

Research Article

A Low Cost Hospital Information System: A Case Study of the Mehr Hospital in Mashhad City

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Abstract: Nowadays healthcare organizations globally recognize the importance of applying information technologies to improve the quality of their services and reduce costs. The Hospital Information Systems (HISs) are the information systems applied in hospitals in order to provide necessary services for the hospitals. In addition to include all the facilities of the HIS, the implementation cost of the system should be reasonable and cost worthy. In this study we explain different parts of the HIS which has been implemented at the Mehr hospital in the Mashhad city of Iran. The HIS implementation cost is low and economical with the hospital income. Furthermore we investigate the effect of the HIS in different aspects of the hospital. The results indicate that applying HIS in Mehr hospital reduces the hospital cost by reducing the amount of paper consumption, omitting several stages of the hospital procedure doing by staff which concludes thrift. It also improves the quality of services in the hospital by increasing the speed of services.

Keywords: Cost reduction, hospital information systems, quality of service

INTRODUCTION

In this modern informational decade, knowledge is updated continuously and fast. It is needed a fast, exact and efficient method to acquire and process information. Medical information also requires computerized process due to the need for speed. Researchers overcome this problem with the Hospital Information System (HIS). In the last four decades, many efforts have been made on the HISs.

Jay and Anderson (1982) emphasize on the increasing need of the computerized medical services and HIS. HISs generally consist of strategic decision support systems and clinical documentation systems, such as Computerized Order Entry (COE), Laboratory Information Systems (LIS) and Radiology Information Systems (RIS). There are several other parts in a HIS including pharmacy information systems and personal data analysis systems which has the ability of messaging between providers and staff and the ability to share data with other medical facilities (Keenan *et al.*, 2006). HISs have also been implemented in Asia and Africa countries in order to improve the healthcare systems.

In 2010 in Malaysia, approximately 16 public hospitals were supplied by different categories of HISs as Total Hospital Information System (THIS), Intermediate Hospital Information System (IHIS) and Basic Hospital Information System (BHIS) (Ismail and

Abdullah, 2012). As the Malaysia is going towards becoming a developed country it is required to implement a model to test and revise the systems in order to measure the benefits and the problems of the HISs.

Researchers in Taiwan implemented a study on the characteristics which affects the acceptance of the HISs by the physicians. They implemented their study based on a six part model including: system quality, information quality, service quality, perceived usefulness, perceived ease of use and HIS acceptance. Their results help the manager to understand the key factors affecting HIS and to find the improving methods (Chen and Hsiao, 2012). In Pakistan an HIS designed and implemented successfully in the Pakistan Institute of Medical Sciences (PIMS) without any prior electronic information systems (Malik and Khan, 2009).

Several further studies implemented in Asia aiming to design and improve the HIS and solve the system's problems such as India (Latifov *et al.*, 2012), Turkey (Sagiroglu and Ozturan, 2006), Iran (Kahouie *et al.*, 2008), Malaysia (Ismail *et al.*, 2010; Lee *et al.*, 2012). During the last decade the HIS has been implemented in several public and private hospitals in Iran.

Mashhad is the second largest city of Iran. It has 11 public hospitals and 11 private hospitals. Some hospitals in the city have started to apply HIS since 2008 while several other hospitals have started to use HIS since 2011. In this study I will discuss the process

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of the HIS stages in one of the these hospitals named Mehr hospital.

The rest of the paper is organized as follows: section two provides a brief introduction to the case study, furthermore the structure of the implemented HIS is explained. Afterwards the network architecture designed for the implementation of the HIS is described. The last part of section two is about introducing and illustrating the interface of the HIS. In section three, the result of applying the HIS on the Mehr hospital and the effects and benefits of running the system on different units of the hospital is discussed. Finally, concluding remarks are given in section four.

