The Pros and Cons of Digital Divide and E-Readiness Assessments

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ABSTRACT

Evolving information and communication technologies (ICTs) have yielded new terms like “information society,” “digital divide,” and “e-readiness” which have attracted many scholars, practitioners, and policymakers. Therefore, in recent years numerous attempts have been done to develop e-readiness and digital divide models oriented toward certain objectives. In this research, these models are investigated with view to their definitions and methodologies, and their strengths and weaknesses are identified. These findings can help researchers and policymakers select the models that fit in with their objectives as well as identify the defects of previous models and rectify them in their own models. Moreover, the extensive literature review led to an integrated model which is proposed to assess the e-readiness of small and medium-sized enterprises (SMEs). Such a model can serve as a basis and standard for developing comprehensive models in SMEs.

Keywords: Composite Index, Digital Divide, E-Readiness, Information and Communication Technology, Small to Medium Sized Enterprises SMEs, Structural Modelling

INTRODUCTION

Thus far, information and communication technology (ICT) has developed considerably among countries and organizations and brought them many benefits. Even though ICTs have provided tremendous opportunities, it is generally acknowledged that they have also potential pitfalls, such as the digital divide. The digital divide concept initially emerged in media and government reports (e.g., “Fall-through the Net” and “A Nation Online”; NTIA, 1995; 1997, 1999, 2000, 2002, 2004) (Vehovar, Sicherl, Husing, & Dolnicar, 2006). The first scholarly papers on such a topic appeared around 1997 (Vehovar et al., 2006). As the information revolution has turned out to be a significant driver of the global economy, the digital divide has increasingly attracted researchers and policymakers (Dewan, Ganley, & Kraemer, 2004). But the first step in any approach to the digital divide problem is

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to consider a country’s ability or “readiness” to integrate information technology (IT) and e-commerce to provide a baseline that can be used for global and regional comparisons and planning. It is essential to understand what it means for a country or economy to be “e-ready” and conduct an evaluation based on objective criteria to establish basic benchmarks. Therefore, if a country is to narrow the digital divide, an understanding of where that country currently stands vis-à-vis the information society must be achieved, which is called “e-readiness.” Until now, various academic institutions, private organizations, and commercial publishers have put forward models for assessing and measuring e-readiness and the digital divide. These earlier measurements should be implemented for providing solid foundations for next stages of digital divide analysis and narrowing the gap. This paper addresses current widely diffused measurement instruments with the purpose of measuring e-readiness and the digital divide and their strengths and weaknesses.

DEFINING THE DIGITAL DIVIDE

There has been widespread debate about the definition of the digital divide and of the empirical analyses of its components (Barzilai-Nahon, 2006). The Organization for Economic Co-operation and Development (OECD) (2001) defined the digital divide as differences between individuals, households, companies, or regions related to the access to and use of ICT (Vehovar et al., 2006). The various factors may cause such a divide such as historical, socio-economic, geographic, educational, behavioral, generation factors, or the physical incapability of individuals. There are a myriad of studies that address the factors influencing the digital divide and the plentiful models that measure it in terms of different factors widening inequalities including income, occupation, gender and age, education, geographic centrality, ethnicity and race, religion, language, family structure, physical capacity, frequency, time online, purpose, skills and experience, autonomy, affordability, competitive market structure, ownership and density of computers and Web sites, communication infrastructure, equipment, social support, policy structure. In this paper, a brief focus is centered on some of the efforts that are more popular (for more information, see also Barzilai-Nahon, 2006).

In one study, DiMaggio and Hargittai (2001) pointed out that there are at least five factors of digital inequality: equipment, autonomy of use, skill, social support, and the purpose of using the Internet. Another framework, the MOSAIC model, was built as part of the “Global Diffusion of the Internet (GDI) Project” by Wolcott, Press, McHenry, Goodman, and Foster (2001). They examined the digital divide in terms of the diffusion of the Internet in a country based on six discrete valued factors: pervasiveness, geographic dispersion, sectoral absorption, connectivity infrastructure, organizational infrastructure, and sophistication of use. In addition, Corrocher and Ordanini (2002) quantified the digital divide as a multidimensional construct by combining multiple socio-economic factors into one. Their composite digitization index is based on six factors: markets, diffusion, infrastructures, human resources, competitiveness, and competition. Similarly, Mossberger, Tolbert, and Stansbury (2003) distinguished between an access divide, a skills divide, an economic opportunity divide, and a democratic divide. Orbicom (2005), the Network of United Nations Educational, Scientific and Cultural Organization (UNESCO) Chairs in Communications, advocated a framework for measuring the digital divide that develops concepts such as information density (info-density) and information use (info-use) (Sciadas, 2005). Finally, based on the TAI (UNDP) and the Industrial Development Scoreboard, Archibugi and Coco (2004) developed the ArCo Index, which consists of eight indicators that depend on three main factors: the creation of technology, infrastructure, and human development skills.
METODOLOGIES OF DIGITAL DIVIDE AND E-READINESS MEASUREMENT

The construction of a digital divide and e-readiness model is not unsophisticated; besides, the methodological challenges raise a series of technical issues that, if not addressed adequately, can lead to models being misinterpreted or manipulated. Hence, we will focus on these essential methodological issues that are associated with any empirical research on the digital divide and e-readiness. Examining the efforts made to identify the digital divide and e-readiness, it points out that the most widespread methodology that has been used by scholars and practitioners to measure and analyze the digital divide and e-readiness is to construct a composite index from indicators, such as the Internet Connectedness Index (Jung, Qiu, & Kim, 2001), the Technology Achievement Index (TAI) of the United Nations Development Programme (UNDP, 2001), the Information Society Index (ISI) (IDC, 2001), the synthetic index of digitalization presented by Corrocher and Ordanini (2002), the Digital Access Index (DAI) of the International Telecommunication Union (ITU) (2003), the Network Readiness Index (NRI) (Dutta & Jain, 2004), the ArCo Index (Archibugi & Coco, 2004), the Digital Divide Index (DIDIX) (Husing & Selhofer, 2004), the Info-state (Sciadas, 2005), the Digital Opportunity Index (DOI) (ITU, 2005), and two telecommunication and ICT infrastructure indices developed recently by Hanafizadeh, Saghaei, and Hanafizadeh (2009) and Almutawkkil, Heshmati, and Hwang (2009). A composite index integrates different kinds of indicators, that is, qualitative parameters with quantitative parameters, and hard data with soft data. Therefore, central to the construction of a composite index is the need to combine different indicators and dimensions measured on different scales in a meaningful way. This implies a decision as to which weighting model will be used and which procedure will be applied to aggregate the information (Nardo, Saisana, Saltelli, & Tarantola, 2005).

A few modelers, such as Sciadas (2005), never used any weights for aggregation of their indicators and dimensions. He introduced the notion of a country’s “ICTization” or Info-state, as the aggregation of Info-density and Info-use. The Info-state was developed based on an unweighted geometric average of 21 indicators that assessed 192 countries for nine years (Sciadas, 2005). In contrast to this index, most researchers have employed weighted aggregations to build their indices.

