A Model for E-Readiness Assessment of Iranian Small and Medium Enterprises

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Abstract

The current dynamic and turbulent business environment has forced companies that are competing in global markets to change their traditional methods of conducting business. Recent developments in applying Information Technology (IT) offer the most exciting business opportunities in the marketplace. Organizations must re-evaluate every aspect of their strategies and quickly move to a working mode where the electronic commerce is essential for their success. One of tools that can be used for measuring the diffusion rate of IT is e-readiness assessment. Small and Medium Enterprises (SMEs) are critical to the economies of all countries, including developing ones. They cannot be left behind and many are already demonstrating their entrepreneurship strength by grasping opportunities offered by IT. The concept of e-readiness assessment for SMEs has received limited attention in the literature.

This paper first studies e-readiness assessment models proposed for countries and then tries to develop a model for measuring the e-readiness of SMEs (ESME) by an exploratory study. Finally, the proposed model is used for the assessment and comparison for e-readiness of three considered Iranian SMEs.

Keywords: Information Technology - E-readiness Assessment - Small and Medium Enterprise

Introduction

E-readiness can mean different things to different people, in different contexts, and for different purposes [1]. Thus, it is important to define e-readiness in the context of this paper. E-readiness of a Small and Medium Enterprise(SME) is defined here as the ability of an SME to successfully adopt, use and benefit from information technologies (IT) such as e-commerce.

Information technology (IT) is a term that generally covers the harnessing of electronic technology for the information needs of a business at all levels. It utilizes computer-based systems as well as telecommunication technologies for the storage, processing and communication [2,3]. While an information system (IS) is a group of formal processes that together collect, retrieve, process, store and disseminate information for the purpose of facilitating, planning, control, coordination and decision-making in organizations, IT on the other hand provides the technical solutions identified in the IS, including the networks, hardware and software [4]. IT today is basically electronics and is based on integrated circuits or silicon chips. Hanson and Narula further identified two major forms of IT as Telematics (meaning 'big media') and Ethnotronic (meaning 'small media'). Telematics are to be identified with such technologies as computers, telephone, satellites, television, radio, video and those that rely on large-scale infrastructure. Ethnotronics include technologies such as typewriters, audio cassette recorders, fax machines, paper copiers, calculators, digital watches and other more personal types of technology [5].

IT is creating many new inter-relationships among businesses, expanding the scope of industries in which a company must compete to achieve competitive advantage. Information systems and technology allow companies to coordinate their activities in far-flung geographic locations. Thus, IT is also changing the way companies operate [6].

IT has a great role in supporting the current and common operations in most of the contemporary organizations. Nowadays, the time cycle of these operations keep shrinking. Risk of missing opportunities that negatively impact businesses is very high. In this situation, because of the increasing rate of

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changes, the role of IT becomes much more profound. Although IT itself can increase the fixed cost, the organization can not meet the information needs without it and consequently companies are forced to stay on the side of the world market or respond weakly to information-powered competitors. Furthermore, not only for achieving victory but also for surviving in the competitive marketplace, the companies need to adapt and take advantages of rapidly emerging opportunities.

Information and Communication Technologies (ICT) centered on the internet are today generally recognized as one of the central forces in the transition toward a new economic system. During the height of the techno-enthusiasm that underpinned the dot.com phenomenon, this transition tended to be identified with e-business which mostly meant the 'transfer' of existing business processes onto an online environment [26]. A number of studies have been conducted towards assessing countries' e-readiness that is their preparedness for using IT and entering to the digital world. Assessments were based on combinations of indicators such as e-connectivity, human capital, business climate, leadership and others. Quantitative and qualitative indices were devised and used to evaluate and rank countries on the e-readiness scale.

While providing insight into the overall e-readiness of countries on the macro level, few studies have attempted to evaluate e-readiness from a micro perspective. In particular, a small number of studies have undertaken as assessment of the adoption e-commerce in small and medium enterprises (SMEs) in the United States, Australia, some European and Asian countries [27]. The objective of the research is to present a model that assesses the e-readiness of SMEs, particularly their preparedness for adoption of electronic commerce.

E-readiness models and concepts

Over the last years, a number of models for e-readiness assessment of countries on the macro level have been developed by different organizations. On the surface, each model gauges how ready a society or economy is to benefit from information technology and electronic commerce. On closer examination, the models use widely varying definitions for e-readiness and different methods for measurement. These models mainly are in four categories as follows:

1. Ready-to-use tools: There are few ready-to-use tools freely available on the web.
2. Case studies: There are numerous case studies assessing specific countries' e-readiness, and many of these could be used as bases for e-readiness tools.
3. Third party surveys and reports: These reports aim to rank and rate countries on various measures held to indicate e-readiness.
4. Other e-readiness assessment models: In addition to the formal tools and surveys described above, there is a range of other frameworks such as digital divide reports and position papers that can be similarly used for e-readiness assessment.

The above mentioned models can be divided into two main categories, first those that focus on basic infrastructure or a nation's readiness for business or economic growth, which are e-economy models and second, those that focus on the ability of the overall society to benefit from IT which are "e-society" models. These two categories of models also have different assessment methodologies such as questionnaires, Statistical methods, best practices, historical analyses [27,28]. Table 1 shows detail of some important e-readiness assessment models.