CASE STUDY

In this section, we describe the Mehr hospital's HIS which has started to work since June 2012. The Mehr hospital is a well-known private hospital in Mashhad with reputable medical staff and famous physicians, supplying with 220 beds. The hospital has several departments including: surgical, orthopedic, pathology, radiology, endoscopy, pharmacy, obstetric and gynecology, pediatric, eurology, imaging and diagnostics, cardiology, angiography, NICU, ICU, CCU. Since the hospital has approximately 50 indoor patients per day the management decides to apply HIS in all the departments in order to accumulate better

services. The following three sections explain the different parts of implementing the HIS on the Mehr hospital including design, network, software.

The HIS structure: The HIS is designed based on the medical and administrative structure of the Mehr hospital. In this system, all the clinical information of all the patients is being stored electronically as a HIS. The system's database stores all the data related to medical actions, such as accounting information, laboratory examinations, insurance information and patient records described by medical staffs. Figure 1 shows the structure of the HIS in Mehr Hospital. All the medical units of the hospital are supplied by the HIS and they are connected through HIS and they are also connected to financial department. As shown in the Fig. 1, all the clinical inputs are included in the system which medical staff can retrieve their information from their terminals.

All the staff activity in the HIS can be monitored and supervised by the hospital manager and the nursing manager. The manager's user is also able to do several activities such as respond to the vacation request letters, patient medical requests from the pharmacy and the requests for the supplies of the departments.

The workflow of the implemented HIS is shown as the form of the program functions in Table 1 as it is illustrated in Table 1 the process starting with patient referring to the hospital with the prescription

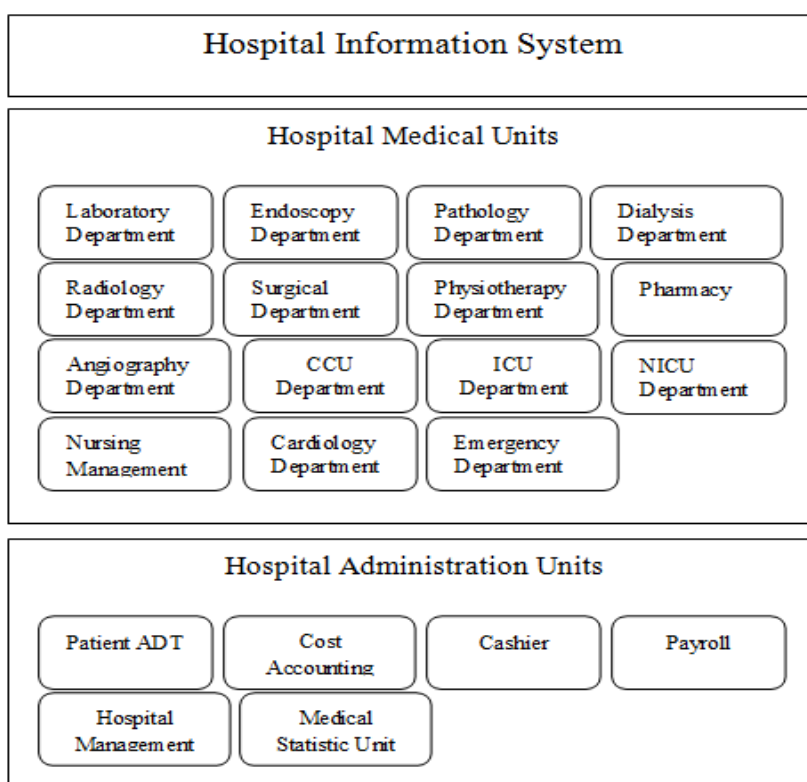


Fig. 1: Hospital information system in Mehr hospital

Table 1: Development control process and functions of information system of the inpatients

Stage	Activity	Functions of information system
1	Patient Registration at the reception with the doctor's prescription.	<ul style="list-style-type: none"> Existing patient in the system: Finding the patient Id, adding a new refree to his/her profile. Non-existing patient: making a profile based on the patient information. Nurses enter the medical information, room information in the patient's profile.
2	Patient entrance to the related department (Surgical Department, Cardiology Department, ICU, CCU)	
3	During the hospitalization	<p>Nurses enter the medical information and services into the HIS:</p> <ul style="list-style-type: none"> The surgery patients: The surgical unit enters the surgery information, services and medications into the patient's profile. The patients without surgery: the unit enters the medicine, services into the patient's profile. <p>The hospital services are requested by the doctors including several units as radiology, laboratory, endoscopy, physiotherapy, dialysis</p>
4	Patient discharge	The accounting department prepares the hospital bill and transferred it to the cashier unit

