranets (McCormack, 1997; CSTB, 2001). The industry has yet to settle on all of the standards for Internet tools, but progressive healthcare systems have already begun the implementation of this very robust technology. Investments in Internet and intranet technologies are expected to increase as more organisations enhance existing client-server networks with intranet capabilities (CSTB, 2000).

An integrated architecture model for Kuwait's healthcare seems a favourable attribute to the delivery of healthcare. The benefits of such an architecture are not only applicable to a country like Kuwait but also have significance globally.

The following diagrammatic representation of a model architecture provides an overview of the integrated operational features of such a system (Figure 5.5). Details of the steps follow. Most of the technical words used here come from ORACLE technology, due to the Ministry of Health having invested in this technology. Lower case letters are used for some terminology for 'meaning ' and not 'technology' purposes.

Figure 5.5 Architecture Integration



The numbers shown in the figure represent the interaction among client PC with a Java enabled browser and the Application Server and finally with the data base server.

1. The client end-user uses a Java-enabled web browser as means of viewing contents. Upon encountering a web page that requires the use of the sponsor's PORTAL (a portal is a single gateway to personalised information that aggregates content from multiple sources to make an informed health decision), a request is sent to the web server, which resides on the application server, or middle tier (Citrix, 2002).

2. The web server automatically sends the applet and a Java Archive (JAR) file, which contains the classes required to run the applet. The applet starts the application process at the client. The applet includes the parameters required to start a client session for the application with the application server, including communication protocol, such as 'socket connection' or 'HTTP socket connection'. It also contains a server key. The initial applet installs the corresponding client key so that the applet running the application at the client will trust the server.

3. The client process applet on the end user's PC contacts the application server listener (listener defines authorisation mechanisms to protect web pages and scripts) using the port that was specified in the applet parameters. The client applet passes the parameters to start an application process. These parameters include application name, user ID and password (stored locally in an encrypted format), and so on (Virginia Technical, 2002)

4. The application server listener spawns an application cartridge runtime engine process for the session (cartridges are responsible for executing applications on the server and

returning HTML content back to the browser via the listener), and passes the parameters to this process (Virginia Technical, 2002).

5. The application server listener establishes a socket or HTTP socket connection with the application cartridge server runtime engine, and sends the connection information to the client. The client establishes a direct socket or HTTP socket connection with the application cartridge runtime engine. The client and application cartridge runtime engine then communicate directly, running the requested application. The application server listener is now free to accept other end-user startup requests.

6. The application cartridge runtime engine communicates directly with the directed database through the web-request-broker or inter-object-request-broker (this request broker provide a powerful distributed run time environment for deploying applications) (Virginia Technical 2002). Thus various HCSTA interact with the EPHRDSS to process Healthcare Service Provider's(HCSPs) recording of EPHR DETAILS in the XML format in the respective Database servers.

Finally, we note that Extensible Mark-up Language (XML) to explicate our intention, and XML is on its way to becoming a global standard for the representation, exchange, and presentation of information on the World Wide Web. More than that, XML is constructing a standardisation framework, in terms of an open network of meta-standards and mediators that permits the definition of further conventions and agreements in specific business domains. Such an approach is particularly required in the healthcare domain; XML promises to mainly suit the particularities of patient records and their lifelong storage, retrieval, and exchange (Bertino and Ferrari, 2001; Dudeck, 2001).

5.8 Discussion of the Conceptual Solution Limitation

A variety of cultural, social, and political forces influence the ways in which healthcare providers, health management organisations, researchers, patients, and others use the Internet. Policies affecting Internet use, and the debates surrounding them, reflect basic beliefs about the way things work or should work both internationally and in the State of Kuwait. The framework (template) presented in this chapter may be expected to encounter many barriers as it attempts to apply these technologies to realize the strategic visions. In particular, the framework will face the usual barriers to organisational change. A conflict to change might come from denial of the need to change, the inability to manage change, uncertainties about the types of changes needed and how best to make them, as well as failures in executing the changes (Lorenzi et al, 2000).

In addition to these standard, and well documented (e.g. Murphy et al, 1999; Lorenzi et al, 2000), barriers to organizational change in general there may also be some specific issues for the proposed framework. For example, the lack of suitable price mechanisms per atom (transaction commitment, service delivery, network usage, data retrieval and so on) for the suggested conceptual applications framework sessions could be a significant impediment to the use of information technology within the pay-per-use concept and the investment-independence strategy in the healthcare environment in the State of Kuwait. Furthermore the adoption of *standarisation concept* may lead to a potential reluctance of services providers towards this model as a potential limitation and this could lead to a lock or threat of competitive market. Payment policies may have to be modified further to enable these applications as other technical and organisational impediments are overcome and the applications themselves are demonstrated to be efficacious and potentially cost-effective. Also, providers may be expected to view Internet-based service delivery not as competing with face-to-face service delivery but as a tool to reduce the customer service burden on their facilities and confer a competitive advantage (CSTB, 2000).

The discussion below classifies barriers into two broad categories: (i) *external factors* that define the environment in which an organisation operates and are often difficult for an individual organisation to address directly because they demand collective action; and (ii) *internal factors* that define the ability to implement change and are easier to overcome but in many cases still present significant difficulties, even if the need for change is recognised as urgent (Glaser and Hus, 1999).

In case of *external factors*, these define the environment in which healthcare organisations operate and shape their ability to capitalize on the suggested framework solution. The barriers here assume many forms, including policies and standards, and technology. *Policies and standards* (government laws and regulations, professional standards, and technical standards, etc.) remain largely outside the exclusive control of the healthcare industry and are among the policy barriers that can impede healthcare organisations. These barriers can interfere with business opportunities enabled by the Internet, reducing the incentive to undertake initiatives that would benefit the nation's healthcare system and citizens' health. For example, policies on professional licensure, regulations on data security and patient privacy can create disincentives for the transmission of information across public communication networks such as the Internet (Norris, 2000).

T*echnology* itself can also be a barrier to change in organisations. Technological change is especially rapid in information technology, a supreme challenge for organisations that try to keep up with the pace of innovation while controlling costs. Significant technological changes can create major dislocations, rendering investments in existing technologies obsolete. Organisations cannot allow prior investments to depreciate fast enough to keep up with the rate of change or shift their technical and human infrastructures rapidly enough without undermining organisational performance. This process of technological change is particularly challenging in a healthcare context, where there is a heightened need to demonstrate the efficiency of such change (a process that can be expensive, time-consuming, and difficult to do well) and there is wide range of potential users involved (patients, physicians, nurses, administrators), all of whom may have different work flows and skills (Lorenzi et al, 2000; Norris, 2001).

Therefore, external barriers present a significant challenge to organisations. Additional barriers, such as demographic trends and the complex and politicized decision-making processes in healthcare are also generally out of the control of organisations, although they can take steps to anticipate and mitigate the effects.

On the other hand, *internal factors* can prevent organisations from recognizing the need to change and properly implementing the required changes. A lack of organisational self-awareness, responsiveness, and competency, and a reluctance to change all impede attempts to implement necessary change (Murphy et al, 1999). An organisation's ability to change is influenced by many factors, including its competence, sophistication, and history of action with other technologies (Lorenzi et al, 2000). When basic operating principles must be reinterpreted, organisations require time to promulgate, implement, and assimilate the new standards, policies, and guidelines based on the new principles. The appropriate use of new technology often requires a degree of process and role redefinition not usually encountered in healthcare settings. It may pose threats to individual roles or positions, challenge the rationale of current business or clinical practices, demand rapid political mobilization, encounter user resistance, and require additional investment. Processes used in implementing new technologies, particularly if reliant on consensus, can slow the effort to adopt them (Murphy et al, 1999). New forms of communication can require new interpretations of basic principles such as the core nature of an organisation's services. Achieving consensus takes time, perhaps more time than is feasible given the rapid pace of technological advances (Friedman et al, 2001).

Hesitancy to change may result from legitimate organisational concerns as well as organisational inertia. Organisations may be reluctant to adopt a new technology because it is a poor fit with the existing strategy or because they are in a market segment that does not reward innovation. In addition, change may be hindered by conflicts between the ability of management to maintain coherent integration throughout an enterprise and the need for rapid deployment of a new technology in a more localized setting, such as in a particular department or laboratory (Friedman et al, 2001).

Therefore, internal barriers must be changed by individual organisations. At the very least, organisations need to be aware that these barriers exist and that their persistence will hinder the efficient and effective use of the ASP or pay-per-use concept (and a wide range of other technologies and innovations). Barriers actually encountered, and the degree to which a particular barrier is viewed as problematic, will vary among organisations. For example, clinics, particularly small group practices outside academic health science centres, lack the administrative and financial resources of larger organisations. They may face barriers to full Internet implementation as a result of reimbursement policies that prohibit cost recovery (Murphy et al, 1999). Additionally, they may lack the organisational resilience to deliberate and manage the uncertainty inherent in investing in technologies such as electronic medical records or distributed information systems (CSTB, 2000). A hospital, on the other hand, may fail to capitalise on emerging technologies because its staff is not competent to understand how such technologies could benefit the hospital. Even if organisations can be convinced of the need to embrace an Internet-based strategy and can overcome some of the internal and external barriers to doing so, their progress can be inhibited by considerable uncertainty about how best to proceed. Uncertainty could cause an organisation to hesitate to pursue an Internet-based strategy and could result in deleterious, or unnecessarily turbulent or inefficient change (Glaser and Hus, 1999; Friedman et al, 2001).

5.9 Summary

In this chapter, discussion was maintained so far on a recommendable model for Kuwait's healthcare delivery system. Based on Kuwait's typical clinical scenario, the pay-per-use concept provided the basis for interpreting a model theory, after interpreting available resources. The theory further set the guidelines for an operable framework, which further threw light on a typical architecture setting the standard guidelines for communication, security and data management, thus delineating and recommending a model for the healthcare in the evolving technology.

Having set the framework for the pay-per-use concept, the next chapter is the extension of the technological solution which discusses the key issues in establishing a communication link between the two parties when we use 'pay-per-use' concept within investment independence strategy. Our intention is to shed light on these issue so the healthcare service provider (body in charge) is aware of these issues.

Chapter 6

Network and Communication Technologies in Healthcare

6.1 Introduction

Continuing efforts to build up and install improved networking and communication technologies promise to enhance the capabilities of national (Kuwait) information networking (a seamless web of interconnected, interoperable information networks – Internet), and thereby the healthcare information networking. Health institutions have arrived at a position where they can tailor their network architectures to their specific requirements. When security and QOS are important, and the relationships between communicating centres are adequately known in advance, private networks are to be preferred. Therefore, health institutions persist in the use of dedicated networks to convey sensitive patient information and share large image files. In some cases, the most well judged choice might be a network that uses a mixture of private or dedicated lines that are connected in appropriate ways to the Internet to allow broader access, but with suitable security capabilities in place. What may be most important in the case of 'pay-per-use' is the use of consistent, interoperable protocols for all communications, so that various networks can be connected as needed with appropriate gateways using the 'investment-independence' strategy. The significance of communication theory was pointed out by Schramm (1954, 1971) when he stated that it is "misleading to think of the communication process as starting somewhere and ending somewhere". This is because we are constantly receiving and decoding signs from the environment where we interpret these signs and encode something as a result. Saleh (2002) explained how information can be transmitted and received in a system, using communication theory. Shannon and Weaver (1949) had also established the importance of signals being successfully conveyed between the transmitter and the receiver.

While the previous chapter set the basic framework for the architecture in order to use the pay-per-use concept, this chapter deals with key issues related to communication and network technologies that the responsible body (MOH or private sector) should be aware of as a part of the infrastructure in the case of providing the health service with communication and network independence to the State of Kuwait. It is very hard to quantify these issues during this study since this is the first study in Kuwait in the field of health informatics, and has selected Kuwait as testbed using an incremental approach for each health discipline. As the research question raised in Chapter One implies the need for quality technology, this chapter particularly shed lights on some issues related to the communication and network technologies that will facilitate the use of the 'pay-per-use' concept within communication theory. The chapter starts with quality of service as an issue, to examine the bandwidth and other related issues, and also discusses useful policies that can enable effective implementation of the proposed concept.

