Clinical Staff Attitude Toward the Computerized Physician Order Entry System in Cardiac Care Unit Based on a Model by the Name of "Technology Acceptance Model in Health Care Centers of Iran"

Fatemeh Ghaznavi [1], Payam Farhadi [2] and Roxana Sharifian [3, *]

[1]Student Research Committee, Shiraz University of Medical Sciences, Shiraz, Iran
[2]Department of Management, Zand Higher Education Institute, Shiraz, Iran
[3]Department of Health Information Management, Health Human Resources Research Center, School of Management and Medical Information Sciences, Shiraz University of Medical Sciences, Shiraz, Iran

*Corresponding author: Department of Health Information Management, School of Management and Medical Information Sciences, Shiraz University of Medical Sciences, Shiraz, Iran. Tel: +98-9173154866. Email: sharifianr@sums.ac.ir

Abstract

Background: Currently, many physicians use the computerized physician order entry (CPOE) system, and the adoption of this system is increasing worldwide. The technology acceptance model has been implemented and evaluated. It has become one of the most recognized empirical models. Besides, recent studies showed that this model well anticipates users' behavioral tendencies in accepting technology in healthcare centers. The use of the technology acceptance model in the implementation of health care systems such as CPOE, which is effective in reducing medical errors, is necessary.

Objectives: This applied research has used a descriptive-analytical approach. In the current study the technology acceptance model in Iranian health care centers, which was proposed by Safdari and colleagues aimed to investigate the attitudes of clinical staff toward the computerized physician orders entry system, was used in the Cardiac Care Unit of Alzahra's Heart Hospital in Shiraz to determine the importance and effectiveness of each dimension on attitudes toward using CPOE by 140 of physicians and nurses.

Methods: Three main dimensions, including human, monitoring-management, and organizational strategies factors, were evaluated using a researcher-made questionnaire. Data were analyzed by SPSS version 25 using the descriptive and analytical statistics (i.e., Pearson correlation test and t-test).

Results: The results showed that organizational strategies dimension with an average of 3.85 (out of 5) had the highest users' attention, followed by monitoring-management and human dimensions. The overall average of all dimensions was 3.78. All dimensions had a positive and direct effect on the attitudes toward using the CPOE. Demographic characteristics did not have a meaningful relationship with any dimensions.

Conclusions: Finally, the average above 3 in the mean of the total dimensions, as well as each dimension, shows views of the users are appropriate to using the CPOE., the views of the users are appropriated toward using CPOE. It should be noted that the difference in the dimension means is a small amount. The centered focus on organizational strategies with the highest average should not cause to neglect other dimensions.

Keywords: Computerized Physician Order Entry System, Technology, Medication Error, Technology Acceptance Model, Cardiac Care Unit

1. Background

With the high speed of development and penetration of technology in different sectors, systems are trying to shift from traditional patterns to new models that are in accordance with the requirements of the information age (1). Electronic health records (EHR) and CPOE are examples of new technologies that can reduce the time spent on providing health care services, particularly when retrieving information (2). Models on the expansion of technologies and awareness about factors that affect their acceptance in organizations have an important role in improving the quality of services and providing a clear view about the future, and simultaneously minimizing the risks (3). During the past two decades, some theoretical models have been proposed to evaluate and explain how users behave in the face of information communication technol (ICT) adoption (4). Technology reasoned action (TRA), Technol-

