

Identification of hospital information system (HIS) performance benchmarking indicators in Tehran province social security hospitals

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ABSTRACT

Introduction: To have an optimal hospital information system, the performance indicators used for evaluation need to be identified. Knowing that the quality of performance indicators is an important issue in benchmarking a system, this study investigated key indicators for benchmarking the performance of hospital information system including structural, process and results indicators. **Method:** This is a descriptive qualitative research. The research population consisted of experts working in Information Technology and data processing units at Social Security Hospitals in Tehran Province. The present study was conducted in two stages using interview and focused group discussion. Using snowball method, purposeful sampling was done in the first stage of this research and the subjects were interviewed. In the second stage, the participants helped classify and confirm the main themes and subcategories obtained from the first stage. **Findings:** In the first stage, 9 main themes and 121 subthemes or key indicators obtained for benchmarking of hospital information system. In the second stage, the results were organized and classified in terms of structure, process, and results through focused group discussion. **Conclusion:** The results of this research can be used as a basis for improvement of quality in the evaluation process of Hospital Information Systems. In other words, improving quality and productivity requires planning to improve HIS key indicators.

Keywords: Key performance indicators, hospital information system, benchmarking

Introduction

Due to the widespread development of medical technology and increased patient expectations, the need for hospital information systems in hospitals is obvious. This issue becomes more important due to the goal of an HIS which is to manage the information that hospital staff need for the Efficiency and effectiveness of their tasks and activities, ^[1-3].

There are many ways to achieve Efficient HIS, one of the best is Benchmarking. According to the Joint Commission on Accreditation of Health Care Centers, optimal mining can be defined as a continuous measurement of a process, product, or service in comparison with the most successful competitors or for similar activities in the organization in order to find or implement ways to improve it ^[4, 5]. Today, in the world of competition and global competitiveness, using successful experiences of organizations creates a constructive role in management desirability. Instead of using a time-consuming process of creating knowledge, organizations are more likely to take advantage of the successful experiences of organizations; therefore, process efficiency and effectiveness are at the core of optimal mining activities ^[6]. Generally, optimal mining includes the selection of an appropriate target and the definition of performance indicators used for comparative purposes and targeted decisions ^[7].

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An important issue in defining optimal mining is the definition of functional indicators. In order to have a good HIS which provides useful information for key system users, we need to know with which of functional indicators we can evaluate that [8]. In fact, providing a suitable template for selecting and implementing an appropriate hospital information system can directly, completely, and operationally lead to a more correct selection and prevention of waste of financial and human resources in hospitals; hence, it is possible to provide better care services to patients and more resources efficiency by using the computer system appropriately [9]. Benchmarking does not only address indicator definitions and measurements, but compares it with the bests is also placed in this process; therefore, hospital information technology management can address the strengths and weaknesses points of the HIS and systematically improves it [10].

If indicators are well known for evaluating hospital information systems, it will be of great help in furthering the goals of the organization. It seems that although the operational indicators obtained in the field of Benchmarking in various studies are apparently different, in practice, they all seek to determine the optimal aspects and indicators for the proper evaluation of the information system. In addition to the financial, technical, and software aspects that mostly are considered in evaluations, the proposed indicators in this study have also focused on system architecture, support service, provider quality, and system users. Therefore, this study aimed to provide a framework of key performance indicators for HIS optimal mining.

Materials and Method

This study is a descriptive and qualitative study. The population of the study consisted of experts in health information technology and information transmission departments of Tehran's social security hospitals. The inclusion criteria included the Professional knowledge and people experience in the field of hospital information systems, the experience of working with these systems and the interest in participating in the research. During the study period, if each of the participants in the hospitals were not willing to cooperate, they were excluded from the study. The social security hospitals of Tehran province include eleven hospitals (Ayatollah Kashani, Imam Reza (AS), Shariat Razavi, Fayazbakhsh, Labafinejad, Lavasani, Mo'ayeri, Varamin Martyrs of fifteen Khordad, Hedayat, Shahriar and 12 Bahman). In this research, sampling was done purposefully using snowball method to select participants in the research among people who had the inclusion criteria; interviews were conducted with these people. Subsequently, other persons who had the ability to enter the study were introduced to them. The data collection continued until there was no probable emergence of the new concept. Therefore, this sequence continued to reach the information saturation stage and thus the number of samples under study reached to 15 people including 8 persons responsible for the Department of Health Information Management 7 persons responsible for the

