International Journal of Engineering & Technology, 7 (I) (2018) 1-18

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET
doi: 10.14419/ijet.v7i1.8404
Research paper

An evaluation model for the implementation of hospital information system in public hospitals using multi-criteria-decision-making (MCDM) approaches

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Abstract

Background: Hospital Information System (HIS) is implemented to provide high-quality patient care. The aim of this study is to identify significant dimensional factors that influence the hospital decision in adopting the HIS.
Methods: This study designs the initial integrated model by taking the three main dimensions in adopting HIS technology. Accordingly, DEMATEL was utilized to test the strength of interdependencies among the dimensions and variables. Then ANP approach is adapted to determining how the factors are weighted and prioritized by professionals and main users working in the Iranian public hospitals, involved with the HIS system.
Results: The results indicated that "Perceived Technical Competence" is a key factor in the Human dimension. The respondents also believed that "Relative Advantage," "Compatibility" and "Security Concern" of Technology dimension should be further assessed in relation to other factors. With respect to Organization dimension, "Top Management Support" and "Vendor Support" are considered more important than others.
Conclusion: Applying the TOE and HOT-fit models as the pillar of our developed model with significant findings add to the growing literature on the factors associated with the adoption of HIS and also shed some light for managers of public hospitals in Iran to successfully adopt the HIS.

Keywords: *Adoption Model; Iranian Public Hospitals; TOE Framework; HOT-Fit Model; ANP; DEMATEL.*

1. Introduction

Rapid changes in the healthcare delivery system throughout the world have been possible by the advancement of Information System (IS). The increasing attention has been given to implementing a Hospital Information System (HIS) in hospitals, particularly on the need to consider the acceptance and usage of HIS among healthcare professionals[1, 2]. Hospitals by adopting Information Technology (IT) applications such as HIS would gain the great benefit, ranging from medical systems to administration systems. HIS is broadly employed in the hospitals around the world [3-8]. HIS was introduced in the 1960s to support hospital's financial services [9]. Subsequently, in the 1980s, it was used in clinical services where a large amount of laboratory examination data was stored electronically [10]. Since the HIS assists healthcare providers to streamline the flow of patients' information and its accessibility, the significance of the HIS in providing high-quality patient care has been developed [4, 9, 11-14]. Therefore, implementation of HIS becomes fundamentally crucial in making the right diagnostic, treatment and administration requirements, and thereby delivers better patient care and support to clinical decision making [15-17]. Even though the HIS has brought the immense change to process of care delivery, it has attempted to increase the quality and safety of care [1], [9], [18-20]. However, compared to other technologies in the healthcare domain, the acceptance level of HIS is low [5], [17], [21-24]. HIS can support patient care planning and enhance decision making of clinical or administrative functions. Besides, there are some limitations in the clinical practice that are being addressed via the HIS implementation [5], [25-31]. As an example, HIS systems used by nurses are able to control and track carefully the patient's care in an electronic manner. Additionally, nursing documentation as a chief clinical activity, stand to obtain a benefit from HIS [5], [24], [32-36]. Thus, it is imperative that HIS is designed to address the needs of main users in

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optimally coordinating user activities. At this time, IT priorities serve to alleviate medical errors, upgrade in-patient clinical systems and implementing HIS in the hospitals [33], [37-39]. Although the potential benefits of HIS in public hospitals are highlighted, no comprehensive theoretical assessment of HIS implementation in Iranian public hospitals has been done. Iran is a developing country that introduces national plans, including SEPAS and TAKFAB as well as organizational e-Health projects, for instance, HISs in hospitals that are under development. According to several authors in Iran [22], [35], [40-44], the challenges of HIS implementation in Iran related to some fundamental issues of Human, Technology and Organization. Hence, this study is aimed to propose a strategic integrated theoretical model to serve in guiding a proper and successful HIS implementation within public hospitals. Considering that there are no comprehensive studies on the HIS adoption maturity model and professional knowledge in this area with regard to Iranian public hospitals, this study was designed based on two mature theories to identify the significant dimensional factors of HIS adoption and their important interrelationship in two different public hospitals and also to provide some suggestions to enhance their HIS implementation. Hence, the questions that guide us to achieve the main study goal, are: (a) what significant factors can affect the decision to adopt the HIS based on TOE and HOT-fit model? (b) What is the appropriate theoretical model that can be used to ease the HIS adoption? And (c) what Multi Criteria Decision-Making (MCDM) model is appropriate to weigh and prioritize the factors for HIS adoption in Iranian public hospitals?

2. Literature review

2.1. HIS definition

Several definitions have been provided pertaining to the HIS. According to the National Library of Medicine [45], HIS is "the integrated, computer-assisted system designed to keep, manipulate, and retrieve information concerned with the administrative and clinical aspects of providing medical services within the hospital." In addition, according to Ismail et al. [21], HIS is defined as a computer system by which the whole administrative and medical data of a hospital is managed to make the career of health experts well-organized and operational. In another definition by Kim [46, 47], HIS has been defined as "a designer computer system devised to enhance the clinical and administrative functions of a hospital." He further added that "HIS is required by the nature of its function to be integrated, and hence is referred to an integrated hospital information processing system." Referring to several definitions of HIS, the present research defines HIS as a comprehensive, integrated information system designed to enhance clinical, financial and administrative functions of a hospital.

2.2. Adoption of HIS

The term, adoption is about the decision of any individual or organization to make use of innovation [48-54]. In the organizational context, adoption is associated to admit a innovation for implementation [55]. In addition, in terms of technology adoption in the organizational context, Gallivan [56] and Lin et al. [56] defined adoption as employing a new technology in organizational work and encouraging employees to oblige in applying the technology. As such, in terms of the research topic, adoption refers to the decision of employing HIS in the public hospital work practices and encouraging healthcare professionals to apply HIS.

2.3. Innovation adoption in organizations

Organizational innovation has been generally defined as an idea, system, practice, product or technology that is perceived as new by an adopting organization [49], [53], [54], [57], [58]. A type of innovation may be novel for an individual adopter, the majority of individuals at that unit of adoption, for the entire organization, and for the majority of organizations in the population of an organization or for all the world [59], [60]. Consequently, innovation has been studied at various levels [60], [61]. The present study focuses on innovation through HIS at the organizational level. Thus, following the above, HIS can be considered as innovation for hospital's organization, if the hospital organization perceives HIS as new. Hence, the organizational innovation theories can be potentially useful to this research development of a new model of HIS adoption. Generally, studies on technology adoption and diffusion in the area on IS are conducted in two levels, user level and organizational level [22], [62], [63]. Furthermore, the stage of adoption and the context of study should be carefully paid attention to, especially in the technology and innovation adoption studies [62], [64]. This study is based on the organizational innovation, which is intended to seek potential dimensional factors that can influence the HIS adoption by Iranian public hospitals. Hence, the organizational innovation theories and models along with the existing HIS literature might help to achieve identifying these significant factors that affect the HIS adoption in the context of public hospitals.

2.4. Adoption theories in IS domain

Studies on technology adoption of innovation have been a long source of research across various IS domains. Historically, adoption/diffusion theories have a similarity in content and objectives, but some differences exist in practice [65-67]. The purpose of theories of adoption in IS discipline is to understand, explain, or predict how, why and to what extend individuals or organizations will adopt and decide to deploy a new technology [16]. In the broadest sense, adoption theories describe the significant factors influencing technology adoption by individuals or organizations. Thus, adoption theories are aimed at recognizing and examining all these determinants [68]. In contrast, diffusion innovation theories illustrate how an innovation can spread throughout a population over time [65]. According to Wolfe [69], in previous studies related to IS, several theories and models on innovation have been determined and used in various situations. Major differences can be observed with respect to the level of analysis such as individual level versus organizational level, unit of analysis such as individual versus the innovation versus the organization, and the outcome variable such as use versus adoption. Given the aim of this study, several theoretical models have been assessed on their applicability in investigating factors that have effects on HIS adoption in the context of hospital organization. Several adoption/diffusion theories in IS research have been proposed to make the understanding of factors affecting adoption and acceptance of particular technologies easier. In general, the researchers have investigated two levels of innovation adoption: the individual and the organization. At the individual level, Technology Acceptance Model (TAM)[70], Theories of Planned Behavior (TPB) [71], Unified Theory of Acceptance and Use of Technology (UTAUT) [69] and Rogers' early diffusion of Innovation (DOI) theory [49] are the most commonly-used adoption/diffusion theories in IS research [65], [72], [73]. Although such models are very useful and important, their main focus is on users (individual-level) as well as technological attributes, while they fail to consider the attributes related to organization [69]. In particular, the first three theoretical models can only be used at individual-level [69], whereas DOI theory can be used at an individual level as well as at the organizational level [74], [75]. At the organizational level, the most

frequently used adoption theoretical models, Diffusion of Innovation (DOI) theory [81] as well as a Technology-Organization-Environment (TOE) framework [76] are most widely used [72]. DOI theory has been frequently employed to investigate drivers of innovation adoption, since it can be used at an individual level as well as at the organizational level [60], [74]. More attention has been given to TOE framework and it is accepted from diverse fields of study as it creates Rogers' DOI theory more capable of explaining organizational innovation adoption by including an important novel component of environmental dimension [72], [77]. A lot of research works which have empirically examined the TOE framework, revealed that the TOE framework importantly helped to understand the adoption of technological innovations [12], [54], [72], [73], [78], [79]. In many noticeable researches conducted based on TOE framework, factors, which are crucial in information system's adoption were carefully investigated. This is also the case for different health information systems [48], [72], [73], [78], [80]. However, regarding the context of sensitiveness and complexity of technology adoption, different factors in TOE framework may vary across different innovation and adoption contexts [73], [76]. Consequently, even though there are various studies adopted TOE framework for investigating organizational adoption of a health information systems, this framework has not been scrutinized within the domain of HIS adoption by Iranian public hospitals, particularly in two cities of Bandar Abbas and Qeshm. According to the above discussion, DOI and TOE are the most commonly-used adoption theories in the IS discipline with respect to the organizational innovation adoption. As such, the researcher in this study examines their ability to explain the HIS adoption.

