



## Factors Influencing Acceptance of E-health: an Interpretive Structural Modeling

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### Abstract

The aim of this study is to analyze the factors affecting the acceptance of electronic health on the basis of the theory of planned behavior. E-health is a growing field of health communication that entails using medical informatics, public health, and trades. As a result, E-health facilitates the provision of health information and services through the internet and related technologies. In this regard, this study aims to explain the acceptance of e-health by its beneficiaries such as physicians, patients, and healthcare managers. The results have shown that the most important factors affecting the acceptance of e-health are: 1. Organizational related factors of e-health services; 2. Human-related factors of acceptors; 3. Environment-related factors; 4. Factors associated with financial sources and expenditures; 5. Technical and infrastructural factors. Taking advantage of interpretive structural modeling, we demonstrated these factors and determined the level of their reciprocal relations.

**Keywords:** Electronic Health, Technology Acceptance, Public Health, Information and Communication Technology.

## Introduction

During the twentieth century, technology has progressed dramatically, and its widespread acceptance has had a great impact on industries and businesses. In particular, the invention and commercialization of the internet in the 1990s influenced technology in many aspects of daily life (Gücin and Berk, 2015). The internet has a great potential for improving health and preventing diseases (Reis et al., 2013). An important area in which the internet has been used in health subject is the distribution of data across all developed and developing countries. Many of the features associated with the World Wide Web have become an auspicious source for Public Health (Kelly et al., 2015). Information and communication technologies have had a profound impact on different industries and occupations. This technology can improve quality and reduce costs of running industries. These centers produce lots of information in their working processes that should be collected, distributed, registered, recovered and purified. IT applications in the form of electronic records of health data and electronic health system are one of the most pressing issues in the quest to improve the quality of healthcare in the country. E-health is a novel field of health information, public health, and business. There is no precise definition for e-health; e-health is widely used and has various characteristics with regard to its area of application. Oh and others, compared 51 definitions of e-health in 2005 (Oh et al., 2005). In this study, we consider e-health as a whole technology which is used in hospital systems and other health service communications. One of the recommendations of the World Health Organization to the member states is to develop strategic programs that include logical frameworks and infrastructure to ensure the successful implementation of electronic health (Chopra et al., 2011). World Health Organization stated that e-health should be an essential part of any strategy, and it is the most important plan for change in the health system in the 21st century. Various applications of e-health such as remote care, electronic consulting and distance education is mentioned in strategic plans of different countries (WHO, 2008).

The level of utilization and implementation of these applications show the rate of attention given to e-health in some countries. Several studies have identified different social, financial, economic, technical, technological, managerial, civil, and legal factors as barriers to the implementation of e-health systems. However, in developing countries, lack of a specific authority in this area was identified as the main impediment for the establishment of electronic health. Hence, the central question of this study is “What factors affect the adoption of electronic health by stakeholders”? The secondary research questions are:

- What are the size and components affecting the adoption of electronic health?
- What is the relationship between these dimensions and the elements?
- What is the standard model of technology adopted for e-health?

## Materials and Methods

### Electronic Health

- **Definitions**

Electronic Health (e-health) was first introduced by NASA to provide medical consultation and treatment through telemedicine for astronauts (Simpson, 2013). E-health is a new and growing area of intersection of medical informatics, public health and trade that have been designed to provide health information and services or enhancement of health through the internet and related technologies (Gholamhosseini and Ayatollahi, 2016). The term refers not only to the development of technology but also to a comprehensive field for local, regional and international promotion of health employing information technology and communications. The purpose of this definition is to create a dynamic environment for greater use of computers and the internet in the area of health.

E-health is a new field of integration in informatics, medicine, public health, and e-commerce which evolved via the World Wide Web and related upgraded technologies (Sultan, 2014). World Health Organization defined e-health as a safe and affordable usage of electronic information and communication technologies in support of health-related fields including healthcare, supervision, health education, knowledge, and health researches. E-health has been introduced as a customer-oriented model to provide health services. Therefore, users are at the center of these services and can interact with health professionals who see and recognize their health needs (Kummervold et al., 2008). E-health includes all health blueprints for prevention, treatment, and rehabilitative support (Hilty, 2016). Moreover, e-health as an integrated and multidisciplinary field that can connect the following principal areas: strategic planning of health systems, e-marketing concepts, and all electronic medical forms that are related to occupational health professionals, teamwork and extensive investment in health technology management (Leung and Chen, 2019).

- **Advantages**

The use of technology in healthcare has many advantages such as saving time for patients and doctors (Gücin and Berk, 2015). Mobile technologies offer many benefits such as access to healthcare, exposure to treatment process, monitoring, self-assessment and review of patients' diseases. Additionally, the use of technology in healthcare saves money for patients, physicians, and the government. The use of technology by healthcare professionals shortens the period of healing and guarantees precise shifting and free medical documents. These improvements will reduce errors in the treatment process. In a survey of US primary care physicians, about 75 % of physicians stated that e-health reduces errors, 70% reported that it increases productivity, and more than 60% believed that information technology tools cut costs. In e-health, all patients' data is stored in a determined place, and doctors can easily have access to the patient health data through electronic records (Sultan, 2014). The

emergence of e-health technologies offers a highly accessible and cost-effective way to promote health behavior changes. Professional healthcare providers have developed many e-health intervention programs to help people break unhealthy habits (e.g., smoking and alcohol consumption) and treat severe diseases (Dale et al., 2015; and Leung and Chen, 2019).

