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A Prototyping and Evaluation of Hospital Dashboard through End-User Computing Satisfaction Model (EUCS)

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Abstract

In today's competitive environment, one of the new tools in the field of information technology is business or organizational dashboards that are as a backup in the process of strategic management of organizations. The aim of this study is building a prototype of a hospital dashboard on the principles and guidelines of dashboards and evaluating it based on End User Computing Satisfaction (EUCS). The prototype of a simple dashboard was prepared for evaluation, using experimental research through a questionnaire according to the end-user computing satisfaction model. The test results to compare the average of research variables consisted of satisfaction of the dashboard format, being up to date, ease of use, accuracy and content with average status showed a significant difference between the average of all variables and their average value. Results concluded that among the variables, the format which has had the highest satisfaction rate and accuracy has had the lowest levels of satisfaction among users. Also, the level of users' satisfaction of all factors of the dashboard is equal.

Keywords: Hospital dashboard, Prototyping, End-user computing, Satisfaction model.

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Introduction

Given the globalization of the world, recently, in the public sectors, data science and dashboards have attracted more attention (Matheus, Janssen, & Maheshwari, 2018). In fact, the dashboard has been created for visualizing all types of data according specific targets (Matheus et al., 2018).

The dashboard is an overall package of applications such as strategy maps, balanced scorecard, and business intelligence for organizations performance management which provides information for decision-making in a particular format (Velcu-Laitinen & Yigitbasioglu, 2012).

A hospital is a complex ecosystem of services, customers, personnel, equipment, data and information(Steele & Schomer, 2009). In the past, hospital management was equal to financial management, but today it is believed that with proper management, they can achieve a seamless integration between organizational intelligence (specialists), business intelligence (data types) and competitive intelligence (permanent communication with internal and external customers). This integration provides an opportunity for the hospital to be able to observe actual *performance* against strategic objectives, and changes to the innovative organization (Ghazanfari, Rouhani, Jafari, & Taghavifard, 2009). In order to achieve such intelligence, for correct and crucial decisions, timely access to strategic information is required. To exchange such information and management priorities between different levels of operational intelligent tools like dashboards can be very value-creating and effective (Karami & Safdari, 2016). Today, technological advances such as dashboards have not only made it easier to access and use data but also have increase their credit. Meanwhile, the integration of all clinical and environmental information in a single screen has been possible, which improves worker productivity, accelerates decision making, streamlines workflow processes, and reduces negligence and errors in management and nursing performance (Ghazi Saeedi, Khara, & Hosseiniravandi, 2015). At first, the dashboard was used only in the business department, but has now been expanded into several sectors, such as the healthcare sector (Auliya, Aknuranda, & Tolle, 2018). Dashboards can be easily implemented as a tool to assist measure execution by identifying trends, templates, and abnormalities in information to catalyze an efficient decision-making (Auliya et al., 2018).

Dashboards, report the key performance data of enterprise, integrates them and they could be considered as real-time basic facilities. (Kobana & Vijay, 2003). Dashboards are designed to prepare a quick view of the performance to the user at a glance (Zarandi, Tarimoradi, Alavidoost, & Shirazi, 2015). Their content may be presented as a table, a chart or key performance indicators (Pappas & Whitman, 2011).

Using the dashboard as a tool and guide involves showing patient's health status, monitoring patient improvement illness, and also determining practical, clinical and professional practices for the patient (Auliya et al., 2018). Due to the effective use of the dashboard, its utilization in different healthcare departments has been expanded and several

studies have been conducted on the topic, however, such a development and expansion implicates a systematic and a comprehensive study of textual features in the improvement of healthcare dashboards that can cater theoretical and scientific foundations for its improvement (Auliya et al., 2018).

In order to create a dashboard, the its design must first be prepared by designers and technical architects, and then the specifications for its infrastructure should be specified. For this purpose, the firm's technical architecture level, the all over organization of the firm's infrastructure, and the construction and publication of standards on how to use the various software of each firm should be identified.

Since health system features are the main indicators of peoples' health (Ismagilova, Hughes, Dwivedi, & Raman, 2019), health authorities and policymakers confront complicated decisions, that need deep information of health care systems which include all organizations, individuals and actions that are in place to maintain, revitalize and strengthen the welfare of humans (Chung et al., 2020).

