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Information technology in the health care industry: A primer

P. SOUTHARD

S. J. HONG

Keng SIAU
Singapore Management University, klsiau@smu.edu.sg

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Peter B. Southard, Soongoo Hong, Keng Siau
Department of Management
College of Business Administration
University of Nebraska-Lincoln
Lincoln, NE 68588-0491
USA
E-mail: psouthar@unlserve.unl.edu, shong@tamiu.edu, ksiau1@unl.edu

Abstract

The paper discusses current and future applications of information technology within the healthcare industry. It presents some broad strategies for approaching information technology investments and various tools available.

1. Introduction

Today, information technology is considered not just a supporting tool but a "strategic necessity" by world class organizations. As competition increases, the use of more sophisticated information technology tools and techniques, such as information warehousing and the Internet, is imperative in order for organizations to obtain a competitive advantage. The health care industry, with its shifting regulation, is not immune from this escalating wave of competitiveness. Information has been developed regarding how a company should approach capital expenditures in information technology but none of it appears practical with regards to this particular segment of industry. This paper discusses how health care organizations should approach information systems investments. It also discusses how information technology can support the medical providers' competitive strategy.

2. Background

Information systems have been employed in health care organizations for almost three decades. The information systems currently utilized by the health care organizations generally fall into three main areas: transaction processing systems, management information systems, and decision support systems (DSSs). In addition, a few organizations have begun to use the Internet as an avenue for communication in both research and health care marketing.

Most hospitals and clinics in the 1970s and 1980s implemented hospital information systems for administrative purposes as a way to deal with patient admission and billing processes. In the 1990s, health care organizations started to use information systems for clinical purposes to improve patient care [1]. Health care organizations (providers) must carefully plan how to use scarce assets in order to best compete. A structured framework is the best way to allocate those capital investments in information technology.

3. Information Technology Strategies – Proposed Framework

The framework for evaluation consists of three basic steps: 1) decide what goals the health care organization wants to accomplish, strategically, 2) decide what tools can accomplish the goal most effectively and, 3) decide how and when to measure the accomplishment of those goals. While these steps sound simplistic and common sense, it is how the health care organization approaches them, which makes them unique.

3.1 Strategic Analysis

The first step for a health care provider in evaluating the opportunities presented by information technology is to develop a strategic plan. This plan must include a strategic analysis of the industry and of the individual provider through the establishment of goals and priorities, decisions made regarding the control and architecture of the system, analysis of the effects not only on the MIS department but also the other functional areas, and evaluation of the infrastructure and management issues associated with new technologies. Health care organizations that are

considering moves into more advanced information technology must realize how important and comprehensive their strategic plan must be. Investing in information technology merely because the competition has done so is a common but shortsighted goal. The strategic analysis begins with a review of the industry.

3.1.1 Strategic Analysis – Industry. There was little competition in the health care organizations until the mid-1960s [2]. Hospitals simply calculated service fees, "cost plus reasonable profits," and billed this to patients. Medicare paid hospital costs related to patients' treatment – the payer of hospital services covering 45% of such expense [3]. This continued until 1983. In 1984, Medicare altered its payment system from "a flat amount per discharge" to a "fixed rate" based on each patient's diagnosis given by a Diagnosis Related Group [3]. In the1990s, the health care industry has been confronting more severe challenges resulting from severe market competition brought about in large part by changes in government regulations. As competition intensifies, health care providers have shifted their strategy from "a fee-for-service" to "a managed-care" and "a patient-focused hospital" whose implementation is almost impossible without the support of information technology.

As the health care environment changes, so does the role of health care information systems. Most experts agreed that when rivalry was less intense, information systems in the organizations were used for automation and to support simple management operations such as billing and administrative tasks. The role of information systems remained at the automation stage, dealing with management tasks that occurred routinely at the lower and middle management level. In this stage, transaction processing systems and management information systems are heavily used for the daily operations and managerial reports in health care organizations. Traditional DSSs were implemented in the administrative fields, in which numerical analysis is heavily involved (e.g., financial planning, scheduling, contracts, etc.), but not usually for clinical purposes. Butters and Eom [3] examined applications of traditional DSSs in the health care industry.