Recent research has shown that IT can solve recurring problems in healthcare, like medical errors and escalating costs. Hence, the use of IT in healthcare is an important concern in public policy (Salge et al., 2015).

- **Challenges**

Designing an innovative e-health system and then assessing its end use is not unlike manufacturing a product and controlling for quality assurance only at the end of the assembly line. Defects become costly if not spotted and fixed on this Hypothetical production line (Razmak et al., 2018).

The development of e-health is facing many challenges. Some of the limitations of electronic health systems are High deployment/maintenance costs, recording/ exchange of patient data, and lack of e-health standards.

On the other hand, there are also some disadvantages associated with the use of technology in healthcare. The biggest downside of this field is ensuring the privacy of the patients' data. This issue can become a big problem if the data of patients is leaked through stolen or lost mobile phones. Additionally, mobile apps for tracking sexual health, alcohol consumption, etc. may induce social pressure that can lead to reliability problems (Swendeman and et al., 2014). Other challenges relate to the adoption of e-health. A case in point refers to the billions of dollars invested in an integrated Electronic Medical Records (EMR) system to improve the automation of health service delivery among Canadian healthcare stakeholders (Canada Health Infoway, 2014-2015), but still yielding low adoption by physicians (NPS, 2014). According to the Analytics study of Healthcare Information and Management Systems Society (HIMSS, 2017), only 3% of 644 hospitals in Canada are using a fully functional paperless system of EMR. Research has shown that organizations in the healthcare sector have been remarkably slow to adopt IT, despite its promise for business value. Uncertainties as well as deficiencies in the understanding, re-engineering, deployment and use of complex E-Health innovations have contributed to a lack of widespread success (Hsia et al., 2019).

## **Information Technology Acceptance in Healthcare**

The use of a new technology relates to various behavioral contexts. Acceptance behavior of the technology by any individual is determined by factors such as age, sex, and socioeconomic status. Many theories and models have explained the adoption and use of technology. In particular, related technologies to healthcare in some aspects are distinct from other fields. Moreover, with the advent of smartphones, many IT applications have been

transferred to these devices This issue can precipitate changes in social life, interpersonal relationships, and speech. Social factors influencing the use of technology from the perspective of various disciplines have been studied and interpreted by scientists (Gücin and Berk, 2015).

The most famous theories and models that are used to explain the adoption of technology are the theory of reasoned action, the theory of planned behavior, Technology Acceptance Model(TAM), and diffusion of innovations theory. The theory of reasoned action suggests that attitudes and behaviors are internalized norms for decisive actions. Attitudes, beliefs, and expectations about behavioral outcomes are related to behavior while the internal norms include beliefs that are associated with the evaluation of people who are important to everyone (Fishbein and Ajzen, 1975). In addition, Fishbein and Ajzen proposed the theory of planned behavior as well as control variable. Perceived control includes beliefs about surmounting problems associated with behaviors (Ajzen, 1991). Another model that is based on the rational behavior theory is Davis Technology Acceptance Model (Davis, 1989) that elucidates the technology decision making processes. According to this model, two variables that affect the use of technology by individuals are perceived usefulness and perceived ease of use. These two factors include people's attitudes towards the use of technology and effect of people's behavior on technology (Davis, 1989). Diffusion of innovations theory explains certain features of innovation such as relative advantage, complexity, compatibility, testing ability and observations that determine acceptance (Rogers, 2003). Also, technology acceptance is divided into the following groups: innovators, early adopters, early majority adopters, late majority adopters and backwardness (Rogers, 2003). The primary purpose of theories and models that explain technology adoption and behavior towards it is to interpret the internal and external factors that affect the acceptance and improvement of technology adoption. Two other related models are TOE and HOT-fit models. The TOE model (Technology Environmental Organization) is applied to understand the critical factors affecting the use of new information technology in an organization. It should be noted that this framework has three main dimensions: organizational, technological and environmental, which affect the process of technology implementation. Although this framework has not been designed for the healthcare industry, it can be used to facilitate understanding of the use of information systems in the healthcare industry (Chong and Chan, 2012). The HOT-fit model (human, organizational and technological fit model) is focused directly on the use of information systems in healthcare organizations including the hospital. This model assesses health information systems through the combination and integration of human, organizational, and technological dimensions. In other words, this model incorporates three factors that should be considered in the application and implementation of any technological innovation in the field of healthcare (Sultan, 2014).