In many composite indices, all variables are given the same weight when there are no statistical or empirical grounds for choosing a different scheme. Equal weighting could imply the recognition of an equal status for all indicators (e.g., when policy assessments are involved). Alternatively, it could be the result of insufficient knowledge of causal relationships, or ignorance about the correct model to apply, or even stem from the lack of consensus on alternative solutions. The DOI is an example that used this methodology for constructing its model. The DOI was devised, as the United Nations (UN) World Summit on the Information Society (WSIS) (2003) recognized an urgent need for improving the measurement capabilities for ICT investment, adoption, and impact (ITU, 2005). This composite index utilized a set of eleven indicators and assigned an equal weight to create a single value that can be compared to other countries. Another example of these indices is the NRI, which includes three dimensions, and each dimension is further disaggregated into equally weighted sub-indices and variables. The TAI, which was proposed in a recent Human Development Report by the UNDP (2001), also assigned equal weight to its dimensions. Moreover, Archibugi and Coco (2004) constructed a new indicator (ArCo) of technological capabilities based on the equal weighting of its three dimensions. Likewise, The Bulgarian e-readiness assessment model (index) (2002) was defined as an average value of the four dimensions. In this model, each dimension was defined as an average value of several indicators and each indicator was quantified based on an average value of hard
data and soft data. However, when using equal weighting, a variable might occur to be double counted in the composite index by combining variables with high degree of correlation. For example, indicators of the telephone lines and the percentage of households that have a phone line installed in the Bulgarian e-readiness assessment model, indicators of (fixed) broadband Internet subscribers and (mobile) broadband Internet subscribers in the DOI, indicators of internet penetration and telephone penetration in the ArCo index and finally indicators of mean years of schooling and gross enrolment ratio of tertiary students enrolled in science, mathematics and engineering in the TAI, highly correlated but were assigned equal weight. In addition to the aforementioned problems, in most cases it is not advisable to assign the same weight to the indicators which are not of equal importance, for example, “teledensity” is more important than “ISDN connectivity.”

Modelers have used experts’ opinions, who are aware of policy priorities and theoretical backgrounds, to reflect the multiplicity of stakeholders’ viewpoints and weight indicators and dimensions. For example, in July 2001, the Ministry of the Information Industry of the People’s Republic of China built the national informatization quotient (NIQ) (Jin & Chengyu, 2002) based on the opinions of the experts. The NIQ is a composite index based on twenty indicators in six dimensions, which were weighted based on experts’ opinions. In other words, the NIQ uses a subjective expert evaluation for determining the weights of the different dimensions, which are summed to give the final index value. Bui, Sankaran, and Sebastian (2003) applied the same weight for calculating the e-readiness value for each country. In this index, the weight assigned to each indicator reflects the analyst’s view of how important or influential that criterion is relative to the entire set of 52 indicators for a particular country based on its overall economy. Therefore, in this case, assigning weights is also a subjective process. Moreover, the Economist Intelligence Unit (EIU) (2009) that has developed a composite index to rank e-readiness in 60 to 70 countries annually since 2000 and has applied this method to determine how each of its six dimensions influences overall e-readiness of countries. Another ICT readiness index measure, the DAI, was developed by the ITU (2003), around five main factors that were weighted based on the same method as the EIU. One of the main drawbacks of this method is that modelers may not have access to the experts. Even, in some cases, there are a few experts, that is, fewer than 30; accordingly, the outcome of a composite index and countries ranking in a benchmarking exercise is not robust. It is worth mentioning that such a method is of limited use when the number of variables of the model, in turn, the number of questions rises. For instance, in the case of Bui’s et al. composite index, they calculated e-readiness values for the various countries by assigning the equal weight to each indicators in their paper since the number of indicators, those the experts should weight was high (52 indicators), despite the fact the equal weight method was proposed in their methodology (Bui et al., 2003). Finally, owing to the fact that this weighing process is based on individuals’ perceptions, it may be dubious.

To avoid these limitations, modelers use regression approach that is suitable for a host of variables of different types. In such models, (usually linear) multiple regression models are estimated to retrieve the relative weights of indicators. Enormous endeavors have been made in this context such as studies done by Beilock and Dimitrova (2003), Caselli and Coleman (2001), Chinn and Fairlie (2004), Dasgupta, Lall, and Wheeler (2001), Dewan et al. (2004), Guillen and Suarez (2001), Hargittai (1999), Norris (2001), Oxley and Yeung (2001), Pohjola (2003), Quibria, Ahmed, Tschang, and Reyes-Macasquit (2003), Robison and Crenshaw (2001), Shih, Kraemer, and Dedrick (2003), and Wallsten (2003), to name but a few. This approach, although lends itself to numerous variables, implies the assumption of linear behavior and requires the independence of explanatory variables. Indeed, if these variables are correlated, estimators will have high
variance; as a result, parameters estimates will not be precise and hypothesis testing will not be powerful. In the extreme case of perfect collinearity among regressors, the model will not even be identified. This problem arises specifically about ICT indicators, which are very likely to lead to overlapping information. Such indicators would be hard to reconcile in the context of econometric models and their estimations for the purposes of associational and causal explanations would not of practical use.

Nearly in all studies listed above, unfortunately the authors apply correlated explanatory variables to evaluate IT penetration and digital divide, so the obtained validity and accuracy results decline. Examining a dataset of OECD countries in 1998, Hargittai (1999) concludes that, while GDP is a large driver of Internet connectivity, telecommunications policy can also have a large effect that is correlated with the telephone density level. Similarly, Oxley and Yeung (2001) studied 30 countries in the same year and found out that Internet host penetration was positively associated with physical communication infrastructure, rule of law and credit card use, while negatively correlated with telephone service costs. What was neglected in this model is the high correlation between variables of communication infrastructure and telephone service costs, which calls the results into question. Robison and Crenshaw (2001) examine the level of economic development, political openness/democracy, mass education, the presence of a sizeable tertiary/services sector as drivers of Internet diffusion. They do a cross-sectional analysis of 74 countries over 1995–1999, using the number of Internet hosts per ten thousand people as their dependent variable. They deduced that Internet penetration is driven most significantly by development level, political freedom, and education. But education and level of economic development are closely related, so the presence of both of these variables in the model without considering their correlations may bias the findings.

Beilock and Dimitrova (2003) examined the impact of GNP, including the log and exponential forms, the level of civil liberties, infrastructure and regional variables on internet use in a sample of 105 countries from a dataset published in 2000. They noticed that GNP is “by far” the most important determinant and that the relationship appears to be non-linear, and that increasing civil liberties have a positive and significant impact even in the presence of infrastructure advantages. Hanafizadeh, Saghaei, et al. (2009) state that “a close correlation exists between ICT infrastructure and GDP per capita.” This finding can demonstrate high correlation between variables used in the model presented by Beilock and Dimitrova. Wallsten (2003) used a 45-country data set from 2001 to conduct a cross sectional analysis of similar variables as mentioned in the previous studies on two dependent variables, the number of Internet users and the number of Internet hosts per capita. He focused on variables of regulatory regime characteristics and price regulation, and found out that the more formal and controlled a country’s regulatory system, the fewer Internet users and hosts. Similarly, Guillen and Suarez (2001) studied the number of Internet hosts and the number of Internet users per capita, using a matched set of independent variables in a cross section of 141 countries in 1998/1999. They incorporated variables associated with telecommunications policy and infrastructure, as well as two predictable policymaking and a democracy indices that are indicative of an environment conducive to entrepreneurship. They came to the conclusion that policy variables have an impact when the entrepreneurship variables aren’t taken into account, but lose their effect when they are. Dasgupta et al. (2001) examined Internet use in a sample of 44 countries from 1990-1997, but used the measure of Internet hosts/telephone mainlines as the dependent variable. They conducted a log-log regression against measures of the baseline (1990) value of the ratio, the urban population, income per capita, and an index of competition policy and some regional dummies. They concluded that the ratio is significantly and positively related to policy and percentage urban population, and negatively related to the baseline value. Despite
other studies, income per capita was not found to be significant. Using a different and novel approach to the problem, Norris (2001) examined the dispersion of Internet use by grouping the information on Internet use in over 100 countries into a “New Media Index,” and comparing it with an “Old Media Index” representing the distribution of radio, TV sets, and newspaper readership in each nation. She inferred that the two are highly correlated, and concluded that the basic non-technology problems of access to earlier communications technologies, such as illiteracy and government policy controls, are also applied with respect to Internet access. In this model, also, radio, TV sets, and newspaper readership are correlated variables that should be considered. There are a few studies that examine more than one technology concurrently. Quibria et al. (2003) examined a data set of more than 100 countries in 1999 that included counts of personal computer (PC) and Internet use per capita. They found that GDP, education levels, and infrastructure play critical roles in the levels of these and other information technologies.