There are several definitions for e-readiness. The CSPP model defines an 'e-ready' community as one that has high-speed access in a competitive market; with constant access and application of ICT in schools, government offices, businesses, healthcare facilities and homes; user privacy and online security; and government policies which are favorable to promoting connectedness and use of the network [29]. The Asian Pacific Economic Cooperation (APEC) group defines a country as e-ready that is 'ready' for e-commerce, has free trade, industry self-regulation, ease of exports, and compliance with international standards and trade agreements [7]. McConnell International defines e-readiness as the capacity of nations to participate in the digital economy[8] and finally, the Center for International Development at Harvard University the most acclaimed institution in e-readiness research defines an 'e-ready' society is one that has the necessary physical infrastructure (high bandwidth, reliability, and affordable prices); integrated current ICT

throughout businesses (e-commerce, local ICT sector), communities (local content, many organizations online, ICT used in everyday life, ICT taught in schools), and the government (e-government); strong telecommunications competition; independent regulation with a commitment to universal access; and no limits on trade or foreign investment[9,10].

While the above mentioned tools focus on assessing readiness of countries, governments and policies for adopting information technologies, some others e.g. IQ Net Readiness Scorecard [23] assess the readiness to adopt other different concepts. IQ Net Readiness Scorecard was developed by CISCO and is a Web-based application that assesses an organization's ability to migrate to an Internet Business model. It is based on the book Net Ready [64], which gauges the readiness of IT service providers.

E-readiness of small and medium enterprises

There are a number of definitions of what constitutes a small to medium enterprise (SME). Some of these definitions are based on quantitative measures such as staffing levels, turnover or assets, while others employ a qualitative approach [25]. Meredith (1994) suggests that any description or definition must include a quantitative component that takes into account staff levels, turnover, assets together with financial and non-financial measurements, but the description must also include a qualitative component that reflects how the business is organized and how it operates[25]. One of the SME definitions is shown in the table 2 [24].

Table1: Some of important e-readiness assessment models.

Model Name	Author	Reference	Focus
Apec	The Asian Pacific Economic Cooperation (APEC) Electronic Commerce Steering Group	[7]	E-Commerce Readiness
CSPP	Computer Systems Policy Project	[29]	Existing Infrastructure
CID's	The Center for International Development at Harvard and IBM.	[9,10]	Society
McConnell International	McConnell International prepared this report in collaboration with World Information Technology and Services Alliance (WITSA)	[8]	Infrastructure, Digital Economy, Education and Government
MQ	Mosaic Group	[11,12]	Internet
CIDCM	University of Maryland, Center for International Development and Conflict Management	[13]	Qualitative Assessment based on past performance and current internet pervasiveness
EIU	The Economist Intelligence Unit	[14]	E-Business Readiness
IDC	World Times / IDC's Information Society Index	[15]	Infrastructure
KAM	World Bank, Knowledge Assessment Matrix	[16]	K-Economy
NRI	Center for International Development (CID) at Harvard and the World Economic Forum	[17]	Infrastructure, E-Society, Policies, Digital Economy, Education and Government
ITU	International Telecommunications Union's Internet Country Case Studies	[18]	Telecommunications
Sida	Swedish International Development Cooperation Agency (Sida)	[19,20]	Mainly SWOT analysis of a Nation
USAID	U.S. Agency for International Development	[21,22]	Access, Government, People

Table2: Definition of SMEs.

Enterprise category	Headcount	Turnover	or	Balance sheet total
medium-sized	< 250	≤ € 50 million		≤ € 43 million
small	< 50	≤ € 10 million		≤ € 10 million
micro	< 10	≤ € 2 million		≤ € 2 million

Until the middle seventies, SMEs had a minor role in the debate about economic development due to the dominance of the mass production paradigm in industry. After this period, this paradigm was increasingly challenged, leading to large firms' fragmentation, unemployment growth and creation of new SMEs [35].

Empirical studies show a clear trend towards reduction of size in firms of the manufacturing sector in developed countries. Possible reasons for this are the diffusion of flexible modes of production and the downsizing of large firms [34, 35].

There are two main findings in the literature that have implications for economic policy concerning SMEs. The first is that the nature of innovation adoption differs according to the size of the firm. The second is that clusters of small firms or industrial districts can be important for regional development [30].

As Rothwell and Dodgson (1993) warn, both SMEs and large firms have advantages in innovation adoption, but these advantages differ. While large firms have material advantages, due to their greater capability to support R&D, SMEs have behavioral advantages that stem from their greater flexibility and ability to adapt to changes in the market [31].

SMEs can be classified in four different types, according to the market structure where they are located, to the prevalent innovation rate and to their organization. SMEs can be individually in competitive markets with low innovation rates. They can also be individually in highly dynamic industries with high innovation rates. On the other hand, SMEs can be organized as production cooperatives (clusters), or in networks under the dominance of a large firm. Each type of SME has specific contributions to economic growth, and will accordingly perceive IT in different ways. The first type perceives IT as a cost reduction tool, while the second perceives IT as a business opportunity. The third and the fourth use IT in their productive processes and in their relations with the other firms, thus improving their interface with the Market [30, 32].

The differences between SMEs and their larger counterparts are highlighted even more when their approaches to IT are considered. Khan and Khan [36] suggest that most SMEs avoid sophisticated software and applications. This view is supported by studies carried out by Chen [37], Cragg and King [38], Holzinger and Hotch [39] and Delvecchio[40]. In addition, the locations of the SMEs are also important. Gillespie et al. [33] note that the use of IT applications can vary in different regions of a country.