6.2 Quality of Service

Quality of service (QOS) (Stravs, 1999) is a requirement of many internet-related health applications. Health institutions cannot rely on adopting the 'pay-per-use' concept within the 'investment independence' strategy on the Internet for critical mission functions unless they receive assurances that information will be delivered to its destination swiftly and correctly. For example, healthcare professionals must be able to retrieve patient health records easily and reliably when needed for patient care, and health professionals and patients must be able to obtain continual access to high-bandwidth services for remote consultations if video-based telemedicine is to become viable (Loula et al, 1999). In emergency care situations, both bandwidth and latency may be critical factors, because health professionals may need quick access to large patient health records and images from different locations connected to the Internet (Davie et al, 2001). Other applications, such as business teleconferencing, require similar technical capabilities (Dutta-Roy, 1998), but the failure to gain needed QOS in a health application might put human life at risk.

The challenge of QOS in healthcare is the variability of a healthcare institution's needs over the course of a single day. The information data sets that support healthcare vary in size and complexity. While simple text represents the content of a health professional's notes, consultation reports, and common laboratory test results, health diagnoses need to be communicated with the help of clinical images such as X-rays, computer tomography (CT), and magnetic resonance imaging (MRI). The electronic forms of these images comprise tens to hundreds of megabytes of information that may need to be communicated to the end user within several seconds or less. Medical information demands on digital networks are thus notable for their great variation in the size of transmitted files. When such files need to be transmitted in short times, very high bandwidths become necessary (Crudele et al, 2001). Almost all Internet service providers (ISPs) make every effort to transport packets to their correct destination, but with no guarantees against packet loss or latency (Paxson, 1997). Furthermore, as many applications attempt to downsize congestion by slowing their transmission rates, packet loss directly affects the time taken to complete a transaction, such as an image transfer, over the network (Lefelhocz et al, 1996).

Several effective steps can be taken to improve QOS across the Internet. Internet users can upgrade their access lines to overcome bottlenecks in their links to ISPs, or to improve service by expanding the capacity of their backbone links (Huitema, 1995). However, such efforts provide neither means for assuring a given level of QOS over any distance nor guarantees that bandwidth will be available when required, and include no mechanisms for prioritising message traffic in the face of congestion (McWerter et al, 2000). To beat these limitations, efforts are on to develop specific protocols for providing QOS guarantees across the Internet. These protocols promise to expand the availability of assured services (CSTB, 2000; Braun et al, 2001)

6.2.1 Quality of Care

The healthcare system as currently structured does not, as a whole, make the best use of its resources. Many types of medical errors result in the subsequent need for additional healthcare services to treat patients who have been harmed (Kohn et al, 2000). A highly fragmented delivery system that largely lacks even elementary global clinical information capabilities results in poorly designed care processes characterized by unnecessary duplication of services and long waiting times and delays. What is perhaps most disturbing is the absence of real progress toward restructuring healthcare systems to address both quality and cost concerns, or toward applying advances in information technology (IT) to improve administrative and clinical processes (Chassin et al, 1998).

A healthcare system should be supported by systems that are carefully designed to generate care that is *Safe* (avoiding injuries to patients from the care that is intended to help them), *Effective* (providing services based on scientific knowledge to all who could benefit and refraining from providing services to those not likely to benefit), *Patient-centered* (providing care that is responsive to individual patient preferences, needs, and values and ensuring that patient values guide all clinical decisions), *Timely* (reducing waits and sometimes harmful delays for both those who receive and those who give care), *Efficient* (avoiding waste, including waste of equipment, supplies, ideas, and energy), *Equitable* (providing care that does not vary in quality because of personal characteristics such as gender, ethnicity, geographic location, and socioeconomic status) (Chassin, 1998).

A healthcare system that is able to achieve significant gains in these six dimensions would be far better at meeting patient needs. Information technology (IT) has enormous potential to improve the quality of care with regard to all six of these aims. Healthcare delivery has been behind the revolution in information technology that has been transforming nearly every other aspect of society. The majority of patient and clinician encounters take place for purposes of exchanging clinical information: patients share information with clinicians about their general health, symptoms, and concerns, and clinicians use their knowledge and skills to respond with pertinent medical information, and in many cases reassurance (Kohn et al, 2000).

The collection of personal health information throughout a patient's life can be one of the most important inputs to the provision of proper care. Yet for most individuals, that health information is dispersed in a collection of paper records, that are often poorly organised and sometimes even illegible, or unconnected computer records that frequently cannot be retrieved in a timely fashion, making it very difficult to manage effectively many forms of chronic illness that require frequent monitoring and ongoing patient support. Although growth in clinical knowledge and technology has been profound, many healthcare settings in Kuwait lack basic computer systems to provide health information or support health decision making. The development and application of more sophisticated information systems is essential to enhance quality and improve efficiency (Murphy et al, 1999).

The Internet has enormous potential to transform healthcare through information technology applications in such areas as patient health, clinical care, administrative and financial transactions, public health, professional education, and biomedical and health services research (CSTB, 2000). Many of these applications are currently within reach, including remote medical consultation with patients in their homes or offices; patient and clinician access to the medical literature; and videoconferencing among public health officials during emergency situations. Other applications are more experimental, such as simulation of surgical procedures; consultation among providers involving manipulation of digital images; and control of experimental equipment, such as electron microscopes CSTB, 2000).

A fundamental axiom of this work is that information technology must play a central role in the redesign of the healthcare system if a substantial improvement in quality is to be achieved over the coming decade. Automation of clinical, financial, and administrative transactions is essential to improving quality, preventing errors, enhancing consumer confidence in the health system, and improving efficiency (Cain et al, 2000).

Central to many information technology applications is the automation of patient-specific clinical information (Murphy et al, 1999). A fully electronic patient health /medical record, including all types of patient information, are not needed to achieve many, if not most, of the benefits of automated clinical data. Efforts to automate clinical information date back several decades, but progress has been slow (Dick et al, 1997) in part because of the barriers and risks involved. An important constraint is that patients and authorities share concerns about the privacy and confidentiality of these data, and also the lack of national and international standards for the capture, storage, communication, processing, and presentation of health information (Cain et al, 2000).

The challenges of applying information technology to healthcare should not be underestimated. Healthcare is undoubtedly one of the most, if not the most, complex sectors of the economy. Widespread adoption of many information technology applications will require behavioral adaptations on the part of large numbers of patients, professionals, and organizations. Yet, the Internet is rapidly transforming many aspects of society, and many health-related processes stand to be reshaped as well (CSTB, 2001).

6.3 Bandwidth

The Computer Science and Telecommunication Board (CSTB) (2001; 2002) and the National Research Council (NRC) in the USA shed light on the appropriate state-of-the-art as Internet technology continues to evolve, with an eye towards identifying technical issues that merit attention. One approach taken by Internet service providers (ISPs) to improve their data-carrying capacity and reduce congestion across the Internet has been to increase considerably the bandwidth of the backbones. This increase lightens some of the concerns about QOS, but may not completely reduce congestion. Demand for bandwidth is growing quickly due to the increasing number of Internet users, the increasing amount of time the average user spends connected, and new applications that are inherently bandwidth-intensive, such as medical image files that now contain about 250 megabytes (MB) of data and are expected to top several gigabytes in the near future as the resolution of digital imaging technology improves (Kelso, 2001).

Moreover, the Transmission Control Protocol (TCP) is designed to find out the bandwidth of the slowest or most congested link in the path traversed by a particular message, and to attempt to use a fair share of that bottleneck bandwidth. This characteristic is significant to the success of the Internet because it allows many connections to share a congested link in a fair way. However, it also means that TCP connections always try to use as much bandwidth as is available in the network. Thus, if one bottleneck is lightened by the addition of more bandwidth, TCP will try to use more bandwidth, possibly causing congestion on another link. As a result, some congested links always exist in a network carrying a large amount of TCP traffic. Adding more capacity in one place causes the congestion to move somewhere else (Birman, 1999). The only way out of this dilemma, apparently, is to provide so much bandwidth throughout the network that applications are unable to use it fully (CSTB, 2001; Blanton and Allman, 2002).

Applications that do not use TCP are not the solution, because some non-adaptive applications (which maintain a fixed delay between packet creation and playback), for which TCP is not well suited, are typically those involving real-time interaction (most real-time applications will be adaptive, meaning that the delay between packet creation at the source and packet playback at the destination will vary over the lifetime of the application). Internet telephony is an example of such an application. Although a personal call might use only a few kilobits per second, many modern Internet telephony applications transmit data at a constant rate, despite any congestion along their path. As these applications do not react to congestion, large-scale deployment can lead to a situation called congestive collapse, in which links are so jammed that they become effectively ineffective (Halabi, 1997).

Furthermore, when these applications share links with TCP-based applications, the latter will react to congestion to the point where they may become unusable. Addressing this problem is either to supply routers with new mechanisms to prevent congestive collapse, or to provide suitable incentives to encourage the development of adaptive applications (Huitema, 1995; Clark, 1999). Therefore, the simple fact that Internet backbones are shared resources that carry traffic from a large number of users means that no single user can be guaranteed a particular amount of bandwidth unless dedicated allocation mechanisms are in place (Mahajan et al, 2002).

In the case of a lack of QOS mechanisms, it is impossible to ensure that critical-mission applications are protected from excessive time lags (people have converted all of their legacy applications and their business-critical applications over to IP from their proprietary private network). IP solves one problem because it builds for people that economy of scale. But it brings another problem, which is loss of control. QOS is the mechanism by which control is brought back into the hands of the network manager (LaMonica, 2001). Moreover, in theory, ISPs could attempt to provide extra bandwidth to the Internet to meet the demands during peak time, especially when bandwidth demands vary among different applications, as is the case in healthcare, and thus ensure service quality (CSTB, 2001).

One way to control IP is to have sophisticated classification mechanisms so that one can identify a customer. And then identify the application that the customer is using. Once the application is identified, then techniques can be brought in that include identification performance for that particular customer on that IP network. This can not be done with rudimentary queuing; it is necessary to go down to a lower-level control for such traffic. If the objective is to make efficient use of networking resources and offer superior overall service, then mechanisms that enable the network to handle heterogeneous data types become necessary for separating different types of data streams (e.g. real-time video, text, and images) into discrete networks (Alam et al, 2001).

It is in this context that the authorised services bodies of pay-per-use should periodically undertake the responsibility to define and select best-of-breed solution mechanisms for providing QOS across the Internet to manage available bandwidth and to meet customer-specific needs and challenges of health applications. Equally important is another area of networking, multicast, discussed in the next section.

6.4 Multicast

Parallel with efforts to implement QOS mechanisms for the Internet, attempts are in progress to deploy multicast capabilities, which provide a means to make more efficient use of available bandwidth to distribute concurrently information from one user to a number of specific recipients (Van Mieghem et al, 2001).

Multicast, in general, is expected to be useful in a variety of applications, including health. Multicast technologies could be used to provide ongoing medical education online through the real-time transmission of lectures over the Internet. It would allow for teleconsultations among geographically isolated public health officials responding to a perceived public health hazard or bio-terrorist attack. Moreover, it could smooth the progress of collaborative consultations among physicians, medical specialists, and patients (Stravs, 1999). Healthcare applications of multicast may stress different design and implementation features from those in other domains. A health application might involve large numbers of small multicast groups featuring the structure of dynamic memberships to link collaborating physicians. The technical considerations that invest in designing multicast protocols that can support large numbers of small groups may differ from those that can support smaller numbers of large groups (Borella et al, 2001; Van Mieghem et al, 2001).

The 'pay-per-use' authorised body must consider suitable multicast capabilities for all services that are going to be provided within an investment-independent strategy. Having stated the technical challenges that the 'pay-per-use' concept encounters within healthcare, it is necessary to discuss the supporting policies that will assist the effective implementation of the concept by healthcare decision-makers, policy-makers, administrators or providers.