ogy Acceptance model (TAM), technology planned behavior (TPB), Extended Technology Acceptance model (TAM2), and the latest technology acceptance model, unified theory of acceptance and use of technology (UTAUT) are models with the highest acceptance (5). Recent empirical research suggests that the Technology Acceptance model is widely used to advance the understanding and acceptance of technology among nurses and physicians in the workplace (4). This model was developed in 1980 in response to the concern of why employees did not use the information technology (IT) systems available to them. Its founders believed that the key to increasing the use of IT was at first increasing its acceptance, which can be measured and evaluated through questions about users' expectations about IT (6). This model has been implemented and tested on a wide range of IT and communication applications and has become one of the most recognized empirical models (7). Besides, the results of recent studies on the technology acceptance model revealed that this model well anticipates users' attitudes towards accepting technology in the health sector (8). It is essential to use the technology acceptance model concerning systems such as CPOE that are effective in reducing errors. Medical errors, especially in patients with critical conditions, are dangerous and may increase the unintended adverse effects (9). On average, patients hospitalized in the Intensive Care Unit (ICU) experience 1.7 medical errors per day, and approximately all patients admitted to the ICU are at increased risk of error (10). CPOE is one of the subsystems of the medical information system that is used to increase patients' safety and reduce medical errors (3). The Australian Sydney Hospital installed the first CPOE system for inpatient and outpatient units and ICU in 1969. In 2001, with the cooperation of a local IT company, the system was revised and customized. Since then, the revised system is using (11).

Currently, many physicians use CPOE systems in their daily routine health care, and the acceptance of this system, as well as the EHR, is increasing worldwide. In general, using CPOE has reduced the prescription errors (12, 13), increased the safety of data processing, ensured availability of meaningful data in all sections, and provided clinical support decisions to poor patients, while receiving complex medical and pharmaceutical services (12). But the positive effect of these systems on the disease process and the results of the patient's treatment is not well known, and unfortunately, this efficiency does not always occur (14). Although much research is conducted on information system (IS) models and frameworks, the role of the users in measuring IS success, especially in cases that staff are mandated to use the system, is neglected. Therefore, a more

effective theoretical model for evaluating information system (IS) success for organization managers is needed to increase their understanding of the role of the users in mitigating the risks of failure (15, 16). Awareness about criteria that shape the expectations of users gives the organizations enough time to recognize and investigated the criteria to improve the acceptance of new systems and increasing the use of IT. The technology acceptance model predicts a significant part of the use and adoption of IT, but it may require revisions to be more useful (6). Martin et al. (17) in the safe implementation of computerized provider order entry for adult oncology study argued that the number of safety gap reports provided by the staff has dropped after the implementation of CPOE for chemotherapy patients. This indicates that CPOE can be safely used for outpatient chemotherapy, even in a very complex environment (17). Cho et al. (18) in a study on understanding the nature of medication errors in an ICU equipped with a CPOE system reported that the number of medical errors at each stage of treatment is relatively high despite the long history of using CPOE. The main reason was the errors related to the management and documentation of prescriptions as well as the language process. To mitigate these errors, efforts should be made in hospitals and clinics to improve the system (10). Cho and colleagues in another research with the subject of acceptability and feasibility of the leapfrog computerized physician order entry evaluation tool for hospitals outside the United States concluded that the acceptance of the CPOE evaluation tool was modest, but the feasibility of testing outside the United States was adequate and appropriate, and the results revealed many opportunities, such as when the program was introduced in the United States, for improvements in Korean systems (18). In the present study, we used a model named "Technology Acceptance Model in Iran's Health Care Centers", which was presented by Safdari et al. (2) to adopt CPOE technology in cardiac care units at Alzahra's Heart Hospital in Shiraz.

2. Objectives

We examined the importance and impact of each dimension on the attitudes of physicians and nurses toward using CPOE.

3. Methods

This is an applied research that was conducted in 2018. Meanwhile, regarding its goal and type can be considered