As an easy access to healthcare information increases the effectiveness of decision making and leads to better decision making on evidence (Chung et al., 2020), visual analysis tools such as a dashboard plays an important role in the effective analysis of healthcare data (Chung et al., 2020). It mentions to the proper tools for combining analysis techniques with visualizations, and analytical capabilities of users to apply complex data to ameliorate comprehension, and decision making (Ruppert, 2018). Using visual analysis tools such as dashboards will allow data to be combined from different sources, when it comes to search for information from complex data and interacting with them, based on evidence of perception, implicit knowledge, and decision making (McInerny et al., 2014). Also a new ability is provided for gaining insight from enormous, dynamic, and variable data (Chung et al., 2020). In this way, the anticipated patterns, as well as the unanticipated patterns of information, are recognized and thus a timely, indictable and comprehensible evaluation, and the effective relevance of this evaluation leads to timely actions (Chung et al., 2018; Ola & Sedig, 2016). In recent years, a wide range of visual analysis methods have created and widely used to detect science and introduction in health sciences, such as infectious disease control, patient health information and healthcare ecosystem investigation (Chung et al., 2020).

Visually displaying basic data and dialogues between the users are possible by interacting with visualizations (Nazemi & Burkhardt, 2019). Capability to solve different functions and discover insights are enabled by interactive data manipulation, visual construction, or visual profiling (Nazemi & Burkhardt, 2019).

Decision-makers need to be able to see in real time how to provide information so that they can make effective decisions, therefore, how to provide information with regard to their complexity, volume, and principles of design and technical architecture dashboard is very important. However, in the recent years a number of governmental and nongovernmental agencies have taken some steps to create management dashboards, and have not been

successful. Despite the popularity of the dashboard, there is little information about the principles and framework of its creation to enhance the effectiveness, this means that the dashboard with which “design and architecture” is the best performance for the enterprise.

It is essential to note that making high quality decisions and achieving a high-performance in an organization depends on the quality of information provided by the dashboard. Unfortunately, little research has been done in this regard, and the production of dashboards and formatted information is opposed to visual techniques and there is very little mentioned about the technical architecture dashboards. Technical architecture dashboard is actually a general structure for its implementation based on a set of functional requirements of the system which could also implement the intended applications, optimizing and accelerating the quality of the dashboard, production and maintenance. by focusing on the principles of technical architecture we can cover all the needed technical and operational requirements. Compliance with this technique in decision-making managers is very important. Thus, considering the principles and framework of design and technical architecture dashboards, is an important and significant problem. The Research questions of this research are:

RQ1: "How is prototyping a sample dashboard based on derived principles?"

RQ2: "What is the extent of the end-user’s satisfaction from a dashboard?"

In this study, we try with provide the framework and principles of design and technical architecture of dashboards. A hospital dashboard prototype was built and tested by statistical samples, by considering these principles, to understand if dashboards could produce the highest levels of performance for decision-making. After studies in the field of design and technical architecture dashboards structure, indicators of research and results using this index on the dashboard of the attitude of researchers were extracted and some of the best are mentioned in the summary.

Background

The dashboard term is taken from the vehicle's dashboard, as the vehicle dashboard, it has indications to provide information to users, including managers and staff, so that they can visually recognize trend templates, and abnormalities of the company (Vilarinho, Lopes, & Sousa, 2018).

According to Dowding et al. (2019), dashboards are developed to visually summarize data for individual physicians to aid in decision-making at the point of care. The users' capability to interpret and remember relevant data is improved by the dashboard, and the cognitive overload is also reduced. In the field of healthcare, dashboards have various usages, including encouraging physicians to cater evidence-based care, providing feedback on how physicians deal with clinical operation guidelines, as well as combining and demonstrating patient status information to help clinical decisions. primary assessments of dashboards have shown that response times to find related information have been reduced, data retrieval has

become more precise, and dependence on evidence-based care interventions has increased (Dowding et al., 2019)

Matheus and colleagues in his paper defined dashboards as "visualizing the most important information required to get one or more goals, unifying and adjusting on a single page so that information can be viewed at a glance" (Matheus et al., 2018). Since the governments and organizations may have conflicting objectives and do not allow for intervention, this definition is likely to be challenged, in addition, dashboards can focus on more accurate information, which makes the dashboards not limited to a single screen (Matheus et al., 2018).

Kuo and colleagues refer to four types of timed, hierarchical, interfaced, and multi-dimensional display information, and the results of this process include controlling and monitoring the project process using the Gantt chart, the possibility of three-dimensional view of the structure and its components, a clear understanding of the organize and classification of the system for controlling the project, and achieving higher construction performance, understanding the relationships between the items and the components of the system (Kuo, Tsai, & Kang, 2011).

Yigitbasioglu and Velcu know principles like the possibility of changing the formats of display information, the possibility of pop-up and automated alerts, the ability to drill-down and drill-up, the possibility of integration to online analytical processing system or data warehouse, single page display using colors and guidelines to design in two-dimensional and three-dimensional diagrams, zoom in and zoom out which makes flexibility of the system, select the appropriate display format, allowing complete access to data details to users for dimensional analysis to maximize understand diagrams, and providing a general view and a detailed view to the relationship between sections which helps to strategy and corporate value (Yigitbasioglu & Velcu, 2012). Gröger and colleagues point to the three-tier architecture made up of data security and data analysis, announcement of results, and a presentation layer in order to know their results as a piece of comprehensive data warehouse with processing and operational data and providing data near-real-time, calculation criteria, storage of pattern recognition based on data mining and open sharing of knowledge in audio and video communications, intuitive and easy user interface, combined with customized content mobile and flexible access (Gröger, Hillmann, Hahn, Mitschang, & Westkämper, 2013).