6.5 Supporting Policies

Since QOS normally involves providing enhanced service to some sets of packets at the expense of others, the exploitation of QOS technologies requires a sustaining policy infrastructure tailored to the technology baseline architecture. In some applications, QOS assurance can be lost for some short periods of time, provided that such slight faults occur irregularly. In other applications, however, the QOS guarantee must be met at all times, unless the network has become entirely partitioned by failures. A 'pay-per-use' authorised body should possess resources for providing solid guarantees of QOS for critical mission applications as part of the contract 'configuration-independence'. Such mechanisms must scale well enough to be installed in the Internet and will involve matters of policy (whose traffic deserves higher priority), as well as of technology (IETF, 2002). Policy decisions in healthcare are likely to be complex, because of the number of stakeholders involved in decision making (Murphy et al, 1999). Consequently, the plans of policy servers, which are liable for storing policy data and making policy decisions, would take advantage from the input of the healthcare community based on an incremental design approach for each health discipline, as suggested in Chapter One.

6.5.1 Security-Related Policy

"Security is a top priority for health applications of the Internet" (Computer Science Telecommunication Board, 2000, p 144). Whenever personal health information is conveyed across the Internet or stored in a device attached to the network, security measures must be taken to ensure that the information is:

1. Available to those who need it
2. Protected against those deficient of proper credentials, and
3. Not modified in violation of established policies and procedures.

The above three, referred to as availability, confidentiality, and integrity, are of concern in most healthcare applications of the Internet whether they involve the transmission of personal healthcare records between healthcare providers, video telemedicine consultations, or the reporting of information in a home monitoring location (CSTB, 1997a.).

To date, harmful attempts to interrupt the availability or integrity of electronic health information have been rare (Murphy et al, 1999; Bygholm, 2001). However, the confidentiality of electronic patient health records (EPHRs) has, on some occasions, been compromised by individuals such as healthcare professionals or administrators who have legitimate access to some aspect of an electronic record. Indeed, a prior study by the Computer Science and Telecommunications Board (1997a) found that the most significant threats to patient privacy stem not from violations of conventional confidentiality policies or security practices, but from the routine sharing of patient health information among care professionals, administrators and public health officials without prior patient knowledge or consent. The effects of such compromises on the patient can range from embarrassment to loss of employment or loss of health insurance (Health Privacy Working Group, 1999). In general, such concerns cannot be addressed by the use of security technologies, but are the province instead of organisational policies and government legislation that lay out acceptable information-sharing practices (Bourka et al, 2001).

Nevertheless, security technologies are increasingly significant in an internet environment (Bourka et al, 2001). Health institutions have tended to count on trust among health professionals to sustain the confidentiality of personal health information and have privileged broad access to information (with some form of review of access) over strict controls. Connection to the larger, public Internet will necessitate a new strategy (CSTB, 1999; 2001). Health institutions contemplating the Internet as a source of networking infrastructure for critical transactions will need to be given guarantees concerning their protection against security risks while making their systems and data available to those who need them.

The execution of security necessitates a combination of technological solutions and institutional policies and procedures. Institutional policies define the set of rules to be imposed; these rules are then allocated to administrative procedures, physical security measures, and technology (CSTB, 1997a). For example, healthcare institutions cannot simply install access control technologies to control access to online data without first establishing rules to verify which users have the authority to view and modify information and under what conditions. In addition to implementing technologies such as passwords and smart cards to authenticate users, healthcare institutions also need to set up procedures for issuing, changing, and revoking passwords, and policies must be in a place to discipline offenders (CSTB, 2000; Kara, 2001).

Efforts continue on firewalls, which attempt to limit and manage Internet-based access to an institution's computing resources and, hence, support the objectives of confidentiality, integrity, and access. A firewall implements an access control policy. The function of a firewall is to control access to the healthcare institution's network from the outside by permitting only presumably safe traffic to move across. A healthcare institution can sustain a public presence on the Internet for general health information without opening up its complete network to unrestricted access by outsiders. However, regardless of their popularity, firewalls have several limitations. Most notably, firewalls are efficient only against external threats to a healthcare institution's data networks; they do not tackle threats caused by internal users who may purposely or accidentally breach security and confidentiality policies (Grimson et al, 2001).

Furthermore, two security protocols can be used. Internet Protocol Security (IPS) is an architecture and set of standards that presents a variety of services, such as encryption and authentication of IP packets, at the network layer (Kent and Atkinson, 1998a; 1998b; 1998c). IPS can guard traffic across any LAN or WAN technology, and can be completed at end systems or security gateways (e.g. firewalls). Each gateway encrypts the data and transmits them to the other gateway. The receiving gateway then decrypts the data before transmitting them on to the final receiver at the site. Because the data are encrypted via a key recognised only to the two gateways, the message cannot be interpreted by anyone else while crossing the Internet. However, in healthcare, Virtual Private Networks (VPNs) (VPNs allow corporations to leverage the Internet for all their secure communication needs) might be practical for secure communications among elements of an integrated delivery system (IDS) or between healthcare professionals and the Ministry of Health (MOH), but they could not readily sustain exchanges of patient records between unaffiliated hospitals in an emergency situation (Baltatu et al, 2000; Davie et al, 2001).

Secondly, another mechanism for employing encryption and authentication across the Internet is transport layer security, which is broadly used across the Internet in the form of the Secure Socket Layer (SSL) system (Dierks and Allen, 1999). This technology conveys sensitive information (such as credit card numbers) between web browsers and servers (Apostolopouls et al, 2000; Davie et al, 2001).

Therefore, as a result of the above, an active policy committee is needed all the time in the State of Kuwait to review and examine the performance of the 'pay-per-use' concept in communications and networks technology as long as technology evolves and a new contract is signed. These advances ensure offering greatly improved security across the Internet but continued effort will be required to ensure their adaptation to a universal standard so that the 'pay-per-use' model within an 'investment-independence' strategy can be deployed.

6.6 Network Availability

Network availability is the possibility that the network (i.e., the Internet as an example of currently used technology) will be operational at an exact point in time and reachable by those who need it. The Computer Science Telecommunication Board 2000 states, "High availability is a key requirement for mission-critical and time-critical applications of the Internet, including many in healthcare" (p. 160). If the availability of the Internet is unsure, then healthcare professionals cannot count on it for the provision of distant patient care or access to electronic patient health records

(EPHRs) in the emergency room, although they may still be able to make use of it with frustration (Grimson et al, 2001)

Network availability can be compromised by a number of issues, including hardware or software failures, operator errors, attacks, or environmental distractions such as cutting fibre-optic cable, etc., that cause particular links or complete sectors of the network to stop working. Availability is closely associated to both QOS and security in that the breakdown of a link connecting two routers across the Internet can influence the capability of an ISP to address its QOS assurances, and security measures that defend a network from any attack and can help guarantee its availability (Alam et al, 2001; LaMonica, 2001).

Furthermore, security measures such as guaranteeing software accuracy and ensuring software integrity will tackle some issues of availability. However, such mechanisms do not necessarily shield a network from unintended operator errors or physical harm or ensure a network's continued existence in the face of aggressive attacks. By virtue of its design, the Internet is practically opposed to various forms of failure. Its web-like interconnections along with routers ensure the continuation of multiple routes for channelling messages across the network. If one link stops working, then traffic can be routed along a substitute pathway. In many cases, the network can take on a new path and stay away from the failed link within a matter of seconds, which provides sufficient reliability for many Internet applications (Al-Fawzan and Hoymany, 2000).

Further attempts are required to think about means of reacting to disaster scenarios in which great segments of the network fail, resulting in main outages. Such disasters could be restrained to the network, in which case mechanisms are required for ensuring sustained transmission of a variety of network traffic, or necessitate ways of mobilising healthcare resources regardless of prevalent network outages. Therefore, many policy issues would require to be addressed to assist in balancing the networking needs of healthcare institutions in opposition to those of other critical network communications (Mathy, 2000; CSTB,1996, 1999, 2000)

6.7 Technology Challenge and Implications in Healthcare

As the discussion in this chapter reveals, continuing efforts to improve the capabilities of the Internet will create many benefits for the health community. They will provide mechanisms for presenting QOS guarantees, improved securing of health information, and safeguarding patient privacy. At the same time, the technologies expected to be deployed across the Internet in the near future will not completely meet the needs of critical-mission healthcare applications in the absence of international standards (Dick et al, 1977; Murphy et al, 1999).

Efforts in both technical and policy matters will be needed to improve network access for health informatics applications. In several cases, technical effort will be followed by the computing and communications industries in collaboration with the health community. The health community can assist to ensure that the articulation of precise requirements will be necessary, and involvement in research may be desired as well (Waegeman, 1999).

One way to ensure that health-related needs are reflected in networking research and development is to increase the interaction between the health and technical communities. As researchers attest, most networking research is conducted with some potential applications in mind. Those applications are shaped by interactions with system users who can envision new applications. To date, interaction between health informatics professionals and networking researchers has been limited. By contrast, the interests of industries such as automobile manufacturing and banking are well represented within the networking community, in part because of their participation in the IETF (Internet Enginerrinf Task Force, is a large open international community of network designers, more information at www.ietf.org) and other networking groups. The health community may need to engage these groups better to ensure that health interests are considered (CSTB, 2000).

The complex nature of health informatics across networks means that in developing policy and appropriate mechanisms in this field, public authorities must take into account a range of economic, organizational, technical (Chapter Five and Six) and social aspects (Chapter Seven), and be aware of the global character of communication networks. Policy procedures and measures can be more effective if they are part of an international community approach, built on increased co-operation between developed countries, and developing countries and deployed on a global level (Sekikawa et al, 2000).

A substantial body of policy and even legislation relevant to health informatics across networks needs to be in place, notably as part of the international efforts to deploy a standard framework for telecommunications, global electronic patient health records, and electronic signatures. There are legal requirements forced on providers of telecommunications services to take appropriate technical and organisational measures to maintain the security (in broad definition) of their services. These measures are to guarantee a level of security appropriate to the risk represented in transmitting patient health records. The international standard ISO (information technology) and similar national guidelines are becoming recognised practice for deploying and exchanging health informatics on networks in private and public organisations (ISO, 2001).

The State of Kuwait must take actions to launch or strengthen information and education campaigns to boost awareness of health informatics across networks and of security, particularly with business, private users and public administrations. Awareness should be raised in the private sector, and initiatives strengthened, for promoting security concepts as part of computer education and training (doctor-patient relationship as in Chapter Seven). The effectiveness of national arrangements regarding computer emergency response, which could include virus alert systems, with a view to strengthening, where necessary, their ability to prevent, detect, and react efficiently at national and international levels against network and IS disruption and attack should be reviewed (Al adwani, 2001; Alshawaf, 2001).

Therefore, 'pay-per-use' is an evolving concept. As technology evolves this concept has the ability to be in line with the technology under an investment independence strategy. For the State of Kuwait an incremental approach towards implementing health displine is more likely to be accepted due to lack of expertise resources, and this communication and network technology are part of the investment independence strategy.

