

## Digital Dashboard for Improving Pharmacy Management: A mixed-method study

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### Abstract

**Aim:** This study aimed to determine the performance indicators required for hospital pharmacies and design a hospital pharmacy dashboard through defining requirements.

**Methods:** This study was conducted in three phases in 2017. A qualitative approach was employed to collect and formulate key performance indicators (KPIs) for hospital pharmacies. A semi-structured questionnaire was constructed to determine KPIs. The data were analyzed using framework analysis. The classic Delphi technique was used to determine the dashboard requirements. Finally, the Dashboard was designed using QlikView12 and implemented in the selected hospital. The data displayed on the pharmacy dashboard was driven by the hospital information system (HIS).

**Results:** The KPIs consisted of three domains including managerial, clinical, and financial indicators.

**Conclusion:** Pharmacy services have been affected by the complexity and diversity of drugs, clinical concerns, and costs. The dashboard can help pharmacies' managers by monitoring. The dashboard design process begins by identifying KPIs that are important to decision-makers.

**Keywords:** Key performance indicators, Dashboards, Pharmacy Administration

Hospital pharmacies have a critical role in inpatient care. Hospital pharmacy activities require retrieving, processing, comparing, and updating of information (1,2). In the pharmacy, the data must be precisely managed from different sources to monitor and analyze data to improve performance and decision-making (3-5). Automatic monitoring is required to ensure the efficiency and effectiveness of pharmacy services, which can reduce drug side effects, improve drug cost-effectiveness, and generally improve hospital pharmacy management (6).

The need for better performance, resource reduction, and increased expenditures indicate that the healthcare industry requires new approaches for monitoring and managing performance (7). Therefore, pharmacy managers need to use new tools with which they gather and present data effectively and efficiently (4, 8-10). Key Performance Indicators (KPIs) are the criteria related to performance objectives that allow organizations to measure their progress against set strategic and operational goals (11, 12).

The pharmaceutical budget, patient safety, and quality of care have an impact on determining KPI to use timely decision-making (1). These indicators include varieties of measurements like financial, clinical, and educational indicators (2, 5, 8). The managers of healthcare organizations have experienced a growth in performance indicators with a new focus on key operational issues such as patient safety and care management that finally affect financial performance. To exchange such information and management priorities between different operational levels, application of a dashboard tool can be very useful and valuable (6).

Dashboards are a visual display of KPIs that offer a visual view of the overall business performance (12, 13). They are also considered as intellectual tools used in healthcare organizations (1, 14). Several factors should be considered in dashboard development; first, the metrics' selection for monitoring; second, the data set collection and deletion methods; third, the frequency of data collection and updates; fourth, development of an effective report and consideration of the person who uses the report; fifth, the right to access the dashboard based on user groups; and sixth, security (15, 16).

A dashboard helps surveillance progress of the pharmacies in real-time and tries to manage cost and labor resources. The information represents in a dashboard facilitates a better understanding of drug expenses (17,18).

The study aimed to determine suitable performance indicators for hospital pharmacies. In the next phase, we identified the requirements of dashboard development and developed a digital dashboard for hospital pharmacies.

## Method

The study was conducted in three phases of a qualitative method, classic Delphi technique, and dashboard development. The details of each phase are discussed below.

### Phase I: Determining KPIs for hospital pharmacies

A qualitative approach was employed to collect and formulate KPIs for hospital pharmacies. The participants included managers of hospitals and pharmacies (4 public, 2 private, 1 charity hospitals) in Yazd City, Iran. Based on a literature review, a semi-structured questionnaire was designed for determining KPIs of the hospital pharmacy department. The data were collected using face-to-face interviews and focus group discussion. The focus group was held in the largest public hospital with participation of the hospital and pharmacy managers. The interviews started with general questions and later more detailed questions were asked based on the participants' responses. The interviews were recorded after obtaining the participants' consent. Each interview took at least 30 to 50 minutes and data saturation was achieved after 15 interviews.

The interviews were transcribed and analyzed thematically. A list of coded concepts was developed to characterize the pharmacy key performance indicators. The codes were then grouped to delineate emerging themes and their relationships. Finally, the results were sent back to the participants for validation and accreditation. For anonymity of the participants, the identification information was covered.