Karami points to principles such as determining the purpose of the dashboard's design, coordination with organizational goals, determining key performance indicators, setting a time frame, extracting detailed data, flexibility, drill-down and analysis capabilities, security, methods which could be used to display the data, displaying a warning and knowing their results. The former must be done in order to achieve the defined goals and to create an appropriate design to achieve the objectives and visions of the organization. Specific measures to improve the quality of performance, updated information according to user view, type of use and the importance of the task, relevant and accurate data to standard definitions

and acceptable to calculate, optimal functionality and personalization based on user requirements, organization and change, ability for users to perform analysis deep by clicking on operational indicators, methods, techniques and technologies used to protect data security, according to the visual design components, structure, design and presentation, highlighting important information such exceptions mechanism (Karami, 2014).

Mattingly and colleagues point to the flexibility of design to support changing project requirements, real-time capabilities, easy development and maintenance and considers them useful for improving organizational behavior (Mattingly et al., 2015).

Rouhani and colleagues presented the principles and guidelines for designing and technical architecture of organizational dashboards with Meta-synthesis method and in Table 1, they showed that each of the previous studies referred to which of the extracted indicators in their research (Rouhani, Ashrafi, Zare Ravasan, & Afshari, 2016).

Table 1. Indicators extracted by Rohani et al (2016) along with the studies pointing to these indices

Indicators	**(Hansoti, 2010)**	**(Mohd, Embong, & Zain, 2010)**	**(Kuo et al., 2011)**	**(Yigitbasioglu & Velcu, 2012)**	**(Pappas & Whitman, 2011)**	**(Elias & Bezerianos, 2011)**	**(Khan & Khan, 2011)**	**(Kintz, 2012)**	**(Gröger et al., 2013)**	**(Lechner & Fruhling, 2014)**	**(Karami, 2014)**	**(Cahyadi & Prananto, 2015)**	**(Rouhani et al., 2016)**
Target				✓	✓			✓			✓	✓	✓
Organizational Culture											✓	✓	✓
Type and character of users	✓	✓		✓	✓	✓			✓		✓	✓	✓
Type of interaction	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
How to display	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Determination of indicators		✓		✓	✓			✓	✓		✓	✓	✓
Analysis and Prediction		✓		✓		✓	✓		✓	✓	✓	✓	✓
Accessibility	✓								✓		✓		✓
Personalization	✓								✓		✓		✓
Database		✓	✓		✓			✓	✓		✓	✓	✓
System architecture		✓	✓					✓	✓				✓
Infrastructure			✓								✓	✓	✓
Integrity	✓			✓							✓	✓	✓
maintenance		✓	✓					✓	✓	✓	✓		✓
security	✓										✓		✓

Methodology

In this research firstly with the experimental research method, we developed a sample model of a simple dashboard for evaluation, using Tableau's Business Intelligence tool. In this phase, the functional data of Ayatollah Rohani Hospital in Babol city in the years 2011-2013 were used and we prepared the dashboard according to the principles and guidelines for the design and technical architecture of the organization dashboards obtained in the table of research background indicators. So that in the layout of the presentation, in view of the intended purpose of the hospital departments and their perspective, attention to the culture in the organization to accept dashboards, the type of users who want to use this system and their needs, attention to the type of interaction with facilities such as drill-up and drill-down, search capability and filter, the ability to compare standard status with data, how to display information on a page without the need for scrolling, the ability to link to relevant pages, the use of graphs and diagrams with respect to information , in the application layer according to the key performance indicators of the parts, in the data layer, according to the database and standardized data sources for the required queries, were used in the technical infrastructure layer with regard to the architecture required for the system and the infrastructure, integrity and upgradeability design and readiness. Table 2 gives a number of key performance indicators of hospitals.