As the competition in the industry intensified, the role of information systems has become more sophisticated. Advanced information technology and the integration of information systems through the telecommunication network, including Internet applications, are used to increase operational efficiency, decision making process efficiencies, and management effectiveness. The radical change of business environments in the health care industry has forced health care providers to utilize advanced DSSs to make better decisions faster. It also forces the creation of network-based information systems for sharing of information and easy communications among the members of health care community.

With changes in government policy, increased competition, and the evolution of information technology, the health care industry in the 1990s has been described as unstable and highly agitated [4]. This new challenging market encourages health care providers to pursue more efficient management activities such as cutting administrative costs, improving decision making processes, and providing high quality patient care with accurate diagnosis. To survive in this turbulent business environment, health care organizations have been turning to more advanced information technology tools. Health care organizations have been increasing their investment in information technology from 2 percent of their operating budgets to between 5 percent and 7 percent according to John Glaser, vice president and chief information officer at Partners HealthCare System [5]. In addition, Raghupathi [6] estimated that the health care industry spent between $12 billion and $16 billion on information technology in 1996.

Even though health care organizations have increased their capital investments in information technology, health care sectors still lag behind the financial industry, the telecommunications industry, and the airline industry in terms of the implementation of information technology [7]. Intelligent and efficient investment in information technology is essential in order for health care organizations to catch up to these leading industries. Doing so improves management and decision processes, which in turn brings competitive advantages and market share gains. Unplanned investment in information technology does not always bring good results to investors. According to Roach [8], there is little correlation between investment in information technology and profitability, or return on investment. This is known as the information technology paradox. It is important for the management of health care organizations to understand the trend of information systems and to have a clear future vision of health care information.

3.1.2 Strategic Analysis – Competition. A health care organization needs to evaluate its critical success factors and decide where its competitive advantage will lie. One model to use is the impact of information technology (IT) on the industry (and its

leaders) by Applegate's matrix [9]. Health care providers have a high dependence on IT for their operations due to the data processing and retrieval requirements but, in general, they have not used it for customer focus or a marketing tool. This may, or will, place them at a competitive disadvantage to industry leaders.

Another model is Applegate's strategic relevance [9]. Health care organizations usually reside relatively low in the factory quadrant as their existing systems are critical for day to day operations. If the computer system goes down, business will likely grind to a halt unless backup systems are available. On the other hand, most providers do not rely strategically on new applications of IT development. In the future, however, it is likely they will need to look at moving into the strategic quadrant if they want to develop and maintain a competitive advantage.

Competition in health care is very high. An analysis of competitive factors using Porter's five forces model helps to explain why, even in the IT arena [9]. As in most service industries, suppliers consist mainly of labor and the companies supplying technology and medical supplies. In the industry, the bargaining power of suppliers is relatively low as there are, in general, ample supplies to fill the demand. Competition between suppliers is fairly high leading to lower switching costs by providers and a reduction in bargaining power. On the other hand, the bargaining power of buyers is high. The availability of substitute services, relatively low volumes and relatively low switching costs combine to increase their power. The threat of new entrants is low as high entry barriers, scales of economy, and government regulation limit this factor. The threat of substitute products is relatively low but not low enough to compensate for the other factors.

The most critical factor in the model, however, is intra-industry competition and the intensity of rivalry. The industry is in the maturity stage with relatively little growth. Providers wishing to increase market share must take it away from someone else. Switching costs are relatively low. Customers will shop around based on price, even in small communities. Admittedly, customer loyalty tends to be higher in smaller communities but this loyalty is shrinking as another factor, mergers and acquisitions, increase. There is little relevant difference in products and the diversity among competitors is low. With this high competitive environment comes the opportunity to use IT to gain a competitive advantage. Several tools are available to develop this advantage.

3.2 . Evaluating the Tools.

Opportunities for IT using information technology lay in two general areas: decision support systems and Internet technology. Internet technology can be further described as the Internet itself, intranets, and extranets. Each one is examined in turn.

3.2.1. Decision Support Systems. Historically four types of DSSs – traditional DSSs, group decision support systems (GDSSs), executive information systems (EISs), and information warehousing – were developed in the health care industry. The purpose of early traditional DSSs was to support a single decision-maker who had requirements to tackle in primarily semi-structured problems. Recently the scope of health care DSSs has widely expanded into clinical research and disease diagnosis. Unlike the earlier healthcare DSSs that focused on financial and scheduling domains, current DSSs have been developed for "diagnostic situations in health care specialties including pharmacy, emergency, and nursing practice." [4].

