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SYSTEMS-LEVEL QUALITY IMPROVEMENT

Prioritizing Barriers to Successful Implementation of Hospital Information Systems

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Abstract Hospital information systems (HIS) are often implemented to enhance the quality of care, as well as to improve the efficiency and safety of health care services. However, there are various barriers for their successful implementation. The aim of this paper is to prioritize these barriers. This research is a cross sectional analytic-descriptive study. The study populations were hospital managers, IT department administrators, and clinical supervisors at the academic and non-academic hospitals of two cities in Iran. The data was collected by a questionnaire that its

content validity was confirmed by three specialists. Its reliability was confirmed using Cronbach's alpha ($\alpha=0.78$). Questionnaire contained five dimensions and 39 implementation barriers. The collected data was analyzed by descriptive and analytical statistics using the Kendall Rank Correlation Coefficient and Chi2 tests. The findings of the study revealed that lack of powerful information networks, error in data entry, technical problems related to system design, lack of organizational training, lack of users' knowledge about system and working with it, and negative attitudes of providers and patients toward systems are the most important barriers of HIS implementation. Prioritizing of these barriers helps policy makers to decide what to do when planning for HIS utilization.

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Introduction

Hospital Information System (HIS) is considered as an important tool in health care institutions for managing administrative, financial and clinical data. Many hospitals in around the world are adopting HISs to bring efficiency and safety in their current practices [1]. However, the implementation of such systems is a complex task.

HIS employs computers and different communications tools and mechanisms for the collection, storage, processing, extraction and linkage of information necessary to manage health related activities such as clinical planning, monitoring, coordination and decision making in hospitals [2]. It also supports all activities in technical, operational, and strategic levels [3].

In general, HIS is supposed to provide immediate access to a patient's full medical history and health information, and accessibility to data that are not easily found within the

traditional patients charts [4]. It can help to ensure that patient data is accurate through quality assurance checks [5]. Studies have shown that HIS improves quality of healthcare services provided to patients and increases patient safety by reducing medication errors. The implementation of HIS also contributed to improving providers' performance, reducing treatment costs, and saving resources in healthcare organizations [6, 7].

Despite reported advances that HISs could bring to healthcare organizations and the agreement on their benefits; these systems are not adopted widely in healthcare organizations nor accepted very well by their users [8–10]. Many factors may influence the adoption and acceptance of these systems. Several studies have investigated these factors [1, 11, 12]. According to Anderson et al. [13] since physicians are the main front line users of HIS, their resistance is one of the important factors affecting implementation of this system. Other researches [12, 10, 14, 15] addressing failure factors showed that obstacles such as time constraints, security and privacy risk, lack of an adequate policy regarding medical IT, non-applicability with regard to patient characteristics, and complex clinical settings are among culprits. Similarly, lack of financial resources and high costs; poor management and bureaucracy; poor staff IT competency; lack of qualified IT personnel and lack of awareness of HIT (health information technology) values, are barriers to the adoption of health information technology in Arab countries' hospitals [16].

Some of these challenges are enormous obstacles and consume lots financial and time resources to resolve, while a number of them can be overcome through a proper planning. Therefore, for the proper use of limited resources and to help authorities to make sensible and wise decisions, it is required to prioritize these challenges and barriers. Hence, the objective of this study is to prioritize barriers of hospital information system implementation.

Materials and methods

This was a cross-sectional descriptive and analytic study to prioritize the challenges for implementing hospital information systems. The study population was hospital managers, IT department administrators, and clinical supervisors at the academic and non-academic hospitals of two cities in Iran (Kerman and Birjand). By the time of study, all these hospitals had already implemented HISs and used them for more than three years. Because statistical population was limited, the whole population was studied.

Data was collected by a questionnaire which was made using the results of a systematic review on barriers and facilitators to implementing electronic health records [17] and expert consensus. This questionnaire had two parts. The first part was related to demographic information of participants comprising age, gender, educational degree, job position and

years in practice. The second part of the questionnaire included 39 questions concerning challenges of implementing hospital information system in five dimensions including system characteristics, human factors, human and organizational environments and hardware-related factors. Participants were asked to prioritize each challenge by a five point Likert scale ranging from "very low important" on one end to "very important" on the other. Each level on the scale was assigned a value starting at 1 (very low important) and ended to 5 (very important). The content validity of the questionnaire was confirmed by three specialists (two medical informaticians and one health services management specialist). Cronbach's alpha was used to evaluate reliability of the questionnaire ($\alpha=0.78$).

Data analysis was performed by descriptive analysis and analytical statistics using the Kendall Rank Correlation Coefficient and Chi2 tests. To analyze the data SPSS version 20 were used.