Data Transmission Unit (Computer). In the second phase, the most informed participants were asked to participate in a focused group discussion at the first stage. The number of experts reached 8 at this stage. In the second stage, the most informed individuals of the first stage were asked to participate in focus group discussion. The number of the experts in this stage reached 8 people. Based on comments and suggestions, the indicators were confirmed and categorized into three axes of structure, process, and results, using thematic analysis method.

Analysis of Findings

For the measurement and benchmarking of the hospital information system, the results of this research are presented in two parts: descriptive findings and analytical findings as follows: Descriptive Findings (personal data) Participants in this study showed that among the 15 participants in the study, 60% of female interviewees and 40% of men were interviewed. 7% of the interviewees had a Ph.D. degree, 33% had a master's degree, and 60% had a Bachelor Degree. 53% of interviewees had a degree in health information technology, 47% had a degree in computer engineering.

Findings of the first stage of the research (interview): The identified indicators at this stage were categorized in the 9 main axes of hardware and hardware, software, design, and architecture, software provider and vendor companies, support services, workflow, output and gave out, cost and users. 121 key indicators were classified under the main axes as sub-axes.

Findings of the second stage of the research (focused group discussion): The findings of the first stage were divided into three groups of structure, process, and results with the view of the participants in the group discussion session. Table 1 refers to structural indicators in this study, which includes 8 main axes and 62 sub-axes. Table 2 also provides process indicators in 8 main axes and 30 sub-axes. Table 3 indicates the results indicators, which include 9 main axes and 29 sub-axes. It is seen that gave out and output item of HIS is only in the results index (Table 1 to 3).

Discussion

In this section, the benchmarking indicators identified in this study were discussed in nine axes. This nine main axis includes:

Technical and hardware indicators

In line with the indices obtained in the field of HIS Benchmarking and in comparison with other studies, Shahmoradi *et al.* referred to only parts of the subsets of technical quality such as system response time, task time, ease of access to system menus [11] while in the present study, in addition to the above, other aspects such as the adequacy of the system hardware equipment, the independence and dynamics of tools for data entry and retrieval were also considered.

In the study of Bloder and Ammenwerth, key indicators in evaluating technical quality included access to information systems (number of system out of access), response speed (time between user instructions and system response), user authentication timeout (time being available for system functions), the amount of data loss, and recovery time^[12]. The present study also has these dimensions.

In the study of Amiresmaili *et al.*, The indices, the number of purchased hardware, the adequacy of the hardware system, the independence and dynamism of the tools for data entry and retrieval, system availability, system performance, response rate, and data loss were the key indicators of evaluation^[13] which is consistent with the indices obtained in this study.

Software indicators

What software is designed and implemented for it is the basis of quality measurement and the Failure to adapt software with its requirements will result in lack of software quality^[14].

Studies have been conducted on the data confidentiality and security of patient information in HIS including the study of Fernando and Dawson in which they explain the confidentiality and security meanings of patients' data and seek to answer this question "How do doctors care about privacy and security in hospital information systems?"^[15]. the confidentiality and access level of individuals to information and the multilayer security of software were one of the important issues that was considered in this study.

In the study of Bloder and Ammenwerth in software quality aspect, key indicators included support for legal guides, ergonomic and integrated interface, the standard time required to perform tasks and adaptation of the system to native conditions^[12]. As we can see, some of these dimensions are also found in the indicators mentioned in this study.

Design and architectural indicators

The architecture of an information system represents the components of a system and their communications. The robust and accurate architecture and design of the database in the information system lead to an optimized system^[16].