2.4.1. Technology-organization-environment framework

The TOE framework as presented by Tornatzky and Fleischer [22], gives a proper analytical framework that is applied for examining the organizational adoption of diverse types of innovations [72], [81]. This framework has focused on analysis of organizational level that is as a lens to predict an adoption decision of technology. It covers three different dimensions. They are described as technology, organization and environment. As illustrated in Fig. 1, the three dimensions interact with each other, and influence decision-making about technological innovation adoption.

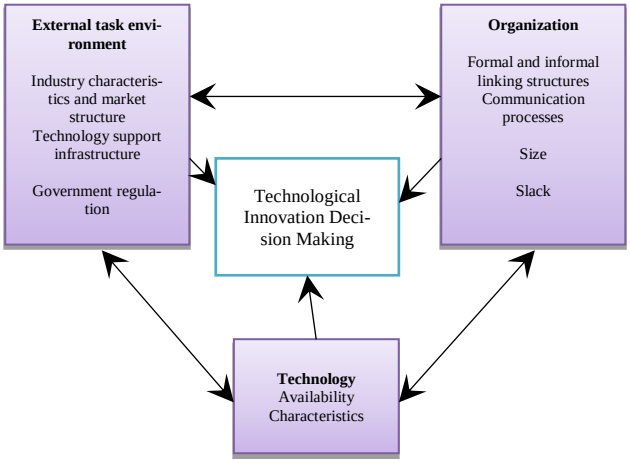


Fig. 1. The TOE Framework [117]

Technological Dimensions describe new/current and external/internal technologies, which are related to organizations (e.g., compatibility, complexity, and relative advantage). Technological Dimensions consist of both technologies to be adopted and existing technologies, and primarily emphasizes on the way that adoption process is affected by the technological characteristics [70]. The organizational dimension provides a description of characteristics of an organization that facilitates or constrains the adoption of technological innovations. The amount of slack resources available internally, the qualities of human resources, top management support, organization structure, and firm size are the instances of organizational characteristics. The external environmental dimension concentrates on firm environment that belongs to different stakeholders with which it interacts. TOE framework has been employed by many empirical studies to better understand the organizational decision of IS adoption (see Table 1). Those studies identify different significant adoption factors pertaining to the three dimensions of the TOE framework that are summarized in Table 1. DOI theory and TOE framework are largely compatible. TOE framework does not only consist of technological dimension that is parallel to the one category in Rogers' model. It also has two significant and innovative components: an organizational and environmental dimensions. Rogers' DOI theory provides a more inclusive description of organizational innovation adoption through TOE framework [48], [72], [77], [82]. There is much evidence of TOE framework that is applicable and has the explanatory power throughout various contexts. It has been applied to understand the adoption of many IS applications or technologies such as inter-organizational systems, e-business, electronic data interchange, open systems, and enterprise systems. However, each study used slightly different factors as measures for each of the framework's dimensions [5], [73], [83]. In addition, according to Table 1, it can be demonstrated that in order to explain the adoption of several diverse IS innovations; TOE framework can successfully be utilized. Likewise, the TOE model was applied and tested in Asian, European, and American, in addition to both developed and developing countries [73], [83-85]. To all intents and purposes, the experts generally agree on the three TOE dimensions suggested by Tornatzky and Fleischer [76], including the effect of environment, organization and technology adoption. However, they asserted that a set of measures or factors for every certain dimension or technology under research are irreplaceable.

Table 1: Research Using TOE Framework in IS Domains

Dimensional Factors within TOE	Frequency & Relationship direction	Author(s)
Technology		
Relative Advantage	10 (+)	[23, 32, 73, 54, 15, 93, 45, 64, 133, 143]
Compatibility	6 (+)	[23, 73, 93, 35, 64]
Complexity	6 (+)	[93, 35, 78, 60, 10, 44, 143]
Trialability	1 (+)	[23]
Perceived Barriers	1 (-)	[12, 13]
Perceived Risks	2 (-)	[42, 91]
Organization		
IS Infrastructure	8 (+)	[90, 7, 52, 38, 103, 83, 13]
Size	6 (+)	[93, 78, 106, 53, 89, 72]
Top Management Support	6 (+)	[9, 77, 49, 89, 78, 133]
Satisfaction with existing Systems	1 (-)	[12, 13]
Financial Resources	3 (+)	[32, 23, 54, 143]
Environment		
Business Competition	4 (+)	[78, 54, 108, 35, 133]
Government Policy	3 (+)	[10, 54, 108]
Market Uncertainty	1 (+)	[12, 13]
Customer Readiness	1 (+)	[106]
Vendor Support	1 (+)	[78]

According to Table 1, certain factors which are suggested to be associated to three dimensions are dissimilar as discovered in various researches. However, there is a reliable empirical support for the TOE framework. Fichman [86] reviewed available research on IS adoption, and found out that organizational adoption of IS innovation is affected by those three characteristics. Therefore, TOE framework can be considered a suitable inclusive theoretical guide that can help organizations to explore the factors having impacts on implementation of IS innovation.

2.4.1.1. Critical analysis of TOE framework in the domain of health information systems

By using the TOE framework [96], succeeding the IS adoption in the context of healthcare industry on many circumstances becomes easier [17], [25], [87-93]. In this regard, within the healthcare context, Chong and Chan [94] believe TOE framework is powerful enough to clarify the notion of Radio Frequency Identification (RFID) adoption. Additionally, Liu et al. [95] in Taiwanese care institutions applied the TOE framework to have been understanding and accelerating the process of telecare adoption. Furthermore, TOE framework was found as meaningful and effective to identify the factors affecting the e-signature adoption within a hospital setting [88]. Lian et al. [91] and Ahmadi et al. [5], [12] also strongly believed that TOE framework is a potential lens that can appropriately analyze the context of hospital technology adoption. Authors applied this framework to explore the significant dimensional factors influencing the HIS adoption in the context of Taiwan and Malaysia, respectively. Considering technology adoption that is sensitive to setting and very complicated several factors in TOE framework may vary across different innovation and adoption contexts [73], [76]. In our study, health information system's works were reviewed with respect to the hospital setting and hospital innovation adoption based on TOE framework, hence. Table 2 was presented. Based on particular circumstances and various requirements of healthcare context, the potential variables for those dimensions of TOE, including the technology, organization and environment were assessed. In this table, factors that empirically influenced on the healthcare IS innovation adoption is shown, in which asterisk indicates the most influential factors, plain text mentions the factors for which partial supports were found, and italic shows the factors that were not statistically important.

Table 2: The Utilization of TOE Framework in a Hospital Information System Domain

Author(s)	Hospital Technology	Technological Dimension	Organizational Dimension	Environmental Dimension
Hsiao et al. [39]	Mobile Nursing Information Systems (MNIS)	Cost benefit, mobile devices suitability, wireless communication suitability, the extent of integration with HIS,	Top management support, project team 's capability, user involvement and cooperation, championship, internal needs*	Business competition*, government policy support, external supplier's support*
Chang et al. [10]	Electronic signature	System complexity, security protection	User involvement, adequate resources*, hospital size*, internet need	Vendor support*, government policy*
Chang et al. [11]	Picture Archiving and Communication System (PACS)	Cost of PACS, compatibility, benefits of PACS*	Centralization, formalization, high-level manager support*	Business competition, governmental policies*
Lee and Shim [57]	RFID	Vendor pressure, perceived benefits*	Presence of champions*	Performance gap*, market uncertainty*
Yang et al. [102]	Healthcare information systems	Technology readiness/receptivity, relative advantage*, complexity*, compatibility*	Hospital type, hospital ownership, hospital size, internal needs*, resource availability*, technological knowledge*, knowledge management capabilities, project team capability*, top management support*	Government involvement*, vendor partnership*, business competition pressure, country wealth
Lin et al. [61]	HL7	System integrity*, security	Staff's technological capability*, hospital's scale*, top management, attitude toward HL7*	Push of the environment, environmental pressure*, pull of the environment
Ahmadi et al. [110]	HIS	Relative advantage*, complexity, compatibility	Centralization, formalization, size*, infrastructure, top management support	Business competition, vendor support, government policy*
Nilashi et al. [123]	HIS	Relative advantage, complexity*, compatibility*, security concern	Infrastructure, top management support, hospital size, financial resources	intensity of competition, vendor support*
Ahmadi et al. [122]	HIS	Relative advantage*, complexity, compatibility*, security concern*	Infrastructure, top management support, hospital size*, financial resources	Vendor support*

Considering the studies shown in Table 2, applying TOE framework in several researches on health information systems adoption, demonstrates the possibility of fitting TOE framework within the context of HIS adoption. These studies are based on circumstances and various needs of the hospital's organization according to the technology, organization, and environment

dimensions. In addition, Table 2 attempts to show noteworthy prior studies that used TOE framework related to the context of HIS with focusing on the adoption decision process of healthcare organizations. Furthermore, factors related to those dimensions have an important role in facilitating or inhibiting the decision to adopt an innovation in hospital organizations. Nonetheless, dimensional factors are measured in their own way based on different needs and definite components of HIS in each of those studies.