Results

Out of 24 participants, eight persons were clinical supervisors, seven were hospital managers, and nine were IT department's administrators. The study population was composed of 62.5 % male and 37.5 % female. They aged between 25 and 50 years. The educational degree of 67 % was bachelor and of the rest was master's and higher. In total, 54 % of participants worked in academic hospitals and 46 % worked in non-academic hospitals.

The analyses of results indicated that the hardware-related factors obtained the highest mean score (4.41), and it was the first priority. Among these factors "lack of powerful information networks" had the highest score (Table 1). Human environment with a mean score of 3.7 had the lowest priority. In total within all evaluated dimensions, challenges like "no evidence regarding the usefulness of system" from system characteristics dimension and "reduce communication with colleagues" from human environment dimension with a mean score of 3.6 had the lowest priorities.

The results of Chi2 tests showed that there is no significant relationship between qualitative variables (gender, job position, educational degree and type of hospitals) and the priority that participants assigned to challenges related to human factors, system characteristics, human and organizational environment and hardware-related factors ($p \geq 0.05$). However, the relationship between the priority given to hardware-related factors and position of participants is positive. IT administrators significantly gave a higher priority to this factor compare to other two groups of participants ($p \leq 0.05$).

The results of the Kendall Rank Correlation Coefficient tests showed a significant relationship between quantitative variables (age and years in practice) and the priority scores given by participants to hardware-related challenges ($p \leq 0.05$). However, there is no relationship

Table 1 The priority scores of HIS implementation barriers

Dimensions	Criteria group	Score (Total)	Mean score	Average of mean scores
Human factors	Lack of users' knowledge about objectives and importance of system	103	4.2	3.9
	Lack of users' knowledge about working with system	99	4.1	
	Negative attitude of users towards the benefits of system	92	3.8	
	Users' lack of confidence to system developers	93	3.8	
	Lack of freedom when working with system	87	3.6	
	Time consuming	95	3.9	
	Failure to achieve the expected outcomes	98	4	
	No incentive to use system	99	4.1	
System characteristics	User disagreement with system in general	96	4	4.04
	Technical problems related to system design	104	4.3	
	Inefficiency of system	102	4.2	
	System task incompatibility	100	4.1	
	Difficulty in using system	89	3.7	
	Lack of trust to system	96	4	
	Lack of interoperability with existing systems	94	3.9	
	No evidence regarding the usefulness of system	87	3.6	
	Low scientific quality of resources (information) used in developing system	96	4	
	User dissatisfaction about content of system	96	4	
	Non-compliance with quality standards	100	4.1	
	Error in data entry	106	4.4	
	Lack of participation of end-users in the design	91	3.7	
	System start-up costs	95	3.9	
Lack of system productivity	104	4.3		
Human environment	Reduce patient's interaction with health care provider	89	3.70	3.7
	Negative attitudes of patients toward systems	90	3.75	
	Negative attitude of colleagues towards system	90	3.75	
	Reduce communication with colleagues	87	3.6	
Organizational environment	Setting of care (e.g. hospital, clinic) setting status and condition	99	4.1	4.01
	Practice size	90	3.7	
	Practice size	92	3.8	
	Staff' salary	99	4.1	
	High workload	97	4	
	No motivation to competition with other organizations	92	3.8	
	Organizational culture	97	4	
	Lack of organizational training	101	4.2	
	Political and social policies in relation to information systems	97	4	
Hardware factors	Lack of an integrated health care delivery system	100	4.1	4.4
	Lack of appropriate hardware	101	4.2	
	Lack of powerful information networks	111	4.6	

between qualitative variables and the priority scores given to other dimensions of the challenges.

Discussion

The results of this study presented the priority of main factors and challenges affecting successful implementation of health

information systems in hospitals from professionals' points of view. Prioritizing the challenges helps health care authorities to decide on their first area of focus and the importance degree of criteria within that area. In this study the main challenge was hardware-related factors and within that area lack of powerful information networks took the highest score. This can be explained by the fact that in developing countries access to internet

and public networks and home-made internet protocols are limited [18].

Lack of required technological infrastructure to establish national health information system, is a prevalent problem in developing countries. They struggle with limited resources and capability that can affect promotion of HIT in private and public hospitals [19].

Technical limitations related to software or hardware, and system problems are the most cited barriers in many studies [20–22]. In a systematic review on studies about barriers and facilitators to implementing electronic health records, issues related to the technical aspects of EHR were the most frequently mentioned factor, cited by 22 of the 52 included studies (42.3 %) [23]. HIT requires software and hardware to improve public health by making evidence based decisions. Often these software and hardware tools are costly and require sufficient training for proper operation. Therefore, allocating adequate funding and appropriate investments could solve these problems [19]. IT administrators gave significantly a higher priority to hardware factors. This could be because of the through conversant of this group of participants with the technical and infrastructural challenges of the implementation.