## **e-Health Acceptance Factors**

Accepting E-health is not only a simple activity of purchasing the required hardware and software for information systems, but it's actually a social interaction process among users, organizations and the environment. During the implementation of an Information System , organizational managers are suggested focusing on critical factors affecting adoption of E-health services (Chang et al., 2007). In this article, authors investigate five major categories of factors identified through focus-group method which will be mentioned in the Methodology section.

- ***Organizational factors related to e-Health services***

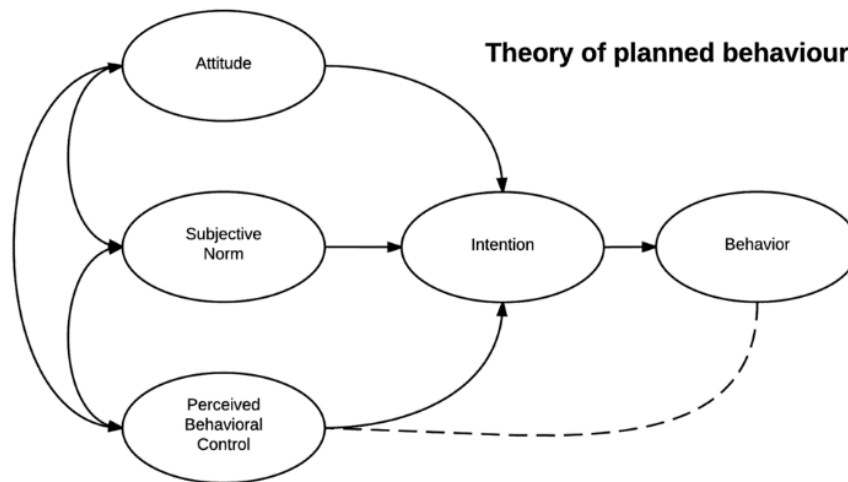
A study about acceptance of an e-hospital service showed that Technology Acceptance Model (TAM) external variables, included “user's characteristics”, “systematic characteristics” and “organizational support”. TAM proposed that IT system, user's characteristics and organizational factors all influence a user's attitude, intention and practical behavior of use (Chang et al., 2015).

“User involvement” has a positive effect on the adoption of new information technologies within an organization, while adopting to innovative IT, sufficient resources could increase the success. A large organization has more resources for changing business strategy. Therefore, the “organizational size” can affect the adoption of innovative IT. Internal demands also play a major role in the adoption decision of information technology (Huang et al., 2005). When a health organization considers moving its service into the IT-based activities, it needs strategic planning to examine factors such as staffing, budget, organizational culture and education. Moreover, it has to assess its capabilities to achieve the goal and identify strategies designed to move forward. (Kuo, 2011).

- ***Human factors related to the host***

In the present research, the primary factors influencing the adoption of electronic health were identified and classified using the theory of planned behavior, taking into account the importance of human treatment approach in the acceptance of new services and technologies.

In psychology, the theory of planned behavior (TPB) is an approach that connects beliefs and actions. This concept was presented to improve the predictive power of reasoned behavior theory including the perceived behavioral control (Ajzen, 1991). It is one of the most famous methods for prediction of encouragement. This method was used to study the relationship between beliefs, attitudes, behavioral intentions and behaviors in various fields such as advertising, public relations, campaigns and healthcare. This theory suggests that attitudes towards behavior, subjective norms and perceived behavioral control and behavioral intentions all form a person's behavior. The following figure shows the theory of planned behavior in the form of a model.



**Figure 1.** Theory of Planned Behavior Model

The theory of planned behavior is an important social cognitive model that evaluates the explanation of inconsistencies of voluntary behavior (Ajzen, 1991). Unlike the TRA, TPB model assumes performance as a concept that should include both voluntary and involuntary factors. In other words, as Kaiser (2006) argues, more behaviors depend on the circumstances and foreigners while less behavior is considered as intentionally controlled (Yazdanpanah and Forouzani, 2015).

TPB has been known as a valid model for predicting motivations and behaviors in a broad range of health-related behaviors (McEachan et al., 2011). To determine human-related factors, authors use The TPB model components including Attitude, Subjective Norm and Perceived Behavioral Control.

- ***Factors related to the environment***

Studies show that different environmental aspects (such as e-health providers) affect the adoption of e-health. In some studies, the reliability of the provider was used as a surrogate for the assessment of the e-health service itself. In many cases, Information from official institutions or health experts was assessed. It seems that the status of dissemination of the e-health services, and accessibilities also affect acceptance decisions. In some cases, the contributors cited that they could not adopt the required e-health service because they did not have access to necessary networks. Limited access is caused by a missing internet connection and/or missing personal computer. (Schmidt, 2015). Moreover, considering cultural dimensions is required for successful implementation of electronic health initiatives since socio-cultural factors would have a moderating effect on electronic health initiatives. One of the most important of these factors is language difference in various countries (Bastani et al., 2014).



- ***Factors related to funds and costs***

Economic analysis can help prioritize investments in e-health with regard to resources, costs, inputs, and outcomes. In rich countries, technological innovation has tended to drive unit health care costs upwards; however, low-cost e-health technologies have the potential to reverse this trend, particularly for poor, under-served populations. An important question about costs, is the amount of investment needed to create and develop an electronic healthcare infrastructure. This investment can stand as a fixed or variable cost, but is an inherent part of e-health infrastructure development. This can include human resources, technology development, initial training, and the costs of developing metrics to measure e-health performance over time (Schweitzer and Synowiec, 2012).