Table 2. Key performance indicators of hospitals

Key performance indicators	source
Staff satisfaction, staff performance, average patient's stay, bed occupancy, mortality rate, percentage of medical incidents, number of outpatients, hospitalization and emergency, patient satisfaction	(Chen, Lin, & Liu, 2014)
Patient satisfaction, Patient complaints, Average waiting time, Percentage of transfer to another hospital, Average length of hospitalization, Bed occupancy	(Grigoroudis, Orfanoudaki, & Zopounidis, 2012)
Hospital infection rate, mortality rate, admission rate, outpatient number, hospitalization and emergency rate, premature death rate, death rate of pregnant women, average patient's stay, number of patient complaints	(Erdem, Kizilelma, & Vural, 2016)
accidents/adverse events, nosocomial infection, incidents/errors, number of operations/ procedures, length of stay, bed occupancy	(Si, You, Liu, & Huang, 2017)
The pure rate of hospital mortality, Readmission number based on diagnose differences, Hospital infection rate based on ward / diagnose/ procedure, Patients satisfaction percentage, Staffs satisfaction percentage, Hospital accidents prevalence rate, legal complaint from hospital within one year, Success to hospitals in obtaining certificates of management quality, Average outpatients waiting time, Average inpatients waiting time, Relation between total number to staffs to active beds, Beds occupation ratio, Beds exchange interval, Average length of stay Based on different diagnosis, Relationship between private income and total costs in hospital, Hospitals the pharmaceutical costs relation to total costs to hospitals	(Gholamzadeh Nikjoo, Jabbari Beyrami, Jannati, & Asghari Jaafarabadi, 2013)
Average hospital stays, Mortality rate, Number of patients readmitted within 30 days, Inter-consultations rate, Pre-surgical waiting in programmed interventions, Diagnostic testing, Nosocomial bacteremia, Falling of the bed, Pressure ulcers	(Govindarajan, 2019)

According to the extracted indicators of the articles and available data from the hospital, key performance indicators for making dashboards were categorized into three categories of input, process, and output. Input indicators included the number of emergency patients admitted in 2015, the number of hospitalized admitted patients in 2015, the number of outpatients admitted in 2015, the total number of admitted patients in 2015, the number of emergency patients to screening in 2015, and the number of outpatient departments of the emergency department in 2015. Process indicators including the percentage of admissions in the months of 2015, the average residence the patient in sections in the months of 2015, the percentage of flat occupancy in the months of 2015, the percentage of deaths in 2015. Output indicators included the admission rate by segments of the years 2011 to 2015, the average patient's residence by sections in 2011 to 2015, percent of the occupancy of the flat by sections in the years 2011 to 2015, percent mortality by sections in the years 2011 to 2015.

In this study, three dashboards have been prepared and, as shown in Figures 1-3, each dashboard contains pages of visualized information that are categorized according to the relevance of the indicators.