6.8 Summary

The distributed corporate networking technology environments of the 1970s and 1980s are gaining new life, only this time the move toward distributed networks is

Web-centric with the potential to link customer and supplier. The scenario (presented in Chapter 5) identifies a number of benefits that Internet-based communication bring to healthcare. Of course, considerable effort would be required to transform such scenario (tacit knowledge) into reality on a broad scale. When exchanging patient-identifiable information over a network, it is necessary to: (i) authenticate users (only intended recipient should be able to access information); (ii) encrypt data (information must be indecipherable to nonrecipients); (iii) promote data integrity (data that is sent must be received uncorrupted); (iv) ensure authorisation logic (access control should be based upon the user's relationship to the paient. Therefore, a range of technical capapbilites must be considered in determining the suitability of networking technologies (as we mentioned in Chapter 2 and in this Chapter). Pressure to reduce overhead in information technology (IT) pushes the healthcare institutions to consider new forms of outsourcing. With the use of Internet technology, a new alternative for IT outsourcing and ASP have evolved. The 'pay-per-use' concept within 'investment-independence' allow healthcare centres to access and run software applications over the Internet on a form of pay-as-you-go basis. By using the Web as an application platform, a healthcare institutions can quickly and easily deploy new systems in response to technology changes and best-of-breed applications as well as reap the savings of using a single, standard platform. The qualitative aspects of technology within pay-per-use have been dealt with in detail and the policies to support them have also been discussed (State of Kuwait should examine policy isuues related to (i) the use of the Internet in support of health objectives under 'pay-per-use'concept; (ii) the protection of personal health information access to information infrastructure; (iii) regulatory issues associated with the electronic delivery of healthcare services). The next thing is to look into the impact of the Internet on the doctor-patient relationship, Internet usage by the patient in that relation the quality of the information on the Internet and the need for the Internet access and training at the hospitals. The Internet (network and communication technology) is altering the tradional roles of and the relationships among patient, doctor/physician, and tertiary hospital specialist. As patients become better informed about health issues they may presure authority (MOH) to relax restrictions on the pursuit of care directly from specialist.who may not be even local. If this happen,then the existing referral patterns and definition of high quality service may change. This is dealt with in the next chapter.

Chapter 7

New Paradigm in Healthcare

7.1 Introduction

Health-related activities stand to benefit extremely significantly from the Internet. As a highly information-intensive set of functions characterised by complex interactions among a large number of stakeholders, primary care physicians, specialists, nurses, patients, health plan administrators, public health officials, medical librarians, researchers, and those in other health-related activities can take benefit of the nearly ubiquitous reach of the Internet and its capability to sustain communication between users who may not have interacted with each other before. Already, the Internet is beginning to influence the health sector by forging new relationships among stakeholders and improving access to health information (Davie et al, 2001).

The new paradigm comes from increased distribution of medical knowledge via Internet, which has the potential to alert the power between doctor and patient. Better informed patients will increasingly wish to actively participate in the diagnostic-therapeutic decision-making process, potentially altering the previously institutionalised balance of power (Hardey, 1999).

The 'pay-per-use' concept within an investment-independence strategy represents a higher level of coupling between the application health service provider and the healthcare organisation than traditional outsourcing and ASP (as mentioned in Table 5.1 Chapter 5). In doing so, the 'pay-per-use' concept allows parties (sender and receiver) to interact along both technical and social dimensions. Thus, it is particularly important to view these interactions from a socio-technical systems perspective (STS) (as mentioned in Chapters 3, 5, 6). According to this STS perspective, "a work system is made up of two jointly independent, but correlative interacting systems - the social and the technical" (Bostrom and Heinen, 1977, p. 17). The STS perspective focuses on the possibility of a reciprocal relationship between these technical and social systems. Technical systems comprise "processes, tasks, and technology needed to transform inputs to outputs"; social systems refer to the "attributes of people (e.g. attitudes, skills, values), the relationships among people, reward systems, and authority structures" (Bostrom and Heinen, 1977, p. 17).

It is therefore essential to examine both technical and social systems in order to gain a comprehensive insight into investment-independence technologies (as a conceptual solution presented in Chapters 5 and 6). Bostrom and Heinen (1977) in their socio-technical model (People, Structure, Technology, Task) mentioned that a change in the technology necessarily implies a change in tasks. Such a change may also entail a change in people's skills, attitudes, values, motivation, and in their relationships (i.e. intangible structures). Whether or not a change in technology necessitates changes in people and relationships is indicative of the extensiveness of systemic change instigated by the technology. This is captured in the O'Hara et al, (1999) levels of change model.

Based on the socio-technical perspective, O'Hara et al, (1999) develop a model of organisational change that accompanies technology intervention (as exemplified by the pay-per-use concept within an investment-independence strategy). They propose a model of three levels of organisational displacement following a technological implementation. Alpha change represents the lowest level of displacement and such a change necessitates only a change in tasks as a consequence of the technological change. Beta change requires a change in both tasks and people, i.e. in what is done or the motivation for doing. Gamma change (to be examined in this chapter) represents the highest level of organisational displacement, necessitating a change in the tasks, people and relationships. Therefore, a better understanding of the impact of the Internet on the doctor-patient relationship is needed to guarantee that this relationship is strengthened rather than damaged.

Traditionally, this is a relationship that has been built on trust and an imbalance in clinical knowledge, giving doctors a power that has both technical and social legitimacy. A doctor working in the Ministry of Health (MoH) derived power from two major sources: a higher medical knowledge and the authority to approve the use of scarce resources in treatment. In the past, the patient has in general accepted the greater knowledge and decision-making ability of the doctor, and the power relationship has continued securely (McKenzie, 1997).

The Internet, however, potentially transforms this dynamic. It facilitates the informed patient, and thus provides a challenging power alternative. The institutionalised doctor-patient power relationship may be challenged on two fronts. Patients may challenge not only the veracity of the doctor's higher clinical knowledge but also their preference of treatment. Research has found that patients will increasingly negotiate, in the light of their newly found knowledge and power, to be afforded the treatment of their preference (Hardey, 1999). As the balance in ownership of clinical information transforms, the decision-making role of doctors will come under increasing examination by patients, potentially leaving their major role to be perceived as determiner of allocation of scarce resources, thus fundamentally changing the dynamic of the historical doctor-patient relationship.

Previous chapters dealt elaborately with two major elements of the pay-per-use concept – the technology and the medical side. Concerning technology, the basic architectural framework, essential network and communication technologies to enhance pay-per-use accessibility, performance and adaptability were dealt with. The medical side probes the efficacy of the proposed concept at the receiver end, all those who will actually use and benefit from the pay-per-use, that is, not only the people in the medical world but the every day patients to use it. The social element forms the core of the pay-per-use concept and the core of the proposed paradigm is the patient health record, as discussed in Chapters One (patient empowerment with global access to patient record), Two (definition of EPHR to be managed by the patient), Three (the social form of the research question) and Five and Six (giving the technological perspective).

In the light of what is mentioned above, the patient-centred care paradigm represents an emerging theme of healthcare in the developed countries (Brennan et al, 2000), and it is the core of the sociality component of the pay-per-use concept. A shift in the healthcare delivery paradigm is clearly emerging and often evident in the changing trends in the communications technology, medical practice, approach, communication and attitudes in the light of advancing technology, particularly the Internet. This potential impact of the Internet on the doctor-patient relationship has remained relatively unexplored in the academic literature. Most studies in this area have concentrated on the quality, benefits and risks of the information on the Internet

(Silberg et al, 1997) and how best to help patients interpret it. There is little information on the extent to which doctors themselves perceive the impact of the Internet on the doctor-patient relationship and whether they require support or training to deal with it. Therefore, the 'pay-per-use' concept can be considered a bridge of knowledge between developed countries where there is increased distribution of medical knowledge via Internet and developing countries where there is a dearth of such knowledge in the Internet within integrated delivery network (IDN) setting.

7.2 Transitions in Medical Practice

The past few decades has witnessed key changes in the concepts of health and disease, and in the relevant role and responsibility of doctors and patients in health maintenance and disease management. These changes were activated by cost-containment imperatives. The original incentive to engage individuals in taking larger responsibility for their own care was economic (cost control). The strategy used to foster commitment to better health was increasing individuals' health awareness and making them confident that they could alter their behaviour, and in so doing reduce their risk for preventable diseases such as cardiovascular diseases (primary prevention), or detect diseases at earlier stages, such as cancers (secondary prevention) (Becker and Rosenstock, 1989).

Only recently, the concept of encouraging individuals to participate in their own care has been extended to patients with chronic diseases. Thus, the objective is to make the patient able to share and to practise self-care in the management of his/her disease, and the incentive is still to trim down the demand for and cost of care. Health promotion, disease prevention and disease self-management all rest on education: systematic education about diseases and risks, practical information on how to implement appropriate behaviours, and training in self-care skills, along with the message that individuals have the capability to change their behaviour and acquire the necessary skills. These changes brought about by economic concerns can be observed as constraining, since they entail active self-monitoring and self-discipline (Becker and Rosenstock, 1989; Strecher et al, 1995).

However, as they rely heavily on health information and the development of self-confidence, their unplanned consequences, enhanced by the current technology developments, are patient empowerment and a change in the doctor-patient relationship. The Internet, by presenting both unfiltered information resources and powerful communication tools, increases the capacity of the willing patient to take an active role in his/her own care. It permits him/her to do it more extensively and more efficiently. Better-informed patients can discuss treatment options with their physician, understand and comply with treatment guidelines, and achieve better clinical outcomes. Besides the rising number of Internet companies and medical institutions offering medical information, we are seeing an increasing number of patient-initiated Web sites that provide at once up-to-date, disease-specific information, practical advice and emotional support (Anderson, 2000; Brennan et al, 2000).

We are witnessing the healthcare institution of the Web-enabled patient community significantly changing the politics of medicine and healthcare. The objective here is to express an emerging trend, one of patients using each other's experiential expertise and the Internet on their own initiative to intensify their understanding and knowledge of their disease(s), so as to enable them to team-up with their physician to address their precise care requirements and it is hoped improve their health outcomes. Since Web-enabled patients do not aim to use the World Wide Web to replace their doctors, and because there is also a need to make these resources accessible to all individuals, this emerging trend conveys both opportunities and challenges to the medical community (Anderson, 2000).

There is a great need for physicians to contribute their expertise in new ways, but it is conditioned upon their increased participation in the interactive health communication networks. Physicians can assist their patients to begin using and navigating the Web by directing them to specific sites, while informing them about these sites' particular content and the type of resource they constitute. For example, physicians can guide their patients through Web information authorised by several government agencies (health and academic institutions) which contain high-quality health information. For example, Net Wellness (2000) is a Web-based consumer health information service developed by the University of Cincinnati Medical Centre, with several university collaborators to provide the most current and accurate health information (Marine et al, 1998). Physicians can inform their patients about the health on the net foundation (Health On Net, 2000) an institution devoted to watching Web sites for information value and credibility, which posts links to the most credible ones. Physicians can also persuade their patients to participate in specific disease forums and to search for patient-initiated Web sites. This gives patients an easy way to check the sites they find on their own for information quality (Bartlett, 2000).

Providing patients with navigation instructions and ways to verify sites' quality while being available to answer their questions will prevent them from being harmed and overwhelmed. While there are clear individual and societal benefits related with the new attitude expected from physicians in their practice, there are significant challenges preventing them from teaming up with their patients. There is the medical training that has not been transformed enough to accommodate the new cultural context in which medicine is practised, from a paternalistic and authoritative approach, to a participatory one (Mechanic, 1998; Jackson, 2000).

The day when patients used to follow medical orders blindly is over. On the positive side that new information tools used in the new paradigm may present efficient responses to the challenges of the overwhelming accumulation of evidence-based medical knowledge on the part of physicians on the one hand, and to the need for improved communication between patients and their doctors on the other. For example, knowledge-coupling software that retrieves medical theoretical information and associates it with patient data in an EPHR may improve diagnostic accuracy and the physician's ability to make appropriate treatment decisions (Jackson, 2000). However, apart from efficiency issues, to be fully functional, these new tools, by design, require a high level of communication and strong collaboration between patients and physicians. Therefore, bringing the 'machine' to the patient-doctor relationship has the potential to strengthen the relationship and make it more human (Hunt et al, 1998).

Therefore, whether reflecting a patient's selection or as a designed way to improve the efficiency of care, the participatory approach requires new skills and attitudes on the part of physicians, and the most important is the art of communication. Unfortunately the demands of medical education represented by the continuously growing body of medical knowledge and the need to keep up with new guidelines and discoveries leave little room for training in communication skills. Currently, the Internet allows direct communication to be established independently of time and location, and increases the ability of patients and doctors to strengthen their mutual communication and collaboration, since it allows both parties to work together at their most convenient time. Education and peer support play a primary role in making this revolution possible via the World Wide Web (Roberts, 1999; Slack, 2000).