Chinn and Fairlie (2004) used the same two dependent variables with a panel of 161 countries over the 1999–2001 period. They deduced that GDP, telephone density, and regulatory quality (as measured by an index assessing market friendly policies) are important determinants of PC and Internet density. In the two recent models, GDP is highly correlated with education levels, infrastructure and telephone density; if such a fact is not taken into consideration, it may harm the accuracy of findings. Another stream of research has used approaches akin to economic growth models to study the problem at hand. Pohjola (2003) examined a data set over 1993–2000 that included measures of income per capita, the relative price of IT equipment, human capital measures, the share of agriculture and openness to international trade. He stated that IT investment is tightly related to income measures and human capital, and inversely related to the importance of agriculture in the economy. Caselli and Coleman (2001) undertook an extensive longitudinal cross-country study of IT use, examining 89 countries from 1970–1990. They used a measure of computer imports/worker ratio as a proxy for the investment in IT, and regressed a large set of explanatory variables on the measure in a cross-sectional regression. They observed that openness to imports from OECD countries, the level of educational attainment, and the index of property rights are statistically significant. Using a flexible accelerator investment model, Shih et al. (2003) studied 39 countries from 1985–1999. They found that there is a positive correlation with the existing stock levels of IT capital, GDP, and education levels, and a negative correlation with interest rates. As it can be seen, the prior studies focused on some specific variables to evaluate IT penetration and digital divide such as the number of Internet hosts and the number of Internet users per capita. In summary, the findings are consistent: national income and infrastructure are important factors in IT penetration levels, and depending on the countries examined, education and policies are also of significance. Dewan et al. (2004) examined the determinants of the digital divide as closest to the analysis of Chinn and Fairlie (2004) described above. While the Chinn and Fairlie (2004) study is restricted to data on PC’s and Internet over the 1999–2001 period, they considered three generations of IT (mainframes, PC’s and Internet), and tracked the evolution of the divide, using suitable metrics, over the substantially longer period of 1985–2001. Further, they considered multiple measures of IT penetration, defined on the basis of both per capita and per income, whereas the earlier study just considers the former construct. Finally, they went beyond the panel regression analyses of Chinn and Fairlie (2004) to conduct quantile regressions, in order to gain a more complete understanding of the sometimes complex relationship between IT penetration and its determinants. In later models (see Caselli & Coleman, 2001; Dewan et al., 2004), also, we can see variables such as GDP per capita, density of main telephone lines and telephone subscription cost that have correlations together and applied in the regression model for analyzing IT penetration.
As it was mentioned before, the use of the correlated variables in regression models reduces the validity of the findings; to tackle such a problem, a useful method for is to use factor analysis (FA) to determine the key constructs and to identify the redundant indicators. Another remedy can be found associating principle components analysis (PCA) with regression analysis. One of the famous studies in this case is the composite index of digitalization presented by Corrocher and Ordanini (2002). They used the PCA to combine factors influencing digitization into an index of digitization. Also, Hanafizadeh, Saghaei, et al. (2009) and Al-mutawwkil et al. (2009) constructed a composite index using Multi-Stage FA and Common FA, respectively, for measuring and analyzing the divide among countries in the area of ICT infrastructure.

As it was already discussed, digital divide and e-readiness indices are often presented as static measures. However, static measures of disparities (e.g., percentage difference, ratio, Gini coefficient, Theil index, coefficient of variation, etc.) are insensitive to changes in the corresponding absolute magnitude of the indicator growth rates. In order to overcome such a problem, an advanced time distance methodology was developed at conceptual and applied levels (Vehovar et al., 2006). This is a new statistical measure in dynamic gap analysis (Sicherl, 2004) where the levels of variable(s) are used as identifiers and time is the focus of comparison. For instance, Selhofer and Husing (2002) used a time-and-distance method for integrating different factors to respond to this question that whether the effect of women’s participation in the economy is additive to the density of installed base of telephones or to the “brain drain.” Similarly, in 2006, Vehovar et al. demonstrated how the use of a specific time-distance measure could result in a meaningful representation of the relative dynamics in ICT deployment. Lee, Gholami, and Tong (2005) used time series analysis to examine the nexus between the ICT and the economic growth. The study showed that the significance of ICT contribution to economic growth is only “in many developed countries and Newly Industrialized Economies (NIEs), but not in developing countries” (Lee et al., 2005).

In described static measures, models and indices are constructed based on correlations between variables. However, correlations among variables reflect the past behavior of a system—construct that we want to study and measure it (Sterman, 2000). Correlations do not represent the structure of the system. If circumstances change, if previously dormant feedback loops become dominant, if new policies are tried, previously reliable correlations among variables may break down. Modelers found system dynamic models (causal models) as a valuable tool to tackle this limitation (Sterman, 2000). In these models, relationships among variables are causal, no matter how strong the correlation, how high the $R^2$ (determinate coefficient), or how great the statistical significance of the coefficients in a regression may be. Among the dynamic models, the logistic model is widely used to explain and predict the diffusion of new products and innovations, and the Internet, in particular. A study in which a logistic model was used is that of Kiiski & Pohjola (2001). They, using a Gompertz model of technology diffusion that is a special case of the logistic model, examined the diffusion of the Internet from 60 countries over 1995–2000. Likewise, Wolcott et al. (2001) presented a comprehensive framework for describing the diffusion of the Internet in a country by using this model (Wolcott et al., 2001). Moreover, the Index of the Massachusetts Innovation Economy that measures progress of three key components of the Massachusetts Innovation Economy—results, innovation process, and resources—is based on a dynamic conceptual framework that links resources to economic results through an innovation process (Massachusetts Technology Collaborative, 2003).

Finally, some researchers such as Mutula and van Brakel (2006a), Barzilai-Nahon (2006), Hanafizadeh, Hanafizadeh, and Khodabakhshi (2009a), and Hanafizadeh, Khodabakhshi, and Hanafizadeh (2009) using an extensive literature survey of digital divide and e-readiness models, constructed integrated models. These
models can be exploited as a basis and a standard for developing comprehensive models and frameworks.