from a doctor. The reception staff, checks the prescription and if the patient is eligible the admission stage will start. The patient's medical information and administration information will be saved into the server. Afterwards the patient enters the related department for the medical services. During the hospitalization the nurses fill the patient's medical records into the HIS. In case of patient having surgeries or other medical services which requires transferring to another department the nurses submit the transforming information and refer the medical record to the new department to gather the patient information in the HIS. As the medical information is being saved into the system the cost of the services and medicine used for the patient is also being saved into the system to be applied by the cost accounting department at the time of patient release.

The Network structure: A network is a basic component of an HIS which transfers the data. The network structure of the HIS of Mehr hospital is LAN network. The designed HIS has a client-server based architecture. The network system itself does not provide direct services to the HIS user, but it is required for all HISs and if the network system stops, the server cannot function because it can not find any connection to the clients.

In order to prevent system failure, the network system is being supported by a power supply. Network's structure can be divided into two categories: bus and star. As an example, Ethernet is in bus style and Asynchronous Transfer Mode (ATM) is a star category. It means that, a bus category network has several network computers connected to one line of the network and all computers are using the line. The structure of the system is simple, but using a single line may conclude to the bottleneck to cause congestion which causes problems in speed of communications. Furthermore, as corruption on the single line would affect all the computers, the reliability of the bus style network is not very high. On the other hand, in a star style network, several computers are connected to a hub

or switch. Despite the fact that the star system costs more, corruption on one line does not affect the function of other lines. Therefore, it can be said that the reliability of star category networks is higher than that of bus category networks.

Recently, ATM switches's price is decreased and using them is more common. To build a highly reliable HIS, ATM network seems a good choice. In Mehr hospital HIS four ATM switches have been applied. Each of these switches is connected to several computers which build four star style network and these four switches are connected to a router. Figure 2 illustrates the structure of the implemented network for the HIS in the Mehr hospital.

The router is applied to minimize unnecessary traffic load and to provide efficient movement of frames from one location to another, the interconnected computers are grouped into separate star networks. As a result of this grouping the router which functions as an interconnect device determines the best path between two networks (which is determined by the network designer and administrator of the HIS). As the number of computers in the HIS increase, the amount of traffic caused by broadcast increases. High broadcast traffic on a network cause difficulty in the ordinary communication across the network. The router is connected to the server. The server can be controlled at the hospital and it also can be controlled through the Internet with a PC at home.

The HIS interface: The implemented Hospital Information System is now running in the Mehr hospital in Iran. After logging into the system with a username and password authentication, in associated with the username, the user is confronted with a form. The reception user has the ability to enter the information about the patients and save the data. Figure 3 illustrates the reception form which will be filled by the patient information. The information include the patient insurance and personal information of the patient and a person who can attend the hospital in case of emergency. The reception's user main page is