### Phase II: Determining the dashboard requirements

We reviewed the literature over dashboard development. We also investigated some available dashboards and used QlikView website as specialized software for dashboard development. Next, a questionnaire was designed according to the literature review. The designed questionnaire included demographic information, 10 closed-ended questions regarding dashboard goals, alignment with organization strategy, KPIs, time framework for updating, extraction of exact data, flexibility, deep mining, security, data presentation, and alerts. Furthermore, one open-

ended question was used to collect additional information from participants.

To evaluate the questionnaire's content validity, we asked three experts in dashboard development to review the questionnaire. Following their suggestions, we revised the questions by making minor changes. The test-retest method was also used to check the questionnaire reliability. Moreover, three experts were asked (who were excluded from the final study) to complete the questionnaire once and again after ten days. The test-retest reliability index was 85%. The two-round Delphi technique was used to determine the dashboard requirements.

### **First Delphi Round**

In this round, the final questionnaire was sent to 37 experts, including health information management, health informatics, and software engineering in the field of health who were familiar with dashboard development. The questionnaires were sent by e-mail or delivered in person. In this regard, reminders were sent every few days. In addition, 33 participants completed the questionnaire within 7 weeks. Anonymity was ensured in providing feedback to participants in all stages. Researchers were responsible for orienting participants toward research objectives and giving feedback on the data in each round.

The used scaling system was 0 = strongly disagree, 1 = disagree, 2 = no comment, 3 = agree, and 4 = strongly agree. The mean final score of each requirement was calculated.

During the collection of end-user comments in the first Delphi round, three requirements were suggested by end-users in the open-ended question. Requirements with a mean final score of  $\geq 3$  were included, those with a mean final score of  $< 2$  were removed, and those with a mean final score of 2–3 were presented to participants to be considered for assessment in

the second round of the Delphi technique to reach consensus on rejection or acceptance.

### **Second Delphi Round**

The modified questionnaire was distributed in the second Delphi round. In this round, 29 participants completed the questionnaires; two items failed to reach a mean score  $< 2$  and were rejected. To analyze the data, SPSS software, version 18, was used. The descriptive statistics were calculated to analyze the findings of Delphi phases. Later, the items were prioritized and analyzed based on the mean.

### **Phase III: Developing a digital dashboard**

In this phase, the dashboard was designed with QlikView12, as the most flexible Business Intelligence platform for dashboard development. The dashboard's data was derived from HIS (financial, pharmacy, and personnel information) of the study site.

## **Results**

The participants in phase I included 11 pharmacies and four hospital managers. Performance indicators were defined in different levels for the dashboard display to follow various objectives. The main KPIs or first layer indicators were general and measured the overall pharmacy performance. In the next layers, more specific indicators were used compared with the first layer. Table 1 shows KPIs in the first and second layers.

In the first and second Delphi phases, 56.5% and 43.5% of the specialists were women and men, respectively. Given the participants' age, 52.2% of experts were 25–34 years old and the rest had 35–54 years of age. About 43.5% of the participants had 3 to 9 years of work experience and 56.5% had  $> 10$  years of work experience. For academic degrees, 17.4% had a master's degree and 86.2% had a Ph.D. degree. The participants' field of study included health information management ( $n = 12$ , 32.6%), health

informatics (n=20, 54.4%), and software engineering (n = 5, 13%).

Table 2 provides detailed information on the definition and number of requirements. The results of the first and second rounds of the Delphi technique are shown in Tables 3 and 4, respectively.

The dashboard was divided into three parts:

financial, staff, and drug consumption data (Figure 1). The functions of dashboard include determination of user access level, drill down for more information, flexibility, different analysis, representation of the trends, reports' printing according to user opinion, different display types, data search, data retrieval from multiple sources, problem-solving guidance, and alerts.