Recently, GDSSs have been developed in many non-health care organizations to assist in the decision making process of group members by broadening the quantity, quality, and structure of data exchange [10]. While IT-oriented industries, such as financial institutions and retailing stores, are employing GDSSs, little implementation of GDSSs in the health care industry has been reported.

The EIS has been used to support senior executives in analyzing critical management problems. In 1992, 33 percent of hospitals were adopting EIS according to Niederman [4]. The implementation domain, however, is more likely to be on the strategic level rather than on the doctor's level for patient care.

Among the four types of DSSs, information warehousing is one of the fastest growing areas. As computer technology and telecommunications developed, cheap but powerful computers became available. It became possible for entire organizations to use DSSs in an enterprise-wide business environment. In the context of DSSs, information warehousing can be considered an enterprise-wide DSS that is able to support all levels of labor. Inmon [11] reported that top management is allowed to access information warehousing for key indicator analysis, middle management for monthly reports, and line management for daily reports. Administrators and researchers primarily use information warehousing for decision-making purposes. Pharmaceutical makers are using

information warehousing for marketing purposes and healthcare providers for diagnosis and treatment of patients. Glaxo Wellcome in London, a pharmaceutical maker, has implemented information warehousing for the analysis of drug demands. Kaiser Permanente, the largest and oldest HMO in the United States, has employed information warehousing containing diabetic data for accurate and proper treatment of diabetics. Pfizer Inc, a pharmaceutical firm based in New York, has implemented information warehousing that supports 2,700 sales representatives in furnishing doctors with detailed and specific drug information regarding the effectiveness of drugs, side effects and costs.

Recently large firms have implemented information warehousing integrated with a data mining tool for identifying customer needs and hidden business opportunities. Organizations normally generate and collect tremendous volumes of data, which are necessary for day-to-day operations and decision making. Although these organizations produce a lot of data, most companies are not able to extract the right information from the database because information implicit in the data is difficult to distinguish. Moreover, the traditional query language, which is based on the computer skills of the users, simply does not deal with a huge amount of data. While newly developed database query tools support easy access to and extraction from the database, it is still difficult to identify how query tools can assist the users in understanding and analyzing large volumes of data [12]. These facts have lead to research on a new generation of query tools, and companies have turned to data mining.

Data mining intelligently and automatically assists end users through data-driven extraction of information from large databases. It is a new concept that transforms data into useful knowledge for decision makers. It also enhances the use of query, multidimensional analysis, and visualization tools to gain a better understanding of the data. Application of data mining techniques to information warehousing in the health care industry is becoming more common. Data mining permits health care providers to save costs, provide better care, and save lives. Sentara Health System at Norfolk introduced a data mining concept to improve the quality and the treatment of pneumonia patients. After implementing data mining, its mortality rate was reduced from 12 percent to 9 percent. It is expected that data mining with information warehousing will become common place in the health care industry. Brad L. Armstrong, a global managing director of Deloitte & Touche Consulting Group's Health Systems Integration Practice in Los Angeles, says "there are thousands of services, relationships built over time, and multiple diagnoses and interactions. That complexity will continue to push progressive data mining applications that will rival those in banking or retail" [13].

3.2.2 Internet Applications. Of all of the evolving technologies in the 1990s, the network-based system, and Internet-related technology in particular, is the most revolutionary. Many practitioners and researchers claim that Internet technology is the next paradigm shift in the computing field. Even though health care information systems in some hospitals and clinics have been linked together with a local area network or a wide area network [7], until the advent of the Internet, the network-based health care systems have not been popular. The development of Internet technology allows construction of health care information networks with lower costs, easier use, higher efficiencies, and greater effectiveness.

One reason the Internet has received so much attention is the development of the World Wide Web (WWW or the web). The web uses hyper text transfer protocol (HTTP) and hyper text markup language (HTML) which allows the end users to link to other sites by simply clicking a computer mouse. All applications use Transaction Control Protocol/Internet Protocol (TCP/IP), which allows communication between diverse operating systems.

All three Internet applications – the Internet, intranets and extranets – are currently being used in industry applications including health care firms, but the scope of organizations that are involved in networking varies. While the Internet is open to anybody who wants to access the system, the number of organizations involved in intranet and extranet applications is limited. An intranet is a system, based on Internet technology that is used within the "four walls" of the organization. An extranet is based on the same technology but is designed to be used between two or more sets of separate users or organizations. Varied use of Internet and intranet applications have been reported in the health care industry but extranet applications are scarce.