A combined study of Danish, Irish and Greek SMEs carried out in the early 1990's by Neergaard(1992) concluded that there were four main reasons for the acquisition of IT by SMEs. These were increased productivity, streamlining work procedures, better client service and better record keeping [41]. Fink and Tjarka (1994) in a study of Australian executives described their three reasons for IT acquisition as 'doing the right thing', 'doing things right' and 'improving the bottom line'[42].

Auger and Gallaugher (1997) noted that improvement in customer services and improvement to internal control of the business were strong criteria for E-commerce acquisition in SMEs [43]. The strong desire for control was also noted in studies carried out by Reimenschneider and Mykytyn (2000) [44], Poon & Joseph (2001)[45] and Domke-Damonte and Levsen (2002)[46]. A number of studies have found that some SMEs have adopted e-commerce nominating pressure from customers as one of the motivating criteria [44, 47].

In our view, SMEs' e-readiness is the ability of an SME to successfully adopt, use and benefit from information technologies (IT) such as e-commerce. It is related to the level of IT acquisition or adoption (especially e-commerce) by them. Many other studies have attempted to describe the factors influencing IT adoption in SMEs. For example, Iacovou et al. [65] studied factors influencing the adoption of electronic data interchange (EDI) by seven SMEs in different industries; they included

perceived benefits, organizational readiness, and external pressure. To measure perceived benefits they used awareness of both direct and indirect benefits. Variables measuring organizational readiness were the financial and technological resources. In order to measure external pressure, they considered competitive pressure and its imposition by partners. The results suggested that a major reason that small firms become EDI-capable is due to external pressure (trading partners). The adoption of the internet was also studied by Mehrtens et al.[66]. In order to develop a model of internet adoption, they conducted a case study on seven SMEs. They devised their model using perceived benefits, organizational readiness, and external pressure as determinant factors. All the factors were found to affect internet adoption by the small firms. Mirchandani and Motwani [67] investigated the factors that differentiate adopters from non-adopters of e-commerce in small businesses. The relevant factors included enthusiasm of top management, compatibility of e-commerce with the work of the company, relative advantage perceived from e-commerce, and knowledge of the company's employees about computers. The degree of dependence of the company on information, managerial time required to plan and implement the e-commerce application, the nature of the company's competition, as well as the financial cost of implementing and operating the e-commerce application were not influencing factors.

Barriers for E-commerce adoption by SMEs

However, SMEs confront some barriers for E-commerce adoption. Hadjimanolis (1999), in a study of E-commerce adoption by SMEs in Cyprus, considers that barriers to E-commerce adoption can be categorised as either external or internal to the organisation. External barriers include difficulties in obtaining finance, difficulties in obtaining technological information and difficulties choosing the appropriate hardware and software. He further nominates two other sub-categories of external barriers which he terms demand barriers and environmental barriers. Demand barriers include e-commerce not fitting with products and services offered or not fitting with the way their customers wished to conduct their business. Environmental barriers included complicated governmental regulations and security concerns. He subdivided his internal barriers into two categories. These he termed resource barriers (which included lack of management enthusiasm and lack of technical expertise) and systems barriers (which included e-commerce not fitting with current business practices)[48].
Lawrence (1997) defined three categories for E-commerce barriers in SMEs, company, personal and industry barriers. Company barriers, included low level of technology use within the business, limited financial and technical resources available, organizational resistance to change and lack of perceived return on investment. Barriers categorized as personal included lack of information on e-commerce, management preferring conventional approaches to business practice and inability to see the advantages of using e-commerce. Industry barriers included some respondents believing that the industry, as a whole was not ready for e-commerce technology [49].
Other studies have shown that many of the barriers reported in the late 1990's by Lawrence and Hadjimanolis are still current in today's SMEs. Tambini (1999)[50] and Eid et al (2002) [51] found that SME managers are still not convinced that e-commerce fits the products or services that their businesses offer. Studies by Bakos and Brynjolfsson (2000) [52], Sawhney and Zabin (2002) [53], and Merhtens et al (2001)[54] have found that there is still a reluctance for SME managers to adjust their businesses to the requirements and demands placed on it by e-commerce participation. Some of these barriers are summarized in table 3.

Benefits and motivations for e-commerce adoption by SMEs

The e-Commerce strategy for SMEs is perceived to offer many advantages. One great benefit of online business is that it lowers the cost of information delivery and transfer. There are no expensive brochures, so publishing and postage costs are reduced.
Another advantage is that Internet technology can be used as a marketing tool. It is an inexpensive way of providing catalogs, and new products or services can be advertised on the Internet immediately. Customers can access business content provided on the WWW instantly an unlimited number of times anytime

day or night. The Internet lowers the cost of market research. Potential or target customers can be reached in both local and international markets. Furthermore, an effective web site that is entertaining and which contains the information needed for buying decisions quickly enhances an organization's image and public recognition.

E-commerce offers greater returns on investment. Traditional storefronts are costly to build. The expenses include the purchasing or renting a premises, store decorations, labor, and products. On the other hand, the main expense in setting up an online storefront is the fee paid to web designers for developing web sites. The amount involved in the latter case is substantially less than the former.

Further, online business may lower costs in the long run such as lower costs for business transactions and lower cost for customer services are suggested. From the service perspective, product support or customer services on the Internet can be accessed instantly 24 hours a day. Web technology can be used to improve customer services and reduce costs[78].