WHAT IS THE GAP OF E-READINESS ASSESSMENTS?

The literature on e-readiness assessments discloses the fact while numerous studies have been conducted on assessing countries’ e-readiness—a macro perspective—few have attempted to evaluate it from a micro perspective (Barzilai-Nahon, 2006; Hanafizadeh, Hanafizadeh, and Khodabakhshi 2009b; Mutula & van Brakel, 2006b; Rizk, 2004). E-readiness assessment at the macro-level means assessment at the international and national level or country, government, policy levels and at the micro level denotes assessment of levels of sectors, community, public systems, enterprises, organizations, institutions, and individual levels (consumers) (Barzilai-Nahon, 2006; Corrocher & Ordanini, 2002; Dewan & Riggins, 2005; Mutula & van Brakel, 2006a; Rizk, 2004). Further, even in these scarce endeavors, the construction of the most of the models (and the choice of the indicators behind it) is not driven by sound theoretical and policy concerns, but rather driven by the simple willingness to provide an empirical measure for e-readiness (Ramayah, Yan, & Sulaiman, 2005; Rizk, 2004). In other words, in the development of the models, the modelers often confuse “what is needed” with “what is available” in terms of data. They start their design process with variables and indicator levels and thereby enter the “loop of decision makers”; they are trying to come up with factors that are measurable, and they overlook what is truly meaningful in any particular context. To tackle these problems, we proposed an integrated model that measure e-readiness of SMEs—one of the most important of (in many countries the most important of) economic sectors at the micro level—based on defining and conceptualizing the e-readiness at this level and subsequently operationalize this definition.

The definition of SMEs varies in different countries. For the purposes of the research, we adopt the new SME definition published by European Commission in 2005 (Table 1).

WHY FOCUS ON SMEs?

Involvement in a networked economy is one of the new challenges that are encountered by SMEs today and has unfortunately left many them behind in the race toward a networked economy. While big organizations can generally muster the resources needed for the networked economy, the challenge is in getting SMEs to work around their resource and skills shortages in ICT. Since it is expensive for SMEs to train and retain ICT workforce, they are suffering from lack of ICT technically staff. Resources needed for investment in ICT must compete with demands from the shop floor and the rate at which technology changes tends to make any investment in ICT un-remunerative from an SME perspective. Yet, in the age of globalization, the leveraging of ICT by SMEs remains crucial.

Although limited resources are a distinguishing characteristic of SMEs and thus as a barrier, to many, they offer counter-balancing

Table 1. SME thresholds

<table>
<thead>
<tr>
<th>Enterprise category</th>
<th>Headcount: Annual Work Unit (AWU)</th>
<th>Annual turnover</th>
<th>Annual balance sheet total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium-sized enterprise</td>
<td>&lt; 250</td>
<td>≤ € 50 million</td>
<td>≤ € 43 million</td>
</tr>
<tr>
<td>Small enterprise</td>
<td>&lt; 50</td>
<td>≤ € 10 million</td>
<td>≤ € 10 million</td>
</tr>
<tr>
<td>Micro enterprise</td>
<td>&lt; 10</td>
<td>≤ € 2 million</td>
<td>≤ € 2 million</td>
</tr>
</tbody>
</table>

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advantages as well. An obvious advantage is that small and medium-sized companies are usually more entrepreneurial and willing to experiment and innovate in terms of business models and operations than larger organizations with established hierarchies. Thus, government initiatives aimed at increasing the e-readiness of SMEs can result in a higher level of national competitiveness in this crucial sector.

Since SMEs fulfill an important role in economic growth and in campaign against unemployment in countries, various endeavors have been channeled to ensure that they remain globally competitive. In the United Nations Conference on Trade and Development (UNCTAD), SME’s account for 60 to 70% of all employment in developing countries (UNCTAD, 2002). Ninety-nine percent of all businesses in North America and Europe are SMEs (Jutla, Bodorik, & Dhaliwal, 2002). In the enlarged European Union of 25 countries, some 23 million SMEs provide around 75 million jobs and represent 99% of all enterprises (European Commission, 2005). In this intensely changing and competitive market, the decision-makers, particularly the chief executive officers and chief financial officers in SMEs, have difficulties in evaluating and adopting Internet strategies. Many factors affect decision-making in the adoption of Internet and managers’ awareness of the SMEs’ level of e-readiness that can help them make better decisions. In the next section, we will build a model included various factors that can be used to assess their SME’s capacity to participate in the networked world and make the necessary preparations to involve in a networked economy.

DEFINING E-READINESS AT DIFFERENT LEVELS: TOWARD AN INTEGRATED SME E-READINESS ASSESSMENT MODEL

As stated previously, e-readiness can be viewed and defined from two perspectives: macro-level and micro-level. The concept of e-readiness from macro perspective, originated as a result of an attempt to provide a unified framework to evaluate the breadth and depth of the digital divide between the developed and developing countries during the later part of the 1990s. This concept from micro perspective has been given impetus by the rapid rate of Internet penetration throughout the world, and the dramatic advances in IT applications in business and industry (Mutula & van Brakel, 2006a).

The first efforts in defining e-readiness were undertaken from a macro perspective in 1998 by the Computer Systems Policy Project (CSPP). CSPP defined e-readiness as the degree to which a community is prepared to participate in the networked world (CSPP, 1998). Since the development of the first e-readiness definition, Centre for International Development (CID) at Harvard University (2000) with the support of International Business Machines (IBM) (CID, 2000) and the INSEAD, the World Bank and the World Economic Forum (WEF) (Kirkman, Osorio, & Sachs, 2002) developed the same definition as the CSPP. From the same perspective and in contrast to these measures that focus on community’s readiness for participating in the networked world, Asian Pacific Economic Cooperation (APEC) in 2000, McConnell International (MI) in 2001 and Association of Southeast Asian Nations (ASEAN) in 2001 defined e-readiness as the degree to which an economy or community is prepared to participate in the digital economy (for more definitions see Hanafizadeh et al., 2009b). Providing general insights into the countries’ e-readiness, macro studies at the same time suffer from a major drawback: the choice of factors and their relative weights may vary from one country to country. Relative measures and country rankings may ignore internal variations within a country, as such could be misleading. Micro studies are therefore recommended as they capture many of the factors that may escape macro analysis, and hence offer a more accurate picture (Rizk, 2004). From the latter perspective, e-readiness can be defined as “the level of preparedness pertaining to the ability of exploiting Internet technology for economic purposes through
the rapid adoption of e-business” (Jutla et al., 2002). Most studies carried out from a micro perspective are associated with e-readiness assessment of SMEs in a country (e.g., in Egypt, India, Korea, Canada, Malaysia, Iran, etc.) and there are others which are pertinent to companies and financial organizations’ e-readiness assessment. In the study of Hartman, Sifonis, and Kador (2000), net readiness is measured as a company’s preparedness to exploit the enormous opportunities in the e-economy landscape. Grant (1999) asserted in his maturity model where a business is “ready” to implement e-business and e-commerce strategy, with the business plans and expectations clear, with no insurmountable obstacles impeding progress, and have identified any needed partners or professional support. Another report by Parker (2000) described e-readiness as “preparedness” to operate in an e-business and e-commerce marketplace.