After hardware-related challenges, system characteristics were the second most important challenge. Within this class of barriers, challenges such as technical problems related to system design, error in data entry and lack of productivity had the highest priorities for system implementation. The poor design of the system can lead to inefficiency, user frustration, errors and eventually dissatisfaction and rejection [24, 25]. It can also result in undesirable changes in working routines of health care providers, miscommunications and introducing a new organizational structure which is not acceptable by many providers [26]. Meanwhile, a well-designed system can reduce cognitive and physical demands of its users and increase their efficiency and productivity [27].

Most of respondents in this study pointed to error in data entry as one of the important barriers. This result is in line with the results of study by Loomis et al. which indicated that only 55 % of users and 13.4 % of nonusers believed data entry is easy for current EMRs [28]. Therefore, perceived and actual ease of data entry must be improved before widespread adoption of HIS by users. Problems in data entry are a major barrier to successful implementation of HIS, because some healthcare providers finding it too difficult to allocate the necessary time [29]. Treating patients from multiple age groups, diagnosing conditions from a myriad of potentially unrelated complaints, and keeping a comprehensive record from multiple sources are factors make data entry the largest potential obstacle to the effective use of computers in health care sectors [30].

Other factors addressed by respondents were training and knowledge about objectives and importance of the system. Lack of computer skills has been noted as a barrier to HIT implementation in many studies [31, 32, 22]. The importance

of computer literacy suggests the need to plan for assessing and improving computer skills as not only a part of early HIS implementation, but as a part of later adoption and use processes. Regardless of who provides training and assistance, the assistance offered must yield good user understanding of the HIS and data entry into the system [29] and make sure that the requirements of the physicians will be fulfilled by new system.

Finally, in this study human environment factors had the lowest priority for HIS implementation. Respondents believed that among these factors negative attitude of colleagues and patients towards the system is the most important factor. User training of information systems is necessary for the employees to change their attitudes, too. Managers, assistants, clerks and all the employees of organization who are supposed to interact with the system, as an important factor of any information system implementation, must be having enough skills, positive attitude and interest towards the system [33]. In study done by Alasmay et al. [34], it is demonstrated that users with high computer literacy skills were more satisfied with using the system than users with low computer literacy skills. Therefore, health care decision makers and managers need to address users training once a system is implemented and planned to be used. This may reduce users' anxiety and frustration to use the system.

Creating a clear vision of new system among the employees can motivate them to accept the upcoming system instead of showing resistance. Meanwhile, authorities should give assurance to employees that they will not lose their jobs. Employees have to be aware of the potential advantages of HIS that how it is helping to make their tasks simple and easy [29]. Many physicians, once they got the initial training, wondered why they ever did not use the system in delivering the care. Trivedi et al. [35] in their study about barriers to implementation of a computerized decision support system indicated that despite prior concerns about computer use, feedback from patients revealed that patients in general felt comfortable with the care being provided by physicians using the CDSS. Patients should be guided in decision-making process and their awareness should be increased about the benefits of HIS. As the use of health information systems becomes more commonplace, organizations should assess the possibility of providing access for patients to their electronic records [36].

The results of this study provide a good insight for policymakers and researchers concerning different factors dealing with HIS implementation. The limitations of current study include the small sample size, lack of awareness of some officials about items of the questionnaire and lack of their cooperation to complete questionnaire. Nevertheless, to our knowledge this is the first study organizing the barriers of HIS implementation in order of importance in Iran. This can help authorities to have effective planning by assigning appropriate

budget and time for each of the barriers. Although we did not recruit heads of clinical wards in this study, we believe that in the organizational structure of Iranian health care system they do not have a key role in the implementation of health care systems.

Conclusion

Most developing countries do have limitation in adequate and required infrastructure such as hardware, software and skilled human resources to implement health care information systems. Therefore, proper planning needs to be done to increase productivity of existing resources. Determining the barriers regarding implementation of health care information systems and arranging them in order of importance helps authorities to decide about what to pay more attention to. It can also give them the idea of where invest their limited funding. Health information system implementation requires proper planning and considerable investment in funding, effort and time. These must be done to minimize the potential of HIS implementation failure. This is more important in developing countries where funding is difficult to get and often limited.

Based on the results of this study, it is suggested that short and long term policies to deal with these barriers need to be established. More financial resources are to be allocated toward the development of information systems that fit the local needs. It is recommended that in-service training and continual support to be provided to the health care providers as the end users of HIS.

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Conflict of Interest None.

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