

# Advantages of a Web-Based Real-Time Bed-Management System for Hospital Admission Monitoring in Iran

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**Abstract.** Lack of up-to-date information of hospitals beds, specifically in emergencies, is a significant problem in many large countries; The Ministry of Health and Medical Education of Iran (MOHME) designed and implemented a dynamic system that reports the status of beds in 2012. This system created great opportunities for national bed management, including real-time hospital admission monitoring, especially for emergency departments, ICUs and CCUs. Therefore, an additional online system was planned to be implemented for monitoring hospital admissions, including a national alert system. Prior to the design of this system, a study was done using literature study and expert opinion to investigate the advantages and features that this monitoring system was required to have. We used the MoSCoW method to prioritize the requirements of the system. This system was designed to have the following advantages, among other things: the hospitals as well as government should be able to track the patients, manage patient distribution in healthcare centers, and make policy for supplying extra beds. It should also be possible for the hospitals executive board, as well as the government, to monitor the performance of the hospitals regarding patient admissions (i.e., the rate of rejection of patients with severe conditions).

**Keywords:** Bed management, Hospital patient management, Real-time hospital admission system. Bed management dashboard.

## 1. Introduction

Hospital beds are a scarce resource, specifically in wards such as intensive care units (ICUs), coronary care units (CCUs) or emergency departments. Managing the distribution of patients over unoccupied hospital beds is an important task of hospitals; In addition, one of the critical determinants of the work undertaken by hospitals is the bed occupancy rate [1]. The average bed occupancy, Inpatient Bed Occupancy Rate (IBOR), has been the primary measure that has guided hospital bed capacity decisions at both policy and managerial levels. However, hospitals need to plan capacity based on standards that reflect the ability to place patients in appropriate beds timely rather than on

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target occupancy levels. Doing so will require the collection and analysis of operational data—such as demands for and use of beds, as well as patient delays—which generally are not available [2]. There is no doubt that lack of beds leads to premature discharge from hospital. Premature discharges have a significant impact on the mortality rate [3]. Previous studies showed that each hour of waiting is independently associated with 1.5% increased risk of ICU death [4]. There is a significant association between time to admission and survival rates. Early admission to the ICU is more likely to produce positive outcomes.

Therefore, it is important to improve bed management and admission monitoring, which not only leads to faster service delivery but also enhances the quality of care [5].

Previous studies introduced solutions for bed control. For example, SAGEC 67 is a virtual system that is applied in France, Germany, and Switzerland that helps care givers in case of mass casualty disaster to cope with lack of beds [6].

In 2012, the Iranian Ministry of Health and Medical Education (MOHME) designed a national-wide bed management system for managing cross-hospital patient referral in hospitals. This system was also intended to serve for accommodating victims in mass-casualty incidents [7]. It was not patient centered and only reported the status of beds (i.e., “ready to accept patient”, “out of service”, “reserved”, “patient in transition”, “patient in discharge”, “free”, or “occupied”). No information was available about occupied beds.

Following the development of a "Cross Hospital Bed Management System" by the IT department of MOHME (2014) [7], there has been an increased interest in developing a live system for national hospital bed and admission management in Iranian hospitals for fast communication and watch-out of inpatient admission, especially for emergency departments, ICUs and CCU beds. While little research has been done regarding online solutions for managing multiple hospitals in terms of admission and discharge turnover, MOHME planned to design a web-based monitoring system that reports all new patients admitted to SEPAS (National Infrastructure of Iranian Electronic Health Record, locally called SEPAS).

Prior to the development of this system, we studied the advantages and desired features of this online monitoring bed management. This paper demonstrates the results of this study.

## **2. Methods**

We performed a literature study to gain knowledge about monitoring bed management systems. This study served as a foundation for our interviews with experts for defining the desired functionalities of the system. Based on expert opinion (ten experts from Iran and The Netherlands: four medical informaticians, four computer scientists and two medical doctors), we first investigated the advantages that the system should offer. Next, the initial functionalities and features were defined which were validated by discussing them with the key-stakeholders in and organizes congress. In this process, we leaned on the concept of co-creation for innovation. The final sets of functionalities were then created using the MoSCoW method. The next section reveals the findings of this study.

### 3. Results

#### 3.1 Advantages of the availability of the online monitoring bed management system

A web-based system was proposed for the hospital bed management system, that should be able to report any type of bed status data and admission data to SEPAS. Moreover, the system should be patient-centered and only associated with the occupied bed, and should help the Iranian government in different ways. With these functionalities, when lack of beds is often reported for certain public hospitals, the government will have the opportunity to equip those hospitals with extra beds.

Due to the severity of accident casualties' conditions, hospital staff is often reluctant to accept these patients. They also require intensive care beds, which are scarce. Therefore, the online system should also report to health care executives, so that they can help solving this problem. In the proposed system, it should be possible for the government to monitor turnover rates of admissions and easily search for missing persons in the hospitals. It should also be easy for the Iranian government to monitor the annual planning for hospital bed management. Moreover, the government should be able to monitor the transmission of patients between wards within hospitals, so that the need for different bed types can be analyzed.