3.2.3 The Internet. Based on the survey results of the Health Information Management Systems Society, 87 percent of its members were using the Internet [14]. Another survey noted that most researchers, patients, and doctors have access to medical information systems through the Internet [15].

Internet technology facilitates distribution of important medical information and knowledge to the medical community [16]. This includes use by health

practitioners to locate medical information on the Web.

For the provider, offering health information via the Internet has many benefits. For example, a recent study noted that 79% of those people who currently have Internet access would like to access health information. There is a large and growing group of consumers who use the Internet as their primary resource on health and medical matters. This creates an additional benefit for the health information providers. People seeking out the provider's web site are 'self-selected.' Unlike mass advertising campaigns, where information is delivered to everyone regardless of their interest, the provider can be sure that the consumer who accesses their site wants that information. Not only are the consumers visiting one's sites self-selected to be there, but it is also fairly inexpensive to provide the site for those visitors.

A recent study found the cost of designing and implementing a web site equivalent to the production of 3-4 average quality brochures. Experiences show that the cost is approximately $0.10/visitor.

Internet web sites are also a popular choice for health providers because they are effective, both as a means of communicating information and as a contributor to improved health. A recent study found that mass communication campaigns contributed to health in three ways; they directly changed lifestyle habits, they encouraged health practitioners to become more active and, they influenced public opinion in favor of health promoting policies. In addition, it has been shown that the interactive nature of many computer based education models, which are easily supported on the Internet, allow greater knowledge retention by users than traditional means.

The Internet offers the health care consumer the ability to make sense of the vast amounts of health information that exist. It has been noted that we have been compiling and storing vast quantities of data like an army of mad squirrels but have had no meaningful way to access those data. The information is there. Being able to access it in such a way that it is useful can still be difficult. Enter the Internet.

The Internet provides an easy to use, attractive and organized method by which to access this information data. It is significantly faster and more efficient in providing and updating information than paper based distribution. Its user friendliness allows even the computer neophyte to quickly grasp its function and use. Additionally, it allows information to be brought directly to the consumer, rather than the consumer having to go out and seek the information (e.g., in a library).

Supporting this concept is the recent finding that patients, new to a given disease, are more likely to seek out health information. Studies showed that patients who discovered their disease for less than 6 months are more curious, more concerned, and more receptive regardless of the educational method. Consumers no longer want irrelevant general health information. Rather, they want immediate access to specific health information when they are faced with the need for it. The Internet enables this.

The Internet offers another interesting possibility. Experts agree that health care information systems in the near future will have a single virtual or physical data repository which will contain information related to health care providers and consumers, such as computerized lifetime patient records, health care provider information, and lab test results. Consequently, heath care providers, including physicians, hospitals, pharmacists, lab researchers and dentists, would be able to utilize those patient records and information to the betterment of the health care community.

To implement a data repository, computerized patient records must be developed before anything else. Raghupathi [6] stated that "one of the important trends is the move toward a universal electronic patient record. It could be defined as electronically stored health information about one individual uniquely identified by an identifier. This entails capturing, storing, retrieving, transmitting and manipulating patient-specific health care-related data, including clinical, administrative, and biographical data." In fact, the efforts of building computerized patient records have already been started by Computer-based Patient Record Institute, Schaumburg, Illinois. However, due to the several obstacles, including cost, lack of network standards, and difficulty of transferring data to systems from charts, no universal method is available [17]. These problems may be solved in the near future because of evolving information technology and the immense benefits of computerized patient systems. These support the improvement of patient care, the prevention of doctor errors, and the reduction of administrative and treatment costs. It was expected that the health care industry would implement a computerized patient record by the year 2000 [18].

With individual computerized patient systems, the next question is how to implement medical information systems at different sites and how to connect the networks, allowing users in multiple sites to access the systems. Since the middle

1980s, various information systems have virtually been integrated into the enterprise-wide system via networks that connect individual information systems. Due to the fact that Internet applications have been extended in almost all industries, the integration of systems and sharing of information within the organization and inter-organizations can be achieved very easily with lower costs. One of the biggest advantages of Internet applications is their open architecture and connectivity. TCP/IP, the standard protocol of the Internet, offers organizations the ability to build networks in which different applications and hardware can be connected. All levels of employees at multiple sites are able to share information and communicate at low costs. Ruffin [19] claimed that the "WWW provides the technical design necessary for standardized, vendor-independent, computer-based patient records to flourish."