Some articles mentioned initial and ongoing financial investment in IT (IT costs) as disadvantages of e-health, while some others have mentioned that using e-health leads to reducing operational costs. (Chang, 2015). Moreover, financial indicators must be considered in any acceptance model.

- ***Technical factors and infrastructure***

Some researchers have stated that organizational readiness to adopt e-health initiatives, includes technological readiness and financial readiness. The first has been supported by a number of empirical studies and refers to the sophistication level of IT usage and IT management, which reflects the level of required technological resources. These technical resources include both tangible resources (comprising of the physical IT infrastructure components such as IT infrastructure and hardware) and intangible resources (human IT resources comprising of the technical and managerial IT skills such as IT knowledge of management and employees, experience, and expertise) (Zhu et al., 2006). Thus, technological readiness is reflected not only by physical assets but also by human resources that are complementary to physical assets. Technology infrastructure establishes a platform on which e-health can be built, while IT human resources provide the knowledge and skills to implement e-health. Technological readiness can be divided into the following four categories:

- available IT infrastructure, including interoperability
- available IT human resources (support),
- IT governance regarding IT vision and strategy, and
- IT security in terms of compliance with information security standards, including privacy issues (Faber et al., 2017).

- ***Research Background and Contributions***

Several researches have been conducted in the scientific literature in order to identify of the use of information technology in the field of healthcare and the acceptance and recognition of



the key factors that affect acceptance of e-health. In this study, a variety of resources and scientific papers were examined and the most notable among them are:

**Table 1.** Summarization of the research background

No.	Source	Country	The identified influencing factors	Summary of results
1	Roham, Gabrielyan, Archer (2012)	Canada	Patient Registration / Records Management/ Registry Services/ Point-of-Care Order Entry/ Clinical Documentation/ Results Reporting/ Information Infrastructure	The results through simulation scenarios revealed that full implementation of HIT in hospitals can lead to significant improvement in patient satisfaction.
2	Chang, Pang, Tarn, Liu, Yen, (2015)	Taiwan	User Experience/ Web Site Quality/ Service Quality/ Perceived Usefulness/ Perceived Ease of Use/ Intention of Use	Since The web-based appointment system (WAS) is the pilot trial of the e-hospital, the health-care industry and the academic pay high attention to the acceptance of WAS. Only the TAM fails to fully disclose the acceptance of WAS.
3	Kelly, Ziebland, Jenkinson (2015)	England	Attitudes towards online health information/ Attitudes towards sharing health experiences online/ Confidence and identification/ Information and presentation/ Understanding and motivation	Two independent item pools entered psychometric testing: (1) Items relating to general views of using the internet in relation to health and, (2) Items relating to the consequences of using a specific health-related website.
4	Gücin, and Berk (2015)	Turkey	Attitudes/ Subjective norms/ Perceived control/ Relative advantage/ Complexity/ Compatibility/ trialability/ Observability	
5	Bastani, Abolhasani, Shaarbafchizadeh, (2014)	Iran	The effect of health technology education on electronic health/ The effect of society illness rate on electronic health/ The effect of socio-cultural factors on electronic health/ The effect of global economy position on electronic health	Southern Iran University of Medical Sciences should consider the user-friendly and probable resistances of the present clients, in this regard it is suggested that the used technology must be accepted by users, having standard base, inexpensive and simple enough while less vulnerable in response to changes.

The main reason of this literature review is to realize the major contributions of existing works in order to differentiate this research from those studies. According to the gap analysis of recent literature conducted by the authors, the major findings of the studied literature and contributions of this work are summarized as follows:

- The authors have used Interpretive Structural Modeling (ISM) methodology in the field of electronic health. Although this method has been used in a variety of topics, the use of ISM to identify and rank the factors affecting the adoption of electronic health is a new approach.

- Researchers have taken into account the field data of developing countries in collecting data and used the views of academic and professional experts in Iran.
- While many related studies have only identified e-health acceptance factors, this paper presents a structured interpretation model of factors that indicate ranking and dependence among them.

This research aims to apply social behavior models to explain technology adoption. For this purpose, Interpretive Structural Modeling has been used to identify the factors affecting e-health acceptance and the relationships among them. Finally, an optimal cognitive model is presented.