In the study of Bloder and Ammenwerth, following of user communication standards was identified as a key indicator of information system architecture^[12]; in this study, this indicator was approved by the experts.

In the study of Amiresmaili *et al.*, Indicators such as system topography development based on hospital map, relations between HIS components connected together by connectors, and components that are non-connecting and dual system communications are considered^[13]. As we can see, some of these dimensions are also found in the indicators mentioned in this study.

Indices of software provider and vendor companies

The results of the studies indicate that ignoring the expectations and roles of users by the vendor company will boycott 40% of

the newly designed systems^[14]. Therefore, user-oriented design and providing end-user requirements are the main responsibility of software organizations and suppliers^[17].

In Bloder's study, the stability of the information system vendor, operational support and system bug fixing, and the number of qualified employees in the vendor company have been suggested as key indicators of performance in the vendor's quality dimension^[12]; these are consistent with the findings of this study.

Amiresmaili *et al.* conducted a study titled "Determination of Hospital Information System Evaluation Indicators" and emphasized the importance of the vendor's quality index with subsets such as HIS vendor membership in standardized organizations, firmware vendor stability, prepare user manuals, and user training^[13] which is consistent with the results of this study.

Support Services Indicators

Using HIS can greatly improve the accuracy and correctness of data while improving working processes. Scattering of information and lack of access to some data will be minimized through integrated HIS^[18].

Behfar has considered the lack of proper education and preparing access to information technology and its tools as the ineffective factors of this system^[19].

According to some studies, some indicators of this axis, such as the prediction and quality of the protection system, access to data, and the training course have been taken into consideration in the research of Shahmoradi *et al.*^[11] and Hamborg and Vehse^[20].

In the study of Amiresmaili, number of support staffs compared to the number of users, bed, outpatient and workstations, the competence of the support staff, the ability to define processes in the support department for documentation, prediction of defects in the support section and its emergency management, the prediction and quality of the protection system and allowing access to data as key indicators were determined^[13]. Regarding the importance of these indicators in the HIS evaluation in the present research, other than the mentioned cases such as the competence and efficiency of the support staff, the number of problems that are resolved in the standard time frame and other items are considered.

Workflow Indicators

Workflow Benchmarking reduces errors and, as a result, improves data accuracy, increases efficiency, creates a reliable time to deliver services, and ultimately improves service to patients. Raadabadi *et al.* said that by implementing HIS, they showed a significant reduction in working processes and it has led to improvement in hospital performance^[21].

A study by Vehse and Hamborg considered indicators such as simplifying processes in the scope of complex system operations, coverage, and accessibility of medical databases, improving clinical research, improving documentation and data quality levels, accessibility, completeness and accuracy, and

other issues.^[20] as we can see, some of these dimensions are also found in the indicators mentioned in this study.

In Bloder's study, user satisfaction, system task spectrum, continuity of system support services, Repeatability during data collection, the time required for documentation and completeness of electronic health records have been considered as key indicators^[12]. In the present study, some of these indicators were identified as key indicators.

Gave out and Output Indicators

Patient satisfaction in health care processes is an important indicator of quality and health promotion^[22]. Therefore, the satisfaction of patients from reducing the acceptance time to discharge is one of the most important outputs of HIS^[23].

The role of HIS in improving the performance of the hospital management of and its treatment staff is indisputable. HIS provides this facility to hospital management to access decision-making information at any time and location and make a decision based on actual workplace information. Management decision based on actual information leads to increased efficiency and development in its performance and ultimately leads to the efficiency and effectiveness of the hospital. Improving the quality of healthcare services, creating scientific management in hospitals, improving the economy of treatment, developing research in medical sciences, reforming macro policies in health care, and developing medical education are among the results of this system^[24-26].

The study of Shahmoradi et al. referred to aspects such as the quality of service, usefulness, strategic use of the system in decision making and communication improvement^[11]. In the present study, in addition to the above aspects, patients' satisfaction and safety of providing quality services, the contribution of the system to hospital success, timely availability and accuracy and correctness in clinical documentation in the system, the amount of management benefits from system implementation and the clinical benefits of run the system is also mentioned. It is consistent with some of the indices obtained in this study.

