Application of Delphi Technique for Development of E-Readiness Assessment Model: A Study on Small and Medium Enterprises of Iran

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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 develops a model for measuring the e-readiness of SMEs (ESME) by an exploratory study using Delphi technique.

Keywords: E-readiness Assessment, Small and Medium Enterprise, Information Technology, Delphi technique, Iran.

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].

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 [24]. 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 ICTs 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 [26]. 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 [6]. McConnell International defines e-readiness as the capacity of nations to participate in the digital economy[7] 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

Table 1. Some of important e-readiness assessment models

Model Name	Author	Reference	Focus
Apec	The Asian Pacific Economic Cooperation (APEC) Electronic Commerce Steering Group	[6]	E-Commerce Readiness
CSPP	Computer Systems Policy Project	[26]	Existing Infrastructure
CID's	The Center for International Development at Harvard and IBM.	[8,9]	Society
McConnell International	McConnell International prepared this report in collaboration with World Information Technology and Services Alliance (WITSA)	[7]	Infrastructure, Digital Economy, Education and Government
MQ	Mosaic Group	[10, 11]	Internet
CIDCM's	University of Maryland, Center for International Development and Conflict Management	[12]	Qualitative Assessment based on past performance and current internet pervasiveness
EIU	The Economist Intelligence Unit	[13]	E-Business Readiness
IDC	World Times / IDC's Information Society Index	[14]	Infrastructure
KAM	World Bank, Knowledge Assessment Matrix	[15]	K-Economy
NRI	Center for International Development (CID) at Harvard and the World Economic Forum	[16]	Infrastructure, E-Society, Policies, Digital Economy, Education and Government
ITU	International Telecommunications Union's Internet Country Case Studies	[17]	Telecommunications
Sida	Swedish International Development Cooperation Agency (Sida)	[18,19]	Mainly SWOT analysis of a Nation
USAID	U.S. Agency for International Development	[20,21]	Access, Government, People

ICTs throughout businesses (e-commerce, local ICT sector), communities (local content, many organizations online, ICTs used in everyday life, ICTs 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[8,9].

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 [22] 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 [43], 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 [23]. Some researchers 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[23].

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. [44] 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.[45].

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)[29] and Eid et al (2002) [30] 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) [31], Sawhney and Zabin (2002) [32], and Merhtens et al (2001)[33] 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 2.

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.

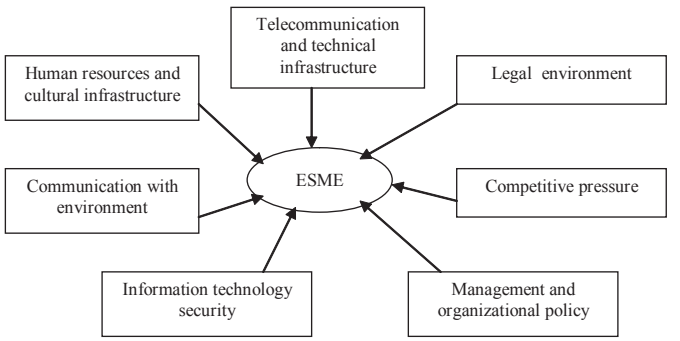
In this paper, we propose an assessment preliminary model of ESME with regarding the seven mentioned dimensions which are as follows (as shown in figure 1):

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.

Table 2. Some barriers to e-commerce adoption in SMEs

Barriers	Ref.
E-commerce doesn't fit with products/services	Eid et al [30] , Kendall et al [34] Tambini [29], Hadjimanolis [27]
E-commerce doesn't fit with the way we do business	Sawhney & Zabin [32],Mehrtens et al [33] Bakos & Brynjolfsson [31], Farhoomand et al [35],Poon & Swatman [36]
E-commerce doesn't fit the way our customers work	Bakos & Brynjolfsson [31],Hadjimanolis [27]
We don't see the advantages of using E-commerce	Lee & Runge [39],Chau & Hui [40] Purao & Campbell [38],Lawrence [28] Hadjimanolis [27]
Lack of technical know how	Mirchandani & Motwani [43], Hadjimanolis [27] Farhoomand et al [35], Purao & Campbell [38]
Security risks	Oxley & Yeung [42], Reimenschneider & McKinney [37] Purao & Campbell [38], Hadjimanolis [27]
Cost too high	Reimenschneider & McKinney [37] Ratnasingam [41] , Hadjimanolis [27] Purao & Campbell [38],Lawrence [28]
Not sure what hardware/software to choose	Farhoomand et al [35], Hadjimanolis [27]