In addition, the system should help the "guidance staff", who work in the emergency departments of every medical science university and are responsible for transferring patient between hospitals in the public/governmental sector. Ambulance personnel should be able to quickly identify the closest hospital with empty and suitable beds, which would be useful especially in rural areas.

The benefits of the system are described in table 1.

**Table 1.** The benefits of the real-time bed management and admission system.

Stakeholder who can benefit from the system	Advantages/benefits
Ministry Of Health and Medical Education	<ul style="list-style-type: none"> <li>• Monitoring the performance of hospitals regarding bed management.</li> <li>• Tracking a hospital's admitted patients.</li> <li>• Searching for missing persons and persons who are injured due to accidents.</li> <li>• Monitoring patient admission turnovers and referrals to other healthcare centers.</li> <li>• Managing patient distribution in healthcare centers.</li> <li>• Improving the speed of patient admissions in hospitals and creating transparency in the process of pre-patient emergency admissions.</li> <li>• Policy making for supplying suitable beds.</li> </ul>
Medical Science University (managerial staff in hospitals)	<ul style="list-style-type: none"> <li>• Managing patient distribution in healthcare centers.</li> <li>• Monitoring on human resource performance at the hospitals.</li> <li>• Observing patient admissions turnovers.</li> <li>• Searching for missing persons and persons who are injured due to accidents.</li> </ul>
Staff (e.g. guidance of the ambulances to hospitals)	<ul style="list-style-type: none"> <li>• Monitoring patient distribution in healthcare centers.</li> <li>• Searching for suitable empty beds for patient transfers for pre-hospital emergency.</li> </ul>

#### 3.2 Functionality and features

Table 2 demonstrates the main desired functionalities of the web-based admission system. These requirements were defined based on the initial study with the experts. In

general, if the government wants to monitor the turnover of patient admissions to hospitals or needs to search a person who is missing or for policy making regarding bed supplements, this system should be able to provide the needed information.

The system should work using trigger activation (i.e., without user intervention). The local HIS should call the web-based bed management and admission system to transfer data to SEPAS. The status of the bed should be changed when a patient is admitted in HIS, and the web services should be triggered. Furthermore, in addition to these functionalities, it was recommended that a guideline should be developed for the local HIS developers how to update their software to connect to the system.

**Table 2.** Requirements of the online bed management and admission system.

MoSCoW	Requirements
<b>Must-haves</b>	<ul style="list-style-type: none"> <li>• The system must provide a web-based monitoring system (as an online system).</li> <li>• The system must work with trigger activation (i.e., without user intervention).</li> <li>• Web services must be triggered when a change in status of beds happens, or a patient is admitted in HIS.</li> <li>• Web services must be deployed simultaneously in all local HISs.</li> <li>• Local coding in HIS must be mapped with national coding (e.g. Ward Type, Bed Type, Insurer, Admission Type and Nationality).</li> </ul>
<b>Should-haves</b>	<ul style="list-style-type: none"> <li>• The system should have a Data Mart to store transaction logs.</li> <li>• The system should work reliably, according to the predefined quality indicators (e.g. percentage of correct beds flow process or average delay in sending information to SEPAS).</li> </ul>
<b>Could-haves</b>	<ul style="list-style-type: none"> <li>• Develop a monitoring dashboard for stakeholders.</li> <li>• Design a warning system to report the free ICU and CCU beds.</li> </ul>

#### 4. Discussion

In this paper, we investigated the advantages and the possible functionalities of a national real-time bed and admission-management system in Iran, meant to be managed by the government of Iran and designed for monitoring patient referrals to public/governmental hospitals. Important features that were proposed were to providing a web-based real-time monitoring system, which works with trigger activation (i.e., without user intervention) to manage all hospitals in terms of admission and discharge turnover. When the status of a bed changes in the local HIS or when a patient is admitted, the local HIS should trigger the web-service.

The advantages mentioned by our experts were to provide real-time hospital information so that bed status and admitted patients are easily traceable by ministry of health. The system should be able to facilitate decision making for management of patient's referrals, especially those who need CCU and ICU admission as well as policy making for supplying these beds. Moreover, monitoring the performance of hospital regarding bed management, the ability to search for missing persons and persons injured due to an accident, the possibility to monitor patient admission turnovers to monitor the statistics of referrals to healthcare centers.

To the best of our knowledge, this is the first study that investigate the advantages of a nation-wide online monitoring bed management system for real-time patient referrals. The hospitals as well as the government might be able to track the patients, manage

patient distribution in healthcare centers and make policy for supplying extra beds. It should also be possible for the government and hospital executive boards to monitor the performance of the hospitals in admission of patients. Although the system design is unique in its sort, its reliability of the system is not tested yet. Future studies are needed to test the reliability of such system.

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