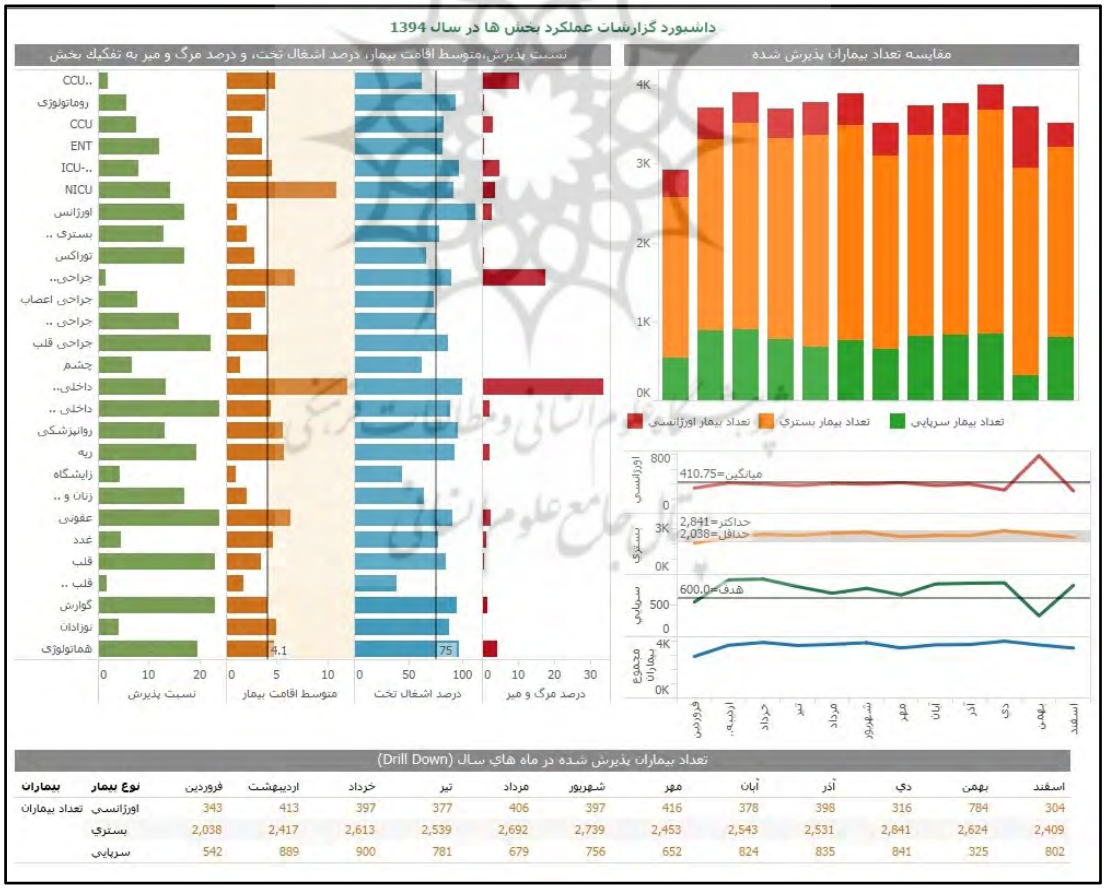

Figure 1. An overview of the Performance Reports Dashboard in 1394

Figure 2. An overview of the comparison dashboard of 1394

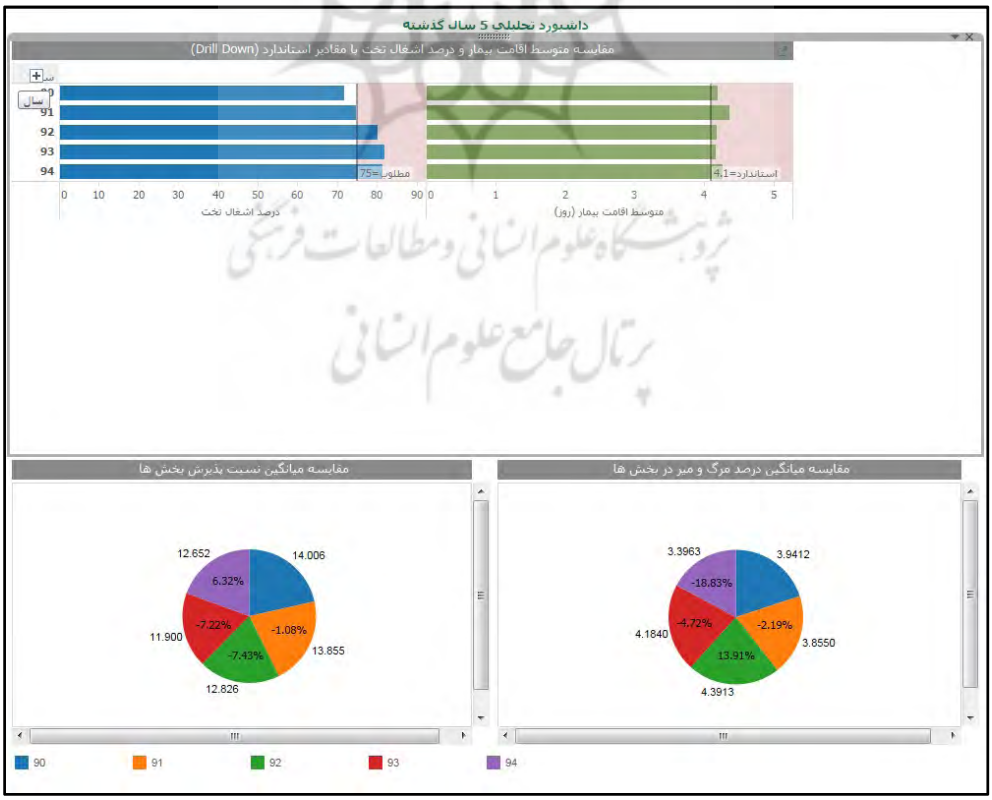

Figure 3. An overview of the last 5 years of analytical dashboard

Then, using a survey method, a questionnaire based on the end user computing satisfaction model, a review of the studies history and considering the conceptual framework of the research, was designed and surveyed. The questionnaire in this study consists of 16 questions and the subset of five independent variables of the final user satisfaction model, namely content, accuracy, format, ease of use and being up to date. The Questionnaire's answers were driven based on the Likert scale and demographic characteristics of gender, age, the level of education and job position which were used at the beginning of the questionnaire. To evaluate its reliability, Cronbach's alpha coefficient obtained the variables of the questionnaire. Since the Cronbach's alpha coefficient of each of the variables used in the questionnaire is higher than 0.7, it can be concluded that the reliability of these questionnaires is desirable in the present study.

The Doll and Torkzadeh end user computing satisfaction model is based on five independent variables to estimate a dependent variable of satisfaction (Doll & Torkzadeh, 1988). These independent variables include content, accuracy, format, ease of use, and being on time. Since then, this model has been tested and the end user computing satisfaction has been accepted as a decisive and reliable element for the success of information systems. This model has been widely tested by many researchers and has been tested for validity (content validity, construct validity, and reliability). Also, internal validity, external validity, reliability testing and statistical validity have been proven (Aggelidis & Chatzoglou, 2012).