2.4.2. Human-organization-technology fit model

Research conducted on adoption of health information technology stressed on a large number of adoption complications that emanated from lack of fit between technological, human and organizational contexts [5], [96-99]. Recently, Yusof et al. [100] and Yusof et al. [101] identified the important dimensions through conducting a rigorous evaluation of health information system adoption. Through evaluating the results of IS assessment research and health information system, the authors defined and designed a new general model based on human, organization and technology dimensions. Fig. 2 shows the HOT-fit model. The dimensions addressed technological, human and organizational issues.

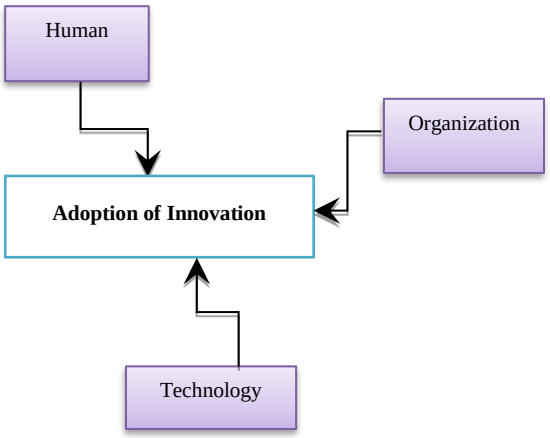


Fig. 2: HOT-Fit Model [126].

Yusof et al. [101] suggest that HOT-fit model is flexible that can be employed to analyze and assess different phases of the system development life cycle in developed and developing countries. Theirproposed framework contains comprehensive dimensions and measures. Yusof et al. indicate that HOT-fit model can be deployed both by practitioners and researchers to effectively assess the IS applications adoption in the healthcare centers. Most of the previous HIS researches have emphasized technical issues that direct success or failure of HIS in certain context and with certain user [5], [12], [91], [96], [102], [103]. Kilsdonk et al. [104] noted that adopting healthcare information systems in hospital setting is the most important emphasis of HOT-fit model. Ahmadi et al. [5] provided evidences about the importance of HOT-fit to lead the successful adoption of HIS in the context of Malaysia. In line with this, Yusof et al. [100] classified human into user involvement, clarity of system purpose, user skills, user roles, user perception and user training. These factors pertain to the human context, which their effects have been measured on the organizational adoption of health information systems. This research examines the effect of human resources in the adoption of HIS. According to the aforementioned discussions, HOT-fit model may be entirely a suitable model in this study applied to assess and determine the relevant factors affecting the decision process of HIS adoption within public hospitals regarding a developing country, Iran.

2.5. Main drivers and barriers of the HIS adoption

The research model developed in this study requires being comprehensive for examining drivers and barriers of HIS adoption in the hospital context; thereby covering dimensional variables that are crucial. Regarding the technology adoption context, some previous studies approached to identify major dimensions and variables that have a significant role in ensuring the successful adoption behavior [15], [17], [25], [80], [91], [96], [105]. Hence, assuming this study and the results achieved from a review of relevant research, the comprehensive dimensions and variables are included to investigate the adoption of IS in the healthcare domain, particularly hospitals. Table 3 lists dimensions and variables extracted from the TOE framework and HOT-fit model based on the prior innovation and HIS empirical studies regarding the adoption context.

Table 3 shows the prior empirical studies pertaining to the HIS context that used the TOE and HOT-fit theoretical model to assess the effects of respective variables on HIS adoption. Hence, possible articles related to HIS have been retrieved and read. Variables which can have a strong effect on the process of adoption of HIS pertaining to each dimension of technology, organization, and human were sought and depicted. Thus, it can be said that HIS adoption has been mostly affected by those dimensional factors. However, the measures were different for each study using the generic theories of organizational innovation adoption. Therefore, by investigating and looking at empirical studies of HIS adoption that used different theories, we carry out theoretical dimensional factors in the process of developing the conceptual model for HIS adoption in Iranian context. Authors in this study believe that the three dimensions, including technology, organization, and human are well suited in this research for studying the HIS adoption by public hospitals in Iran.

3. Materials and methods

To perform this study, two public hospitals of Iran in Bandar Abbas and Qeshm cities were selected. These hospitals implemented minor components of HIS. This research was performed in two rounds. During the first round, different reliable databases with the thesaurus terms "hospital information system," "adoption," "implementation," “TOE framework," and “HOT-fit models" were searched. These databases include MEDLINE, IEEE, Emerald, Elsevier, and PubMed. We limited the search year from 2000 to 2017. In the second round and after identifying the potential dimensional factors that affect hospital's adoption decision of HIS in public hospitals, we evaluated the identified dimensional factors using Dematel and ANP techniques to find the significant result. We used convenient sampling, and the main selection criteria were based on the feasibility of data gathering from hospital's staffs and their potential to share the required information. The data were collected from the 19 of February till 15 of March.

Table 3: Summary of Variable's Results by Theories/Models with Respect to HIS Adoption

Author(s)	Hospital Innovation/ Technology Studied	Theories/Models Used	Dimensions/Variables: Technology: Relative Advantage	Technology: Compatibility	Technology: Complexity**	Technology: Security Concern**	Organization: IS Infrastructure	Organization: Vendor Support	Organization: Top Management Support	Organization: Financial Resources	Human: Perceived Technical Competence of IS Staff	Human: Employees' IS Knowledge
Yang et al. [102]	Vital signs monitoring System	TOE	√*	√*	√*			√	√*	√*		
Hsiao et al. [39]	MNIS	TOE		√				√*	√		√*	
Lin et al. [61]	HL7	TOE		√*	√*	√		√	√*			√*
Chang et al. [10]	E-signature	TOE			√	√	√*	√*		√*		
Chang et al. [11]	PACS	TOE	√*	√					√*			
Lee and Shim [57]	Hospital RFID	TOE (need pull & technology push)	√*									
Lian et al. [60]	Health cloud computing	TOE+HOT-fit	√	√*	√	√*			√*	√*		

* Empirical significant factors
** Barriers to HIS adoption

Table 3: Summary of Variables Results by Theories/Models with Respect to HIS Adoption (Continued)

Author(s)	Hospital Innovation/ Technology Studied	Theories/Models Used	Dimensions/Variables: Technology: Relative Advantage	Technology: Compatibility	Technology: Complexity**	Technology: Security Concern**	Organization: IS Infrastructure	Organization: Vendor Support	Organization: Top Management Support	Organization: Financial Resources	Human: Perceived Technical Competence of IS Staff	Human: Employees' IS Knowledge
Li et al. [59]	Mobile nursing technology	TOE		√					√			
Hung et al. [44]	Hospital CRM system	TOE	√*		√		√*	√*				√*
Liu [62]	Telecare	TOE	√	√				√*	√			
Marques et al. [69]	Medical Records System	TOE+HOT-fit						√			√*	
Ahmadi et al. [109]	THIS	TOE	√	√	√	√	√	√*	√*	√		
Ahmadi et al. [110]	HIS	TOE+HOT-fit	√*	√	√		√	√	√	√	√	
Ahmadi et al. [122]	HIS	TOE+HOT-fit	√*	√*	√	√*	√	√*	√	√	√	√
Alam et al. [142]	Human Resource Information System (HRIS)	TOE+HOT-fit	√	√	√		√*		√*			√*
Alharbi et al. [144]	Cloud based hospital information system	TOE+HOT-fit	√	√	√	√			√	√	√	√

* Empirical significant factors
** Barriers to HIS adoption

3.1. Proposing an integrated hospital information system adoption model

The findings of the existing-related literature based on TOE and HOT-fit theoretical model with an attempt on reflection to the prior hospital innovation adoption studies, provided a great insight into the HIS adoption and served as an important function by informing the development of an integrated HIS adoption model. The literature about health and innovation adoption was explored further to investigate the roles of these findings in determining the behavior of innovation adoption. In addition, those dimensional factors were found based on the existing literature review of hospital innovation adoption in the hospital context of

Iran and other countries. Therefore, this would help a researcher to develop an initial model for HIS adoption. The next section presents the initial integrate theoretical model for HIS adoption. Fig. 3 illustrates an initial integrated theoretical model for adoption of HIS.