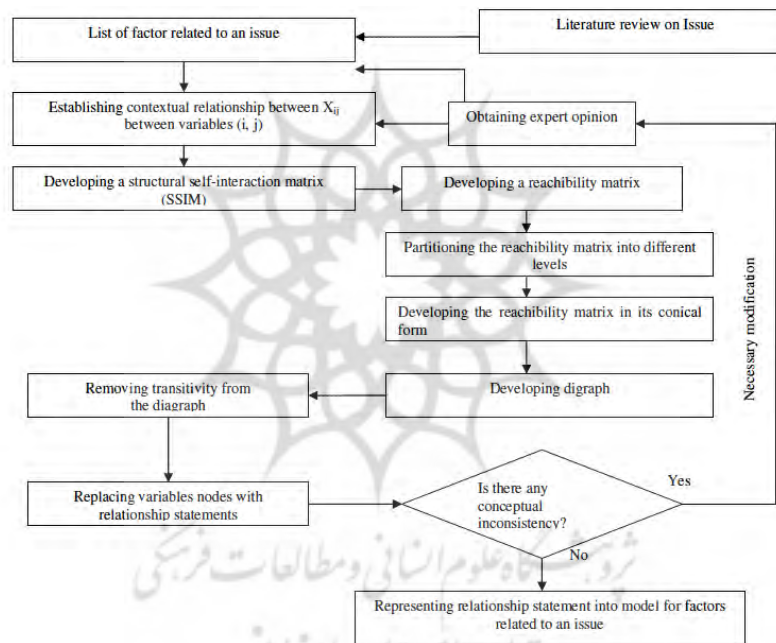
## Methodology

Interpretive Structural Modeling (ISM) is a proven method that makes it possible to understand the relationship between unique items that define a problem or an issue (Agi and Nishant, 2017). This approach has increasingly been used by researchers to express the relationship between the various elements related to the theme. ISM is a process that aims to help people better understand what to believe and detect what not to believe. Its primary function is in organizations. Not any information is added to the results through the process; the added value structural. ISM process converts weakly established, mental and unknown system models to well-defined models. This methodology is an interpretation that enables group decision-making to decide on how the different elements are related. This structure is formed based on collaborative relationships. It is a general structure derived from some complex elements. This is a method of modeling; therefore, the specific relationships and overall structure should be depicted in a graph model. The procedure makes it possible to apply the complexity of the relationships between the various elements of a system (Agi and Nishant, 2017). This method is intended primarily as a collective learning process, but people can also use it. ISM provides various benefits such as:

1. It is a systematic process, and the computer is programmed to consider all possible pairwise relations system elements; the direct relationships that have been extracted from responses of participants and those that are derived from the infringement.
2. This process is efficient depending on the context; the use of transitive inference may reduce the number of displayed and required connections between 50 and 80 % respectively.
3. Participants do not need any knowledge of the basic process; they simply need to have an adequate understanding of the system to enable them to respond to the communication problems generated by the computer.
4. The process records and directs the collective bargaining on complex issues efficiently and systematically.

5. This process is a structured model or a graphical view of the situation, which is the main problem and may be connected more effectively to other topics.
6. This method improves the quality of interdisciplinary relationships and individual attention by the participants on the difficult situation and a specific question at a time (Attri et al., 2013).

The ISM process transforms unclear, poorly articulated mental models of systems into visible and well-defined models. This process begins with the study of literature, continues by identifying the factors and prioritizing them, and ends with the development of a visual model. The following figure shows an algorithm based on process modeling and structural interpretation. In this research, the steps of this approach (the following algorithm) have been done for the “e-health Acceptance” topic.



**Figure 2.** Interpretive Structural Modeling Algorithm (Attri et al., 2013)

ISM could be used at a high level of secession such as the need for long-term planning. It could also be a more realistic model for processing of details associated with the problem of structure or activity. These activities may include process design, product design, process re-engineering, complex technical issues, financial decisions, human resources, competitive analysis, and e-commerce (Attri et al., 2013). To represent Interpretive structural modeling of the factors affecting the adoption of e-health, we have considered e-health as a set of technologies used in hospital systems and other healthcare services. In order to determine some of the indicators and dimensions, and sum up the dimensions and indicators, the focus group was used. Focus Group is a type of in-depth interview accomplished in a group, whose meetings present characteristics defined with respect to the proposal, size, composition, and

interview procedures. The focus or object of analysis is the interaction inside the group. The participants influence each other through their answers to the ideas and contributions during the discussion. The moderator stimulates discussion with comments or subjects. The fundamental data produced by this technique are the transcripts of the group discussions and the moderator's reflections and annotations (Freitas, 1998). Focus group refers to a group exploratory discussion on specific topics to obtain a perception of an issue in a defined space. This method has increasingly been used as a tool in social sciences and primarily in sociology. In the focus group, the participants share their perceptions, feelings, and experience; therefore, the area of comments on specific topics spreads, and the problems caused by the unilateral tendencies are prevented (Fisher, 2011).

### **Focus group stages**

Focus Groups can be executed in three stages: planning; conducting the interviews and analysing the data (Freitas, 1998).