The literature identifies a large volume of potential benefits from the adoption of E-commerce for SMEs. These may be divided into three main areas[77]:

- Cost savings, including lower logistic costs, lower postal cost, lower storage costs and lower personnel costs.
- Time savings, including quicker response time to markets, customers, suppliers, higher flexibility and a reduction in the delivery time and processing of payments
- Quality improvements, such as access to new markets, new ways of marketing new products.

Proposed model for assessment of ESME

E-readiness of SMEs (ESME) is related to the level of IT acquisition or adoption especially e-commerce by them. SMEs for achieving to a good level of e-readiness must remove the above mentioned barriers and also pay attention to the factors influencing IT adoption. Therefore, assessment model of ESME should be determined with regarding these barriers and also the factors affect IT adoption in SMEs. We consider the mentioned barriers and the factors influencing IT adoption in SMEs in seven groups which are, Telecommunication and technical infrastructure, Legal environment, Competitive pressure, Human resources and cultural infrastructure, Management and organizational policy, Communication with environment and finally, Information technology security.

Table 3: Some barriers to e-commerce adoption in SMEs.

Barriers	Reference
E-commerce doesn't fit with products/services	Eid et al [51] , Kendall et al [55] Tambini [50], Hadjimanolis [48]
E-commerce doesn't fit with the way we do business	Sawhney & Zabin [53],Mehrtens et al [54] Bakos & Brynjolfsson [52], Farhoomand et al [56],Poon & Swatman [57]
E-commerce doesn't fit the way our customers work	Bakos & Brynjolfsson [52],Hadjimanolis [48]
We don't see the advantages of using E-commerce	Lee & Runge [60],Chau & Hui [61] Purao & Campbell [59],Lawrence [49] Hadjimanolis [48]
Lack of technical know how	Mirchandani & Motwani [64], Hadjimanolis [48] Farhoomand et al [56], Purao & Campbell [59]
Security risks	Oxley & Yeung [63], Reimenschneider & McKinney [58] Purao & Campbell [59], Hadjimanolis [48]
Cost too high	Reimenschneider & McKinney [58] Ratnasingam [62] , Hadjimanolis [48] Purao & Campbell [59],Lawrence [49]
Not sure what hardware/software to choose	Farhoomand et al [56], Hadjimanolis [48]

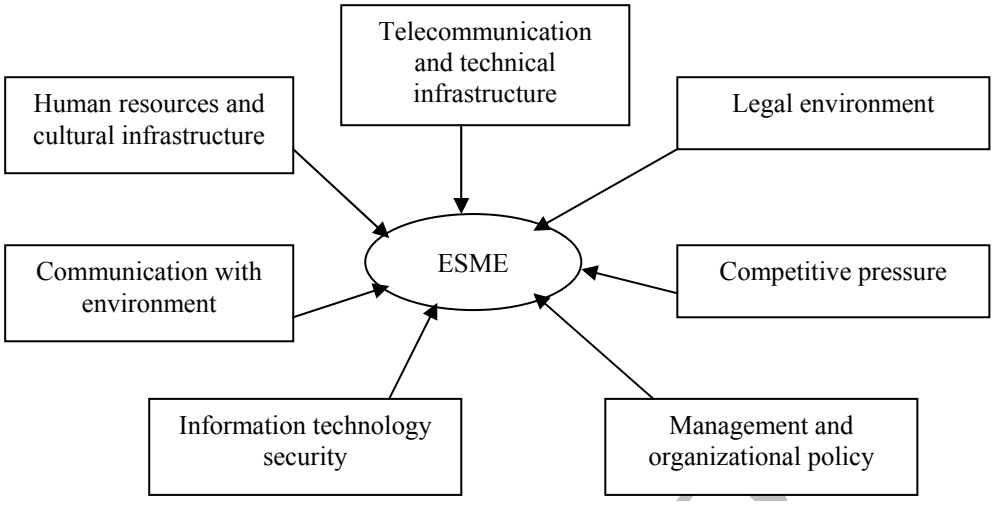

Figure1: Proposed model for assessment of ESME.

In this paper, we propose an assessment preliminary model of ESME with regarding the seven mentioned dimensions which are as follows (as shown in figure 1):

a. Telecommunication and technical infrastructure which determines the status of telecommunication and technical infrastructure in SMEs.

b. Legal environment which determines the required legal conditions for IT adoption in SMEs.

c. Human resources and cultural infrastructure that is related to the quality and quantity of IT workers and cultural circumstance for IT adoption in SMEs.

d. Management and organizational policy which determines status of organizational plans and management commitment for IT adoption in SMEs.

e. Communication with environment which determines the status of electronic communications with SME's stakeholders.

f. Information technology security which determines the status of IT security in SMEs.

g. Competitive pressure which influencing IT adoption in SMEs.

Research methodology

In the previous sections, the concept of e-readiness and its assessment models for countries on the macro level was introduced. In addition, we proposed an e-readiness assessment model for SMEs based on study of barriers and factors influencing IT adoption in SMEs.

In this research for validating the model, we use an exploratory Delphi study. The Delphi technique, which was developed by the Rand Corporation in the 1950s, is a data collection approach that is designed to structure group opinion [75]. A two-round Delphi technique was used to implement this research. Delphi panel members were selected amongst researchers and academics with experience in the use of IT and e-commerce applications within SMEs. A total of 100 members were identified as eligible for panel membership, and were mailed electronically invitation letter soliciting their participation in the research. A total 45 members volunteered to participate in two data collection rounds.