**Table 1:** KPIs in the first and second layers

Performance domains	General indicators	Detailed indicators
Managerial performance indicators	Satisfaction indicators	Other wards' satisfaction
		Physician satisfaction
		Management satisfaction
	Education indicators	Access to the Internet
		Access to E-guideline
		Access to hospital pharmaceutical guidelines
		Access to drug software
	Staffing indicators	Number of pharmacists
		Number of pharmacy technicians
	Department management indicators	Number of expired and out of date drugs
		Number of expired and out of date equipment
		Number of prescriptions not completely filled
		Time to emergence's sending order
Consumption rate for drug and equipment in various periods		
Consumption rate for drug and equipment according to diagnosis		
Clinical performance indicators	Patient safety indicators	Rate of drug's availability
		Control of drug allergies rate
		Control of drug contraindication
		Out of date drug's rate return from wards
Financial performance indicators	Income indicators	Total drug billing according to various periods
		Total drug billing according to wards
		Total drug billing according to intensive care unit, emergency ward and operation room
		Total drug billing according to type of drug and equipment
		Reimbursement rate
		Total selling of special drugs
		Total selling of special drugs
		Total selling rate according to drugs(most consumed drugs)
		Calculation of inventory based on drugs and various periods
		Rate of discount and gifts from drug selling companies
		cost indicators
	Most expensive drug in various periods	
	Total buying rate of equipment	
	Total deduction based of wards	
	Total out of date's drug cost	
	Total personnel salary	
	Total personnel bonus	
	Financial Utilization indicators	Sales profit based on drugs, equipment, domestic, hoteling
		Total income in drugs and equipment
		Staffing ratio on total income
		Return income from out of pockets
		Return income from reimbursement

**Table 2:** Dashboard development requirements

Requirement	Description
Determining dashboard goals	Determining goals in order to define the type of criteria and the required data for calculation (29,34)
Alignment with organizational strategies	Dashboard development according to organizational strategies (29,32)
Determining key performance indicators	Determining necessary indicators relevant to the quality of organization's performance with method of calculation and their threshold (10,29)
Time framework for updating	Determining time intervals for data updating according to user's preference and type of use(8,29)
Extraction of exact data	Exact and relevant data with accepted and standard definition for calculation (29)
Flexibility	Optimization and customization capability according to user needs and time (14,29)
Deep mining	User's ability to analyze deeply with clicking on operational indicators (28,29)
Security	Use of log-in technology for user access to dashboard (24,25,29)
Data presentation	Quick and brief presentation of data with tables and charts without scrolling (18,29,33)
Alerts	Presentation of situations requiring action using color codes (17,29)

**Table 3:** Dashboard development requirements from participant's view point in the first Delphi round

Participant's view points Requirement	Strongly agree	Agree	No comment	Disagree	Strongly disagree
Determining dashboard goals	72.7	18.1	9.2	0	0
Alignment with organizational strategies	72.7	27.3	0	0	0
Determining key performance indicator	100	0	0	0	0
Time framework for updating	36.3	45.6	18.1	0	0
Extraction of exact data	63.4	36.6	0	0	0
Flexibility	18.1	63.8	18.1	0	0
Deep mining	27.4	27.4	45.2	0	0
Security	36.3	36.3	27.4	0	0
Data presentation	27.4	72.6	0	0	0
Alerts	54.5	27.4	18.1	0	0

**Table 4:** Dashboard development requirements, from participant's view point in the second Delphi round

Participant's view points Requirement	Strongly agree	Agree	No comment	Disagree	Strongly disagree
Determining dashboard goals	72.7	18.1	9.2	0	0
Alignment with organizational strategies	72.7	27.3	0	0	0
Determining Key Performance Indicator	100	0	0	0	0
Time framework for updating	36.3	45.6	18.1	0	0
Extraction of exact data	63.4	36.6	0	0	0
Flexibility	18.1	63.8	18.1	0	0
Deep mining	27.4	27.4	45.2	0	0
Security	36.3	36.3	27.4	0	0
Data presentation	27.4	72.6	0	0	0
Alerts	54.5	27.4	18.1	0	0
Messaging between users	9.09	27.4	18.1	45.4	0
Ability to joint portals	9.09	18.1	18.1	54.5	0
Presentation of written data in addition to the visual presentation	0	18.1	27.4	45.4	9.09