3.2. An initial integrated theoretical model for his adoption

Fig. 3 illustrates an initial integrated theoretical model for adoption of HIS. The initial model is proposed through enfolding literature within a hospital's context. Moreover, the model is founded by two theories, including TOE framework and HOT-fit model. In this model, the factors of and the barriers to HIS adoption are categorized into three dimensions, which are Technology, Organization, and Human. As shown in Fig. 3, Relative Advantage, Compatibility, Complexity and Security Concern are categorized as the Technological Dimension. IS Infrastructure, Top Management Support, Financial Resources and Vendor Support are categorized as the Organizational Dimension. Finally, Perceived Technical Competence of IS Staff and Employees' IS Knowledge are grouped as the Human Dimension to accelerate the adoption of HIS. However, the researcher found that the barriers to HIS adoption are mainly related to technological dimension, which are the complexity and security concern.

3.2.1. Technological dimension

Technological Dimensions are about the innovation characteristics intensively influencing the adoption which various studies of IS innovation have used it [49]. Most of the innovation characteristics that highlighted and emphasized in the prior HIS studies, include relative advantage, compatibility, complexity and security concern [5], [26], [87], [106-109].

3.2.1.1. Relative advantage of HIS

Hung et al. [92] conducted a study within the context of HIS to determine the role of factor relative advantage on its adoption. The authors found out the more enthusiasm the hospital would have in HIS adoption, if advantages realized from adopting HIS. Furthermore, Lin et al. [106] investigate the adoption of Health Level Seven (HL7) and found out that using HL7 simplifies communication interfaces and permits the interoperability among heterogeneous healthcare application. According to Chang et al. [88] and Ahmadi et al. [5], within hospital's environment, operating costs have become a big concern as competition among hospitals are being increased. IDT offers that relative advantage of an innovation positively affects an organization's propensity to adopt an innovation.

3.2.1.2. Compatibility of HIS

According to Rogers [49], compatibility refers to "the degree to which an innovation is perceived as consistent with the values, experience and needs of potential units of adoption." Innovation Diffusion Theory (IDT) explains that the adoption of an innovation is highly depended on higher compatibility of an innovation with values, experiences, and needs of an organization. Nilashi et al. [25] believed that compatibility is a crucial factor affecting the decision of an organization to adopt HIS adoption of Malaysian public hospitals. In a study conducted by Ahmadian et al. [40] regarding the implementation of HIS innovation in two academic and non-academic hospital's context of Iran, most respondents expressed the compatibility of HIS was low, which related to system characteristics of the system task. The authors described this as a major barrier in HIS system implementation. To being consistent with results of former IS innovation researchers and more emphasized by prior HIS adoption studies, perceived high level of compatibility positively has a significant effect on the innovation adoption process [40], [42], [110].

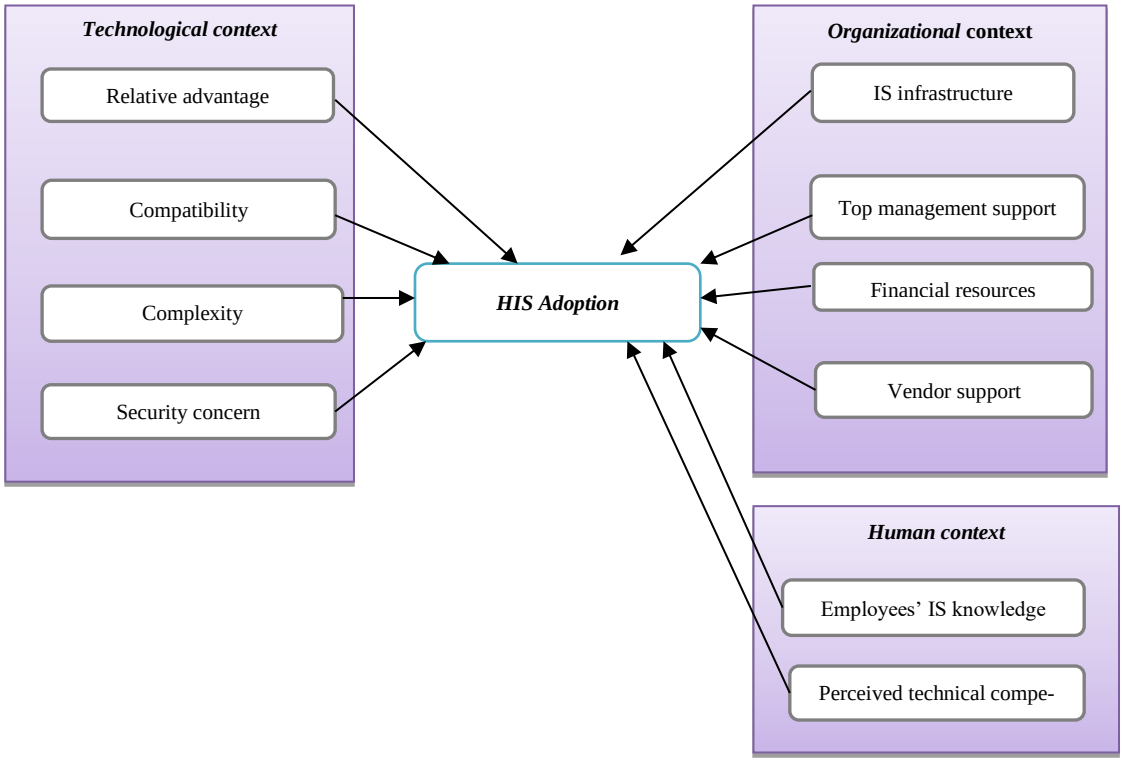


Fig. 3: The Initial Integrated Theoretical Model and Hypotheses.

3.2.1.3. Complexity of HIS

According to Rogers [49] complexity refers to "the degree to which an innovation is perceived as relatively difficult to understand and use." Jahanbakhsh et al. [22], [78] emphasized that HIS importance becomes clear when the great complexity of health system and the huge number of interventions that each patient faces, the high errors in healthcare organizations. Today, technological complexity and managing more patients with lesser resources are come from recent environment of medical involving with its IT base, and hence, causing medical staffs and professionals with higher demands [111]. Due to the lack of skills and knowledge of IS innovations within organizations, the perceived complexity of an innovation easily causes resistance, and therefore, has been a critical concern in adopting the decision process [112-115]. Based on studies that applied TOE to examine the adoption process of an innovation, complexity is negatively associated with the adoption of IS innovation [42].

3.2.1.4. HIS security concern

Data security, in the healthcare environment, is one of the concerns regarding adoption of a health information systems [116], [117]. According to Lin et al. [106], information security and accuracy should be taken into consideration by the healthcare provider, attempting to punish any possible errors. This is because medical behavior is closely linked to a patient's personal life or privacy and safety. Sulaiman [118] in Malaysia conducted a case study in equipped HIS public hospital. She found that due to the fear of the breach of patient's privacy during data transaction, the level of HIS security concern has been high. Additionally, Luxton et al. [107] believe that security problem is the most important barrier in the context of a distribute environment of healthcare affecting technology adoption. Hospitals are more exposed to this problem where the data requires more secured environment for storage and retrieval [91], [119]. Jahanbakhsh et al. [22] investigated the factors affecting the successful utilization of e-health technology with regard to HIS, in several Iranian public hospitals. They found that mechanisms of IT security protection are lacked and also there are familiarities of staffs with standards of IT security such as ISO/IEC 27001. In addition, in other studies of technological innovation in the healthcare, security concern has been one of the critical factors that inhibit the process of adoption decision in the healthcare context [22], [109], [120-122]. Thus, in our research, this component is taken to be assessed.

3.2.2. Organizational dimension

Characteristics of an organization can affect the technological innovation adoption of an organization [76], [91]. According to TOE [76], three dimensions that affect the adoption of technological innovation with regard to organizational dimension are IS infrastructure, top management support, vendor support, and financial resources.

3.2.2.1. IS infrastructure

IS innovation literature strongly suggesting that technological strength has a crucial role in adopting any kinds of technological innovation [123], [124]. IS infrastructure, including tangible resources, namely infrastructure components such as hardware and software. Infrastructure in many of the developing countries faced the limitation of sufficient and necessary infrastructure such as skilled human resources, hardware, and software to implement healthcare systems [40]. Ahmadian et al. [40] believed that in Iran, a proper planning should be applied, which can help growing the available resources' productivity.
Moreover, in developing countries, public hospitals encountered some issues regarding the IS infrastructure [125]. According to Zhu et al. [126], regarding the technical context, there is less developed IS infrastructure within organizations in developing countries. As an example, in Pakistan, hospital sector faces a barrier of IS infrastructure, which finds difficulty in obtaining a suitable software and hardware [126]. Additionally, Ismail et al. [21] surveyed several tertiary public hospitals in Malaysia to identify the issues and challenges in the development of HIS. They found that infrastructure issue should be considered as well within the country. Accordingly, it is imperative that IS infrastructure be investigated in the context of Iranian public hospitals to see its effect on the adoption of HIS technology.