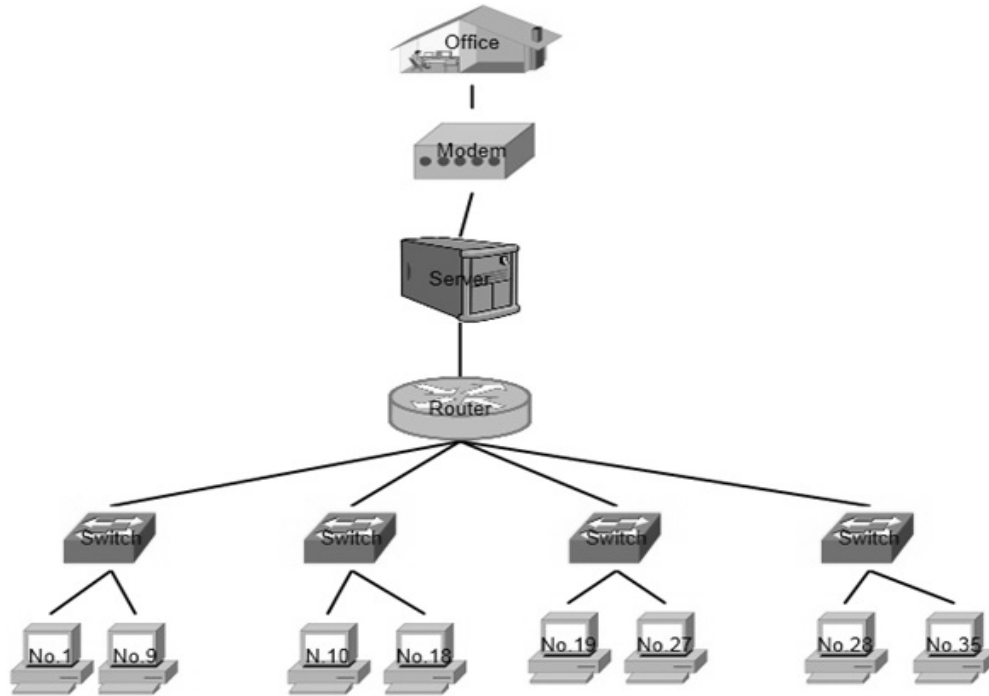


Fig. 2: The network structure of the implemented HIS in the Mehr hospital

Fig. 3: The administration form of the HIS

divided into two sections. The upper section is designed to be filled by the patient's personal information and contacts. The below section is needed to gather the

insurance information and doctor's information and the emergency contact information. By pressing the save button on the top of the form, the patient information

The screenshot shows a window titled "Patience list of the Section" with a subtitle "Patients list of: The Heart Section". The main content is a table with the following data:

Status	Reception's Date	Bed	Father's Name	Age	Last Name	First Name	Record ID
Indoor	1-12-2012	A-351	Tino	56	Ejodi	Jack	1037
Indoor	2-12-2012	A-234	Jim	67	koli	Zahra	1120
Indoor	3-12-2012	A-241	Matin	55	javari	Tom	1067
Indoor	3-12-2012	A-237	Ali	61	Abdi	Nini	1093
Indoor	4-12-2012	A-238	David	48	Hosna	Sara	1115
Indoor	5-12-2012	A-239	Peter	51	Karimi	Noshi	1133
Indoor	5-12-2012	A-240	Javad	57	Fazla	Mimi	1141
Indoor	6-12-2012	A-242	Abdi	78	Hamra	Ali	1077
Indoor	7-12-2012	A-244	Harold	81	Obri	John	1181
Indoor	8-12-2012	A-245	Luis	75	Jojo	Maryam	1119
Indoor	9-12-2012	B-244	Tom	83	Kami	Sarah	1235
Indoor	10-12-2012	B-245	George	68	Ohimi	Nazi	1100
Indoor	11-12-2012	B-238	Omar	64	Jamli	Nasi	1254
Indoor	11-12-2012	B-239	Abbas	71	Marjani	Nezin	1096
Indoor	12-12-2012	B-351	Jack	80	Kanomi	Souzi	1042
Indoor	13-12-2012	B-234	Ali	69	Milano	Mohsen	1211
Indoor	14-12-2012	C-234	Joda	81	Avril	Mina	1099
Indoor	15-12-2012	C-351	Ehsan	28	Tomi	Fahim	1255
Indoor	16-12-2012	C-244	Mehdi	65	Kotin	Pari	1189

Below the table is a row of action buttons: Change the Status, Request Med and Eq for the section, Prescription, Meds and Eq stock, Exit, Request supplies, Transfer, Delivery Service, Release Notice, Infant Register, Angio Service, Surgery Schedule, Pathology Request, Lab Request, physio Request, Section Service, Sonography Request, Radio Request, Medicine, and Equipment.

Fig. 4: The form which performs the patient's data search and medical service requests for each department

will be saved into the database and a record will be formed in the server and maintain as the patient's history for twenty years.