Cost Indicators

Hospitals, due to the use of sophisticated technologies, have a large part of the resources allocated to the health section, but because of the inefficiency and lack of proper management of technology in the cost part or in the income creation part, they have not used good resources and have wasted part of these resources.

The value added generated through HIS in the evaluating processes can have a direct impact on reducing the cost of services and manpower and increasing the utilization of hospital resources, which can be considered as criteria for improvement and development of hospital performance. Studies show that increasing the quality level alone cannot meet the needs of customers, and the additional factor, that is the reducing the level of costs and fixed price, should also be taken into consideration. In the research of Shahmoradi et al., The cost of technology, the cost of training staff and the cost of support

have been paid attention^[11]. In this study, in addition to the above cases, indicators such as the cost of effectiveness of the system, total system costs compared to hospital returns, financial benefits of the system include staff cuts, reduced paperwork, and satisfaction of financial payers.

In another study, Garrido et al. examined the status of investment in the information system in one of the healthcare centers. They considered the total cost of the information system to include the required hardware Infrastructure to install and provide the appropriate software. In addition, the cost of maintaining the system is also due to the use of expensive equipment and components, are of great importance to the system. The cost of training system users and adapting to the new system are among the main factors affecting the effectiveness of the information system, because if the use of the information system is actually worthwhile, but in practice, the tasks and features of the system do not perform, this leads to a hospital failure and failure in its investment^[27]. In addition to the total cost and cost of maintenance and the cost of training, the cost of the system effectiveness has been considered in this study.

users

Users are, in fact, customers of the system, services, and information that are not considered as the next in other dimensions, but due to its importance as one of the main dimensions is considered.

In a study in Mashhad, Kimia Far et al. considered problems with the inadequacy of information system quality and its mismatch with the needs of users as a necessity for the revision and renew of HIS^[28]. As it can be seen, the results of this study are also in line with this research.

In the study of Mokhtari et al. entitled "The HIS User's Performance Assessment on Deductions", there is a significant relationship between the user's computer knowledge and the system's self-descriptiveness and compliance with the needs of users with having a system, and also user satisfaction from the system is an effective and important factor for meeting the organization's needs by the system^[28]. It is consistent with the results obtained in this study.

Conclusion

The indicators presented in this study provide a comprehensive tool for assessing HIS, which by using that, it will produce a great opportunity to improve the performance of these systems over time. The indicators provided in this study provide a comprehensive assessment of HIS. Considering the widespread use of HIS and its significant effect on the continuation of treatment of patients, and also with regard to the results of this study, the necessity of taking into account all aspects of HIS optimal mining is essential and important. The study of optimal hospital information system shows that, work processes can be greatly facilitated and expedited by the implementation of information systems. Improving the health information system

will increase patient satisfaction, improve data management, reduce current costs, increase employee's efficiency, and the returns of the health center in the long run.

Given the fact that today's organizations have made significant investments in organizing and developing information systems in organizations, depending on the type and size of the organization, in order to evaluate the services provided by these systems, it is necessary to provide systems that are optimal and appropriate to each organization in order to measure the quality of their information system services. They should be designed and implemented and, by creating reflection, can improve the services provided by these systems.

Employee's comments on how to deploy HIS and using optimal mining indexes can motivate individuals to make high and optimal use of HIS and increase the staff's comfort and access to essential hospital information and, as a result, it helps to increase the efficiency and effectiveness of this system a lot.

The results of this study can be used as a basis for improving the quality of hospital information systems and it is expected to improve the quality and productivity of the system by planning to improve the indicators. Therefore, the results of this study are applicable to all patients, managers and staff of hospitals, information system designers, providers of hospital systems, and all organizations that have an information system.