3.2.2.2. Top management support

On an attempt to review the prior empirical studies of health innovation adoption of Ahmadi et al. [12], it was indicated that the frequent role of top manager's support has a positive effect to change the attitude of the organization towards adopting the HIS innovation. In addition to that, Thong and Yap [127] asserted that the attitude of top managers influences the innovative technology adoption, particularly when they understood advantages and disadvantages of IT and knowledge or experiences in IT.
Top management support realized to be vital for the introduction of PACS innovation in Taiwanese hospital's context [88]. In this regard, Chang et al. [88] believe top manager's support importantly influences the PACS adoption decision. Yang and Lim [80] and Ahmadi et al. [12], stressed the importance of top management in allocating the sufficient resources (financial and other sources) for the purpose of adopting vital sign monitoring system and HIS technologies, respectively. Accordingly, it is crucial to understand the relationship between sufficient knowledge or experience of top managers and HIS technology adoption. Hence, it is concluded that hospitals with high support of top management regarding HIS, have more willingness in adopting it.

3.2.2.3. Financial resources

One of the popular antecedents to IS diffusion is financial resources [83], [128]. In the same line, one of the strongest predictors for successful adoption and implementation is sustainable funding available for implementing and continuing an innovation [129]. Previous studies strengthen that calculating return on investment, high costs, and sufficient financial resources are a critical element of HIS technology adoption [87], [130]. Sulaiman [118] indicates that financial resources have been reported to be the main reason of why the assimilation of HIS is slow and unsuccessful, within public hospitals in Malaysia. In addition, the importance of financial resources in the context of various IS adoption context, has been highlighted. For example, MacKay et al. [131] determined that financial resources can positively influence the organizational decision in establishing a website. Another example is Chang et al. [10] emphasizing that financial resources available in the hospital's organizations highly affect e-signature adoption. Thus, hospitals require a long-term plan for obtaining financial resources in terms of IT budget to facilitate HIS implementation.

3.2.2.4. Vendor support

Sulaiman and Wickramasinghe [118] and Ismail et al. [21] pointed out the apparent issue of vendor support in the Malaysian public hospitals. Jahanbakhsh et al. [22] conduct a study to identify the major barriers regarding the HIS utilization. The authors found that when the new HIS system is ordered by a hospital. A vendor is assigned to do the network-based application to integrate in different hospital areas such as wards, pharmacy, reception, financial and departments. In addition, they

found that the vendors are far from them and updating their system assuming their needs takes sometimes, hence HIS implementation has been unsuccessful [22], [132]. Chang et al. [87] noted that in Taiwan, healthcare technology assisted by vendors usually provides solutions from on-site training to link the innovative technology to the IS buyers. Hence, perceived system complexity by all hospitals are low. Barlow et al. [133] found that to achieve a successful project plan, assigning a skilled team to fulfill the plan will undoubtedly be the crucial factors at the final stage of telecare adoption. Nilashi et al. [25] and Ahmadi et al. [5] strongly suggest that Malaysian public hospitals should not overlook the importance of vendor support if they want to successfully implement HIS. Therefore, vendor support has been frequently suggested to be a critical factor for the adopting unit to successfully continue the adoption of Hospital technology in hospitals [4], [21], [25], [87], [95], [134].

3.2.3. Human Dimension

According to the HOT-fit model, human factor is central to the evaluation of health information system adoption and development [100], [101]. Literature on HIS shows that the studies neglect this important concept in explaining the role of human context in behavior of hospital setting towards HIS adoption, with respect to perceived technical competence and employees IS knowledge [5], [74]. Hence, taken from HOT-fit model, this study embarks on the analysis of human components in understanding the decision to adopt HIS in the hospital industry.

3.2.3.1. Perceived technical competence

Perceived technical competence is about the IS employees' capability [91]. Ross et al. [135] believe that IS staffs are the core features of a valuable human asset that frequently leads the solution to the business problems and addresses business opportunities through IT. Employee's skill has been identified crucial influencing the organizational adoption of IS within the context of innovation, particularly within the healthcare industry [46], [91], [136-139].

According to prior studies of HIS, staffs' technological capabilities has a crucial role when a hospital is adopting an innovative IS [95], [106]. To ensure that business problems will be solved and able to attain business opportunities through the usage of IT, possessing powerful IS skills and competency are vital [135]. According to Lian et al. [91], if the IS staffs having sufficient knowledge and the needed skills to adopt the new IT, that hospital will undoubtedly have more certainty throughout the process [91], [128]. In addition, Moghadam and Fayaz-bakhsh [41] conducted a study of the interview in the year 2009 to explore the most important issue of HIS use among the Iranian public hospitals. They strongly believed that if the hospitals want to receive an ultimate goal of successfully implementing HIS, system training and obtaining the feedback from the healthcare staff are vital.

To adopt HIS, the organization of a hospital requires a capable IS department consists of a group of IS staff who has technical competence; it consists of enough knowledge of IT and experiences to work with and maintain the HIS functions and hence adopting the HIS. Consequently, it is highly likely that hospital with strong IS staff manpower for HIS are certain to adopt this technology. As such, our study looks at the human dimensional characteristics as very crucial in HIS adoption of Iranian hospital context.

3.2.3.2. Employees' is knowledge

Hung et al. [92] emphasized that most of the organizations are unable to successfully adopt innovation adoption due to the lack of skill and technical knowledge, which are intensively required in the process of development. Hence, they have to postpone until required technical expertise can be available. Accordingly, arming with staffs with more knowledge of IS leads to have more hope in successfully implementing IS [92], [106], [140], [141]. Sulaiman [118] indicates that staffs are more concerned about the use of HIS in the Malaysian public hospitals. This includes the lack of IS/IT exposure to healthcare staff and human resources management assigned by government [118]. Furthermore, Sobol et al. [142] strongly believed that the medical computerized system implementation is highly affected by staff's IT knowledge and capability. Lin et al. [106] found that staffs' IS capabilities would help hospitals more likely to accept the HL7 which known as an integrated hospital technology. Besides, Ahmadian et al. [40] investigated the HIS adoption through an analytic-descriptive study. They obtained the same result as Lin et al. [106] that users' knowledge on the system are crucially needed to accept and utilize the technology of HIS.

3.3. Dematel

Decision-Making Trial and Evaluation Laboratory (DEMATEL) have been an effective technique of Multi-Criteria Decision Making (MCDM) for decision analysis in recent years [135]. This technique is mainly used for discovering the relationships among the factors or complex dependency issues among criteria for a problem under investigation [136]. The effect scale described earlier is used to register the degree of influence. The steps of DEMATEL are described as follows:

Step 1: Subsequent to the accumulation of statistics from the experts, design an $n \times n$ (factors under investigation) answer matrix $X^k = [\, x_{ij}^{\,k} \,]$ with, where H indicates the number of experts. The experts provide their responses on a scale ranging between 0 and 4 (see Table 4).

$$X = \begin{bmatrix} 0 & x_{12} & \cdots & x_{1n} \\ x_{21} & 0 & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{n1} & x_{n2} & \cdots & 0 \end{bmatrix}$$

The response matrices for each of the experts are expressed as X^1, X^2. X^H. Every element of X_k (x^{ij}) is an integer on the effect scale denoting the extent to which factor *i* influences factor *j*. It should be noted that due to the fact that the DEMATEL procedure does not include an assessment of a factor's self-influence, the major diagonals of each answer matrix are fixed as zero.

Table 4: Effect Scale

Value	Meaning
0	No effect
1	Low effect
2	Medium effect
3	High effect
4	Very high effect

Step 2: Generate an average matrix A = [a_{ij}] by computing the average influence level as follows:

$$a_{ij} = \frac{1}{H} \sum_{k=1}^{H} x_{ij}^{k} \tag{1}$$

Matrix A, also known as the initial direct relation matrix, reveals the preliminary direct effects of a factor on other factors. This matrix can also be represented in an influence map.