Figure 1. Proposed model for assessment of ESME



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 stackholders.
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 [50]. 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.

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 [51]. Figure 2 shows the frame structure of this research.

The rating used to assess each dimension or indicator (item) is ranked according to the table 3. 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 3, 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.

Table 3. Rating used to assess dimensions or indicators

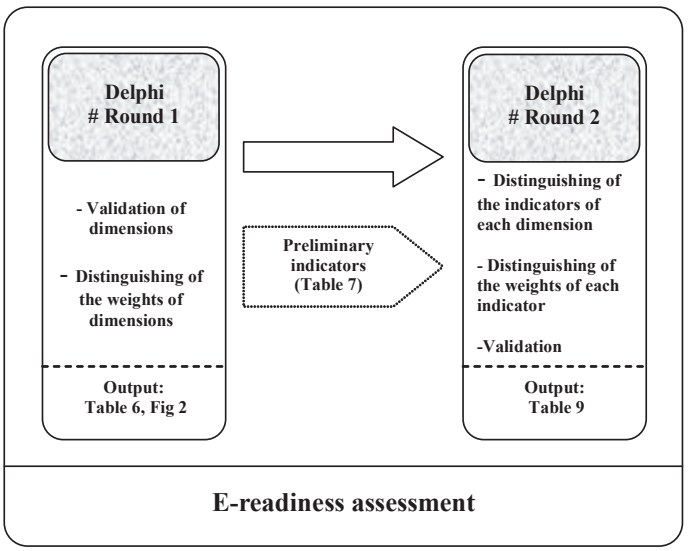
	Criteria	Assigned Rating
1	If the amount of the population mean is greater than or equal to 4, dimension or indicator has a strong effect.	+++
2	If the amount of the population mean is greater than or equal to 3 and less than 4, (3≤ mean <4) dimension or indicator has a medium effect	++
3	If the amount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

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

As indicated in Table 4, 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 ≥ 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 3.

Figure 2. Research structure



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 5.

Table 6, shows another result of Round 1 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 pairwise 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 ith is more important than dimension jth, and n_{ji} is the number of experts that believe dimension jth 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)

On the other hand, the main objective of the Round 2 was to identify validated indicators for the validated dimensions of the model. Table 7, 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 8, 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 9, shows another result of Round 2, is related to calculating weight for validated indicators of the dimensions with using eigenvector algorithm that explained before.

The model can be used for the assessment and comparison of e-readiness of the considered SMEs with measurement of the indicators (qualitative or quantitative) and applying their weights and also dimensions' weights. For achieving more exact results, it must be further examined especially for different categories of SMEs.

Table 4. 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	+

Table 5. 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

Table 6. 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

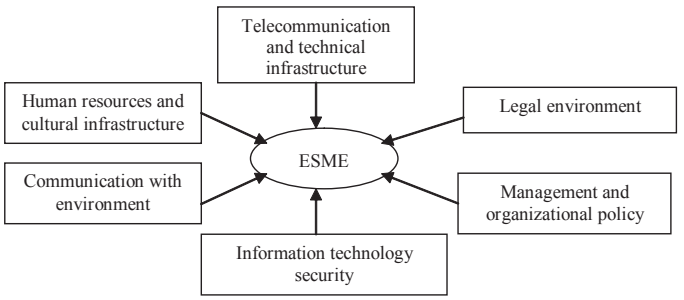
Table 7. Preliminary indicators for assessing the validated dimensions

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)
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 8. 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	+

Figure 3. Validated model for assessment of ESME



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 can be 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.

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