### **Planning for Focus Group**

- The number and size of the groups: The Focus group may be very small (consist of two to six people) or medium (consist of seven to ten people) or large (consist of eleven to twenty people).(Cooper and Schindler, 2006). In this study, due to the subject, authors interviewed seven experts. These experts have a specialty in information technology and healthcare.
- The participants: The determination of who will participate in the study is a function of the purpose of the research. The need to segment the people in categories should be considered. The experts of this study are categorized as described below: two specialists in the healthcare industry; three experts in the information technology range and three professors of Information Technology Management.
- The level of moderator involvement: The level of the moderator's involvement is always treated as a continuum. At one extreme the moderator has a small part in the group discussion. At the other extreme, it is high, where the moderator controls the topics that are discussed and the dynamics of the discussion. In this study, authors have a median involvement.
- The interview content: Morgan, 1988 presents four aspects to be observed in a Focus Group discussion: (1) to cover the maximum number of relevant topics; (2) to collect the most accurate data; (3) to promote interactions that explore the participants' feelings in some depth; and (4) to take into account the personal context in which the participants generated their responses to the topic. In this research, the main subject of interviews and discussion sessions is ISM methodology matrix and how to fill them, which explains below.

- The place selection and data collection: Focus Groups have been conducted with success in several places such as hotel rooms, public buildings, etc. For this study, meetings were held at Shahid Beheshti University (Tehran, Iran), faculty of management and accounting, information technology department.
- Conduct of the sessions: Focus Group success depends on good questions formulated appropriately for the chosen respondents, and the other essential ability is the moderator's capability to lead the discussion.
- The data analysis: Production of the transcriptions and the analysis thereof is a slow, time-consuming process. it can take few days Depending on the number of groups, the participants' readiness, and the type of analysis intended for the transcripts,. In this study, data analysis was performed through ISM stages.

## Results

The results of this study are presented in the form of interpretive structural modeling steps.

### Step 1: Developing a/the Structural Self-Interaction Matrix (SSIM):

Interpretive structural modeling starts with preparation of a list of variables that are related to the problem or issue. These variables are achieved by reviewing literature, interviews with experts, and using the questionnaire. Dimensions and indicators of acceptance of e-health according to the study of literature and literature review are presented in the table below:

**Table 2.** Summarization of the dimensions and indicators of acceptance of e-health

Factors	Determinants	Source
Organizational factors related to e-health services	The relative benefits	[Chang et al., 2007]
	Senior management support	[Thong, 1999]
	Knowledge and intellectual capital	[Kuo, 2011]
	Compatibility and complexity	[Yusof et al., 2008]
	Education	[Bastani et al., 2014]
	Security and privacy	[Kelly et al., 2015]
Human factors related to the host	Quality of Services	[Chang et al., 2015]
	Attitudes	[Hsieh, 2015]
	Subjective norms	[Hsieh, 2015]
Factors related to the environment	Perceived behavioral control	[Hsieh, 2015]
	Policies and upstream strategies	[Lin and Chen, 2012]
	Legal support	[Bastani et al., 2014]
	Unemployment and the need for healthcare services	[Bastani et al., 2014]
Factors related to funds and costs	Socio-cultural factors	[Bastani et al., 2014]
	Sufficient funds	[Sultan and Sultan, 2012]
	Cost savings	[Roham et al., 2015]
Technical factors and infrastructure	Health insurance	<i>Focus Group Method</i>
	IT infrastructure	[Roham et al., 2015]
	Technical standards	[Bastani et al., 2014]
	Information Systems Architecture	<i>Focus Group Method</i>

Structural self-interaction matrix is an established structure that is considered as an aspect of e-health acceptance parameters and can be used in comparing the acceptance parameters using the four conceptual relationships. Experts and IT professionals completed this matrix.

At this stage, the relations among the factors affecting the adoption of e-health were analyzed in pairs, using the "leading to" conceptual relationship. In rows and columns of the matrix, the factors are listed in order of size. (Sarkis et al., 2010)

The relationship of the moods and symptoms of these factors include:

V: the variable i leads j.

X: to show the double-sided effect.

A: the variable j leads to i.

O: to show the relationship between two variables (Thakkar et al., 2007).

**Table 3:** Structural Self-Interaction Matrix of e-health and their Level of Acceptance

J \ I	1	2	3	4	5
1. Organizational related factors		A	A	V	V
2. Human related factors			A	O	O
3. Environmental related factors				V	V
4. Factors related to funds and costs					V
5. Technical factors and infrastructure					

### Step 2: Developing Reachability Matrix

To achieve a self-transformation matrix structure, we obtained an array of values. After converting all rows, the result was called the primary access matrix.

The following rules can be established in terms of primary access matrix (Faisal et al., 2006):

- If cell (i, j) in its matrix structure and an interaction with the symbol V is taken, the house is in the matrix to achieve a number of asymmetric house, the house (j, i) is zero.
- If cell (i, j) in its matrix structure and an interaction with the symbol A is taken, the house is in the matrix to achieve zero and asymmetric house, ie the house (j, i) is one.
- If cell (i, j) in its matrix structure and interaction is considered as symbol X, the house is in the matrix to achieve a number of asymmetric house, ie the house (j, i) is the one.
- If cell (i, j) in its matrix structure and interaction is considered as symbol O, the house is in the matrix to achieve zero and asymmetric house, ie the house (j, i) is zero.
- If  $i = j$ , the corresponding cell in the matrix will achieve number one. e-health and their level of acceptance.