7.3 Change in Approach/Attitude Towards Healthcare

Health promotion in the earlier days was conceived within the traditional approach of medicine where education entails passing down knowledge from physician and health professionals to patients, where appropriate behaviour is prescribed, and where patients are expected to pursue medical orders. Health promotion and disease prevention, whether primary (aimed at risk reduction) or secondary (aimed at early detection) were mainly applied to the healthy population, requiring minimal care. The use of the key elements of health promotion, education and behaviour change was substituted for the traditional paternalistic approach through patient empowerment. This patient empowerment trend discovers its roots in education, promoted by the new medical models of health promotion and disease prevention, as well as in the self-help movement (Ctiver et al, 1997; Cline and Haynes, 2001).

One example is Lorig's (1996) chronic disease self-management model that incorporates tertiary prevention objectives. Tertiary prevention addresses the return to maximal function and the prevention of further loss of function for people with chronic diseases. Rehabilitation medicine is an example of tertiary prevention. Maintenance of maximum function for patients with multiple chronic diseases requires that they learn to control their day-to-day lives to accommodate living with one or more chronic conditions, thus learning how to self-manage their disease. The self-management model supports patients in getting hold of skills and, in gaining confidence, they will apply these skills on a day-to-day basis. Contrary to the traditional model of care, self-management places patients and professionals in partnership, and the key to such a partnership's full success is communication between patient and health professionals. At the education level, peers rather than professionals communicate and relay the information. This type of intervention, encouraging patient participation in his/ her own care and based on patient empowerment principles, has shown significant benefits in terms of patients' well-being and utilization of care (Lorig et al, 1999).

Recent definitions of health promotion extend the concept to any population, and reflect the current shift from the paternalistic to the newly advocated partnership approach in the practice of medicine. For example, Fries et al, (1998) propose the use of an extended definition of health promotion to include all activities that educate, guide and motivate the individual to act in a way that increases the likelihood of sustained good health and the use of appropriate medical services. For these authors, the purpose of health promotion is to trim down the need and demand for care at any level of the continuum between healthy and chronic disease stages. Achieving this objective requires autonomous and responsible behaviour on the part of the individual, and a move from a paternalistic attitude to health advocacy on the part of health professionals. Indeed, the key to success is the articulation and integration of medical management and self-management (Lorig et al, 2001).

Education is central to all initiatives commenced to increase public health and contain healthcare costs. As the definition and scope of health promotion altered, so did the way education was dispensed. Education meant to boost people's participation in their own care is not giving passive information. It consists of providing individuals with the means of taking responsibility for remaining healthy and learning how to manage their disease when necessary (Lorig et al, 2001). More specifically, it necessitates giving them appropriate information and timely advice on what to do on their own, when to request outside help, and how to become skilful at living daily with a chronic condition (Steinweg et al, 1998). On the physician's part, this requires being an educator, a facilitator, and a partner. On the patient's part, it implies learning, becoming knowledgeable and self-confident. Overall, it marks a sharp turn in the patient-doctor relationship, towards partnership (Mechanic, 1999).

The change in the patient-doctor relationship happens at a time when, on average, people are more interested and more knowledgeable regarding medical issues than they used to be (Lowes, 1997). Since people today are encouraged to actively take responsibility for their health and care rather than to passively wait for and blindly follow medical advice, they are more genuinely interested in health issues. As they learn, they become more curious, investigative, and ready to take initiatives. The Internet offers a faster way to satisfy the need for health information and permits browsers to access more information than is available in pamphlets, booklets, or from doctors or nurses. As Desmond writes, "The patient education and self-care trends of the past 20 years have been accelerated by a technology that offers patients and consumers access to nearly all of the same medical information used by physicians"

(Desmond, 1999, p. 37). Modern physicians need to be aware that some of their patients who have access to the Internet and the time to search it might challenge their therapeutic decisions. As suggested by Lowes, there are ways to "manage the relationship with patients educated in cyberspace" (Lowes, 1997, p.176). A collaborative approach towards on-line research can help doctor as well as patient.

The Internet can come to the aid of physicians who, overwhelmed by the demands of both the profession and the healthcare system, find less time to inform patients about their illness. The use of the Internet, along with specific software, can also help physicians share out and customise information to the needs of their patients (Gabello, 1997). In any case, the first sound advice to physicians right now is that they get on the Internet if they do not want to be left behind (Ukens, 1998). Therefore, Internet access provides the educated and empowered patients with the means to further their participation in their own care and become real partners of their physicians, now expected to guide and advise, not to make the final decision. On-line advice and support provided by others sharing the same disease will better equip patients to interact with their physicians (Lowes, 1997; Hayden, 1998).

7.4 Newer Communication Tools

The Internet, by bringing together information and support, can boost the ability of patients with chronic diseases to deal with their condition on a daily basis and dramatically improve their outlook on life. At the other end of the spectrum, people with rare or with 'new' conditions not yet well defined or well categorised, such as fibromyalgia and chronic fatigue, will find information, guidance and support more easily and rapidly on the Web than they would by going to the library. In addition, at a touch of a button, they will be able to reach immediately those sharing the same problem. Meanwhile, anything associated with health and disease can be found on the Internet using the existing search engines (Jadad and Gagliardi, 1998).

Information technology with its powerful communication tools opens a new era, where lay people can access unrestricted health information, rely on peer support and experiential advice, and tap medical expertise independently of and in addition to their personal network resources. Lay people have this new option and use it quite extensively. Conversely, healthcare professionals concerned in improving the medical outcomes of their patients suffering from multiple chronic conditions begin to take advantage of the existing information and support networks to boost the willingness and ability of their patients to take better care of themselves. Using the new communication tools permits rapid exchange of information between patients, their healthcare providers and the health professionals. It allows better adjustment of and greater patient compliance to treatment, both leading to improved outcomes. The Internet, because of its powerful communication properties allows tailoring health information according to an individual's specific health desires and information processing ability level. However, the use of these powerful technologies is conditioned by the ability to access them (Zielstorff, 1998; CSTB, 2000).

In spite of all the difficulties and barriers to accessing relevant health information on the Internet and using it efficiently, patients have demonstrated its utility, mainly benefiting from each other's experience through on-line communication. On-line support groups are also instrumental in changing patients' attitudes towards their doctors, from submissive obedience to curiosity, and this is to their benefit. On-line support groups help patients boost their self-confidence and sense of control over their life, in spite of their illness. These groups also enable patients to make informed decisions concerning what care they want after having explored the available possibilities and get access to the type of treatment they desire. Peer support, more specifically, the strong desire patients have to let others reap the benefits of their own experience, and support users in locating the relevant information tailored to their needs. By making this information understandable, peer support also prepares users to interact more efficiently with their personal physicians or the on-line medical experts, which is an important step in the learning process. However, they are still limited to providing common terms, or academic or general types of information about medical conditions. They can rarely provide the information tailored to the particular needs of a patient suffering from the disease (Hardey, 1999; Pearson et al, 1999; Rice et al, 1999). There is a serious effort to make possible universal on-line access to health information and support (Eng et al, 1998). The rationale for this effort is the changing structure of healthcare delivery, primarily driven by patients, not by the healthcare industry. Nevertheless, if more healthcare services are being shifted from traditional healthcare settings to the home and the community, the prerequisite to make this new structure successful and cost effective is to render access to health information universal. Indeed, individuals do not have to own a computer to access on-line health information and support (Zielstorff, 1998).

Lack of high-speed equipment and the costs of IT utilisation still limit access in rural and poor areas. With the further development of new technologies to improve usability and access, television-based and touch screen systems, as well as the use of programs tailored to different literacy skill levels, the final barriers could be progressively removed. Evidence shows that when access barriers are removed, with appropriate training, people of under-privileged areas want to and can successfully use Internet technology to address health issues (Eng et al, 1998). Access to health information and support can facilitate them to attain enhanced health, improve their clinical outcomes, and promote their more efficient use of healthcare services (Mishra and Chavez, 1998). Furthermore, it appears that the clear benefit envisioned by the use of the new communication technology is the possibility to increase the efficiency of health promotion and prevention initiatives, and enhance the already recognised power of peer support to emulate health promotion and interventions. (Ferguson, 1997)

7.5 Risks of Internet Information

Robinson et al (1998) warned that the technology that permits people to access health-related information on the Internet may also harm them through deceptive claims for medical products, and that such misleading information could confuse people or erode their confidence in their healthcare professionals. The risks recognised above imply that misleading information and quack medicine is a new phenomenon specifically associated with the Internet, which may not be true. If we presume that less educated people are more likely than the more educated to be harmed by fraudulent claims and low quality health information, we may worry that they might take misinformed decisions that may be harmful to their health. However, we have to recognise that the cause of their misinformation is more likely to be a medium other than the Internet, if not friends or family members. As underlined by Coiera (1998), there is no evidence that the quality of information presented on the Internet is different from that of other media, or has influenced different health decisions in the public.

Nevertheless, there are reasons for pinpointing the Internet as a possible cause of misinformation and misleading help. It is a fact that health information found on the World Wide Web is highly changeable in terms of accuracy, completeness and consistency (Impicciatore et al, 1997). In particular, medical information available on the Internet in discussion groups may appear from non-professionals and may therefore be unconventional or based on limited evidence. On the other hand, it is hard to check the credentials of a participant who claims to be or behaves like an authority (Eysenbach and Diepgen, 1998)

Finally, the Internet is a free market of information and therefore is self-regulated. Its dynamic and interactive nature allows regular monitoring and expert input, providing experts use it as much as they should. In the area of health and medicine, we could expect to find more publicised and authoritative Web sites operated by health practitioners with peer review of the material published there.

7.6 Patient-Physician Communication & Interaction

A successful physician is one who is a good listener to patients' problems and concerns, takes accurate and complete medical histories, and gains patient trust and confidence. He/she must assist patients understand their problems better and clearly communicate treatment recommendations and medical advice (Holmes, 2002). Communication is a cornerstone of medical practice, while poor communication is a major reason of misdiagnosis, poor compliance with therapy, and malpractice claims (Mechanic, 1998). Telecommunication technology has produced new lines of communication for patient-physician interaction. Most recently, the global computer network of the Internet has provided electronic mail (e-mail) and the Web. E-mail allows for a direct one-to-one communication (Kane and Daniel, 1998), and the Web is used mainly as a broadcast medium for dissemination of information in a one-to-many form. Just like the Internet's predecessor, the telephone, application and research must be done to determine how this new technology can best be used to enhance the patient-physician relationship (Mandl et al, 1998).

The Internet provides an unprecedented level of instantaneous intercommunication. Web browser technologies offer an interface to the Internet that makes this communication accessible even to novice computer users. The combination of communication and interface technology is an opportunity to explore ways of improving patient healthcare by breaking down existing barriers to quality healthcare management (Anderson, 2000). Web-based communications enable a constant interaction between physician and patients, where patients can freely enter data and concerns, and physicians can address these asynchronously. Therefore, in this 'Internet Age' physicians and patients have unique technological resources available to improve the patient–physician relationship (Weed and Weed, 1999). How they both use on-line medical information will influence the course of their relationship and possibly influence health outcomes. The decision-making process may develop if efforts are made to share the burden of responsibility for knowledge. Further benefits may arise from physicians who assist patients in the information-gathering process (Cooper-Patrick et al, 1999; Robinson et al, 1999).

Although many individuals have the potential to obtain medical knowledge easily through on-line information, others do not. Few studies have examined the benefit of computers in patient education within economically depressed urban areas (Eng et al, 1998). There is also little evidence that explains how individuals lacking the latest technology (including high-speed Internet Service Providers) cannot access resource-intensive Web sites, including those requiring audio or video streaming (Rice et al, 1999). The lasting effects and potential benefits of computer technology for vulnerable populations have yet to be determined. Although there is a substantial amount of data that demonstrate limited access, there still is overwhelming interest in computer education from various segments of the public. Additional research is necessary to define how patients of different cultural or socio-economic backgrounds utilise computers and the Internet for information, and how this has an impact on their relationship with healthcare providers (Dixon and Stewert, 2000).