In this paper, we would like to propose a way to conceptualize the factors influencing SMEs e-readiness—one of the most important sectors relating to literature of e-readiness at micro level—and devise an integrated model that can be used as the basis for their measurement. To do so, 56 international and reputable e-readiness models were selected with regard to the three following criteria:

- **Scientific backing of the model**: There have been several models that assess e-readiness. Some of them were constructed exclusively for assessing a sector of the economy of a specific country (e.g., Bulgaria, Romania, etc.) and have been not used and referred to by any other books, conference papers, working papers, White papers, journal papers, or any other scholarly and official reports. Since these models have been not supported by any scientific references, in this paper, we eliminated these models from selected models for drawing factors and indicators influencing e-readiness.

- **The use of the models that measure e-readiness at micro level**: Since the purpose of the present article is to develop a model for assessing SMEs’ e-readiness that are one of sectors at micro level, we discard models that measure e-readiness of countries—those assess e-readiness at macro level—and confine to those which focus on e-readiness of a sector of the economy, that is, businesses, organizations, institutions, and so forth.

- **Access to the model information**: In this study, access to the information of the model is used as one of the main criteria for selecting a proper model. In some cases, there is not enough information on indicators or factors of the model (e.g., Davidrajuh, 2007; Davidrajuh & Tvedteras, 2006); therefore, we discard these models from the selected models.

The literature on micro e-readiness assessment reveals some common factors (factors on which the majority of researchers have consensus) influencing e-readiness of micro perspective. Table 2 illustrates these factors and their sources drawn from the numerous theoretical, empirical, and summary attempts at defining and measuring the e-readiness at micro level.

Using common factors in Table 2, an integrated model is constructed shown in Figure 1.

Each and every of the factors presented in Figure 1 is an index by itself and was chosen after an extensive literature survey. To measure each factor through benchmarking the studies presented in Table 2, some common indicators are extracted.

In the literature of e-readiness, modelers and theorists have selected indicators and variables to map onto their models using the previous studies or their own opinions. However, due to the high number of extracted indicators, it is not practical here to employ experts’ opinion. In this study, the knowledge and the information...
of e-readiness models is exploited as experts’ (modelers’) opinions. To this end, first all indicators proposed by the models indicated in Table 2 are extracted. Then, content analysis, a quantitative approach taken by counting the frequency of phenomena within a case in order to gauge its importance comparing to other cases (Walliman, 2001), is used; indicators that have been presented at least in two models (at least with the frequency two) were selected as common indicators for assessing SME e-readiness. It is noteworthy that the frequency of indicators in the models was identified based on their definitions, that is, two indicators with different titles but the same definition were assumed as one indicator. In view of adopting the criterion of the existence of the indicator in at least two models, first of all, there is no need for data to extract indicators; second, some models have been built for measuring e-readiness of organizations of a specific country or region (see Al-Solbi & Mayhew, 2005; Van Belle & Vosloo, 2005). Since the selected indicators exist in at least two models and were not limited to a specific model, indicators assessing a certain country or region were not selected as common indicators. Therefore, selected indicators are appropriate to assess e-readiness and measure digital divide between all countries and regions.

The full list of e-readiness indicators for each factor is presented in Appendix.

**Method of Computation of E-Readiness Indices**

The e-readiness indices are a system of synthetic indicators. The main objective in constructing these indices is to reduce the multiple dimensions of the Information Society to a limited set of synthetic measures. The advantages of such an approach include 1) the employment of synthetic indicators is a prerequisite for establishing time series and respectively for analyzing and assessing change, and 2) synthetic indicators facilitate the public presentation of the results of the assessment, thus making analysis easier to perceive.

The method used to construct the e-readiness indices involves a number of steps:

- **First**, the value of each indicator is measured on a 4- or 5-point scale. The scales were created with the following approach in mind: the most developed enterprises were studied and their approximate level was taken as the highest possible; then, the interval was split into five thus giving a linear scale. Most commonly two types of scales are used: one with top level of...
100% (for long-time available service such as telephone lines) and one with top level of 40% (for newer services such as EDI). In some occasions custom scales were used, mainly for high-tech issues.

- **Second**, a rank is assigned to each indicator value using the following procedure:
  
  **A. With 5-point scales:** a rank of 1 is assigned to the first value, a rank of 3 to the second value, a rank of 5 to the third value, a rank of 7 to the fourth value and a rank of 10 to the fifth value.

  **B. With 4-point scales:** a rank of 1 is assigned to the first value, a rank of 4 to the second, a rank of 7 to the third and a rank of 10 to the fourth value.

The purpose of these ranks is to ensure compatibility between different scales.
and present the indicator values in the range 1-10.

- **Third**, different variables are divided in two groups depending on their importance to SMEs' e-readiness assessment. The level of importance is measured on a 2-point scale (“medium” and “high”) based on expert assessment. High-importance variables are weighted by 2 in the computation of the indices.

- **Fourth**, the respective ranks (depending on the real value of a given variable) is multiplied by the importance coefficient of the variable (the weighted coefficients are as follows: “medium importance” w=1 and “high importance” w=2).

- **Fifth**, the values are aggregated in synthetic indicators in several factors. The value of each index is computed as a sum of the weighted ranks of the respective variables included in a given factor. Each index summarizes the values of several variables and is presented in a statistically normalized form: from zero to 10. Values closer to zero indicate a “low level” of e-readiness in the respective factor, and those closer to 10 a “high” state of e-readiness.

Finally, the composite e-readiness index is computed as an average value of the indices for different factors (see Appendix).

**CONCLUSION**

On the one hand, the rapid rate of ICT penetration throughout the world, coupled with dramatic advance in its use in business and society, has created an extensive literature on various aspects of digital divide and e-readiness. Consequently, plentiful models and tools were constructed to measure these aspects. Appreciating the significance of evaluating these concepts on the part of researchers and policymakers, there continues to be more and more research on this topic. On the other hand, the models and indices can send misleading or non-robust policy messages if they are poorly constructed or misinterpreted. The construction of indices involves stages where judgment has to be made: the selection of indicators, the choice of a conceptual model, the weighting of indicators, and so forth. All these sources of subjective judgment will affect the message brought by the indices in a way that deserve analysis and corroboration. Therefore, if we want to receive robust and valid results and messages from our assessments of the e-readiness and the digital divide that imitate the real world as closely as possible, recognizing drawbacks of the existing assessments models, we need to move toward the more accurate and precise models.

In this article, perusing the extensive literature of digital divide and e-readiness assessments, their strengths and weaknesses from conceptualization and methodological standpoints were identified. Recognizing and classifying these strengths and weaknesses is handy, since it can make valuable contribution to researchers and top-level decision-makers to use or construct e-readiness and digital divide model.

One of the most challengeable gaps in literature of e-readiness is that most e-readiness studies have been confined to macro (national) assessments and ignored sectoral-level environments. But even these few studies neglect the stage of the definition and specification of e-readiness at this level. Decision makers often fall into the trap of seeking data that exist, instead of putting in the effort to first systematically conceptualize the digital divide and e-readiness, operationalize it as appropriate to the context, and only then collect data. In the present paper, reviewing the literature of e-readiness at micro level, we extracted the common factors influencing e-readiness one of the main sectors of this level that is SMEs and presented a conceptual model for assessing e-readiness it.