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Table 1: Structural Indicators

A	HIS technical capacity
1	Access rate to health information system
2	The degree of adaptation of the hardware used with any device (portability and Removable)
3	The adequacy of hardware
4	The ability to install HIS on any server
5	The degree of independence and dynamism of tools for data entry and retrieval
B	Software capacity in HIS
1	The level of encompassing all the specialties and all the needs of users of the HIS system and establishing an appropriate link between service providers
2	The amount of support for legal instructions by the software (e.g. ICD 10, DRG, data transfer rules)
3	Ergonomic and uniformity of user relationship with HIS systems
4	The existence of a suitable database and structure in accordance with the hospital processes
5	the possibility of fitting the system with the needs of users, such as the ability to use and function properly
6	Level of software upgrade and productivity
7	The amount of flexibility and system development and modification, such as trying to update or improve software features
8	the amount of Compliance with International Standards
9	Level of access of individuals to data and information (confidentiality)
10	The rate of compliance with the single protocol
11	The degree of security of multiple layers of software in accessing patient information
12	The degree of Process matching with software (equality of the actual use of the system and the designer's intended use)
13	The ability to log system events
14	The ability to apply clinical decision support systems (DSS)
15	The amount of access to reminders and notifies, such as CPOE
16	Failure to impose additional software by software
17	Compatibility with common operating systems (switching capabilities)
18	Matches with the Latest Technology Available according to the percentage
19	The amount of software can be controlled (easy transfer between different levels of the menu, the possibility to return to the main menu and the predictability of the display pages in the next step)
20	Fits the terminology used in the software with the user's working environment
C	HIS Design and Architecture Capacity
1	The level of connection to an internal network for the use of all parts and units of the hospital from the integrated hospital information system
2	Ergonomic design and uniformity of user interface with HIS system
3	Support for interface standards (such as 7HL, DICOM)
4	Designing the relationships between system components to connect to each other (with or without the connector)
5	Communication design between systems for transmitting standard messages
6	External interface design; to demonstrate support for patient care, for example, requesting medical documents from patients by other healthcare institutions
7	Design tailored to activities and needs
8	Proper HIS Infrastructure Design
9	Designing an internal network to integrate HIS
10	Proper database design
11	Optimized process design, structure, and database to reduce the time required for standard operation
12	Optimized design for time to retrieve access to information in the HIS system
13	Optimal design of processes to improve how to do work and better understand information (e.g., use of charts).
14	Designing the link between the clinical units that have their own specific subsystems for recording information.
15	Providing topography of the system based on hospital building map (location of servers and computers)
D	The capacity of the HIS provider
1	Degree of authority and the amount of credit of the HIS provider
2	The extent of HIS vendor participation in compliance
3	Provide a booklet or compact disc instructional and system manual by the HIS provider
4	The number of highly skilled and efficient staff to provide services for the development, support, and updating of HIS
5	The number of clinical departments that use our company's subsystem for documentation (number of completed HIS projects successfully)
E	Support Services Capacity
1	Enough staff to provide services or support of HIS systems
2	The level of competence and efficiency of the support staff
3	The existence of communication networks to access HIS experts and the existence of a CRN system and the requirement to solve problems
4	The requirement for a service provision clause to update the system based on user requirements
F	Workflow support capacity
1	The ability of the system to reduce the error caused by forgetfulness
2	System Ability to Reduce Drug Error
H	HIS cost capacity
1	Total cost of HIS systems
2	The overall cost of HIS in terms of financial turnover and hospital returns
3	The amount of system cost predictability

4	The amount of hardware and software costs to set up your HIS
5	The amount of necessary expenses to add the system to the number of users
6	The cost of clinical documentation in relation to overall hospital income
7	Annual increase of investment for HIS systems
	Cost of HIS Maintenance of Sub-Structures (Technical, Software, Design, Other)
I	System users capacity
1	System derived from the needs of internal users (employees)
2	A system derived from the needs of external users (stakeholders like insurance companies)
3	System derived from user interface requirements (members of Board of Trustees)