Each time that a patient is referred to the hospital, through an emergency medical system (ambulance) or by the doctor's prescription for the hospitalization, a new episode is recorded regardless of the duration of the hospitalization. Every new episode is recorded and maintained in the database using the form shown in Fig. 3. The implemented HIS has a search system which does not categorize patients and the search can be done by the name of the patient or physician or the patient's code. The system is also supplied by other forms which divide patients by the department they are hospitalized in order to make easy access to the patient list and their information for each department (Fig. 4). This window gives easy and fast access to the nurses of all departments to access their indoor patients information. The user can access the different modules of the HIS database such as the medical records, the examination records, the patient's records, surgical records, etc.

If a test or an x-ray are needed, then the user which is a nurse or a department secretary will send a request to the goal department to perform the scheduling of the examination event. On the other hand, these data are stored in the system and are also available to each department responsible for a specific medical examination.

The implemented HIS improves the storehouse performance of the hospital as well as its medical departments by making the process of requesting and responding, fast and easy. The old process of requesting supplies and medicine from the storehouse was time consuming. The process was started with a request from the department, the secretary should have taken it to the nursing management to confirm the request. Then the secretary should take the request into the storehouse to inform them of the request. Finally the storehouse manager would confirm the request and gave the supplies to the department. On the other hand, in the implemented HIS, it is not required to refer to nursing management or storehouse, the HIS would transfer the requests and responds and finally the storehouse would inform the department to collect the confirmed supplies. This new procedure is faster, easier and it requires the minimum human resource. Figure 5 illustrates the storehouse form which relates to the supplies and medicine requests of the departments. The window is divided into three sections. The top bar includes the date of the request and department name and the status of the request. The middle section shows more detail features of the request such as the supervisor, the date and time of the confirmation of the request. The below section is illustrating the supplies and medicine list and the confirmed amount. The storehouse user can confirm