The goal of Round 1 was to validate the seven dimensions of the proposed model. Panelists were requested to respond to the following questions with regarding the seven dimensions (according to figure 1).

a- How important do you think it is to assess each dimension when assessing e-readiness of SMEs?

b- Are there any additional dimensions which should be added?

c- How do you arrange the dimensions according to their importance? In other words, how is the importance order of the dimensions?

Panel members receive Round 1 questionnaire along with a cover letter. We use a Likert-type scale for analyzing the questions, where 1=strongly unimportant, 2=unimportant, 3= neutral, 4=important, 5= strongly important. In addition, for calculating weight of the dimensions in comparison with each other, Eigenvector algorithm is used [76].

The main objective of Round 2 was to identify indicators by which to measure each of the dimensions of the proposed model validated in Round 1. In Round 2, panelists receive Round 2 questionnaire along with a cover letter and also a Round 1 summary report that included, validated dimensions and their importance ratings. Panelists were requested to respond to the following questions with regarding the validated dimensions.

d- How important do you think it is to assess each proposed preliminary indicator when assessing the related dimension?

e- Are there any additional indicators for each validated dimension which should be assessed?

f- How do you arrange the indicators of each validated dimension according to their importance? In other words, how is the importance order of the indicators?

We use a Likert-type scale for analyzing the questions, where 1=strongly unimportant, 2=unimportant, 3= neutral, 4=important, 5= strongly important. In addition, for calculating weight of the indicators in comparison with each other, Eigenvector algorithm is used [76]. The rating used to assess each dimension or indicator (item) is ranked according to the table 4. Also, one sample t-test is performed to test the value of population mean (μ) for determining rating of each dimension or indicator as follows:

a. First, all of items are tested with "$\mu \geq 4$". According to the table 4, accepted items receive strong rating (+++).

b. We will perform two tests " $3 \leq \mu$ "and "$\mu <$ 4" on unaccepted items in part a, the passed items receive medium rating (++).

c. Finally, remained unaccepted items in part b, will be tested with "$\mu < 3$". Accepted items receive weak rating (+). All items are tested at alpha = 0.05.

The dimensions or indicators that receive strong or medium rating are accepted as effective factors for assessment of ESME.(To analyze data the statistic package Minitab for Windows Software is used.)

Research results

In this research for validating the model, we used a two-round Delphi technique. The research results are as follows:

Round1 results

As indicated in Table 5, the average of importance assessment (mean) for the seven proposed dimensions ranged from 2.77 to 4.31. This table also shows that six dimensions receive strong or medium rating (mean $\geq$ 3) and one dimension receives weak rating. Therefore, the accepted dimensions include: Telecommunication and technical infrastructure, Legal environment, Human resources and cultural infrastructure, Management and organizational policy, Communication with environment and finally, Information technology security. Validated model for assessment of ESME will be according to figure 2.

Table4: Rating used to assess dimensions or indicators.

	Criteria	Assigned Rating
1	If the amount of the population mean is greater than or equal to 4, dimension or indicator has a strong effect.	+++
2	If the amount of the population mean is greater than or equal to 3 and less than 4, (3≤ mean <4) dimension or indicator has a medium effect	++
3	If the amount of the population mean is less than 3, dimension or indicator has a weak effect.	+

Table 5: Validation findings for Dimensions of the proposed model (n=45).

Dimensions of the proposed model	mean	stdev	p.value	rating
Telecommunication and technical infrastructure	4.31	1.30634	.069	+++
Legal environment	3.77	0.76541	1, 0.971	++
Human resources and cultural Infrastructure	4.20	1.33463	0.173	+++
Management and organizational policy	4.20	1.28793	0.141	+++
Communication with environment	3.75	0.98062	1, 0.949	++
Information technology security	3.88	0.76739	1, 0.849	++
Competitive pressure	2.77	1.16496	0.086	+

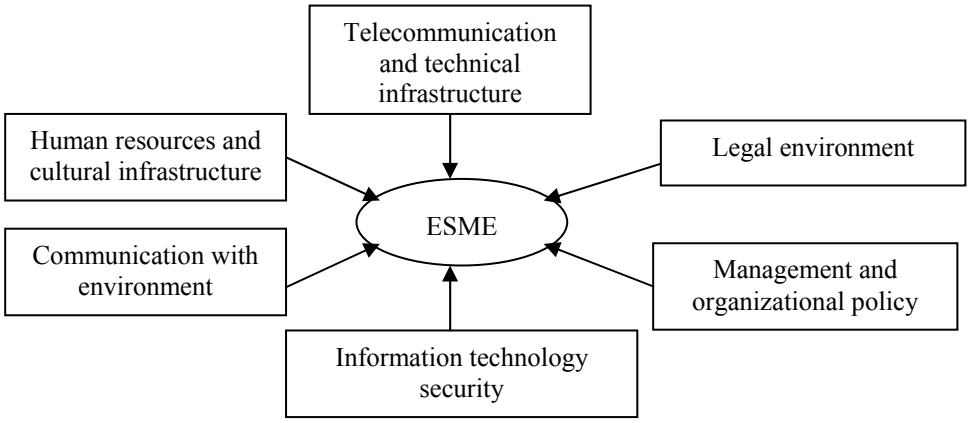

Figure2: Validated model for assessment of ESME.

Table 6: The relation between the validated model and macro level models.