It is acknowledged that the contribution of the paper is currently restricted to a theoretical construct because empirical studies have yet to be carried out with various SMEs that have agreed to collaborate in the research. Empirical testing of the proposed model is expected to demonstrate how fieldwork data can be used to...
support the indicators and the indices that have been presented here. By using case studies in SMEs to test and ultimately formulate a new research base, further questioning and debate can take place around the framework. Future work on this research includes the need to empirically validate the presented framework and develop more indices for SMEs e-readiness assessment. Last but not the least, this article contributes to scarce e-readiness literature at micro level and the presented model can be used as a basis and a standard for developing a comprehensive model of SMEs e-readiness assessment.

REFERENCES


APPENDIX

Definitions of SME E-Readiness Assessment Model and Indexes

The SME E-readiness Assessment Model is defined as an average value of the following indexes: *Infrastructure and Connectivity, Human Resources, Networked World Enablers, IT Applications, ICT Use, Barriers to ICT Use, External Environment Readiness.*

**Index 1. Infrastructure and Connectivity** is defined as follows:
Infrastructure and Connectivity = average of survey data

Survey Data

1. Value of IT investment. (Jutla et al., 2002; Macintyre & Ramnarine, 2003; World Bank, 2004)
2. Value of investment in ICT infrastructure (Jutla et al., 2002; Rizk, 2004)
3. How many PCs do you have? Please classify by type of microprocessor. (Jerman-Blaič, 2008; Keen, 1991; Macintyre & Ramnarine, 2003; Mutula and van Brakel, 2006b; Rizk, 2004; Van Belle & Vosloo, 2005; World Bank, 2004)
4. Do you have network access? If yes, please answer Questions 4-12. If no, please go to Question 13. (APEC, 1999; Keen, 1991; Macintyre & Ramnarine, 2003; Van Belle & Vosloo, 2005; World Bank, 2004)
5. What types of network access facilities do you have? (Jerman-Blaič, 2008; Kasraian, 2007; Keen, 1991; Kleindl, 2000; Mehtrens et al., 2001; Mutula & van Brakel, 2006a; Ramsay et al., 2003; Rizk, 2004; Van Belle & Vosloo, 2005; World Bank, 2004)
   a. Internet;
   b. Intranet;
   c. EDI;
   d. Extranet access to other enterprises.
6. If you have access to Internet, then which of the following access methods do you use? (APEC, 1999; Jerman-Blaič, 2008; Keen, 1991; Macintyre & Ramnarine, 2003; Mehtrens et al., 2001; Mutula & van Brakel, 2006a; Mutula & van Brakel, 2006b; Rizk, 2004; World Bank, 2004)
   a. Dial-up modem;
   b. ISDN;
   c. DSL;
   d. Cable modem;
   e. Leased line;
   f. Others.
7. If you have internal communication, then which of the following access means do you use? (Aminial, 2007; APEC, 1999; Keen, 1991; Kleindl, 2000; Macintyre and Ramnarine, 2003; Mutula & van Brakel, 2006b; Rizk, 2004; Van Belle & Vosloo, 2005)
   a. E-mail;
   b. Fax;
   c. Telephone;
   d. Others.
8. If you have external communication, then which of the following access means do you use? (Aminial, 2007; APEC, 1999; Kasraian, 2007; Keen, 1991; Kleindl, 2000; Macintyre and Ramnarine, 2003; Mutula & van Brakel, 2006b; Rizk, 2004; Van Belle & Vosloo, 2005)
a. E-mail;
b. Fax;
c. Telephone;
d. Others.

9. Do you have a Web site or home page? If yes, please answer questions 10 and 11. (Barua et al., 2000; Jutla et al., 2002; Kasraian, 2007; Mutula & van Brakel, 2006b; Rizk, 2004; Van Belle & Vosloo, 2005; World Bank, 2004)

10. Please provide the following information about your home page: (Barua et al., 2000; Jerman-Blaič, 2008; Macintyre & Ramnarine, 2003; World Bank, 2004)
   a. What is the URL?
   b. Who designed and commissioned your Web site?
   c. Who and how maintains your Web site?
   d. Who hosts your Web site?
   e. What security arrangements are in place to prevent unauthorized access or modification of your Web site?
   f. How many people visit your Web site per day?

11. What activities are possible by visiting your home page and Web site? (Barua et al., 2000; Jerman-Blaič, 2008; Kasraian, 2007; Macintyre & Ramnarine, 2003; World Bank, 2004)
   a. Obtain information about your products;
   b. Obtain financial and operating information about your enterprise;
   c. Place and modify orders on your enterprise;
   d. Track status of orders, production and shipment;
   e. Exchange delivery and payment data;
   f. Identify and research our suppliers;
   g. Others.

12. How often is the content on your Web site of enterprise updated? (Aminali, 2007; Kasraian, 2007)

13. If you do not have a home page or network access, please tick all the reasons for not having a home page or network access: (Aminali, 2007; World Bank, 2004)
   a. Not useful for doing business with major suppliers and buyers;
   b. Cannot afford development and maintenance costs;
   c. Technology is complex;
   d. Internal business procedures are not ready for effective use of network enabled business processes.

14. Ability to generate local content (Barua et al., 2000; Fathian et al., 2008; Jutla et al., 2002; Macintyre & Ramnarine, 2003; Mutula & van Brakel, 2006a; Van Belle & Vosloo, 2005)

15. Allocating adequate resources in terms of time, staff and budget to the development of ICT strategy projects and for information management functions (Aminali, 2007; Fathian et al., 2008; Jerman-Blaič, 2008; Kasraian, 2007; Macintyre & Ramnarine, 2003; Mutula & van Brakel, 2006a)

16. How much of the expenditure is allocated to (Aminali, 2007; Moodley, 2001; World Bank, 2004)
   a. In-house activities;
   b. External purchases.

17. Current ICT and Information infrastructure is adequate for supporting the functions of e-commerce tools (Aminali, 2007; Fathian et al., 2008)
18. ICT networks use standard interchange protocols and industry standard information syntax and semantics to connect, and navigate and manage our shared information assets (Fathian et al., 2008; Kasraian, 2007).


Index 2. Human Resources is defined as follows:

Human Resources = average of survey data

Survey Data

1. Ability to evaluate information and its sources (Horrocks & Haines, 2004; Mutula & van Brakel, 2006a)
2. Ability to organize information (Horrocks & Haines, 2004; Mutula & van Brakel, 2006a)
3. Ability to manage and maintain information (Barua et al., 2000; Mutula & van Brakel, 2006a)
4. Ability to access, analyze, and use information (Barua et al., 2000; Mutula & van Brakel, 2006a)
5. The employees have the necessary levels of IT literacy, functional expertise and skills to use e-commerce tools (Aminali, 2007; Fathian et al., 2008; Van Belle & Vosloo, 2005)
6. Employees recognize the benefits of the use of e-commerce applications, trends, options and models and well organized and managed information (Aminali, 2007; Kasraian, 2007; Mutula & van Brakel, 2006a)
7. Diversity of staff ICT educational qualifications and skills (Attaran, 2001; Fink, 1998; Kwon & Zmud, 1987; Macintyre & Ramnarine, 2003; Mutula & van Brakel, 2006a)
8. Senior management levels of awareness toward ICTs (Aminali, 2007; Doukidis et al., 1994; Mutula & van Brakel, 2006a)
9. Ability of management to determine the organization’s IT needs and communicate the organization’s IT needs to internal or external IT resources (Kasraian, 2007; Mutula & van Brakel, 2006a)
10. Chief executive ICT educational qualifications and prior ICT experience (Aminali, 2007; Doukidis et al., 1994; Macintyre & Ramnarine, 2003; Mutula & van Brakel, 2006a)
11. Information management skills available in the enterprise (Kwon & Zmud, 1987; Macintyre & Ramnarine, 2003; Mutula & van Brakel, 2006a)
12. Lifelong education and training programmes (Doukidis et al., 1994; Kasraian, 2007; Macintyre & Ramnarine, 2003; Mutula & van Brakel, 2006a)
13. Employees are flexible and adaptable to continuously changing business and technological environments, opportunities and challenges. (Aminali, 2007; Kasraian, 2007)
14. Percentage of enterprise’s staffs using of following applications and services: (Doukidis et al., 1994; Fathian et al., 2008; Jutla et al., 2002; Kasraian, 2007)
   a. Knowledge management applications;
   b. Supply chain applications;
   c. Customer relationship management applications;
   d. Online government services;
   e. Stripped-down ERP-type applications (e.g., MS White Plains);
   f. Security applications;
   g. Human resource applications.
Index 3. Networked world enablers is defined as follows:
Networked world enablers = average of survey data
Survey Data