Step 3: During this stage, the regularized direct relation matrix D is computed from the average matrix A. From this computation, the normalization factor $s = \max_{1 \le i \le n} \sum_{j=1}^{n} a_{ij}$ is computed to realize the normalized direct relation matrix D.

$$s = \max_{1 \le i \le n} \sum_{j=1}^{n} a_{ij} \quad (2)$$

$$D = \frac{A}{s} \quad (3)$$

Step 4: With the results derived in the third stage, the direct/indirect or total relation matrix (T) is computed as:

$$\lim_{k \to \infty} D^k = 0 \quad (4)$$

Where 0 is the null matrix, and so with I being the identity matrix we have:

$$\lim_{k \to \infty} (I + D + D^2 + ... + D^k) = (I - D)^{-1}, \; T = D(I - D)^{-1} \quad (5)$$

Step 5: Calculating r_i and c_i which are direct and indirect effects that factor i and factor j exerts and receives on the other factors.

$$\begin{pmatrix} r_1 \\ \vdots \\ r_n \end{pmatrix} with \; r_i = \sum_{j=1}^{n} t_{ij} \quad \text{Where } (i = 1, 2, ..., n) \quad (6)$$

$$(c_1 \; ... \; c_n) \, with \; c_j = \sum_{i=1}^{n} t_{ij} \quad \text{Where } (j = 1, 2, ..., n) \quad (7)$$

Step 6: The degree of importance of the factor *i* in the entire system is calculated as:

$$im_i = (r_i + c_i) = \sum_{j=1}^{n} t_{ij} + \sum_{k=1}^{n} t_{ki} \quad (8)$$

$$ef_i = (r_i - c_i) = \sum_{j=1}^{n} t_{ij} - \sum_{k=1}^{n} t_{ki} \quad (10)$$

The net effect that factor i contributes to the system is expressed as ef_i. To be precise, if ef_i is positive, the factor *i* is deemed a net cause. On the other hand, if ef_i is negative, the factor *i* is deemed a net receiver. The results attained through these computations can be portrayed in a directed graph to demonstrate the structural linkage existing between the various influence factors.

3.4. ANP

The ANP is a generalization of the Analytical Hierarchy Process (AHP) to the case in which there exists dependence and feedback among factors in decision making problems. Regarding to the independence problem, Saaty has developed an advanced method named Analytic Network Process (ANP). ANP differs slightly from AHP and offers more flexible methodology for a decision maker. In AHP, elements in lower level of hierarchy are weighted and ranked with respect to the higher level. In ANP, however, the model is not restricted by such a hierarchy. This point is clearly explained by Saaty [11], [143], [144], the founder of AHP as well as ANP. Aiming at solving the decision problems which cannot be structured hierarchically on account of the interaction and dependence of higher-level elements on lower-level elements as well as elements in the same level, a feedback network like structure is proposed. In particular, the super matrix approach is the generalization of the hierarchy approach. It is difficult for many decision making problems to be formulated in a hierarchical way [143], [145], [146]. The computation of ANP can be divided into two main parts:
Construction of the super matrix (a) the decision maker enters for each criteria and alternative a pairwise comparison matrix. (b) The values for the super matrix are obtained by computing the eigenvectors of the pairwise comparison matrix and writing them as column vectors in the super matrix.
2. Computation of the limit matrix from the super matrix (a) Next the super matrix has to be normalized to obtain a column stochastic matrix. (b) Raise the matrix by the power of 3. (c) Repeat the previous two steps until the difference between the matrix from step n-1 and step n are smaller than a predefined value.
Although the ranking and weighting can be generated by other methods, ANP is found to be more appropriate in meeting the needs of this research. Furthermore, it is important to reiterate that ANP is a developed form of AHP that has an ability to deal with a more complex decision making problem. ANP is employed in this case as it represents the more appropriate methodology for the first step of this research.

4. Empirical study

In our study, based on the analysis of relevant theories in line with reviewing the previous empirical researches on technology adoption with a direct attention to HIS adoption. The potential inter and intra-organizational factors were identified for the adoption of HIS. This study provides evidence for the applicability of the new theoretical model integrated by HOT-fit and TOE framework in the IS and health IS domains to specifically explaining the adoption of HIS by public hospitals in the Iranian context. In other words, this study adopted the TOE as the basis of this research and integrated the human capability's perspective to its dimensions. In other words, human dimension as a necessary supplement was integrated into the developed model. This research uses this integrated theoretical model to develop the Hospitals-Integrated Hospital Information System Evaluation Adoption Model (Hospitals-IHISEAM). In comparison to previous models, Hospitals-IHISEAM emphasizes more on intra-organizational factors rather than inter-organizational factors.
This study developed the conceptual research model (see Fig. 3) based on the laboratory search of extensive literature review and theoretical background. Now, we develop a hybrid MCDM model for the process of HIS adoption decision. Two main stages have been included within the proposed MCDM model. Fig. 4 presents the hybrid proposed model using DEMATEL and ANP. In this regard, the DEMATEL method has been applied for revealing the relationship between the dimensions as the main factors and variables as sub-factors and also to determine interdependency among them. It is important to discover the relationships by applying this approach to identify the weights of main factors and sub-factors properly. Therefore, DEMATEL is a suitable approach to be used in the context of decision-making as it is more appropriate for application of the real-world in interdependency analysis among the network components.
As discussed earlier, in the first step, we have applied DEMATEL to find the interdependencies among the dimensions and sub-factors. Table 6 presents the overall importance for each factor. From Table 6, it can be found that technological context and Human context are the most important influence factors on HIS adoption. In addition, this table also provides the ranks of sub-factors in each dimension. From the results, Relative advantage followed by Compatibility and Security's concern, Top management supports followed by Vendor support, and Perceived technical competence are respectively the most important factors in Technological context, Organizational context and Human context. Further, in Table 7 we can find two groups of factors, which are net cause and net receiver factors. From the results, it can be found that the positive values are Net cause factors, and negative values are Net receiver factors. The results reveal that technological context and Human context are Net cause, and Organizational context is Net receiver. Moreover, from the results it can be found that relative advantage, Top management support and Perceived technical competence have

the highest net effect on the decision to adopt HIS in each dimension. Furthermore, from the Net receiver group of a factor, it can be found that Employees IS knowledge, Complexity and IS infrastructure have the highest negative effect on the decision to adopt HIS in each dimension.

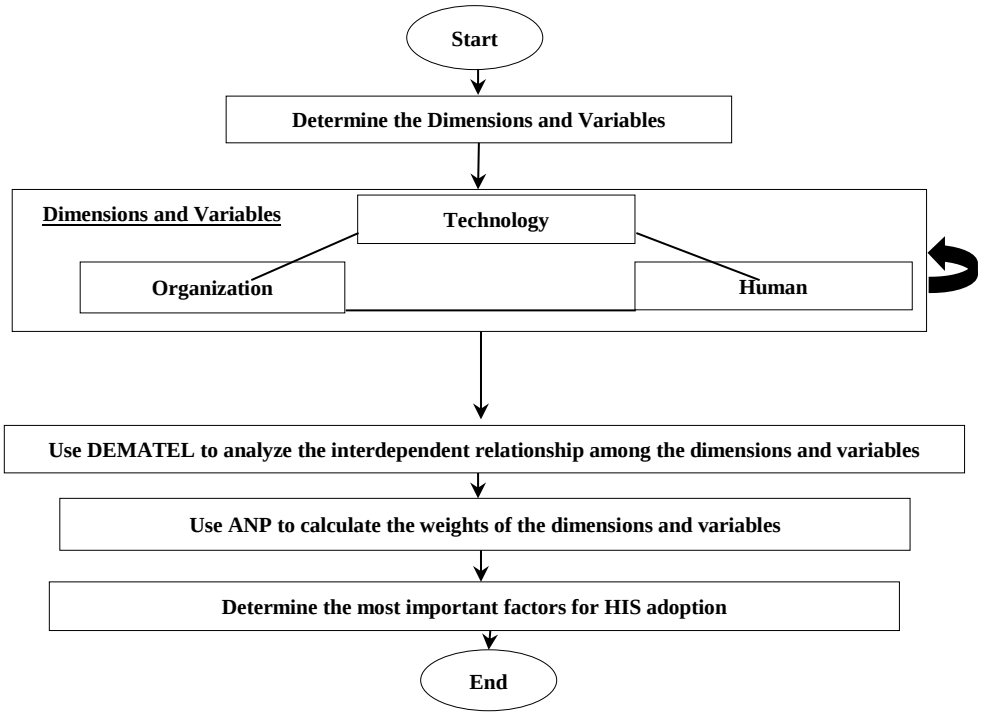


Fig. 4: Research Flow for MCDM Model.