**Table 4.** Reachability Matrix of Acceptance of e-health

<b>J \ I</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
1. Organizational related factors	1	0	0	1	1
2. Human related factors	1	1	0	0	0
3. Environmental related factors	1	1	1	1	1
4. Factors related to funds and costs	0	0	0	1	1
5. Technical factors and infrastructure	0	0	0	0	1

**Step 3: Finalizing Reachability Matrix**

After the acquisition of the primary matrix, its transitivity should be established. That is, if (i, j) communicate with each other and (j, k) connect with each other, then (i, k) are linked together. At this stage, secondary relationships (transitive property of matrix) are handled.

Identification of the secondary relationships and modifications of the reachability matrix leads to achievement of a correct reachability matrix (Final). Column leverage was obtained by adding lines and line dependency of the index column.

**Table 5.** Final reachability matrix on acceptance of e-health

<b>J \ I</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>Drive power</b>
1. Organizational related factors	1	0	0	1	1	3
2. Human related factors	1	1	0	1*	1*	4
3. Environmental related factors	1	1	1	1	1	5
4. Factors related to funds and costs	0	0	0	1	1	2
5. Technical factors and infrastructure	0	0	0	0	1	1
Dependence power	3	2	1	4	5	

**Step 4: Determination of the relationships and grading factors (Developing conical matrix):**

In order to determine the relationship and classify the factors affecting the adoption of e-health, a set of outputs (achieved) and a set of antecedent should be extracted for each element from the reachability matrix. The set of outputs includes the factors that affect it. The set of inputs includes the factors that affect them. The collection of bilateral relations for each factor was then determined which means that the factors have been repeated in both sets of inputs and outputs.

The factors were then classified based on the resulting sets. Typically, the factors that have the same sets of output and collection of bilateral relations constituted the top-level hierarchies; therefore, the high-level factors will not be the source of anything else. When a high-level factor is defined, it is separated from the other factors. In a similar process,, the next levels are then determined (Agarwal et al., 2006).

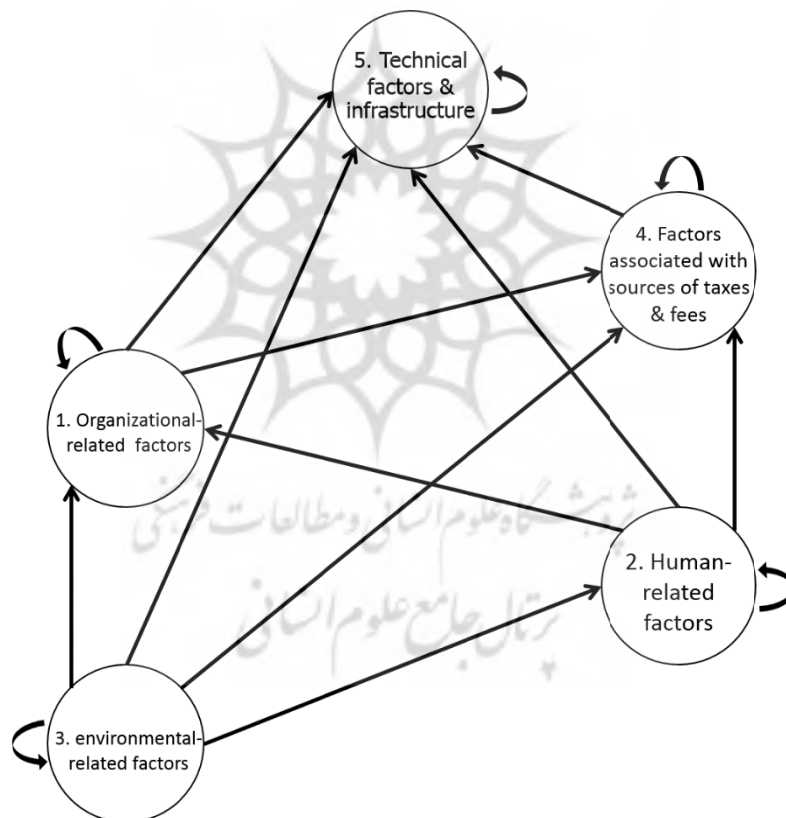


**Table 6.** Conical Matrix of e-health Acceptance

Factors	Reachability set	Antecedent set	Common set	Level
1. Organizational related factors	5,4,1	3,2,1	1	III
2. Human related factors	5,4,2,1	2,3	2	IV
3. Environmental related factors	1,2,3,4,5	3	3	V
4. Factors related to funds and costs	4,5	1,2,3,4	4	II
5. Technical factors and infrastructure	5	1,2,3,4,5	5	I

**Step 5:** Drawing a diagram (structural model or digraphs):

Primarily, the criteria are sort of based on priority from top to bottom. Using the resulting matrix, we sorted the received matrix. If there is a relation from i to j, it is determined by the arrow from i to j (Thakkar et al., 2007).