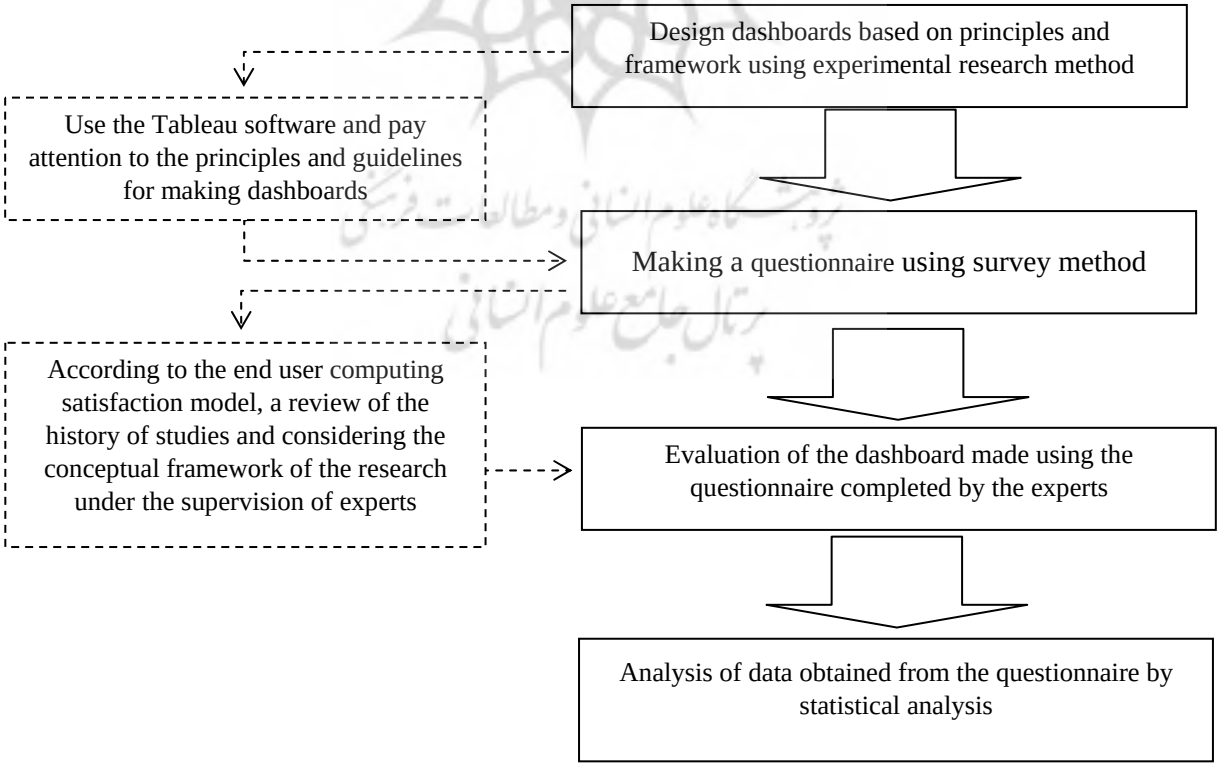

Figure 4. flowchart for steps of the process

The dashboards were made available for evaluation by data and information experts who include the Presidency, supervisors of departments, head nurses, and nurses. After completing the dashboard assessment, they filled in the questionnaire. These subjects, which constitute the sample size of the study, were selected according to the Morgan table and by objective sampling method among the total population size of 40 people, and the sample size was 36 people. To analyze the research findings, using the statistical methods, the data were first described, then the obtained results were examined and interpreted. In Figure 4, the steps of the process are plotted in a flowchart.

Results

In this section, the descriptive findings were first studied. In examining the frequency distribution of data at different levels of the gender variables, the results showed that the percentage of male respondents is 11.1 and the female frequency is 88.9. In examining the frequency distribution of data at different levels of age, the results showed that the frequency of respondents aged less than 30 years was 8.3, the percentage of 31-40 years old people was 47.2, the percentage of 41-50-year-olds was 38.9, the percentage of people 51-60 years old is equal to 2.8 and the percentage of people over the age of 60 is equal to 2.8. In examining the frequency distribution of data at different levels of education, the results showed that the percentage of respondents with a diploma and an apprenticeship equal to zero, the percentage of undergraduate students is 80.6 and the percentage of graduate students and higher is 19.4.

Since the EUCS system considers administrators as users, it can therefore be an appropriate model for evaluation. In the field of inferential findings and in the study of the center of inclination and distribution of each of the research variables, the results indicated that the average satisfaction of the dashboard content was 4.127 ± 0/371, the mean satisfaction of the dashboard accuracy was 430.0 ± The average satisfaction from the dashboard format was 4.118 ± 0.495, the average satisfaction with the ease of use of the dashboard was 4. 1394 ± 0.446 and the average satisfaction with the being up to date of the dashboard was 4.153 ± 0.444. It is noteworthy that the average of all variables is higher than 3. In Table 3, the mean of variables of research is based on satisfaction rate and with regard to the variables of the final user satisfaction model.