Dimensions of the proposed model	E-readiness assessment models for countries (macro level models)
Telecommunication and technical infrastructure	APEC, CID, CSPP, EIU, NRI, UNDP, USAID, SIBIS, SIDA, MI, IDC, Mosaic
Legal environment	CID, APEC, ITU, USAID, SIDA, MI, CIDCM, EIU, NRI
Human resources and cultural infrastructure	CID, APEC, USAID, SIDA, MI, EIU, KAM, NRI
Management and organizational policy	CIDCM, EIU, NRI
Communication with environment	ITU, MI, CIDCM, EIU, NRI
Information technology security	CSPP, USAID, MI, EIU, SIBIS, NRI

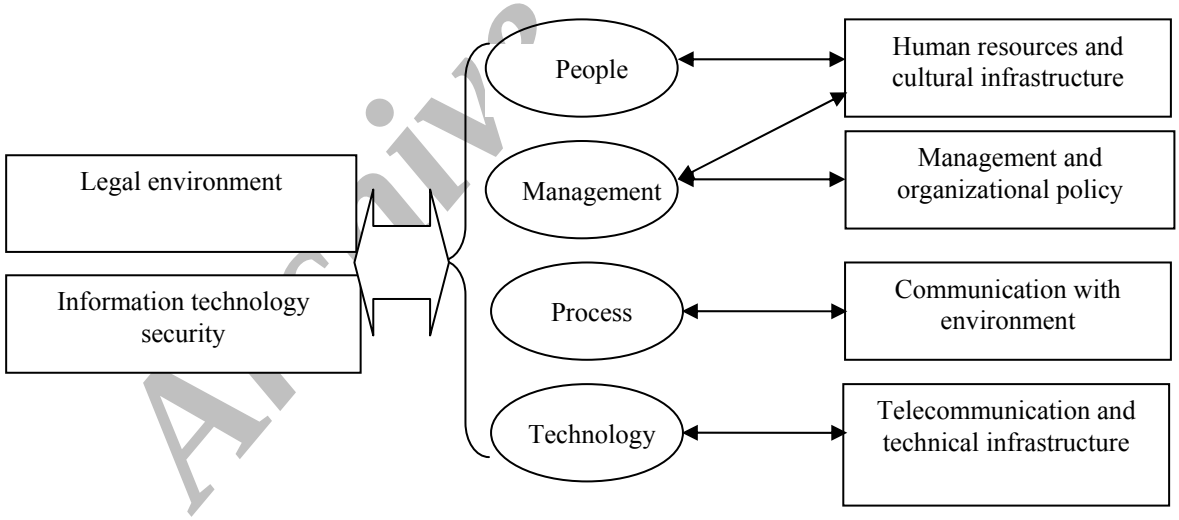

Figure 3: The relation between four key elements for successful implementation of technologies and the validated model.

As before mentioned, most of e-readiness assessment models are in national level and they mainly assess a country readiness for participation in the digital world. Some dimensions of the validated model have been considered for e-readiness assessment in macro level models according to table 6.

From other view, several research publications [68–71] and articles [72–74] indicate that people, processes and technology are the three key aspects that need to be considered for successful implementation of technologies (such as Information Technology). Processes enable and support the successful adoption of the technology and people should have adequate skills, understanding of, and belief in, the technology and finally, technology is tools and infrastructure necessary to support the

business functions. Emmett [74] states that the people, processes, and technology need a leader, just as an orchestra needs a conductor. The conductor in our subject is the management. To successfully implement and use any new technology it requires management buy-in and belief in order to plan and drive policies and strategies. Figure 2 shows the relation between the mentioned four key elements for successful implementation of technologies and the validated model.

Table 7, shows another result of Round1 that is related to calculating weight for dimensions of the validated model with using eigenvector algorithm. First, we make preference matrix. It is a reciprocal matrix which is made based on pair wise comparisons between pair of dimensions. Each element of the matrix is in the form $\frac{n_{ij}}{n_{ji}}$, n_{ij} is the number of experts that believe dimension i_{th} is more important than dimension j_{th}, and n_{ji} is the number of experts that believe dimension j_{th} is more important than dimension i_{th}. The weight of dimensions is calculated by eigenvector of the matrix [76]. (The sum of weights is equal to one)

Table 7: Calculating the weight for dimensions of the validated model (n=45).

Accepted Dimensions of the Model	Preference matrix						weight
Telecommunication and technical infrastructure	1.00	21.50	0.21	2.00	2.10	15.00	0.2846
Legal environment	0.05	1.00	0.11	0.11	8.00	0.17	0.0591
Human resources and cultural infrastructure	4.76	9.50	1.00	3.20	0.41	4.10	0.2607
Management and organizational policy	0.50	9.50	0.31	1.00	14.00	8.00	0.2229
Communication with environment	0.48	0.13	2.44	0.07	1.00	0.11	0.0723
Information technology security	0.07	6.00	0.24	0.13	9.50	1.00	0.1004

Table 8: Preliminary indicators for assessing the validated dimensions.