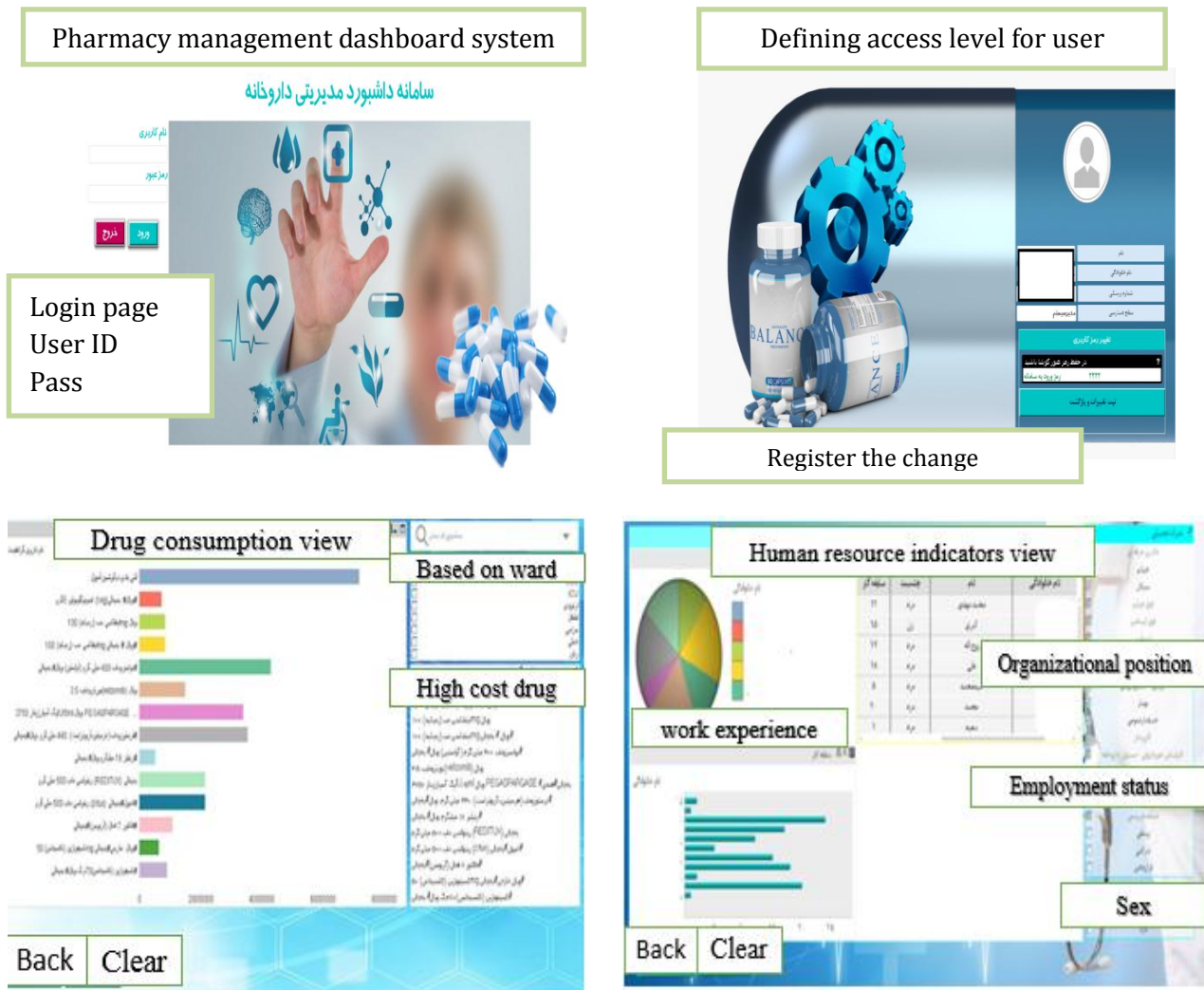


Figure 1: Dashboard layouts

**Discussion**

Managerial, clinical, and financial domains are the core performance domains in the hospital pharmacy. Traditionally, pharmacy services consist of only provision and distribution of drugs in the hospital, but today, with an increase in the complexity and diversity of the medicines, hospital pharmacy services have been affected, raising diverse concerns beyond the clinical concerns (19, 20). The satisfaction of physicians, ward, and management was emphasized as satisfaction indicators; however, due to the lack of knowledge, patient satisfaction was considered as a part of physician satisfaction.