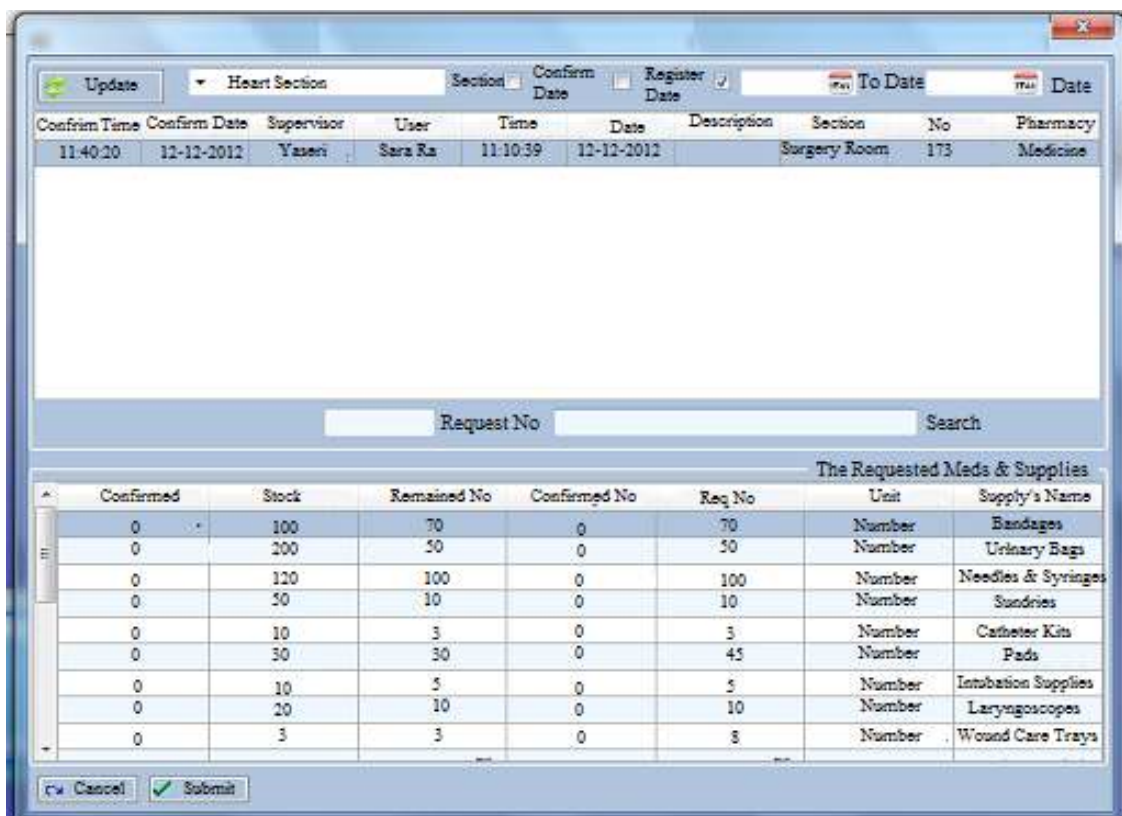


Fig. 5: The store house window to respond to the department's requests

the request by clicking on the save button which will automatically subtract the confirmed amount of all the listed supplies from the previous amount of them, through the storehouse software.

RESULTS

The designed HIS for the Mehr hospital has started to function since June 2012. After five months of functioning the HIS we gathered information in order to discover the benefits of using the HIS for the Mehr hospital. However, in this matter we consider the direct financial benefits of using the HIS, there are several further benefits applying HIS in a hospital such as staff satisfaction, patient trust, physician fulfillment and several direct and indirect benefits.

We compared the costs of designing and implementing the HIS with another paper which proposed an HIS framework for a hospital in Turkey (Özogul *et al.*, 2009). As it is illustrated in Fig. 6, their proposed system is cost excessively more than our described HIS. Expensive systems are not applicable for smaller hospitals because of their low income rate. The Mehr hospital HIS is applicable for small and large hospitals and even clinics because of its affordability.

According to the paper request of the hospital, the paper consumption rate of the hospital decreased to

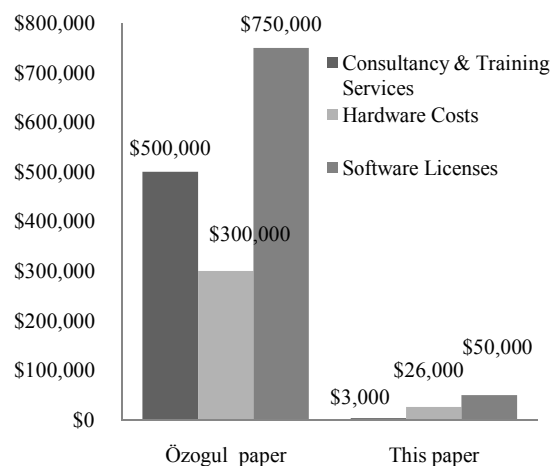


Fig. 6: The comparative analysis of the implementation costs of the HIS project and Özogul *et al.* (2009)

50% after using the HIS. It helps the hospital finance as well as helping the nature by consuming less paper. In addition to the paper consumption, the HIS usage decreased paper works which have been done by staff. This leads to a faster result and more accurate staff functioning. The request confirmation through managers needs one second to get to the manager while

in the old system it was required that the department's secretary, submit the request to the manager's office and collect it several hours later. The HIS implementation in the Mehr hospital aids to omit the unnecessary staff referring to the other departments in order to collect data, requests or formal letters. The HIS decreased the working hours of several staffs with different rates including hospital's secretaries, accounting department staffs, storehouse staffs. We estimate the amount of money saving by applying the HIS in the hospital considering paper consumption and staff working hours. We discovered that the HIS implementation of the hospital saves approximately 15000 US dollars of the hospital budget annually.

CONCLUSION

In recent decades the concept of information systems has been applied in many aspects of human's life. The demand for computerization of the companies is still decreasing. Health care systems are also moving towards automation using various types of information systems. HIS is one of the information systems applied in the health care system. In this study, we introduced and discussed a hospital information system implemented in a hospital in Iran which is a surgical hospital with several medical departments and treatment units. The implemented HIS has several benefits over the old system. In comparing with other HISs, the implemented HIS is a budget system which is suitable and economical for even small hospitals.

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