In Figure 5, the End user computing satisfaction model used to construct a questionnaire in a survey method is characterized by the values of the mean of the research variables obtained in the statistical analysis that shows the satisfaction of users from the dashboard. As indicated, the format variable has the highest satisfaction rate and the accuracy variable has the lowest satisfaction among users.

Table 3. The order of satisfaction of the mean variables of the research based on the variables of the final user satisfaction model

Variables based on EUCS model	Research variables	Average
The independent variable format	Satisfaction with the dashboard format	4.1806
The Independent variable being up to date	Satisfaction with the being up to date of the dashboard	4.1528
The Independent variable ease of use	Satisfaction with the ease of use of the dashboard	4.1389
The dependent variable final user satisfaction	Overall satisfaction of the dashboard	4.0659
The Independent variable content	Satisfaction with dashboard content	4.0167
The Independent variable accuracy	Satisfaction with the accuracy of the dashboard	3.9722

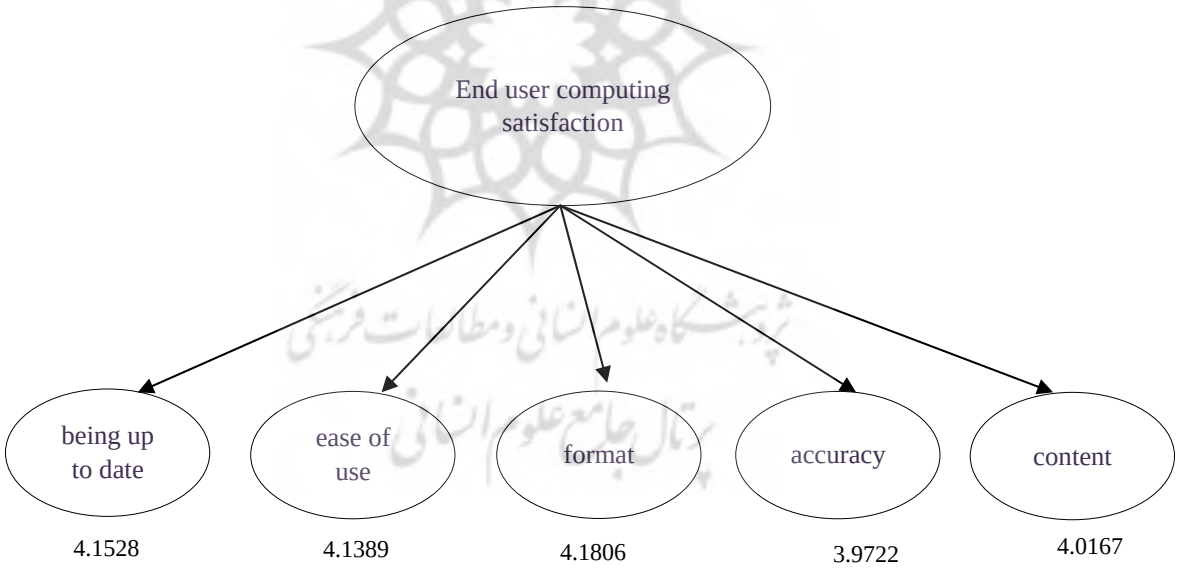

Figure 5. End user computing satisfaction model with mean values of research variables in statistical analysis

The normalization test is performed and because the society is normal, the T test has been performed. In Table 4, a single sample t test is used to compare the mean of dashboards made with moderate status and to determine the meaning or significance of their differences.

Table 4. Single sample t test to compare the mean of dashboard variables made with moderate status

Average test value = 3							
Research variables	**Average**	**t**	**Degrees of freedom**	**Significance level**	**Average difference**	**Confidence Range 95%**	
						Bottom limit	**Upper limit**
Satisfaction with dashboard content	4.0167	16.421	35	0.001	1.01667	0.8910	1.1424
Satisfaction with the accuracy of the dashboard	3.9722	13.565	35	0.001	0.97222	0.8267	1.1177
Satisfaction with the dashboard format	4.1806	14.309	35	0.001	1.18056	1.0131	1.3480
Satisfaction with the ease of use of the dashboard	4.1389	15.310	35	0.001	1.13889	0.9879	1.2899
Satisfaction with the being up to date of the dashboard	4.1528	15.567	35	0.001	1.15278	1.0024	1.3031
Overall satisfaction of the dashboard	4.0659	19.618	35	0.001	1.06586	0.9556	1.1762

The results of all single sample t tests show that there is a significant difference between the mean of variables and the mean value (3); In other words, based on the value of t, the reference value for the degree of freedom is 35 (2.030) and greater than the calculated t, also based on the calculated level of significance (0.001) and its smaller than the numerical value 0.05 it can be concluded that at 95% confidence level, there is a significant difference between the mean of all variables and the mean value (3). Based on the higher mean of variables with a meaningful difference from the average level, it can be concluded that users are highly satisfied with all the variables in the research.