Telecommunication technologies and Internet technologies (to deploy the 'pay-per-use' concept within investment independence as mentioned in Chapters Five and Six) are a useful tool for the dissemination of medical information, the sharing of medical records, and physician intercommunication (Mandl et al, 1998). In response to this information-seeking activity, physicians have expressed concern about access to misinformation and patients' interpretation of available on-line content (Eysnbach and Diepgen, 1998). Many doctors believe that only qualified medical professionals may adequately assess and construe external sources of information. This situation contrasts with physicians' sole possession of medical knowledge, as was the case for most of the 20th century (Robinson et al, 1998).

7.7 Changes in Medical Decision-Making

Until recently, during clinical visits, the healthcare provider had the sole liability for medical knowledge, while the patient was only responsible for his or her own preferences. Patients, by acquiring medical information more simply prior to visiting their healthcare providers, have a different position in the decision-making process: possessing both preferences and knowledge prior to any physician contact. Another likely advantage comes from having the opportunity to reflect on and reconsider preferences prior to discussions with health professionals. People are likely to redefine their requirements and intentions over time, because they frequently are uncertain (Charles et al, 1997). Paradoxically, a patient's awareness in knowledge may not always accompany an interest in the medical decision-making process. Patients may investigate information about their medical conditions without interest in taking responsibility for making decisions about treatment (Ende et al, 1989).

Let us presume that in this process, a patient may be encouraged to become concerned in the decision-making and have access to additional sources of information about a particular sickness as well as the treatments available. Such a patient could be at an additional benefit by having accessed related information via the Internet prior to meeting with a healthcare provider. Instead of utilising scheduled time to furnish the patient with basic knowledge, the healthcare provider may give extra time to filtering what the patient has learned and offer greater depth on treatment alternatives (assuming the information obtained is accurate). Theoretically, more time could be spent on discussions necessary to reach a clinical decision. However, healthcare providers must be equipped to address alternative possibilities that the patient has learned from external sources. Healthcare providers need to be aware that patients who are involved in obtaining additional knowledge may not be motivated to participate in actual decision-making. One necessary requirement for this decision-making process is that both parties take steps to contribute in the process of treatment decision-making (Kaplan et al, 1996). Thus, it is yet uncertain whether efficiency improves or declines when patient-acquired Internet information is brought into the decision-making process and this subject warrants further investigation and emprical research (Kreuter, 2000).

7.8 Role of Healthcare Institutions

Healthcare institutions have had to adapt to many changes in the world around them, from advances in diagnostic and therapeutic procedures to the emergence of patient-centric approaches and the invention of new information technologies. The Internet represents a particularly profound change that will enable or force significant changes in institutional form and processes. Institutions need to evaluate the potential and implications of new Internet technologies, adapt them to local needs and conditions, minimise the risks associated with new product and service deployment, and plan to demonstrate the value of their efforts. Therefore, the effective use of information technology (IT), including Internet technologies, can have a profound impact on institutional structure and function. As information is distributed efficiently to those who need it when they need it, lines of control and influence become clearer, and individual units often self-organise in new and more effective ways. The impact may be multifaceted, not only flattening institutional structures, but also changing the skill mix of employees (Eysenbach and Jadad, 2001).

The Internet could enable profound changes in the nature and structure of the healthcare industry and, ultimately, the delivery of healthcare services. The healthcare industry is, and will continue to be diverse, with individual institutions facing different environmental pressures, pursuing different missions, and cultivating different cultures, but the Internet appears capable of supporting at least some common strategic interests (Dick et al, 1997; Murphy et al,1999).

The Internet is already empowering patients to become more involved in and take greater control of their own health and care. Patients are already coming into doctor's consulting rooms equipped with information downloaded from the Internet and suggestions for diagnoses and treatments. They may soon be able to access information on the quality of care delivered by different healthcare providers or facilities in their geographic region. The relationship between healthcare institutions and patients could change even further when an institution uses networks effectively to expand its patient base beyond a specific geographic region. The assumption that a patient who lives near a particular hospital will opt to be treated at that hospital is challenged by the ease with which networks afford patients access to clinical specialists worldwide (research question in Chapter One stated can 'pay-per-use' allow easy national and international access to EPHR where health delivery is not restricted to local doctors and hospitals, and the conceptual solution in Chapter Five and Six which introduces an infrastructure to access patient health record globally).

Therefore, healthcare institutions are beginning to experiment with Internet-based systems to serve a variety of functions. Many healthcare institutions, for example, are developing Web sites to provide patients with health-related information, the ability to select physicians or schedule appointments, and the tools to evaluate their immediate healthcare needs. More study is required to measure fully the benefits of such relationship between healthcare institutions and patients using Internet technology in the healthcare institutions (CSTB, 2000).

7.9 Change in Kuwait's Healthcare Paradigm

One of the foremost challenges that the State of Kuwait faces within the health sector is to introduce revolutionary changes within the medical healthcare system in the State of Kuwait so as to implicate favourable improvements to enhance the system of healthcare delivery. The obvious question raised is how the State of Kuwait will, through the Ministry of Health (MOH), cope with emerging trends in the healthcare institutions in order to deliver the quality of health and reduce the cost. An independent authority and health professionals on one hand, and the user of the system on the other, both have an equally important role to play in facilitating the use of IT, and the Internet in particular, in the medical field, and putting it into daily practice in the professional and personal field. The patient should be trained and encouraged to take up responsibilities and enhance awareness in the particular area of healthcare. More future research is needed concerning the magnitude of the organisational change in deploying the 'pay-per-use' within 'investment-independence' strategy. Building social networks, managing and transferring knowledge all become more critical as the level of change increases.

The new emerging trend imposes changes in the social behavioural pattern of the Kuwaiti society. The society, despite tremendous modern living standards, attributes great significance to cultural and traditional values. A change from traditional thinking related to the patient-physician relationship poses a great challenge within the society. It implies changes in attitudes, thinking, behaviour and approach so as to bring about acceptability of the new technology in daily life. The transition to a patient-empowered environment would require some time and tremendous effort on the part of all users. The major challenge is the language, since most of the patients currently can speak only their native language.

In the State of Kuwait, the second language is English, but not all citizens can read and write it. The government should adopt policies to enhance provision of Internet connection at reasonable rates so that the common man will have access to it, whenever required. Co-ordination by governmental agencies will facilitate better operation. Using bilingual web sites edited by a body with credentials will facilitate the education programme to empower the patient. Finally, the press and other media should inculcate awareness among the public about the use of Internet technology for healthcare information. It is the quickest and easiest medium to inform and educate people concerning emerging technologies.

The Internet age is altering the patient–physician relationship. If physicians actively assist patients in the information-gathering process, an improved relationship may result. Through the understanding of evolving professional roles, the decision-making process between physicians and patients may improve with efforts to share the burden of responsibility for knowledge. This change could usher in a new era of patient–physician relationship, with a potential gain for all collaborative parties. However, poor quality of health information gathered by patients on the World Wide Web may lead to adverse consequences, and while the misunderstanding of the proper relevance of particular treatments might foster demand for inappropriate and/or costly interventions, accurate, relevant and evidence-based information retrieved by patients can enhance the quality and appropriateness of their healthcare (Coulter, 1998).

In this perspective, there is need for physicians and health professionals to shift gears and join both consumers and patients on the Internet. The clinicians' new task will be to contribute their expertise in locating high quality health information, in defining its optimal use, and in making themselves available on-line to answer consumers and patients' questions. A collaborative approach towards on-line research that would help patient and physician does not seem to be far-fetched (Biermann et al, 1999). The Web, by making available medical and scientific literature to the public, allows lay people the opportunity to access the same evidence-based medical resources as practising doctors. Some avant-garde physicians see patients coming to them with JAMA and BMJ (Journal of the American Medical Association, British Medical Journal) articles as an opportunity to keep abreast on new advances in their field rather than as a threat to their authority (Lowes, 1997; Zielstorff, 1998).

Finally, technology will never replace human intervention as a prerequisite to effective healing and caring. However, as an interactive agent for promoting self-care through education and peer support, the Internet will act as a direct and effective means of achieving health promotion and disease prevention for the healthy, and better outcomes for those dealing with difficult diseases. It will also ease and strengthen the communication between Web-enabled patients and their physician partners.

Most patients using a home computer have access to medical information on the Internet. This circumstance will likely reflect a select, educated patient population with income levels that support the equipment. Patients with poor literacy skills are less likely to take advantage of the Internet in order to acquire additional medical knowledge, whether they have access or not. Unfortunately, because these individuals are more likely to have more health problems, their need for health education is greater, especially for those with chronic illnesses (Williams et al, 1998).

This issue affects their relationship with physicians; studies have shown that patients' acceptance of diagnoses and treatment plans depends on education (Grueninger, 1995). Hence, additional efforts are required to assist persons with lower literacy skills. With adaptive technologies supplying touch-screen input and audio output, kiosks can be made available for patients motivated to learn, independent of their literacy or education level (Patyk et al, 1998; Pearson et al, 1998). However, additional issues, such as cost, complexity of use, and potential for misinformation, then arise (Glasgow, 1999).

7.10 Summary

The emergence of a new paradigm in healthcare calls for joint efforts and partnership by all those involved in seeking and achieving a solution based on the 'pay-per-use' concept within an investment-independence strategy for the benefit of all. Internet usage, the quality of information on the Internet, and the need for the Internet access and peer communication raise interesting issues regarding training and education (Sosa-Ludciss et al, 1997). Should Internet training be part of medical education or should it be considered an essential life skill that everybody, including doctors should obtain for themselves? If Internet searching in the patient physician relationship is considered an essential part of medical practise, who would pay for the training? Therefore, numerous opportunities exist for empirical studies and theory creation.

The new paradigm for the State of Kuwait (as a State with a young generation population over 50% are less than 19 years old (preventive program education with cultural change can be transformed smoothly) and with a wealthy status position (technological infrastructure can be provided) as mentioned in chapter 4) presented in this chapter provides direction and guidance to such research by grounding future enquiry to measure the appropriate social contacts to leverage knowledge strengths, as well as to facilitate informal governance of the relationship. The next chapter provides the concluding note to the new solution seeking the 'pay-per-use' concept within the healthcare delivery system.

Chapter 8

Conclusions and Future Work

8.1 Introduction

The overall objective of this thesis has been to address the fundamental research question introduced in Chapter one, this was *Can 'pay-per-use' allow easy national and international access to electronic patient health /medical records and is it an appropriate approach for healthcare in a country such as Kuwait?*, the study proceeded to address some of the major issues worldwide and also related to Kuwait. The research reviewed healthcare delivery problems and IT limitations and challenges in the health industry by reviewing available literature. This literature provided information on technological advancements and their impact on the medical world. The research methodology was based on the Grounded Theory (GT), which established the inter-relation between medical and IT worlds. The use of a social scenario (tacit knowledge used to interpret the sociality of the GT) delineated the research process and traced the development of the research, which culminated in the interpretation of a model theory, framework and architecture for healthcare delivery within the health industry. Kuwait's historical perspective and its medical background provided the grounds for which the conceptual solution 'pay-per-use' - within an investment-independent architecture - could be applied and implemented. The study further addressed the qualitative aspect of technology and the provision of standardisation in the use and access of health information so as to accomplish universality of features. The study presents the shift in the healthcare delivery paradigm which has set the optimistic ground to introduce the pay-per-use concept in healthcare delivery. Finally, this research provides the groundwork for future research in the area for the purpose of enhancing healthcare delivery in the health industry.

This chapter presents an overall summary of this research study. It provides a conceptual solution in the framework of the 'pay-per-use' concept within 'investment-independence' strategies, and its contribution to the research. A discussion is provided on its limitations. Finally, the chapter outlines several future research directions which have emerged from this study.