as an analytical study. In 2017, Safdari et al. (2) in an article entitled "Technology Acceptance Model in Health Care centers of Iran" introduced four factors including human, monitoring-managerial, organizational, and technical as the main dimensions of technology acceptance in the Iranian health centers. Their model originated from Technology Acceptance model (TAM), but according to the literature review conducted for the research, the model is adjusted following Iranian medical centers' conditions. In this research, based on the research environment, three dimensions (i.e., human, monitoring-managerial, and organizational approaches) of the technology acceptance model are investigated to apply the computerized registration system of physicians' prescriptions in the cardiac care unit of Alzahra Heart Surgery Center in Shiraz, Iran. Dimensions of the model mentioned in the questionnaire are examined according to the physicians' and other staff's views. A valid and reliable questionnaire (92%) derived from Safdari et al. (2), based on a five-point Likert scale, was designed according to the dimensions mentioned by the researcher. The questionnaire contained questions on demographic characteristics, including age, gender, occupation, and work experience, 9 on the human dimension, 7 on the monitoring-management dimension, and 7 on the organizational strategies dimension. Due to the limitations concerning the research community, the survey approach was used and the entire community (140 subjects) was examined. Questionnaires were distributed in all shifts of the cardiac care unit in person. Out of 140 distributed questionnaires, 129 were filled and returned. The community included 93 nurses, 27 general practitioners, and nine cardiologists who had at least one year of work experience in the cardiac care unit. After collecting the questionnaires, data were extracted and analyzed by SPSS version 25 using the descriptive and analytical statistics (i.e. Pearson correlation test and *t*-test). Statistical significance was considered as P < 0.005. If the Pearson correlation was positive, the association was considered as direct. As the amount of Pearson correlation approaches to 1, the intensity of the association becomes greater. The current study is approved by the Ethics Committee of Shiraz University of Medical Sciences (code: IR.SUMS.REC: 1397.793).

4. Results

The results showed that organizational strategies dimension with an average of 3.85 (out of 5) could attract the attention of users more than other dimensions (Table 1). For all dimensions together, the average was 3.78. The effect of each dimension on the attitude's community research is

shown in Table 2.

4.1. Human Dimension

For the human dimension, communication skills and interpersonal communication had the highest and lowest average, respectively. The human dimension has a direct association with the attitudes toward using CPOE. The highest direct association was for the human dimension with the attitudes toward using CPOE.

4.2. Monitoring-Management Dimension

In the monitoring-management dimension, continuity of technology management and problem management had the highest and lowest average, respectively. The monitoring-management dimension had a direct association with the attitudes toward using CPOE. The direct connection of the monitoring-management dimension with the attitude toward using CPOE was at a high level.

4.3. Organizational Strategies Dimension

In the organizational dimension, general factors and organizational status had the highest and lowest mean. The organizational dimension had a direct association with the attitude toward using CPOE. The direct connection of the organizational dimension with the attitude toward using CPOE was at a high level.

4.4. Demographic Variables

The demographic variables regarding age, sex, job, and work experience are shown in Table 3. In the Pearson correlation test and *t*-test, it was found that demographic variables had no significant association with any of the presented dimensions.

5. Discussion

Researchers all over the world are looking for a model to apply technology. In 2017, Safdari et al. (2) attempted to introduce the main factors of technology acceptance in Iranian health centers, according to experts' opinions. In the present study, before the implementation of CPOE, we examined the attitudes of users toward using this system. In the technology acceptance model, perceived ease of use and perceived usefulness are considered as the main factors that influence attitudes toward using technology. In the technology acceptance model for Iran's health care centers, perceived ease of use and perceived usefulness are covered in human and monitoring-management dimensions. The human dimension includes individual skills

Table 1. Average of Acceptance Dimensions Between the Research Community

Dimension	Average	Standard Deviation	Subcategories	Nurse		General Physician		Specialist	
				Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation
Human	3.73	0.58	Communication skills	11.55	2.15	11.88	2.30	12.00	3.58
			Interpersonal communication	3.63	0.82	3.58	0.85	4.00	1.06
			Awareness and knowledge level	7.60	1.50	8.00	1.70	7.62	1.99
			Total	3.70	0.59	3.97	0.63	3.84	0.95
Monitoring-management	3.80	0.65	Availability	3.74	0.93	4.26	0.59	3.63	1.50
			Problem management	11.23	2.17	11.85	2.19	11.62	3.02
			Continuity Management of Technology	3.59	0.85	3.81	0.84	3.75	1.39
			Time management	7.53	1.46	8.07	1.29	7.25	2.31
			Total	3.73	0.65	3.80	0.65	3.68	1.06
Organization	3.85	0.68	Policymaking	3.84	0.72	4.04	0.65	3.38	1.40
			vision	3.86	0.78	4.07	0.87	3.88	1.24
			Position in the organization	3.75	0.86	3.63	0.92	3.63	1.06
			Organizational support	7.71	1.38	7.66	1.73	8.25	1.75
			Information exchange	3.81	0.80	3.93	0.91	4.38	0.74
			General factors (promotion and motivation)	3.88	0.82	4.15	0.81	4.00	1.19
			Total	3.83	0.65	3.91	0.66	3.92	0.87