In sum, Internet-based networking will be useful in connecting individual medical information systems at multiple sites, and will become a standard for network-based systems. With Internet technology, networked health care information systems that bridge users at multiple sites will be essential for the support of health care community.

Integration of healthcare information systems using Internet applications was suggested for future network-based health care community. Although numerous researchers and practitioners are developing prototypes connecting all members of health care community via the Internet, the network-based medical system is not yet perfect. There are still many problems to be solved and improved. Several problems have surfaced, including data security, the privacy of patient information, and the dissemination of medical knowledge to clinicians. First, as medical information becomes available over the Internet applications, securing critical patient data presents computer science challenges. Although existing tools such as proxies, data encryption, and a firewall security application are able to strengthen the protection of data, security problems may still hinder the network-based systems. Second, in some cases medical records are highly sensitive, so digging the privacy issue is a high priority for health care providers. For example, if anyone who invades the medical database system releases the list of AIDS patients, then severe social problems might occur. Third, the lack of recognizing the necessity of network-based information systems blocks the diffusion of medical knowledge. Detmer, et. al. [16], admitted that "many hospitals, clinics, and private offices do not have Internet access or even local area networks because they have not yet found compelling reasons to invest money and personnel in these technologies."

Raghupathi [6] stated that "unless proper controls and procedures are in place, these kinds of applications [network-based medical systems] also invite unauthorized users to tap into the data. If the concerns are not sufficiently addressed, they can discourage the health care industry from exploiting IT and make health care consumers hesitate to share information." In order for network-based information systems to flourish, health care organizations should consider those managerial and technical problems inherent to Internet applications.

Along with private institutions' research on the Internet network, the government is driving forward the network-based medical information systems. President Clinton [20] mentioned in the 1997 State of the Union Address, that "we should connect every hospital to the Internet, so that doctors can instantly share data about their patients with the best specialists in the field."

3.2.4 Intranets. An intranet, the collection of inter-connected networks within an organization, has been used in the health care industry. According to the recent survey results of the Healthcare Information Management Systems Society, 20 percent of healthcare institutions were implementing an intranet. The growth in medical intranets can be attributed to its advantages; (1) low-cost connectivity, (2) ease of rapid deployment of the technology, (3) use of cross-industry communications standards, (4) user-friendliness, (5) short training times, (6) reduced network administration costs, (7) the ability to extent the value of legacy systems, and (8) the ease of development of strategic links between healthcare organizations and outpatient providers including physicians [17].

As a pioneering effort in connecting different systems by using Internet technology, a number of medical intranets have been developed and implemented for the different purposes. For members of the health care community, offering health care information and sharing data have many benefits. First, physicians can search lifetime patient medical records, use clinical decision support systems, and research specific topics. Second, patients can access the database providing health information. Studies have shown that many unnecessary clinical visits were reduced when health care information is provided to consumers. Third, administrative employees access the database to deal with billing and insurance. To date, the intranet applications have been widely used as a tool of knowledge diffusion within the medical community rather than patient

care. Specific medical intranets have been used mostly to improve knowledge diffusion via the web. MEDLINE, controlled by the National Library of Medicine, maintains medical literature from the past 30 years [16]. Users are able to print journal articles, textbooks and diagnostics tests, and health plan coverage through MEDLINE. Another example is CliniWeb. CliniWeb, an index of clinical information, is designed for retrieving specific clinical topics on the web. It provides an index of clinical information for health care students, providers or researchers via the web [21]. Unlike other search engines (Alta Vista, Infoseek, etc.), CliniWeb furnishes only clinical information by organizing clinical resources with a specific topic. The intranet applications explained above are dominantly used for knowledge diffusion.

Some researchers have started building prototypes not only for sharing information, but also for disease diagnosis and patient care via an intranet. Community Health Information Networks (CHINs), nationwide medical intranet applications, are most popular. They are connected to patients, potential patients, members of health plan, health care providers, and payers [19]. They provide a communication tool for the health care community in an efficient way and provide computerized patient records to physicians. In addition, CareWeb in Boston provides computerized patient records to physicians, although the usage of the system is limited [17].