Indicator	Indicator Description
T1	Percentage of organizational parts that connected to the computer network
T2	Bandwidth of access to the local network
T3	Bandwidth of access to the internet
T4	Number of phone lines
T5	Number of computers
T6	Number of computers that connected to the internet
T7	The quality of supporting telecommunication and technical services
T8	The quality of hardware equipment of the network such as servers, modems, etc
T9	The reliability in access to computer services
L1	The adherence rate to the laws related to information technology such as: copyright law, intellectual property right, e-commerce act, etc.
L2	The adherence rate to the ethical issues in using computer services
C1	Percentage of electronic customers of enterprise
C2	Percentage of electronic communication with customers
C3	The quality of electronic communication with customers
C4	The quality of electronic communication with partners
C5	Percentage of electronic communication with partners
C6	The quality of electronic communication with suppliers
C7	Percentage of electronic communication with suppliers
C8	The rate of communication with the IT developer organizations(consultants, developers of websites, etc)
C9	Percent of organizational revenue which related to the electronic customers
C10	Possibility of electronic communication with outside organizations (the whole of business process such as negotiation, order, deliver, etc.)
C11	The quality of information systems and electronic information exchange in the organization (e-government of the organization)

Table 8 (con'd)

HC1	The level of information literacy of managers (level of computer skills)
HC2	The level of information literacy of employees (level of computer skills)
HC3	The level of information technology skilled literacy of employees such as percentage of employees that have high degrees in information technology related courses
HC4	The level of IT pubic acceptance (organizational environment)
MO1	Existence of organizational unit that is liable for IT development
MO2	Amount of investment by organization related to the IT development
MO3	Commitment and seriousness of management related to the IT development
MO4	Existence of strategy for IT development in the organization
MO5	Existence of clear plan and policy for IT development
I1	Existence of hardware and software infrastructure of information security in the organization such as firewall system, VPN, etc.
I2	Using of security mechanisms in the organization such as authentication, integrity, privacy, access control, etc.

Table 9: Validation findings for preliminary indicators (n=45).

Indicator	mean	Stdev	p.value	Rating
C1	2.9556	0.36739	0.650	+
C2	4.2444	0.90843	0.961	+++
C3	3.7778	0.76541	1.000، 0.971	++
C4	3.7556	0.98062	1.000، 0.949	++
C5	3.8889	0.76739	1.000، 0.849	++
C6	3.8667	0.86865	1.000، 0.846	++
C7	3.9333	1.11600	1.000، 0.691	++
C8	3.9778	1.07638	1.000، 0.890	++
C9	2.9333	0.81600	0.691	+
C10	3.9556	0.76739	1.000, 0.118	++
C11	4.0222	1.01105	0.883	+++
T1	4.3111	1.30634	0.929	+++
T2	2.2000	0.58793	0.141	+
T3	4.2000	1.33463	0.173	+++
T4	2.8222	0.62803	0.272	+
T5	4.2000	1.28793	0.141	+++
T6	3.9556	1.15370	1.000، 0.700	++
T7	3.7778	1.16496	1.000، 0.086	++
T8	4.1111	1.24540	0.390	+++
T9	4.0444	1.30634	0.761	+++
L1	4.2000	0.89443	0.141	+++
L2	4.1333	0.86865	0.309	+++
MO1	2.5111	0.32603	0.029	+
MO2	4.3111	0.59628	0.901	+++
MO3	4.4444	0.62361	0.127	+++
MO4	4.4000	0.61791	0.284	+++
MO5	4.0000	0.52223	0.900	++
I1	4.9189	0.27672	0.549	+++
I2	4.7568	0.43496	0.680	+++
HC1	4.4444	0.69267	0.669	+++
HC2	4.5111	0.69486	0.289	+++
HC3	2.3111	0.56343	0.669	+
HC4	2.5111	0.39267	0.289	+

Round 2 results

The main objective of the Round 2 was to identify validated indicators for the validated dimensions of the model. Table 8, shows the proposed preliminary indicators for assessing the validated dimensions. In this

table, T1 to T9 are preliminary indicators for assessing telecommunication and technical infrastructure, L1 and L2 are preliminary indicators for assessing legal environment, C1 to C11 are preliminary indicators for assessing communication with environment, HC1 to HC4 are preliminary indicators for assessing human resources and cultural infrastructure, MO1 to MO5 are preliminary indicators for assessing management and organizational policy, and finally, I1 and I2 are preliminary indicators for assessing information technology security.

As indicated in Table 9, the average of importance assessment (mean) for the proposed indicators ranged from 2.2 to 4.91. This table also shows that seven indicators receive weak rating (+) include C1, C9, T2, T4, MO1, HC3, HC4 and the others that are validated indicators, receive strong or medium rating.

Table 10, shows another result of Round 2, and is related to calculating weight for validated indicators and inserting the weight for validated dimensions that is extracted from table7.

Discussion

According to the study findings, the major six dimensions that should be considered for assessing of ESME consequently are telecommunication and technical infrastructure, human resources and cultural infrastructure, management and organizational policy, information technology security, communication with environment and finally, legal environment. Therefore, existence of strong telecommunication and technical infrastructure in small and medium enterprises, human resources and cultural climate familiar to IT usage and also management and organizational policy issues are the three most important dimensions for achieving a good level of e-readiness.

All or some of six validated dimensions have been considered in e-readiness assessment models in national level such as APEC, CSPP, NRI, etc.

Table 10: Calculating the weight for the validated indicators (n=45).