Table 2. Effect of Each Dimension on Community Research Attitude

Dimensions	Attitude							
	Total		Nurse		General physician		Specialist	
	P Value	Pearson Correlation	P Value	Pearson Correlation	P Value	Pearson Correlation	P Value	Pearson Correlation
Human	0.000	0.877	0.000	0.839	0.000	0.846	0.000	0.977
Monitoring-management	0.000	0.821	0.000	0.656	0.000	0.817	0.000	0.951
Organization	0.000	0.805	0.001	0.653	0.000	0.813	0.000	0.990

that make the use of the system easy and provide perceived usefulness. Individuals' skills in using technology determine the ability to create personal and organizational communication that, in turn result from the application of the technology. In monitoring-management dimension, access, problem management, and technology continuity are among the perceived ease of use factors, and saving time is a factor of perceived usefulness. Moreover, features of this model implicitly provide a level of assurance to the user, by processing these factors, monitoring-management requirements be prepared, and implementation will be done under appropriate conditions. The user also makes sure that the system is managed by the responsible authority to resolve the problems that arise after im-

plementation. For the organizational dimension, efforts are made to examine the needs and expectations of the user from the organization. The organization's policy in implementing technology should provide users with the conditions of execution and readiness to assure them that the newly employed technology will increase the productivity of the organization. In some cases, after the use of CPOE, medical errors have increased, or despite the elimination of paper errors, new forms of errors have observed (12). If the necessary training is provided to learn technology, the acceptance of technology is measured and then stepped up to increase its acceptance, the level of errors will decrease, and thus the productivity of the technology will increase.

Table 3. Frequency Distribution of Demographic Variables[a]

	Values
Age	
20 - 29	50 (38.8)
30 - 39	67 (51.9)
40 - 49	12 (9.3)
≥ 50	0 (0)
Sex	
Woman	85 (65.9)
Man	44 (34.1)
Job	
Specialist	9 (7.1)
General practitioner	27 (21.1)
Nurse	93 (71.8)
Work Experience	
1 - 5	60 (46.5)
6 - 11	45 (34.8)
12 - 17	19 (14.7)
18 - 22	5 (3.8)

[a]Values are expressed as No. (%).

Having a vision for implementing new technologies will increase their continuity, adaptability, and integration with their previous counterparts and technologies that will be used in the future, and it will not cost the organization too much to integrate and coordinate different technologies. Integrated systems facilitate the information exchange between different centers to accelerate the treatment and care of patients, so the knowledge and facilities of different centers can be used in the shortest possible time to save lives and maintain the health of patients. In this way, the possibility of exchanging and standardization of data increases and, if it can increase organizational productivity, improves the position of the organization. Support for technology, in addition to equipment and people, needs financial supply whenever required. General factors include the promotion and motivation of staff. Participatory management improves the organizational management level and moderates the workload of staff. Using the motivation of users to increase the acceptability of technology makes the successful implementation of the technology possible and while simultaneously increases productivity and saves money.

Organizational strategies dimension with the highest average was at the center of attraction of users. organization by providing all of the items mentioned in this di-

mension, will improved admission during the implementation of the CPOE at appropriate times. Gaining the highest average in this dimension further identifies the importance of organizational strategies for managers of the organization, and the organization should try to explain the policy and the proper vision to encourage the correct use of technology. Considering that motivational factors are the most important subcategory of organizational strategies that indicate the acceptance of technology by users requires management based on the reward.