Discussion and Conclusion

Research findings in relation to the results of the tests to compare the mean of the variables of the research, including the satisfaction of the dashboard format, satisfaction from the dashboard being up to date, satisfaction with the ease of use of the dashboard, satisfaction with the contents of the dashboard, and satisfaction with the accuracy of the dashboard with the moderate status demonstrate that, there is a significant difference between the mean of all variables and their mean value. Among the variables, the highest satisfaction was attributed to the format variable, and the least satisfaction among the users was the accuracy variable. Also, user satisfaction levels are high and equal to all dashboard factors that can be a good sign for accepting this dashboard design in the hospital.

Using dashboards can help managers and decision makers to evaluate the performance of different parts of the hospital, as well as identifying issues, analyzing them, and accessing solutions using accurate information obtained from the dashboard.

In his article Auliya and colleagues stated that many researchers reviewed and studied various aspects of the dashboard, including, the advantages of developing a dashboard for healthcare to ameliorate the patient's status are investigated by Dowding and his co-workers, while the challenges in developing the dashboard for healthcare are studied and surveyed by Ghaziseidi and colleagues, as well as the investigation of visualization sort in the healthcare dashboard has been done by Reese and cooperators (Auliya et al., 2018). Auliya and his co-worker, also stated in their article, that the survey was conducted on the overall dimensions of the dashboard development and the aspects of dashboard development in a specific part; for instance, the dashboard profile as a data analysis device in the nursing part is examined by Willbanks and Langford, and Mold and colleagues reviewed the drug development dashboard. (Auliya et al., 2018).

Reviewing various studies on the dashboard and the principles and guidelines of design and technical design of the dashboards revealed that each research, with emphasis on its chosen field, has disseminated its indicators in relation to these dashboard design principles and the technical architecture of the dashboards. For example, the best way to design a health dashboard was looked by Lechner and Fruhling, and an optimal user interface for the emergency response system was proposed for public health labs. Therefore, in accordance to the target area, and also with the principles mentioned in the table, the indexes of the research background in Lechner and Fruhling's study, referred to the indicators of the type of interaction and the how to display, analysis and prediction and maintenance (Lechner & Fruhling, 2014).

The compliance rate of the dashboard made in the experimental research methodology, with the principles and guidelines for designing and technical architecture of the dashboards, was that attention to the target of the dashboard, the matching of data types with the dashboard objectives and alignment with the goals and prospects of the organization in the target dimension; attention to organizational culture for the adoption of technology in the field of organizational culture; the dependence of the effective influence of each principle on the needs of different parts of the organization; attention to the goals; the views and needs of users; the analysis of the user's personality in the interaction of the dashboard layer in the dimension of user type and character; functions interactive information discovery; emphasis on information important exceptions; time controller and information extraction, drill down and drill up capabilities, general and detailed filtering capabilities; the ability to change information display formats, such as graph and table; link to related information; the ability to clipboard, and tagging and signing (Metadata) for charts; the possibility of grouping data and selecting criteria; reporting in the form of word and PDF on the type of interaction; the ability to display the selection of shared information in different types of shows; the ability to display

different colors in different time situations and display important information; using the guide lines to design diagrams 2D and 3D; the possibility of comparing data with linear charts, lines, points, dispersion, bubbles; displaying information in one page without the need for page movement; clear visual distinction between the data that were selected and those that were filtered in the aspect of display; attention determining the key indicators of the critical specific performance in identifying indicators; aggregating information for analysis and accurate interpretation of data in the analysis and forecasting; standard data sources for sharing, updating and querying them better, accessing clear and reliable data from different sources; an organization in the database dimension; attention to the architecture defined for the system in the architecture dimension of the system; the possibility of changing and updating the indicators in the dimension of maintenance were considered.

Among the limitations of this research, we can mention to the lack of dashboard assessment with a model other than the final user satisfaction model for designing a questionnaire, not designing and constructing a dashboard with the design of a different software dashboard design. Also owing to the confined availability of data by the hospital and the lack of sufficient infrastructure and time to assess the dashboard, it was not feasible to apply all the principles and guidelines in this study.

For future researches, since in this research, all principles and guidelines were not considered in the design of dashboards, it is possible to design dashboards in accordance with all the principles and guidelines mentioned and to be used in part of a hospital or other organization. Also, suggestions for future researchers doing such researches could be to conduct the experiment over a wider range of time and reviewing articles in different languages, assess dashboards based on a model other than the final user satisfaction model for the questionnaire, perform this research in an organization other than the hospital, and this study could be conducted with a software other than Tableau software. These are all suggestion which could be considered by future researchers.

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