Table 5: Sample Characteristics

Respondent Characteristics		Frequency	Percentage (%)
Age	30 and lower than 30	27	61.36
	31-34	12	27.27
	35-40	3	6.81
	41-45	2	4.54
	46-50	-	-
	More than 50	-	-
Gender	Male	14	31.81
	Female	30	68.18
Roles of respondents	Chief technology officer	2	4.54
	Chief executive officer	2	4.54
	Chief information officer	1	2.27
	Senior clinician	3	6.81
	Nurse	18	40.90
	Doctors	2	4.54
	Others	16	36.36
Experience in assigned roles	Lower than 1	5	11.36
	1-3	14	31.81
	4-6	10	22.72
	7-9	6	13.63
	More than 10	6	13.63
Experience in healthcare industry	5 and lower than 5	15	34.09
	6-10	22	50
	11-15	7	15.90
	16-20	2	15.90
	21-25	-	4.54

Table 6: Degree of Importance

Dimensions	Sub-Factors	$im_i = (r_i + c_i)$
Technological context	-	3.7874
	Relative advantage	4.5432
	Compatibility	4.2353
	Security concern	3.0234
	Complexity	1.2343
Organizational context	-	1.3423
	Top management support	4.2433
	Vendor support	3.5432
	Financial resources	2.2847
	IS infrastructure	1.3242
Human context	-	3.3461
	Perceived technical competence	2.5323
	Employees' IS knowledge	1.3413

Table 7: Net Effect

Dimensions	Net Receiver	Net Cause	Sub-Factors	$ef_i = (r_i - c_i)$
Technological context		√	-	1.9256
		√	Relative advantage	0.7852
		√	Compatibility	0.6895
		√	Security concern	0.1639
	√		Complexity	-0.4532
Organizational context	√		-	-0.5642
		√	Top management support	1.3853
		√	Vendor support	0.6438
	√		Financial resources	-0.1245
	√		IS infrastructure	-0.3464
Human context		√	-	0.9321
		√	Perceived technical competence	0.5436
	√		Employees' IS knowledge	-0.3768

In the current study, after using the DEMATEL with the aim of revealing the interdependency among the dimensions and sub-factors, the method of ANP deployed to calculate the final weights of three dimensions and the sub-factors within each dimension. According to the ANP model and structure of relationship regarding both dimensions and variable, an ANP based survey with pairwise questions was applied and distributed to the 44 main users and experts who had experience with the HIS of hospitals in Iran. All of the collected 44 surveys were valid (effective response rate as 100%). As ANP model was used in our study, 44 participants were asked to give their answers based on a scale of 1–9 to the pairwise questions, such as "For the HIS adoption in the Iranian hospitals", how much more important is "Technological factor" to "Organizational factor"?' It is emphasized that in Saaty's 9-point scale, extreme importance is attributed to the 9 point and 1 as the equal importance of one component (dimension and variable) over another. The result obtained from the Consistency Ratio (CR) values show that all of them were acceptable and the eigenvectors were appropriate for entering into the Supermatrix, after computing the results of their assessments. Based on the ANP steps that were described earlier, after the unweighted Supermatrix and weighted Supermatrix calculations, the limit Supermatrix were figured out that is shown in Table 8. This matrix provides the weight of each sub-factor in the dimensions. Accordingly, the final weights of dimensions and sub-factors are presented in Table 9.

Table 8: The Limit Super matrix

Supermatrix		Technology (D1)				Human (D2)		Organization (D3)			
		V1	V 2	V 3	V 4	V 5	V 6	V 7	V 8	V 9	V 10
Technology (D1)	V1	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.282
	V 2	0.198	0.198	0.198	0.198	0.198	0.198	0.198	0.198	0.198	0.198
	V 3	0.141	0.141	0.141	0.141	0.141	0.141	0.141	0.141	0.141	0.141
	V 4	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055
Human (D2)	V 5	0.145	0.145	0.145	0.145	0.145	0.145	0.145	0.145	0.145	0.145
	V 6	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048
	V 7	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044
Organization (D3)	V 8	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033
	V 9	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028
	V 10	0.026	0.026	0.026	0.026	0.026	0.026	0.026	0.026	0.026	0.026

Table 9: Model with Relative Indicator Weights

Dimensions	Variable	Sub-Factors	Final Weights
Technological context	D_1	-	0.487
	V_1	Relative advantage	0.282
	V_2	Compatibility	0.198
	V_3	Security concern	0.141
	V_4	Complexity	0.055
Human context	D_2	-	0.389
	V_5	Perceived technical competence	0.145
	V_6	Employees' IS knowledge	0.048
Organizational context	D_3	-	0.124
	V_7	Top management support	0.044
	V_8	Vendor support	0.033
	V_9	Financial resources	0.028
	V_{10}	IS infrastructure	0.026

5. Discussion

The conceptual research model in this study was developed and the two evaluation methods of ANP and DEMATEL were analyzed. Additionally, data was collected from 44 professionals and main users in the context of hospital, hence, the significant dimensions and variables affecting the organizational innovation of HIS was identified and confirmed. Technology and Human with an influence weight of 0.487 and 0.389 are found as the most crucial dimensions for assessing the HIS adoption. This result was obtained using DEMATEL and ANP analysis techniques. This indicates that major decision-makers of hospitals involving HIS adoption, should not overlook them. Our study has resulted that relative advantage of HIS positively affect HIS adoption (with an influence weight of 0.282). This finding is also consistent with the study of Ahmadi et al. [5]whom asserted that HIS brings convenience to healthcare organizations regarding the cost reduction, patient care processes which can expedite the decision-making process, time saving and improve patient care. The meta-analysis study of Jeyaraj et al. [74] found that relative advantage of innovation is one of the best predictors of innovation adoption in the organizational context. As a result, this study stresses that hospitals require to realize the relative advantage of applying HIS applications or in other words, some expected benefits of using the HIS. Hence, it is important that government develops some strategies to increase the awareness of the average relative advantage hospitals regarding the diverse benefits of HIS technology.

The result of this study identified that high level of compatibility has an evident positive effect on HIS adoption (with an influence weight of 0.198). The study confirms the findings of other studies that high level of HIS compatibility with existing systems is the significant factor influencing hospital's decision of adopting or implementing the HIS [5], [80], [91], [147]. Yang et al. [80] updated TOE to be in line with the health information system environment. The results of their studies support the inclusion of innovation characteristics and in particular, compatibility as part of the TOE perspective that can influence the decision to adopt wireless vital signs monitoring system. Adoption diffusion studies also found that an innovation, which is more compatible, attracts faster adoption by the prospective adopters. This may be because with a high level of compatibility with HIS or any other innovations, solely, the minimal adjustments and change is required to be undertaken within hospital organization, which implies less resistance to adoption. The government and hospital manager should therefore develop best and more extensive HIS strategies and plans, specifically within the average compatibility hospital's context to ensure the integration of new HIS systems within hospitals, leading a hospital to a best future.

The research findings of this study demonstrate that security concern is found to have a significant negative relationship with hospitals to adopt HIS, meaning that higher concern with security will result in lower adoption of HIS by hospitals (with an influence weight of 0.141). The present finding is in accordance with the findings of Lian et al. [91] who explored hospital's adoption of the new technology. Their study concluded that security concern has a greatly negative influence on behavior of hospitals' adoption of innovative technology. Due to the significance of patient data in hospitals, secure environment for storage and retrieval of data is required that hospitals feel safe to use the HIS system. Thus, greater concern about security of data is one of the major issues for every hospital to adopt and migrate to the HIS. Additionally, study by Ahmadi et al. [5] posits that the concern for the data security is one of the major issues for every organization to adopt and migrate to the innovative technology. In other words, the concern of the data security in hospitals is high. Therefore, security concern needs to be identified as one of the crucial factors in HIS adoption. Thus, it is important to develop the strategies in order to ensure the high level of data security regarding the HIS technology, therefore to encourage hospitals to use HIS in their work processes.

In this study, top management support (with an influence weight of 0.044) and vendor support (with an influence weight of 0.033) were observed to have a significant influence on HIS adoption in the hospitals. Sulaiman [118] and Ismail et al. [21] came to the same conclusion. They investigated the hospital's major issue of HIS adoption in a developing country. Is mail et al. [21] through an in-depth interview highlighted that the multiple vendors support in the context of Malaysian public hospitals cause a main challenge for HIS implementation. Furthermore, Jahanbakhsh et al. [22] found that selecting the appropriate vendor that provides the perfect support is essential that lead to succeed the utilization of HIS. Besides, the result of this study is consistent with some previous studies in the domain of healthcare [5], [12], [22] where vendor support found to be significantly affecting the hospital's technology adoption.

This study's result is more supported by the study of Sulaiman [118] that was conducted within a Malaysian public hospital. The author found that being dependent on the international vendor software causes local hospital staff to have insufficient skills and knowledge, thereby causing to increase the cost of overseas vendor support and maintenance. Thus according to the result of this study, more in-house development should be established to reduce a cost as well as strengthen local IT skills and experience. It is also vital to the alignment of the selected IT vendor organization goals to the hospital's HIS strategic goals in order to guarantee better quality delivery and support such as training. There is also a requirement to perform frequent evaluation of the selected IT Vendor company regarding the IS services in terms of efficiency and effectiveness. Additionally, the transparency has to be assured that will assist to ensure positive values of integrity and honesty in procurement and IT vendor selection process.

"Perceived Technical Competence" is another imperative factor with respect to Human dimension with an influence weight of 0.145, which helps to better evaluate the HIS adoption. IT department support has become very important, specifically in the adoption stage. This is to ensure that the technical support is adequate and staffs working in the IT department have the enough ability. Additionally, the investigation of HIS adoption in Malaysian public hospitals conducted by Ahmadi et al. [5] stressed the importance of perceived technical competence. By applying the DEMATEL technique in the current study, we have explored the interrelationship between dimensions and variables with the purpose of enhancing each dimension and variable. Results described that technology dimension (D1) and Human dimension (D2) obtained the most priority for adoption development. Therefore, these two dimensions should be looked carefully by administrators in the healthcare industry and also expand upon since they are the most imperative relative to the other dimensions. Thus, the assessment of importance identified dimensions and variables, found in our study should be performed by administrators in the HIS implementation decision process.