1. E-readiness/information strategy, policy and action plan (Aminali, 2007; Fathian et al., 2008; Grant, 1999; Kasraian, 2007; Mutula & van Brakel, 2006a; Mutula & van Brakel, 2006b)
2. Information /ICT strategy revision plans (Grant, 1999; Mutula & van Brakel, 2006a)
3. Information security and disaster recovery plans (Grant, 1999; Kasraian, 2007; Mutula & van Brakel, 2006a; Mutula & van Brakel, 2006b)
4. Capacity building strategies incorporating information management (Kasraian, 2007; Mutula & van Brakel, 2006a)
5. Security, privacy and reliability of network to support e-commerce (Ainin & Rohana, 2000; Barua et al., 2000; Fathian et al., 2008; Goodwin, 1991; Gupta, 1995; Janes et al., 1997; Kasraian, 2007; Lawrence et al., 1998; Macintyre & Rammarine, 2003; Mutula & van Brakel, 2006a; Norazah, 2001; Ramanathan, 1999; Tan & Teo, 1998)
6. Consumer protection policy commerce (Ainin & Rohana, 2000; Barua et al., 2000; Mutula & van Brakel, 2006a)
7. Top management commitment in developing and implementing enterprise’s e-business strategy. (Aminali, 2007; Fink, 1998; Kasraian, 2007; Mutula & van Brakel, 2006a; Ramayah et al., 2005).
8. Organizational culture is well suited for e-commerce adoption and use (Aminali, 2007; Macintyre & Rammarine, 2003).

Index 4. IT applications is defined as follows:
IT applications = average of survey data
Survey Data

1. Adoption and deployment of Electronic Data Interchange (EDI),Internet-based procurement and other e-commerce tools to improve our overall business and project performance (Aminali, 2007; Barua & Lee, 1997; Clark & Stoddard, 1996; Drury & Farhoomand, 1996; Hart & Saunders, 1998; Iacovou et al., 1995; Massetti & Zmud, 1996; Mukhopadhyay et al., 1995; Premkumar & Ramamurthy, 1995; Riggins & Mukhopadhyay, 1999; Srinivasan et al., 1994; Zaheer & Venkatraman 1994)
2. For which of the following applications do you use digital technology? (Aminali, 2007; Barua et al., 2000; Fathian et al., 2008; Hashem, 2001; Jain, 2005; ; Jerman-Blaič, 2008; Kasraian, 2007; Mutula & van Brakel, 2006b; Ramayah et al., 2005; World Bank, 2004)
   a. Word Processing
   b. Network related activities
   c. Accounting and Budgeting
   d. Financial Planning, Management and Control
   e. Production Planning, Management and Control
   f. Billing and invoicing
   g. CAD/CAM
   h. Marketing and Customer Relations Management (CRM)
   i. Logistics and Supply Chain Management (SCM)
   j. Enterprise Resource Planning (ERP)
   k. Inventory management
1. Group collaboration
m. Scheduling
n. Outsourcing activities
o. Call centre systems
3. Please list the main operating systems and software packages used by you and for what purpose (please also include customized software packages) (Barua et al., 2000; World Bank, 2004)
4. Mechanism and standards formats to organize, collect, store and retrieve information (Barua et al., 2000; Jutla et al., 2002; Mutula & van Brakel, 2006a)
5. Means of sharing and disseminating information within and outside the enterprise (Mutula & van Brakel, 2006a, 2006b)
6. Mechanism for information systems analysis, design and implementation (Mutula & van Brakel, 2006a)
7. Diversity of computer technology and information system used and their ease of use (Jerman-Blaič, 2008; Mutula & van Brakel, 2006a)

**Index 5. ICT use** is defined as follows:
ICT use = average of survey data

**Survey Data**

1. For which of the following purposes do you use the network access facilities? (Aminali, 2007; Barua et al., 2000; Jerman-Blaič, 2008; Kasraian, 2007; Macintyre & Rammarine, 2003; Moodley, 2001; World Bank, 2004)
a. E-mail;
b. Business information and business research;
c. Place orders;
d. Make payments;
e. Receive orders;
f. Receive payments;
g. Send a bill;
h. Exchange business process data with suppliers and buyers;
i. Submit requests and applications to government agencies;
j. Receive approval from government agencies.
2. Are there Transactions involving ICT? If yes please answer below Questions. (Evans & Wurster, 1997; Fathian et al., 2008; Rizk, 2004)
3. What are these Transactions? (Barua et al., 2000; Evans & Wurster, 1997; Jerman-Blaič, 2008; Kotler, 2003; Rizk, 2004)
a. E-Procurement;
b. Sales;
c. Maintenance, Repair and Operations (MRO);
d. Order Tracking;
e. Quality Control;
h. Others.
4. Which of the following purpose do you use of ICTs (especially Internet) (APEC, 2000; Barua et al., 2000; Engler, 1999; Gray and Lawless, 2000; Jain, 2005; Jerman-Blaič, 2008;
Macintyre & Ramnarine, 2003; Mutula & van Brakel, 2006a; Ramayah et al. 2005; Ramsay et al., 2003; Rizk, 2004; Minton, 2003; Moodley, 2001; Payne, 1996):

- In marketing
  - a. Marketing/Advertisement (e.g., Catalog, Product Description, Detailed Specifications, Price, Discount, etc.);
  - b. Sales;
  - c. Pitches;
  - d. Offers;
  - e. Research & Development (R&D);
  - f. Receive Purchases;
  - g. Other.
- In production
  - a. Ware-Housing;
  - b. Sampling;
  - c. Quality Control;
  - d. Production Tracking;
  - e. Assembling Operations;
  - f. Planning Line Loading;
  - g. Markers (Plotter Printing);
  - h. Pattern Making and Grading;
  - i. Design and Creation;
  - j. Research & Development (R&D).
- In management and staffs
  - a. Production Planning and Control;
  - b. Internal & External Communication;
  - c. Financial and Administrative Activities;
  - d. Human Resources;
  - e. Communication with Consumer or Supplier;
  - f. Order Processing and Follow Up;
  - g. Identifying, Storage and Retrieval of Information;
  - h. Human Resources (HR) Management;
  - i. General Management;
  - j. Training.