8.2 Summary of the Research

The phenomenon of electronic patient health rcords (EPHRs) is driven by the idea that healthcare information systems can make key contributions in the control of mounting healthcare costs, facilitate accountability for quality, and spread out access to healthcare to under-served populations (Waegemann, 1998). This phenomenon has prompted many vendors and providers to develop and implement as many functions of the EPHR as possible during the last two decades. Despite the pervasive acceptance of the EPHR phenomenon, several major impediments remain as barriers to the complete implementation of EPHRs. These impediments include the lack of standards that define complete interoperability, lack of accord on the data sets and code sets that make up the content and structure of the EPHR, lack of standards to ensure data quality and comprehensiveness, and the lack of national legislation in several countries to protect the privacy of health records effectively (Amaral et al, 1999). Even though these impediments have not been completely surmounted on a local or national basis, the requirements of a mobile international society are already beginning to recognise the need for a global EPHR framework, which is a key source of health information.

The framework will draw upon the aspects, functions, and characteristics of local and national EPHRs (Murphy et al, 1999). The aspects comprise the use of a common scheme for the content of the record, agreement on the timeframe of a longitudinal record, and the standardisation of medical concept representations. The functions embrace the facility of the record to capture, store, process, communicate, and present information. Characteristics consist of the notions of availability, reliability, data integrity, data security, auditability, usability, and retention. While all of these aspects, functions, and characteristics are required in EPHRs, the global EPHR will only require that certain of these features be standardised on an international basis. The areas requiring global standardisation are communications standards, common elements of information models, linkage or convergence to common medical concept representations, standard syntax for decision support, and minimum levels for data security (Kohane et al, 1996; Dick et al, 1997; Murphy et al, 1999). Finally, the ISO Technical Committee Healthcare Informatics was formed in 1998, and it seeks to play a major role in creating the framework for the global EPHR (CEN/TC 251, 2002). Therefore, a joint effort of collaboration should take place in several leading nations to adopt a number of healthcare information standards that are gaining acceptance internationally, and to integrate the Internet that has great potential to improve such adoption by enhancing communications and improving access to information.

The scenario approach is introduced as a means to explicate the hypothetical (but typical) problem situation to healthcare experts (Cheah and Abidi, 1999), and is used as a problem-solving mechanism for electronic health records. Consequently, a scenario is very similar to a case. However, the major distinction between the two is that a case is a real-life situation-action structure, whereas a scenario represents a sequence of hypothetical situations carefully designed to draw out tacit knowledge (Cheah and Abidi, 2000, 2001). As a result, the scenario structure and its components are used in the research methodology of this thesis, adopting the Grounded Theory approach, to derive the concepts' relationship with categories concerning access to and management of electronic patient health records locally and globally.

As finances become more limited globally, the need to seek cost-efficient and cost-effective strategies for health systems is becoming more urgent. The environment within which health systems and health policies are being developed has changed dramatically. In previous decades, governments looked forward to long periods of independence, national reconstruction, economic growth and a wider sharing of prosperity. "Redistribution with growth" was the theme for development. Economic orthodoxy and development thinking has changed. The redefinition and reduction of the role of the state are now being seen in all continents. Market mechanisms, rather than public intervention, are increasingly being used to drive national economies. The health sector is also experiencing these changes. There is growth in private sector participation in the financing and production of healthcare services. In some countries, public institutions are being sold off to the private sector, and new private institutions are replacing or augmenting them (Warner, 1998).

However, a new challenge will be for governments to continue to steer and regulate the health sector, including private providers, for the benefit of public health. The State of

Kuwait faces new challenges with the need to develop Kuwait's healthcare delivery system, adopt new measures to enhance the quality of that system, while not imposing additional financial burdens on the government or the Ministry of Health. The competitive position of a healthcare delivery service will depend on many factors: the cost structure, the availability and skill level of human resources, service differentiation, and availability of technology and health facilities. These comparative advantages are reinforced by other factors such as geographical proximity, cultural and linguistic affinities, natural endowments, and the ability to market the advantages effectively. The development of a private facility with state-of-the-art technology to provide services for the wealthy or for foreign persons will increase the technology availability in the health system (Wolvaardt, 1998).

From a competitive point of view, the availability of technology in healthcare is an important factor, as it will provide self-reliance within the country, as well as establish reliable healthcare services at reasonable prices that are significantly lower than in the developed countries.

The core objective of national healthcare institutions is to deliver the best possible healthcare to residents. An essential part is the creation and management of EPHRs, which serve as the central clinical repository of information pertaining to patient care. EPHR is a critical information asset for all stakeholders in healthcare delivery. An effective information system infrastructure is crucial for the set-up, maintenance, management and access of the EPHRs (Murphy et al, 1999). The capital investment, in terms of time and money, necessary to build this dedicated infrastructure is phenomenal, and is subject to the large risk of fast technology obsolescence and the resultant loss of the information asset and its access. The healthcare delivery institution requires an infrastructure that is 'investment-independent' with regard to the EPHR information asset management. Investment-independence permits the healthcare institution to procure all the relevant services, namely the technology services, application services, data storage services, and communication services, from the respective vendors with relatively minimal capital investment. This infrastructure would assist the healthcare institution to procure these services on a 'pay-per-use' basis. Platform-independence, database-independence, application-independence, data-independence and communication-technology-independence are the key building blocks to institute the required 'investment-independent information infrastructure' for the healthcare institutions. This research presents a 'conceptual architecture' that allows healthcare institutions to deploy this infrastructure for effective and efficient healthcare delivery, which is its core function.

As healthcare provider networks grow and patients become more mobile, recent trends to link medical practices, clinics, and hospitals into single entities and to share information with affiliated institutions have become more significant. The electronic transmission of patient information among providers via the Internet could improve care and reduce costs to the provider and the patient. Not only must the Internet offer connectivity among the participants in health-related information transactions, but it must also guarantee that such transactions can take place predictably, efficiently, and without jeopardising patient safety. Internet users must be able to determine the quality and authenticity of the information they retrieve from the Internet. Healthcare providers who access patient records remotely must be assured that the network will be available when and where needed. Administrators must be confident that information is not corrupted as it crosses the Internet. Without proper security protections, use of the Internet to transmit medical records could make personal health information more susceptible to breaches of confidentiality and loss of integrity. Therefore, with adequate assurances of network reliability and quality of service, use of the Internet for remote monitoring of patients, controlling remote medical equipment, or conducting remote medical consultations could facilitate the delivery of quality healthcare and reduce the cost burden of healthcare (CSTB, 2000).

Today's Internet computing architecture and the Word Wide Web have laid the foundations for enabling the 'investment-independent' information infrastructure for the healthcare industry. Healthcare institutions face a quantity of pressures to integrate the Internet more effectively into their operations. Tens of thousands of sites on the Web offer information on health issues (Mittman and Cain, 1999), and an increasing number of companies have established Web sites to offer individuals information on specific diseases, therapies, and healthy lifestyles. Some sites permit patients to evaluate risks to their health, manage chronic medical conditions, pose questions to health professionals, or engage in discussions with other patients. As the Internet can link all the participants in the health community, it can be used to improve patient access to health information and healthcare, to enhance clinical decision making and improve health outcomes by making better information available to clinicians on demand, and to reengineer the processes of care to make them more efficient. A number of technical factors need to be considered in deploying this architecture towards a 'pay-per-use' conceptual solution. These factors considered in this research are bandwidth, latency, availability, security, and ubiquity.

The 'Internet age' is altering the patient-physician relationship. This situation contrasts with physicians' sole possession of medical knowledge, as was the case for most of the 20th century (CSTB, 2001). Today, there is greater acceptance of more informed and educated patients. Healthcare providers can take advantage of this unique opportunity to create, support, reference, and promote awareness of high quality electronic sources of medical information. If physicians actively assist patients in the information-gathering process, it may result in an improved relationship between them. Through the understanding of evolving professional roles, the decision-making process between physicians and patients may improve with efforts to share the burden of responsibility for knowledge about health and healthcare. This change could bring about a new era of the patient-physician relationship, with a potential gain for each collaborator. Therefore, both parties (in fact, all those involved) should take steps to participate in the process of treatment decision-making that could have significant impact on the cost and quality of healthcare (Bader and Braude, 1998).

8.3 Research Contribution

This research presents a 'conceptual architecture', in a fast evolving technological environment, that allows health organisations to deploy an infrastructure on the basis of 'pay-per-use' within 'investment independence' for effective and efficient healthcare delivery. The following points are some conclusive research findings:

- The healthcare service is now not bound by application system development and maintenance, or its vendor. This drives a competition among 'application system developers' and service providers for better health-related information management which will improve the quality of care.
- The complexity and the wide spectrum of healthcare areas require specific application systems for each area to record EPHR diagnosis and results using an 'investment-independent information infrastructure' for the healthcare institutions. This research delineates the infrastructure within the architecture and drives the 'healthcare information system' service producers towards an 'industry standards definition' for the methods and means of acquiring, processing and storing the EPHR information for several medical areas. Therefore, healthcare institutions in industry and acadaemia should continue to work with the Ministry of Health to implement common standards in order to improve understanding of Internet effects, the health models that would support them, and impediments to their expansion.
- This study emphasises that the Internet offers greater interactivity and better tailoring of information towards patient-oriented needs. Indeed, the Internet could change the culture of healthcare from one in which patients are viewed as

recipients of care to one in which they are partners in care. Eventually, they may be able to use the Internet to access and update their personal medical records or receive care in their homes. This study maintains that the government, industry, and acadaemia should work together and with experienced professional associations in health and information technology to educate the broader health and healthcare communities about the ways the Internet can benefit them.

Returning now to the four specific research objectives stated in Chapter one, the first objective is *to propose a conceptual IT solution that is apt for Kuwait's healthcare.* Kuwait is a small country with well-equipped state-of-the-art technology availability. The authority and the public are aware of the technology and hence implementing a model based in this proposal is feasible. Since the awareness is not an issue, the patient health information system can be applied incrementally. Initial steps will be to gather the personal profile of the patient through web-enabled applications to maintain general medical records on a daily basis, which could be a stepping stone. This is demonstrated in Chapter 4 where stutus and structure of the healthcare delivery system is explored. The second and the third objectives are *to set the basic framework wherein the concept could be applied,* and *to identify and interpret a suitable model to suit the proposed concept.* The development of the proposed architecture and model for healthcare provision, which is based on the concept of complete independence of the core health function from the information technology that enable the patient health information to be available for stakeholders anywhere, taking place in Chapter 5 and 6. The authority responsible for providing the healthcare using this model is also not bound by the application system that facilitate this information access. The use of social clinical scenarios (tacit knowledge) is introduced to delineat research process using Grounded theory. Chapter 5 and 6 define a clear architecture baseline definition and framework in order to operate major technological components across the organisation. Using specialised application services as part of this healthcare provision via 'Pay-per-use' or 'Business-on-line when needed' allows the health authority a wide choice so as to always be able to look for the best available application services to suit the needs of the State of Kuwait. A major impact is the freedom from continuing in-house support and expertise to manage and maintain the systems, freedom from the IS investment becoming obsolete. IS/IT investments need not to be huge and can be incremental. The last objective is *to demonstrate future implications (social and technical) of the new concept with reference to Kuwait's healthcare.* The major challenge however, is not technical but cultural. One aim of the incremental approach is to address the people aspect effectively. Chapter 7 explores this challenge and requires more attention to be given throughout to education and training. However, the concept of 'pay-per-use' covers all of the stakeholders in the patient health record information system such as Physicians, Authorities, Specialists and different levels and types of healthcare centres. The implications for these are also considered in Chapter 7. It is possible that these arguments could also be generalised to other application areas such as the International Banking sector, where the proposed model could be used to maintain a *Customer Information System*, especially when the customer to the bank has global transactions through the bank or the bank has global customers transacting on various products. This is not considered explicity here however.