Table 2: Process Indicators

A	HIS technical capability
1	response Speed
2	User authentication duration
3	Transparency and Visual and audio clarity
4	The ability to backup mechanism for saving information
5	HIS system capability to maintain stored information
B	HIS software capability
1	The time required to perform a standard performance
2	The equal percentage of similar key functions throughout the program
3	The ability to control and correct data after entering and before processing them
4	The amount of maintaining information in the event of a problem
C	Ability to HIS design and architect
1	The degree of same direction and coordination between the strategy of the HIS functional and functional system
D	The ability of HIS provider companies
1	The amount of Operational and executional support for implementing, using, updating and fixing the problem
2	Obtain an HIS Performance Certificate from the Office of the Ministry of Health
3	Obtaining a Certificate of Ranking and Authentication from the High Country Informatics Department
4	Obtaining a software technical approval certificate from the Supreme Informatics Council
E	The ability to support HIS services
1	Process entities in the HIS provider company for error management, updates, documentation and its management to solve problems.
2	The amount of defect prediction in its support and emergency management section
3	capability of maintaining backup files from all HIS subsystems
4	existence of Effective training for each user
5	Percentage of problems that are resolved within the standard time frame.
F	Ability to support HIS workflow
1	The amount of functional coverage needed to manage and provide patient care
2	The degree of adaptation of the processes in the system to the routine processes of the hospital
3	The simplicity of processes in the range of complex system operations (There are no imposed processes)
4	Durability of workflow support by HIS systems
5	The amount of information recorded in the HIS system in accordance with the Minimum MDS Information items document available on The site of Statistics Office and Technology of the Ministry of Health
6	Ability to match with manual system
7	The level of visualization and simplicity of execution of the operation
H	HIS cost ability
1	Operating costs of HIS systems annually
I	HIS Usage Ability
1	usage of change management systems to replacing HIS based on the views of experts and system users
2	Appropriate monitoring and leadership
3	ability to user training through HIS

Table 3: Indicators of Results

A	Technical quality of HIS
1	System performance (existence sufficient mechanisms for storing and processing a large amount of information, such as cloud processing)
2	The ability to integrate HIS with other existing systems at the performance reliability level (existing result)
B	HIS software quality
1	The ability to provide patient electronic records
2	The possibility of establishing a telemedicine network between different hospitals
C	HIS Design and architecture quality
1	Overall compatibility with existing IT
2	Designing a standard, unique and appropriate system
D	The quality of the companies offering the HIS
1	Consistency and Executive guarantee of the HIS provider's upgrade system in the future
E	Quality of HIS Support Services
1	Commitments contained in the contract

F	support quality of HIS workflow
1	Percentage of satisfaction of different users of the system and compatibility with the expectations of users
2	Lack of duplication
3	Ability to obtain required and diverse reports in electronic and paper form on the system based on the key data required
4	Coverage and access to medical databases
5	Improvement in clinical research
6	Percent of reduction in the time required to record clinical data
7	Level of data quality (accessibility, accuracy, and completeness)
8	The degree of completeness of electronic medical records relative to all medical records of the patient
G	HIS output quality
1	Percentage of patient satisfaction and safety from providing quality services
2	Improving the process of providing more satisfactorily and easiest services (mean reduction in acceptance time to clearance)
3	The degree of completeness and standardization of patients' clinical care processes in HIS systems
4	Being available in time and Correctness and Precision in clinical documents in HIS systems
5	The contribution of HIS systems to the success of hospitals
6	The contribution of HIS systems for hospital strategic goals
7	The system's ability to raise the quality of decision-making
8	The degree of clinical benefits of run the system (avoiding mistakes and other things)
H	Quality of HIS Costs
1	Cost-Effectiveness of HIS Systems
2	The amount of financial system benefits (staff cuts, paper cutbacks, Satisfaction of financial payers)
I	HIS usage quality
1	Optimal use of human resources
2	The degree of popularity and user-friendliness of the system to enhance the participation and motivation of users to accept and develop the HIS system
3	The degree of fitness of the system for the use of staff with any amount of knowledge