5. Frequency of the use of ICT systems (Jerman-Blaič, 2008; Mutula & van Brakel, 2006a)

6. What percent of your sales can be classified as e-commerce sales? (An e-commerce sale in this context means that all the steps of order fulfillment—order booking, processing, shipping, payment is done via Internet or EDI). (Barua et al., 2000; Kotler, 2003; Macintyre & Ramnarine, 2003; Rizk, 2004; World Bank, 2004)

7. What types of IT services do you outsource? (Jerman-Blaič, 2008; World Bank, 2004)
  - a. Systems Design;
  - b. Hardware Acquisition;
  - c. Software Design (including pre-packaged software);
  - d. Hardware Maintenance;
  - e. Systems and Software Maintenance;
  - f. Data Processing;
  - g. Web Development and Web-Hosting;
  - h. Services Provided by Application Service Providers (ASPs).
8. Impact of use of ICT on for example productivity, profitability, and cost reduction (Engler, 1999; Mutula & van Brakel, 2006a)

**Index 6. Barriers to ICT use** is defined as follows:
Barriers to ICT use = survey data

Survey Data

1. Please rank the following barriers to developing ICT and ICT use in decreasing order of importance: (Attaran, 2001; APEC, 1999; Fink, 1998; Khader, 2005; Lawrence et al., 1998; Macintyre & Ramnarine, 2003; Moodley, 2001; Mutula & van Brakel, 2006b; OECD, 2000; Rizk, 2004; Sulaiman & Jani, 2001; World Bank, 2004)
   a. Lack of in-house technological and business expertise to identify and develop IT and network applications;
   b. Cost of adapting and integrating existing business processes to IT and networked enabled processes;
   c. Technical difficulty in adapting and integrating existing business processes to IT and networked enabled processes;
   d. Cost of running a dual system: paper-based system and an e-commerce system;
   e. Limited use of e-commerce among your major customers;
   f. Lack of finance to deploy new technologies;
   g. Concern about security and privacy/ Lack of secure payments settlement mechanisms;
   h. High cost of third party technology and consulting services;
   i. Uncertainty about authentication mechanisms;
   j. Shortages of trained and skilled IT personnel;
   k. Unwilling Personnel;
   l. Lack of standards;
   m. Difficulty to plan / Choose Application;
   n. Shortage of local community and business Web content;
   o. Lack of understanding of electronic commerce techniques and the technology needed to use it;
   p. The high cost of computers;
   q. Lack of adequate e-commerce infrastructures (e.g., Limited and poor-quality bandwidth, Limited quality telecommunication access);
   r. High cost of internet connectivity;
   s. Inadequate legislative framework;
   t. Frequent internet downtime;
   u. High taxation;
   v. Inadequate technical support.

**Index 7. External Environment Readiness** is defined as follows:
External Environment Readiness = 5/27 Hard Data + 22/27 Survey data.

Hard data

1. Maximum broadband transmission speeds (APEC, 1999; Jutla et al., 2002; Macintyre & Ramnarine, 2003)
2. Number of Internet hosts (APEC, 1999; Jutla et al., 2002)
3. Internet access costs (APEC, 1999; Hong, 2002; Jutla et al., 2002; Macintyre & Ramnarine, 2003)
4. Wireless access costs (APEC, 1999; Jutla et al., 2002; Macintyre & Ramnarine, 2003)
5. Broadband access costs (APEC, 1999; Jutla et al., 2002; Macintyre & Ramnarine, 2003)

Survey data

6. Broadband penetration (APEC, 1999; Fathian et al., 2008; Jutla et al., 2002; Macintyre & Ramnarine, 2003)
7. Cable penetration (APEC, 1999; Jutla et al., 2002; Macintyre & Ramnarine, 2003)
8. Telephone penetration (APEC, 1999; Jutla et al., 2002; Macintyre & Ramnarine, 2003)
9. Quality of cable connection (APEC, 1999; Fathian et al., 2008; Jutla et al., 2002; Macintyre & Ramnarine, 2003)
10. Quality of Telephony (APEC, 1999; Jutla et al., 2002; Macintyre & Ramnarine, 2003)
11. Quality of broadband connection (APEC, 1999; Fathian et al., 2008; Jutla et al., 2002; Macintyre & Ramnarine, 2003; Mutula & van Brakel, 2006a)
12. Availability of cable service (APEC, 1999; Fink, 1998; Jutla et al., 2002; Macintyre & Ramnarine, 2003)
13. Availability of hardware and software (APEC, 1999; Fathian et al., 2008; Fink, 1998; Jutla et al., 2002)
14. Availability of online service (Barua et al., 2000; Fink, 1998; Fathian et al., 2008; Jutla et al., 2002; Macintyre & Ramnarine, 2003)
15. Adequacy and affordability of bandwidth (Internet) (APEC, 1999; Fathian et al., 2008; Jutla et al., 2002; Macintyre and Ramnarine, 2003; Mutula & van Brakel, 2006a)
16. Affordability of hardware and software (APEC, 1999; Fathian et al., 2008; Jutla et al., 2002; Macintyre & Ramnarine, 2003)
17. Scalability of network infrastructure (APEC, 1999; Jutla et al., 2002; Macintyre & Ramnarine, 2003)
18. ICTs affordability from the service providers (Macintyre & Ramnarine, 2003; Mutula & van Brakel, 2006a)
19. Enabling legislative and regulatory frameworks (Jutla et al., 2002; Macintyre & Ramnarine, 2003; Mutula & van Brakel, 2006a)
20. Legal and regulatory framework to address information management issues such as (Fathian et al., 2008; Hong, 2002; Jutla et al., 2002; Kasraian, 2007; Mutula & van Brakel, 2006a)
   a. Intellectual property rights
   b. Legal and regulatory mechanism for e-commerce
   c. Freedom of information legal and regulatory framework
21. Adequacy and reliability of national power grid (Kasraian, 2007; Mutula & van Brakel, 2006a)
22. Government support (Kasraian, 2007; Macintyre & Ramnarine, 2003; Mutula & van Brakel, 2006a)
   a. Government Education system can provide adequately trained personnel to engage in e-commerce;
   b. Awareness rising by planning Government demonstration programs and public profile of electronic commerce misrepresented the dynamics of ecommerce and raised dubious expectations;
c. Government provision of online electronic services had a positive effect in drawing our customers and suppliers into the e-commerce environment.

23. Financial supports for R&D, diffusion or uptake were sufficient to encourage the organization to engage in electronic commerce. (Kasraian, 2007; Mutula & van Brakel, 2006a)

24. National information and ICT policy (Macintyre & Ramnarine, 2003; Mutula & van Brakel, 2006a)


26. Taxation regime (Jutla et al., 2002; Macintyre & Ramnarine, 2003; Mutula & van Brakel, 2006a)

27. Competition policy in ICT areas (Macintyre & Ramnarine, 2003; Mutula & van Brakel, 2006a)

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(by Murrell G. Shields) into Persian. It is noteworthy that Hanafizadeh was introduced as the best researcher of Tehran province by the Ministry of Science, Research and Technology and at ATU in 2007. He has seriously worked for developing information systems in Iran. He has been the executive of the national project entitled “Preparing and compiling ICT development indicators in Iran and proposing methods for collecting their statistics”.

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