3.2.5 Extranets. Extranets are the newest innovation based on Internet technology. Simply put, they are networks between a business and the other members of its value chain.

Extranet opportunities for healthcare providers lie both upstream and downstream. Extranets offer a way to link services in a more timely and efficient manner. Upstream, providers can link to their suppliers. Less cumbersome and restrictive than an EDI (electronic data interchange, which first began in the hospital industry) system, the extranet can streamline transactions between providers and their suppliers to the benefit of both.

Downstream, providers have the opportunity to forge strong links to existing and potential patients. By providing access to the local hospital terms of information on valuable services and value-added information, clients will become more reliant on the provider. For example, if the client is currently using an outside market data source, the health care organization can now become the client's lone provider by having that information available on the extranet, cementing closer ties with the provider.

3.2.6 Measuring Success. Intranets and extranets usually require higher capital investments than the previous suggestions due to software, hardware, and training needs. In addition, the other members of the value chain affected by the extranet will require training. Management infrastructure must be adapted, or realigned, to accommodate the changes in information availability and flow. All of this will need to be incorporated into the strategic planning procedure discussed in the beginning of this section.

Most authors agree that traditional financial and productivity measures are shortsighted and not applicable when evaluating IT investments. A more strategic approach is needed. Several formal methods have been proposed including the analytical hierarchy process [22], forecast horizon procedures [23], and information economics [24]. Yet many of these models are either too complex or too limited to be of use. What may be simpler is merely calculating to what degree has the technology helped to achieve the goals set, keeping in mind the long-term strategic nature of the goal. This may be quantifiable in terms of percent market share gained or percent increase in productivity. Then again it may a more qualitative measure such as increased customer awareness or satisfaction through shorter loan processing times. Each goal will require its own unique measurement process that would be established during the initial strategic goal setting process. The value of gaining and maintaining a competitive advantage may be difficult to quantify but the cost of not doing so is immeasurable.

4. Conclusions

The world is continuously changing and information technology is one of the main driving forces for change. Health sciences are not spared from the advancement of information technology. Health care organizations have been trying to capture medical information related to patients, providers, government policy, etc., so that they have a competitive advantage in a turbulent environment using information technology. As a result, the health care industry is becoming a more information-based community that is connected to hospitals, clinics, pharmacies, and customers for sharing information, reducing administrative costs and improving the quality of care. Health care organizations have employed decision support applications and Internet technology as an innovative tool that reduces process time, makes diagnoses more accurate, and diffuses knowledge to the health care community. Moreover, medical intranets are becoming recognized as a

competitive weapon by health care organizations. In order to make the connection of medical Internet applications to individual health care information systems, including medical DSSs, possible, developing computerized patient record systems is fundamental and indispensable. It is time for health care organizations to invest in computerized patient systems, medical DSSs, and Internet-based network systems. Regardless of current managerial and technical obstacles, the near future will find health care information systems that contain computerized patient records, such as information warehousing with data mining, integrated via Internet applications among members of the health care community for sharing information, knowledge diffusion, and one-stop care.

Health care organizations must keep abreast of the changes taking place about them. Some predict it will be virtually unrecognizable in a few years. Competition will lead health care organizations, and their associations, to the opportunities presented by information technology. How well a provider approaches this challenge, from a strategic planning and implementation standpoint, will spell the difference between success and failure in taking advantage of these opportunities.

5. References

[1] Anderson, James, "Clearing the Way for Physicians' Use of Clinical Information Systems," Communications of the ACM, Vol. 40, No. 8, August 1997, PP. 83-90.

[2] Kettelhut, Michael, "Strategic Requirements for IS in the Turbulent Healthcare Environment," Journal of Systems Management, June 1992, PP. 6-18.

[3] Butters, Sandy and Eom, Sean, "Decision Support Systems in the Healthcare Industry," Journal of Systems Management, June 1992, PP. 28-31.

[4] Niederman, Fred, "Data Warehousing at an Urban Hospital," Journal of Data Warehousing, Vol. 2, No. 4, winter 1997, PP. 2-12.

[5] Blodgett, Mindy, "Tighter Control of Medical Records Urged," Computerworld, Vol. 31, No. 10, March 10, 1997, P.8

[6] Raghupathi, W., "Health Care Information Systems," Communications of the ACM, Vol. 40, No. 8, August 1997, PP. 81-82.