It can be concluded that the relative importance of dimensions, and their 10 variables can differ depends on the confinement of each healthcare industry. Nonetheless, factors such as "Complexity," "IS infrastructure," "Financial Resources," and "Employees IS knowledge" were not supported as the significant factor in this study, which created some insights into the Iranian public hospitals.

5.1. Contribution

The goal of this study was to develop a model as an effective lens for a concise and comprehensive understanding of HIS adoption decision in the Iranian public hospitals. In other words, this study provides an insight into the factors and barriers that affect the adoption of HIS and particularly to practice these issues among the Iranian public hospitals. Hence, the integrated theoretical model was developed from the reviewing of relevant extensive literature and empirically tested and validated via a quantitative study in two public hospitals of Bandar Abbas and Qeshm. Thus, our study has both theoretical and practical contributions.

Notwithstanding, there is previous literature about the innovation process, a little information is available about the innovation adoption process in public hospitals. As of now, many studies applied the generic adoption theories to examine HIS adoption with respect to DOI [49] and TOE framework [76]. Therefore, due to lack of this, we analyze the adoption-factors and barriers in the HIS context by integrating TOE [76] with HOT-fit model [100], [101] trying to figure out the successful adopting the HIS by Iranian public hospitals. Furthermore, the consistency of HOT-fit is assessed as a supplement into the TOE framework to design an integrated theoretical model for HIS adoption used by Iranian public hospitals.

There are several studies in all industries that pointing out the importance of the human dimension upon the adoption of IS, where the TOE framework does not have an explicit category "Human". Regarding the literature in HIS, most studies overlooked this concept in explaining the role of human as a strong motivation in behavior of hospital towards HIS. Hence, the present study has an important theoretical implication that the factors, specifically, perceived technical competence of IS staff engaged in the human dimension, crucially need to be considered in further research when adopting and implementing HIS.

In the context of Iran, clarifying the e-Health, national project is important and significant where the Iranian 5-year national plan assists to reveal the efforts and achievements of the government, and lessons learned obtained from this experience within each hospital during HIS utilization. Additionally, prior to this study, little understanding existed in the main barriers and facilitators of

HIS by Iranian public hospitals. However, our study attempted to provide lighter on factor's explanation for the HIS adoption based on theories and former health information system empirical results. Thus, practical guidelines are offered to make strategies geared towards maintaining the effectiveness and availability of those weighty dimensional factors. These results will help drawing better implications for policy makers at Ministry and Healthcare and Medical Education, IT and hospital senior managers as well as researchers in the field of healthcare.

5.2. Practical implications

Several meaningful implications are proposed, which obtained from the findings of present study. The results gained in our study indicate that relative advantage to be an important factor influencing the adoption of HIS technology. This was because participants were aware of the benefits of HIS technology. Therefore, it implies the importance of user awareness of the benefits of HIS positively has an impact on the adoption of HIS. On this basis, an intervention plan should be devised by government to enhance the user awareness by better educating and training of the top hospital management and medical personnel.

Furthermore, our study draws an implication for government and hospital managers to enable the HIS into the hospital work procedures and needs of it. In the other words, HIS is needed to be compatible with the relevant hospital and its tasks. This means that serious efforts should be made to increase the HIS compatibility with existing hospital's IT architectures in all aspects with respect to the average compatibility hospitals.

Participants in our study perceived security concern as a major barrier in their HIS adoption. Jahanbakhsh et al. [22] wrote that despite strong physical security within some Iranian public hospitals, there are inadequacies of IT security in the hospital environments. The reason for obtaining this result is that the confidentiality and security of HIS is imposing the sensitive information to be protected by various stakeholders of hospitals in order to fulfill the needs of an announced act. Hence, hospitals have concerned about HIS implementation due to the data protection issues. This result implies that advanced security features have to be utilized by hospital managers, top management in IT departments and/or vendors to make sure security and data protection are at utmost priority. Authorities of hospitals also require preparing a framework of national IT security, based on the ISO/IEC 27000 family standard, for better protecting of all data on medical servers. Thus, a suitable mechanism helping to protect the healthcare data, are established.

With respect to the environmental dimension factors, the present study discovered that top management support and vendor support are significant factors that affect the implementation of HIS within the public hospital context. Jahanbakhsh et al. [22] conducted an interview study regarding the HIS utilization in several public hospitals of Iran. Authors found that when vendor and hospital have a weak communicating, users face some limitations and problems. As an instance, when the vendor installs the new HIS, some training workshops are performed. Hence, nurses as the main users get a problem with the new HIS, also some resistance occurs. Inside hospitals, the IT department should give support all the time and days of a week to alleviate the issues that emerge. After users satisfied with new HIS, and some effective changes were brought with respect to new system, the HIS will be deployed, accepted and no longer complaints made. Thus, inappropriate management support, technical administration and also avoid accepting changes along with improper selection of vendors are the major barriers to implement HIS in Iranian hospitals. Thus, the Iranian ministry should cautiously explain a clear strategy for vendor selection to offer their HIS according to needs of hospital. Vendors should fully give support to applications they developed as all hospitals met supplementary challenges and shortcomings on the vendors' part. Selecting the same vendor for more than one hospital may give a better result in solving those issues [32], [68], [91], [148-152].

Our study uncovers some requirements to make the training program to the IS staff in hospital's environment [32], [68], [91]. In this case, government agency and in particular, Iranian ministry and hospital administrators should look at this result and prepare their strategy and policy at fostering the uptake of HIS. The developed model of this study is recommended as a guideline for evaluating the factors to better decision-making and improvements in the process of HIS systems implementation.

6. Future work

Our study was performed in the context of non-teaching hospitals. Hence, it is offered that the scope of the present study be extended by future study throughout a combination of teaching and non-teaching hospitals. This will lead more understandings of whether this study's findings are constrained to responses in non-teaching hospitals.

Studies of future can do the investigation of the HIS adoption by performing survey or interview in HIS adopters and non-adopters context to realize the factors in diverse perspectives regarding the HIS adoption. In addition, it is offered to evaluate and distinguish the different influence of those factors between adopters and non-adopters in adopting HIS. By doing so, more generalization of the findings is obtained.

Since the healthcare industry is many institutionalized environments, it is relatively crucial to scrutinize the effects of institutional pressures on hospital adoption of IS innovation. Nevertheless, as of now, few studies have sought the influence of institutional pressures on the process of HIS adoption by using or applying the institutional theory, especially in the organizational context. Hence, this can be a potential area to be focused in future to obtain a better understanding of the HIS adoption in Iranian healthcare.

7. Conclusion

HIS has a growing importance in hospital's management in the Iranian public health system. During the performance of this study, a few studies have paid attention in a comprehensive manner to implementation of the HIS, which may put a negative effect on an Iranian strategic plan of IT decisions in hospital's environment. Therefore, the crucial dimensions and variables in our study have been identified, which can lead to achieve and determine the HIS innovation adoption. TOE framework known as a generic theory of technology diffusion was mainly applied in our study to achieve a better understanding the adoption of technological innovation, specifically HIS systems. Additionally, through focusing on HOT-fit model, which is related to the context of health information system and integrating it with the TOE framework, this study develops a new and suitable model by covering significant factors, which were excluded in former studies to facilitate better the HIS adoption process that to be fulfilled by decision-makers and government within public hospitals of Iran. This developed model allows the administrators and managers to assess the identified important factors in better improving the HIS adoption.

The current study used two approaches of hybrid MCDM model, including ANP and DEMATEL to make a contribution in the health IS literature. Besides, the interdependencies among dimensions and their contributing variables were assessed towards the success of the adoption decision process of HIS innovation. Therefore, from the professionals' and users' viewpoint, it was found that "Perceived Technical Competence" is the most crucial factor in the Human dimension. On the other hand, with respect to Technology dimension, the potential respondents believe that the "Relative Advantage," "Compatibility" and "Security Concern" was significant in relation to the other factors. Moreover, in the dimension of organization, "Vendor Support" and "Top Management Support" was understood more powerful than others. ANP survey results explained that the professionals, and HIS users emphasized that managers should carefully adapt these factors in hospitals in which the HIS adoption is connected to more attention to these

factors. Furthermore, we revealed that the respondents of this study voted more for Technology and Human, as there is a substantial weight of these two dimensions compared to another dimension. Thus, the findings obtained in this study provide guidance to the top management in hospital administration level in HIS field in choosing the suitable way for adoption of HIS, preparing effective mitigation strategies, and contingency plans before HIS implementation and assisting hospital parties to grasp their strategic goals with increased efficiency. In the last part, it is hoped that the present study injected a thorough knowledge regarding the theoretical aspects of HIS technology in the public hospitals as well as gave the future direction for prospective researchers to investigate the HIS adoption.

Acknowledgments

Not applicable

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