Access to the electronic resources about hospital drugs was considered as an educational indicator; other researchers have also mentioned the importance of these resources in clinical pharmacy (21). In the pharmacy management domain, given the increase of pharmaceutical costs and the necessity of spending resources in the best possible way, managerial indicators include: management of expired drugs, incomplete prescriptions, time of sending emergency drugs, drug return rate, as well as drug and equipment consumption rate in various periods based on the diagnosis. Imani mentioned that these indicators must be

considered to evaluate the financial and economic performance of the pharmacy (22, 23). Different studies reported financial indicators as the main element of hospital indicators. They also mentioned total drug and equipment cost, sales profit for drug and equipment, total net profit, staffing cost, assurance reimbursement, and expired drugs cost as the financial indicators in the pharmacy (11, 22-23).

Correct and timely decisions are essential for the survival of companies and institutions. For making correct decisions, reliable, accurate, and timely information are required. Moreover, the information presented in dashboards is a balancing act in avoiding overwhelming the user with information, directing attention to crucial information without unnecessary distraction, and finally presenting information simply and concisely (7). Dashboards are multi-layered applications that enable organizations to measure, monitor, and manage business performance using business intelligence and data integration infrastructure (24).

We need to consider some requirements to design dashboards effectively. To this end, determining the key performance indicators is a crucial step in dashboard development. In organizational management, achieving even one single objective requires information collection that not only comes from diverse sources but also is related to different organizational functions (25, 26). Based on the findings, determining dashboard goals and their alignment with organizational strategies should be considered in dashboard development. Managers need the information to identify the features and data presented in the dashboard. Different goals in dashboard development directly affect the type of selected metrics and the way of their calculation. Dashboard goals determine the metrics to be selected and the overall story

told by the dashboard. Performance measures should reflect the organization's goals (27).

Karami (29) stated that the decision-makers often have to reach multiple objectives quickly to maintain and improve the organization performance. Accordingly, it is essential to choose a tool that supports accurate, consistent, and complete data accessible timely and in a clear format. Since one benefit of dashboard implementation is data accessibility, dashboards should be enriched by updated data. The data update intervals depend on the nature of data (28). Therefore, a timeframe should be specified for updating the data for each metric in the dashboard development.

Another requirement of dashboard development is extraction of accurate data. Dashboards should only present appropriate information required by decision-makers to execute their duties. These information refers to data characteristics, such as accuracy, integrity, consistency, completeness, validity, timeliness, and accessibility. In dashboard texts, data quality is related to the quality of information presented on the dashboard screen. Flexibility refers to the users' ability to view data in different ways, e.g., tables or graphs, and to change them according to their viewpoints (27).

Different analyses are required for accurate presentation of metrics in the dashboard, including a range of analyses from data mining to simple descriptive statistics. Drill down refers to moving from a general to a more detailed level of information. Security is also an essential element in implementing a dashboard like other information systems (28, 30). Hansoti proposed that audience targeting and role-based security should be provided for dashboard development (32).

The type of information display has a significant role in decision making. Serb (31)

stated that a poor information visualization design could lead to inefficiency in reporting. In dashboards, even if all the required information and features are available to the user, an incorrect visual design, such as excessive use of colors, low data-to-ink ratio, etc. may confuse the user. Therefore, visual features are also important. Another requirement that should be considered in dashboard development is alerts. Notifications and alerts that indicate corrective actions must be timely. Alerts can be easily developed through the use of distinct colors, flashing lights, and/or even audio signals (28, 31,33).

Dashboards can be structured to present data at multiple levels, such as the unit, department, service, organization, or system levels (24,34). The piloted dashboard presents data at the unit and service levels. It also facilitates an open dialogue with the hospital manager and hospital pharmacy manager as they can also view the dashboard at any time. Furthermore, a limited number of indicators are required for an effective dashboard (29). For the development of this dashboard, limited key performance indicators were selected according to the data availability and dashboard goals.

## Conclusion

Pharmaceutical services play an important role in patient care and have the main contribution in hospital expenditure. In the case that the system is not effective, the quality of patient care will be affected and hospital costs will increase. Generally, in the pharmacy department, a variety of dimensions are important including services, personnel, equipment, technologies, data, and information. Therefore, effective management can be achieved only by monitoring the KPIs. Dashboards, as a tool can help continuous data analysis and monitoring of the performance in

pharmacies. However, like other systems, dashboards must be evaluated to drive developers in order to achieve goals.

## Disclaimer Statements

- **Conflict of interests:** None
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