[7] Maitra, Amit, Building a Corporate Internet Strategy: The IT Manager's Guide, Van Nostrand Reinhold, 1996.

[8] Roach, Stephen S., "Services Under Siege: The Restructuring Imperative," Harvard Business Review, September – October 1991, PP. 82-91.

[9] Applegate, L.M., McFarlan, F.W., McKenney, J.L., "Corporate Information Systems: Text and Cases," (Irwin, 1996).

[10] Turban, Dfraim, Decision Support and Expert Systems: Management Support Systems, Prentice Hall, 1995.

[11] Inmon, W.H. and Hackathorn, R. D., Using the Data Warehouse, John Wiley & Sons, Inc., 1994.

[12] Piatetsky-Shaprio, G., and Frawley, W.J., Knowledge Discovery in Database, AAAI/MIT Press, 1991.

[13] Bresnahan, Jennifer, "Data Mining: A Delicate Operation," CIO Magazine, June 15, 1997. [Online] Available http://www.cio.com/archive/061597_mining_content.html.

[14] PeopleSoft and Arthur Anderson, "Intranet: Powerful New Tools for Healthcare Organizations," White Paper, March 1998. PP. 1-14.

[15] Cimino, J., Socratous, S., and Clayton, P., "Internet as Clinical Information System: Application Development Using the World Wide Web," Journal of the American Medical Informatics Association, Vol. 2, No. 5, September - October 1995, PP. 273-284.

[16] Detmer, William and Shortliffe, Edward H., "Using the Internet to Improve Knowledge Diffusion in Medicine," Communications of the ACM, Vol. 40, No. 8, August 1997, PP. 101-108.

[17] Fotsch, Edward, "Intranets Promise Value, But Careful Planning Still Necessary," Medical Intranet Forum, September 1997. [Online] Available http://www.misforum.org/news/hfma_sep97.html.

[18] Anderson, James and Aydin, Carolyn, "Evaluating the Impact of Health Care Information Systems," International Journal of Technology Assessment in Health Care, Vol. 13, No. 2, 1997, PP. 380-393.

[19] Ruffin, Marshall, "The World Wide Web Is Coming Soon to an Organization Near You," Medical Intranet Forum, [Online] Available http://www.misforum.org/news/ruffin_soon.html.

[20] Clinton, William, State of the Union Address, February 4, 1997.

[21] Hersh, W., Brown, K., Donohow, L., Campbell, E., and Horacek, A., CliniWeb: Managing Clinical Information on the World Wide Web, Journal of the American Medical Informatics Association, Vol. 3, No. 4, July - August 1996, PP. 273-280.

[22] Angelis, D.I. and Lee, C.Y., "Strategic investment analysis using activity based costing concepts and analytical hierarchy process techniques," International Journal of Production Research Vol. 34, i. 5, May 1996, PP. 1331-1345.

[23] Nair, Suresch K., "Identifying technology horizons for strategic investment decisions," IEEE Transactions on Engineering Management, Vol. 44, no. 3, Aug 1997, pp227-236.
[24] Fisher, Allan, "Information economics: a new paradigm for information management and technology decision making," The Government Accountants Journal, Vol. 44, no. 2, Summer 1995, pp. 30-34.

Table 1. The Traditional Healthcare Decision Support Systems

Financial planning and cost accounting DSSs	Providing information regarding costs and profitability of all hospital service items
Productivity DSSs	Providing and predicting the cost of services to improve department efficiency and productivity
Product line DSSs	Designed to enable hospitals to understand their costs, revenues and profitability by product line
Nurse scheduling/nursing cost management DSSs	Providing knowledge regarding accurate budgets, financial forecasts, and hospital cost accounting, productivity and product line DSSs
Managed care contracts DSSs	Helping hospital managers measure the profitability of their managed care contracts
Equipment purchasing DSSs	Helping hospital managers decide the economics of equipment
Operational assistance DSSs	Providing major assistance to healthcare supervisors in performing their jobs in all stages of the decision making process
Emergency medical service vehicle deployment DSSs	Helping hospital mangers assign the emergency vehicles
Blood distribution DSSs	Helping hospital managers distribute blood to hospitals

Figure 1. The Transition of Healthcare Information Technology