**Figure 3.** The Interpretive Structural Model of e-health Acceptance Factors**Step 6:** Analysis of leverage and dependence (MICMAC):

The abbreviation for the interaction of matrix multiplication applied to classification is MICMAC. The purpose of MICMAC analysis is to investigate the drive power and dependence power of factors (Attri et al., 2013).

In this step, matrix leverage dependent factors (dimensions) affecting the acceptance of electronic health were extracted and divided into four classes due to the leverage and dependence. The four areas are autonomous, dependence, linkage, and independence. Factors that had the minimum influence and minimum dependence on other factors were placed in zone 1 called the autonomous area. These factors are somewhat isolated from other factors and have little relations. The factors that had a greater affinity and lower leverage to other dimensions were placed in area 2 called the dependence area. The factors that had great influences and a great affinity and bilateral relationships were placed in the area of linkage called area 3. Any changes in such factors induce changes in other factors. The variables that had the most influence and little dependence were placed in the area of independence known as area 4.

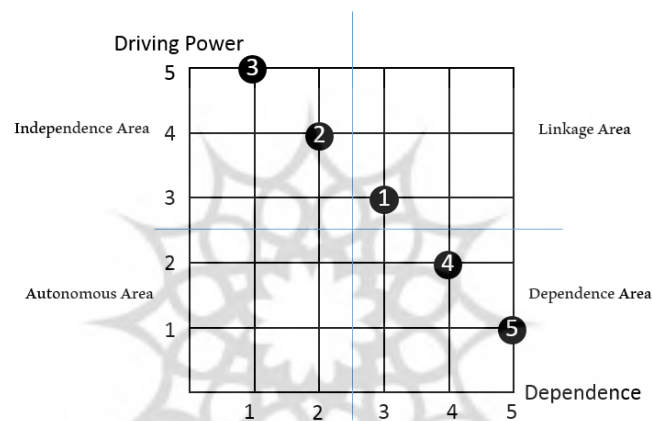


Figure 4. Driving power and dependence matrix

As shown in this figure, the human dimension of the problem and the factors related to the adoption of electronic health are in zone 4 (Independence area). These factors are more independent and more effective than other factors. Organizational factors in the adoption of e-health in district 3 (The Linkage area) had a proportional dependence and influence. Technical and financial factors of the adoption of electronic health are located in area 2 (The Dependence area). This means that these dimensions are dependent on other factors and will have less effect on other factors. None of the elements in area 1 (The Autonomous area) are involved.

## Discussion and Conclusion

According to the interpretation of the extracted model's structure, the dimensions and indicators of the acceptance of e-health are divided into five categories. Infrastructure and technical factors including the existence of the necessary infrastructure, information technology, technical standards, and architecture information systems are at the highest level compared to other dimensions. This means that the dimensions are dependent on size and

other factors. Factors related to funds and costs including indicators of adequate funding, savings, and health insurance are at the next level, the dimensions of environmental, organizational and human-related factors influenced and brought about changes in their status leading to variations in the technical factors. Organizational factors were accepted e-health at the third level. These factors include relative benefits, senior management support, knowledge and intellectual capital, compatibility and complexity, education, security and privacy, and the quality of service. Human factors are consistent with the theory of planned behavior including attitudes, subjective norms, and perceived behavioral control. Ranking factors are in the fourth level, and finally, upstream factors related to the environment including policies and strategies, legal support, the rate of disease and the need for healthcare and socio-cultural factors are at the lowest level and had the most influence on other factors unaffected. The importance of the indicators that are related to each dimension as well as the comprehensive index that is equal to the magnitude of the focus group technique was approved.

For public and private organizations, it is recommended that the interaction of the mentioned factors in this research must be considered in the implementation of e-health services. The effectiveness of the organization was negligible, considering the environmental factors and government policies and macro social processes. Changes in the attitude of adopters of e-health including patients, physicians, and healthcare managers will lead to a change in consistency and complexity. Training and quality of service are internal; therefore, paying attention to the human dimension is essential. It is worth noting that current budget allocation and savings resulting from the use of e-health services will also affect the provision of technical infrastructure. Environmental- related factors (and determinants) are the most independent factors that healthcare managers and e-health specialists can influence them. These factors are controlled by policies and social drivers. On the other side, according to the model, technical factors (and determinants) are the most co-dependent factors that it is essential to be considered in order to extending e-health acceptance because changing them is more feasible. Organization factors (and determinants) have a mediator role between external effects and internal effects in the acceptance process; therefore, considering them creates a balance among different acceptors such as physicians and patients. Other researchers can evaluate this qualitative model with quantitative methods like structural equation and network analysis or develop this interpretive structural modeling base on the determinants instead of factors only. New factors from different perspectives can be added to interpretive structural model or other information technology acceptance models.

In conclusion, it should be noted that the methodology of this article has some limitations. Increasing the number of variables involved in an issue, complicates the ISM process.. So, we can only consider a limited number of variables in the development of ISM model. Furthermore, these models are not statistically validated. Structural equation modeling (SEM), also commonly known as linear structural relationship approach has the capability of testing the validity of such hypothetical model.

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