In the systematic review conducted by Gangon et al. [19], factors influencing the adoption of information and communication technologies by healthcare professionals, design issues, technical concerns, familiarity with information technology, and communications technology and time are reported as the most important determinant factors after perceived usefulness and perceived ease, which are considered in the organizational strategies dimension of the present research. Meanwhile, Gangon et al. [19] argued that, in the case of CPOE, organizational factors, if applicable, are key factors for the successful adoption or implementation of this technology. In a study on modeling nurses' acceptance of bar-coded medication administration technology at a pediatric hospital, Holden et al. [20] reviewed the perceptions of education and support that are overlapping with the organizational dimension of the research, and as in the present study, they achieved a good average (3.68) in this dimension.

The monitoring-management dimension is ranked second, which shows the importance of ease of use and perceived usefulness. The continuity management of technology, with the highest average among sub-branches of this dimension, reflects the need for users to be directed by the project management team through the process of implementation and the necessity of preventing possible irregularities. Gartrell et al. [21], in a study that used Testing the Electronic Personal Health Record Acceptance model for managing nurse's health, investigated perceived usefulness and ease of use on attitudes toward. Ease of use had a negative association with the attitudes toward using, which means that users are less likely to understand the benefits of personal health records because perceived ease of use has a direct effect on perceived usefulness [21]. Regarding the overlap between parts of the monitoring-management dimension with perceived usefulness, the results of this study are not in agreement with Gartrell et al. study [21]. But the association between perceived ease of use and attitudes toward use was positive. Due to the overlapping of parts of the monitoring-management dimension with perceived usefulness, it is in line with the results

of the present study.

The human dimension obtained the lowest average in comparison to the other two dimensions, which emphasizes the importance of perceived ease of use and access, such as the monitoring-management dimension. The ability of individuals to use up-to-date technologies and hospital management systems in comparison with individual communication received a lower average, which indicates that users consider the use of CPOE to be effective in creating individual communication. In Ifinedo study (22) titled "the moderating effects of demographic and individual characteristics on nurses' acceptance of information systems: A Canadian study" which used TAM, two dimensions of perceived usefulness and perceived ease of use on attitudes toward using information systems are investigated. Evidence from these studies show that nurses have a positive view of using ISs (22). Concerning human dimension overlapping, with parts of the perceived usefulness and ease of use, it can be argued that the results of this study are close to the present study. Khammarnia et al. (23) in the study on designing computerized provider order entry software in Iran: the nurses' and physicians' viewpoints concluded that quick access is one of the most important factors for physicians and nurses. According to the "access" is in the human dimension, their results are consistent with the results of the current study (23).

Considering that the overall CPOE acceptance level is high (3.87), the lack of relation between demographic characteristics and the tendency to use CPOE is a sign of the high inclination of individuals regardless of age, occupation, sex, and work experience. It can be argued that the need to use up-to-date technologies, satisfaction from technologies that are using, increasing the role of technology in personal lives, and the loss of traditional views on technology are the main reasons for the lack of dependency on attitudes to use of CPOE with demographic characteristics. Ifinido (22), in a study titled "the moderating effects of demographic and individual characteristics on nurses' acceptance of information systems" concluded that two variables of work experience and age of nurses did not affect their intention to use ISs. However, the level of education and computer knowledge had a significant and positive association to use ISs (22). Therefore, the relationship of education with the intention to use is not in agreement with the results of this research. The main limitation of our research concerns the non-participation of some of the staff due to the high workload. Besides, some of the staff were also on leave.

5.1. Conclusions

Finally, concerning that the total average as well as the average of every dimensions higher than 3, the views of the users for the implementation of CPOE are appropriately evaluated. According to the results, it was observed that the organizational dimension compared to the human and monitoring-management dimensions had the highest average. Participants believed that the hospital can provide the requirements of the CPOE system. Alzahra's Heart Hospital management should consider the importance of the dimensions mentioned, and the average score of each of them take the necessary steps to maximize the efficiency of CPOE before its full implementation. The management team should consider the identified organizational strategies as the most significant aspect of the implementation of this system, which will further increase the responsibility of the organization's management in explaining organizational policies on this path. It should be kept in mind that all three dimensions have a direct and positive effect on the attitudes toward the use of the system, and the difference in the mean of dimensions is not significant. However, the focus on organizational strategies with the highest mean should not prevent hospital management from paying attention to other dimensions.

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