8.4 Limitations of Research

This theoretical research creates concerns about the 'Digital Divide' within society, which has implications for maintaining both health and social inequalities in the State of Kuwait. There is a mounting concern that exclusion of some people from information communication technology (ICT) is leading to a growing 'Digital Divide' such that the people least likely to use ICT are those most likely to be excluded from mainstream education and better job opportunities. Individuals who use ICT can expect to have easy access to a wealth of information, with new opportunities for choice, participation, lifelong learning and leisure, and a chance to get cheaper, tailored goods and services due to business turning to electronic commerce. Individuals who lack access to ICTs are confronted with compounded disadvantages at many levels: children without access to computers and the Internet at home or in the community may find it more difficult to keep up with preventive health behaviour at the childhood stage; for adults, computer literacy can be important for re-entering the labour market and having better job opportunities; and for the community as a whole, lack of access to communications networks can limit the use of better quality services, make it harder to access opportunities in other areas, and reduce the possibilities for enhancing local social cohesion (Digital Divide, 2002).

On the other hand, English is not the first language for Kuwaiti people and some other ethnic groups. Yet, at present, most of the content presented in the health sites is not in Arabic, nor do the contents target minority group populations. Beyond simple translation of content, information will be more useful and meaningful if other elements of communication, including tone, style, and use of images and sound are used in a culturally sensitive manner.

8.5 Conclusion

The research gives rise to the following suggestions for conclusion and future work:

- Communication and co-operation between providers within the healthcare institutions and different organisations require extended security services. More research and investigation are needed to establish a government or semi-government health-data institution where all patients' electronic data are stored. It is approximately similar to a customer depositing money in the bank and instructing the bank to perform all transactions. However, a patient can use his smart card to activate the release of information. He can link to the health-data institution globally to provide access to any healthcare setting using the 'pay-per-use' concept. Therefore, with the support of the government, more research is needed on how to maintain and to access records securely on the national and international level.
- Further research is necessary to understand the cost-benefit analysis of such an adopted 'pay-per-use' concept, and the differences in applying the 'investment independence' concept in areas such as application, data, platform and configuration independence for any country or population. The reason behind this is a scarcity of reliable information on the costs and benefits of Internet-based applications in operational settings. How much will Internet-based systems cost to deploy, operate, and maintain? How will they improve care and/or reduce costs? How well can Internet-based systems be integrated with

legacy databases in large healthcare organiszaions? Healthcare professionals tend to be vigilant about adopting untested technologies because of the overwhelming need to ensure patient safety and positive health outcomes. Kuwait's Ministry of Health would want evidence of cost savings or medical effectiveness if it is to pay for services based on the new technology. Internet technology is still fairly new and untested in healthcare applications, making evaluations and comparisons difficult and prompting caution in the pursuit of Internet strategies.

- Evaluating the costs and benefits of health applications of the Internet is made more difficult by the uncertainties surrounding the effects of Internet-based communications on relationships among the numerous entities involved in healthcare. For example, little is known about the ways in which the Internet will alter the traditional relationships among patients, primary care physicians (PCPs), medical specialists, and hospitals. Will the Internet change the way consumers seek care, enabling them to learn enough about their health to bypass PCPs and go directly to specialists, or will they be confused by all the information and need to consult their PCP more often? Will Internet-based care improve management of the chronically ill, and if so, how will it affect the cost structure of healthcare institutions?
- Network and communication technologies have been shown to alter work patterns within organisations in unanticipated ways. What types of skills will information systems staff need to develop in order to implement Internet-based systems for healthcare? What types of skills will administrative staff and health

professionals need to work with Internet-based healthcare systems? What type of training do intended system users need? What will be the cultural and clinical outcomes from such an approach in the healthcare delivery services? Answers to these questions will come only after additional experimentation and evaluation of the 'pay-per-use' concept within the 'investment-independence' strategy .

- Finally, further research is also necessary to understand, as mentioned earlier, efforts in the patient–physician relationship, along with their corresponding effects on patient and physician satisfaction and clinical outcomes.

8.6 Recommendation

The recommendations outlined in this section are intended to provide a framework for the template outlined in this thesis to be developed to the next stage. This will require development on the technical, organizational, and policy fronts so that the benefits of the Internet may be captured for health applications. Additional work will be needed to identify specific networking technologies of interest to the health community and to ensure that related information technology needs are met. Actions are needed now to develop a truly *healthy* national healthcare delivery system for the future.

- This study has addressed the perspectives and opinions of the potential customers; however, in further studies there is a need to elicit the perspectives of the vendors as well. It would be helpful to explore with the vendor, the range of IS/IT outsourcing / Application Servicese Provider issues.

- Comparative studies could be carried out in countries similar to Kuwait to determine similarities / differences, even in the context of developing nations. In the Western economies, such studies are being undertaken to compare the outsourcing practices between countries (e.g. the USA and the UK) (Khalfan and Gough, 2001).
- Another area for future research would be to examine the inter-relationship between IS/IT outsourcing as currently practised and other developing areas of the application of IS/IT such as knowledge management, organisational learning, business process management, and electronic commerce.
- Health organizations in industry and academia should continue to work with the Ministry of Health (MoH) to evaluate various health applications that may adopt the 'pay-per-use' concept within the 'investment-independence' strategy in order to improve understanding of their effects, the business models that might support them, and impediments to their expansion. Work is needed to evaluate the effectiveness of different forms of telecommunication-based healthcare and to compare their effectiveness against applications run across different network infrastructures. Healthcare organizations have little evidence or data on which to base their decisions about telecommunication strategies. As such evaluations would benefit a wide range of health-related organizations, not just those directly involved in the studies.
- Public and private health organizations should experiment with networks based on Internet protocols and should incorporate the Internet into their future plans for new networked applications and into their overall strategic planning. By

using networks that incorporate Internet protocols, whether the Internet protocol suite per se or those associated with them, Web health organizations could gain a better understanding of the capabilities and trade-offs inherent in the use of the Internet for health applications without exposing themselves to the associated risks and uncertainties. Using these protocols locally would also prepare health organizations to take better advantage of the Internet and the continued advances in its abilities, once technical tools are in place to make it safer and reliable enough for health applications.

- Professional associations with expertise in health issues and information technology should work with healthcare organizations to develop and promulgate guidelines for safe, effective use of the Internet in clinical settings. Part of the challenge of Internet use in healthcare is the development of suitable policies, practices, and procedures to guide its use. For example, how should providers handle e-mail from patients to ensure timely responses, maintenance of patient confidentiality, and the incorporation of necessary information into the medical record? How can care providers be sure of the identity of a patient to whom they are sending e-mail? What is the role of a healthcare organization in monitoring discussion groups that operate under its initiative or that of affiliated care providers? Healthcare organizations have little experience upon which to base such policies, but they can learn from each other's experiences. Professional associations have a significant role to play in helping define industry wide guidelines for safe, effective use of the Internet.

- National institutes of health and their component agencies should fund information technology research that will develop the complementary technologies that are needed if the health community is to take advantage of the improved networking technologies that can be expected in the future. Health applications of the Internet pose a number of challenges for information technology research on topics other than networking. Health centres and agencies should pursue research in those areas that are of particular importance to the health community, such as (1) validation of information retrieved from the Internet, (2) tools for protecting the anonymity of Internet users, (3) access controls governing the ability of many different types of users to access different resources on the network, (4) controls on the secondary distribution of information, (5) improved capabilities for auditing the logs of accesses to databases and information, (6) QOS policies that are suitable for health and healthcare applications, and (7) applications that are alert to network QOS offerings and that use them appropriately. Other technical needs will undoubtedly emerge as new applications are developed and gain acceptance within the health community. The constantly changing context of the Internet implies that the set of applications will evolve and that the need for research will remain. Continued experimentation and evaluation will be the key to the development of a better understanding of the types of health applications that may become popular on the Internet and of the technical capabilities they demand. Through demonstrations of applications such as remote consultation, remote control of experimental equipment and online access to electronic medical records, members of the health community will gain an opportunity to examine the relative costs and benefits of these applications, the business models needed to support them, and the organizational policies needed to govern their use.

- The Ministry of Health or the government should fund pilot projects and larger demonstration programs to develop and demonstrate interoperable, scalable Internet applications for linking multiple health organizations. Pilot projects are needed to explore the full range of health uses of the public Internet, particularly projects that link multiple distinct organizations in an operational context. They could include projects to allow the patients of one organization to obtain remote consultations with specialists at other organizations or to allow the transmission of financial and administrative information among organizations that provide, pay for, and manage healthcare. Few healthcare organizations have a strong incentive to implement such systems on their own, given the significant uncertainties surrounding the effectiveness of different Internet-based systems in healthcare, the fragmented and proprietary nature of the industry, and the scale at which such systems would need to be built. Government funding could play an important role in stimulating such work, especially if it focused on applications that link multiple organizations.
- The establishment of a data council at the national level as an advisory committee on health data, statistics, and national health information policy will be considered a positive steps that should be built upon. They have to make

significant strides in policy areas such as the development of regulations for protecting electronic health information.

As outlined in Chapter 3, the basic idea of the Grounded Theory (GT) approach is to read (and re-read) a textual database (such as a field notes) and 'discover' or label variables (called categories, concepts and properties) and their interrelationships. This approach (data collection, analysis and theory formulation) incorporates explicit procedures to guide for how the model theory may account for research situation (question). Of course, the data does not have to be literally textual; it could be observations of behaviour, such as interactions and events in a healthcare setting. In this thesis GT could only be applied to a limited degree because (i) the nature of all aspects healthcare delivery provision is very complicated and multi-disciplinary; (ii) the privacy and confidentiality between the healthcare provider and patient prevent the researcher from attending any formal interview or patients encounter session; (iii) the process of applying GT techniques to the healthcare delivery provision in general will be time consuming.

Therefore, a scenario has been introduced in this thesis which is very much similar to a *Case*. However, the major distinction between the two is that a case is a real-life situation-action structure, whereas a scenario represents a sequence of hypothetical situations carefully designed to capture the sequence of events as they may have occurred during a particular episode. For all intents and purposes, scenarios can share the same structure as cases though with more contextual and temporal information. In summary, a *scenario* is seemingly a more apt representation of an episode used to explicate GT in the sociality of network communication and medical work practice, as compared to the traditional case-based representation.

Hence, this thesis advocates that the grounded theory methodology can reduce the significance of some of the network research strategy challenges and all understanding of the social aspects of communication within medical work practice. In doing so, a Grounded Theory approach can provide another avenue through which these problems can be investigated in future in healthcare delivery (for each discipline that satisfy building blocks concept) and more incisive health network analysis might be conducted.

8.7 Final Word

This thesis does not focus on Internet technologies, since the capabilities needed in networks are intertwined with other technical, organisational, and policy considerations. The 'pay-per-use' concept within 'investment-independence' is a new form of outsourcing policy and practice. The current status and structure of the healthcare delivery system in the State of Kuwait means that it is not ready to deploy the concept as single country dealing with large IT service companies. The situation will be improved by Kuwait joining with other member of the Gulf Corporation Council (GCC) to form one giant body for negotiation and to make investment decisions. Therefore, the choice for Kuwait is either to persuade other members in GCC to work together, or to form a joint venture with very reputable hospitals outside of Kuwait (Mayo clinics) as a new node of networks to deploy the 'pay-per-use' concept.

Evaluating the costs and benefits of the 'pay-per-use' concept within 'investment-independence' is made more difficult by the uncertainties surrounding the effects of networks and communications on relationships among the numerous entities involved in health care. For example, little is known about the ways in which the Internet will alter the traditional relationships among patients, general practitioners (GPs), medical specialists, and hospitals. Will healthcare institutions become, to a large degree, virtual? What types of skills will administrative staff and health professionals need to work with Internet-based health care systems? How can patient privacy be protected in electronic transactions, and what balance between security and access is acceptable to consumers who want online access to their health records? Answers to these questions and more will come only after additional experimentation and evaluation in selecting a pilot project.

Pilot projects are needed to explore the full range of health uses of the public Internet, particularly projects that link multiple distinct organisations in an operational context. They could include projects to allow the patients of one organisation to obtain remote consultations with specialists at other organisations or to allow the transmission of financial and administrative information among co-operating organisations.

As a result, health organisations and academia should continue to work with the Ministry of Health to evaluate various health applications of the Internet in order to improve understanding of their effects, the business models that might support them, and impediments to their expansion.

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