Dimensions	Indicator	Weight of indicator(W_i)	Weight of Dimensions(W_d)
Communication with environment	C2	0.1524	0.0723
	C3	0.0908	
	C4	0.1183	
	C5	0.0776	
	C6	0.1131	
	C7	0.1108	
	C8	0.118	
	C10	0.0712	
	C11	0.1478	
Telecommunication and technical infrastructure	T1	0.1301	0.2846
	T3	0.1755	
	T5	0.1689	
	T6	0.0823	
	T7	0.0798	
	T8	0.1779	
	T9	0.1855	
Information technology security	I1	0.5238	0.1004
	I2	0.4762	
Legal environment	L1	0.4949	0.0591
	L2	0.5051	
Human resources and cultural infrastructure	HC1	0.5025	0.2607
	HC2	0.4975	
Management and organizational policy	MO2	0.2963	0.2229
	MO3	0.2338	
	MO4	0.2461	
	MO5	0.2238	

Table 11: The average score for each SME.

Indicator	Sign	Weight of indicator(W_i)	SME1	SME2	SME3
C2	c1	0.1524	4.21	4.57	4.91
C3	c2	0.0908	4.61	4.72	4.83
C4	c3	0.1183	4.32	4.55	4.81
C5	c4	0.0776	4.54	4.64	4.83
C6	c5	0.1131	41	3.85	3.95
C7	c6	0.1108	4.53	41.6	4.95
C8	c7	0.118	3.11	3.51	3.14
C10	c8	0.0712	4.25	4.75	4.81
C11	c9	0.1478	4.61	4.92	4.92
T1	t1	0.1301	4.23	4.76	4.53
T3	t2	0.1755	5	4.90	4.81
T5	t3	0.1689	5	4.91	5
T6	t4	0.0823	4.81	4.31	4.6
T7	t5	0.0798	4.71	4.22	4.1
T8	t6	0.1779	4.92	4.81	5
T9	t7	0.1855	4.23	4.53	3.9
I1	i1	0.5238	4.84	4.31	4.12
I2	i2	0.4762	4.91	4.22	4.11
L1	l1	0.4949	4.45	4.24	4.1
L2	l2	0.5051	3.44	3.24	3.5
HC1	h1	0.5025	4.52	4.24	4.14
HC2	h2	0.4975	4.94	4.81	4.94
MO2	m1	0.2963	4.11	4.22	4.36
MO3	m2	0.2338	4.41	4.85	4.97
MO4	m3	0.2461	4.52	4.61	4.95
MO5	m4	0.2238	4.53	4.53	4.82

In addition, the research results determine 26 validated indicators for assessment of the six validated dimensions along with their weights (as shown in table 10). For the communication with environment, for example, some indicators such as percentage of electronic communication with customers, the quality of information systems and electronic information exchange in the organization, the quality of electronic communication with partners, the rate of communication with the IT developer organizations, the quality of electronic communication with suppliers and percentage of electronic communication with suppliers, have more weight.

Assessment of e-readiness for some Iranian SMEs

The model can be used for the assessment and comparison of e-readiness of the considered SMEs with measurement of the indicators and applying their weights and also dimensions' weights. For achieving this goal, we choose 3 Iranian SMEs which their working area is on e-commerce. We set a questionnaire and used a Likert-type scale for analyzing the questions, where 1=very weak, 2=weak, 3= neutral, 4=strong, 5= very strong. A detail of 3 SMEs is mentioned bellow. Managers of Companies fill the questionnaire and return it. We calculate the mean value of the indicators. Results are shown in table 11.

Description of SME1

This company has 120 employees .The main activity of SME1 is: performing e-commerce transactions, offering smart card and their security mechanisms, implementing RF/ID (Radio Frequency Identification) and tracking projects and barcode solutions.

Description of SME2

This company has 102 employees. The main activity of SME2 is: doing transactions such as selling product via internet, providing

software solutions (such as CRM, ERP solutions) and exporting software.

Description of SME3

This company has 98 employees .The main activity of SME3 is: Web Hosting, Web site design and development, Internet marketing and RFID/Smartcard system integration.

Values of each indicator for each company

Table 11 indicates the average score for each SME.

E-readiness assessment of the companies

We can use the relation 1 to measure the e-readiness for each SME. In this relation W shows weight of indicators and dimensions (W_d is weight of dimension).

After calculating the above formula for each SME we will have:

$V_{SME1}= 4.5$

$V_{SME2}= 4.29$

$V_{SME3}= 4.09$

The result shows SME1 is more ready than other two SMEs. Therefore, this company can successfully act for E-commerce adoption.

$$V_{SME_k} = \sum_{j=1}^{6} (\sum_{i=1}^{9} c_i \times w_{c_i} + \sum_{i=1}^{7} t_i \times w_{t_i} + \sum_{i=1}^{2} i_i \times w_{i_i} + \sum_{i=1}^{2} l_i \times w_{l_i} + \sum_{i=1}^{2} h_i \times w_{h_i} + \sum_{i=1}^{4} m_i \times w_{m_i}) \times w_{d_j}$$

For k=1..3 (1)

Conclusion

E-readiness of a small and medium enterprises is defined here as the ability of an SME to successfully adopt, use and benefit from information technologies (IT) such as e-commerce. In this paper, we proposed an assessment preliminary model of ESME with regarding to study of barriers and factors influencing IT adoption in SMEs and used an exploratory Delphi study for validating it. The study findings, showed the major six dimensions for assessing of ESME consequently are telecommunication and technical infrastructure, human resources and cultural infrastructure, management and organizational policy, information technology security, communication with environment and finally, legal environment.

The validated model used for the assessment and comparison of e-readiness of the considered SMEs with measurement of the validated indicators and applying their weights and also dimensions' weights.

Results show that SME1 has higher ranking than the others. This is due to providing essential infrastructure in this company. Then SME2 is in the level2 and SME3 is in the level3.

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