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Determinants of firms' digital divide: A review of recent research

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Abstract

Organizations should implement information and communication technologies (ICT) to their business activities in order to achieve competitive advantage, but not all of them are ready to do that, which results in the digital divide (DD) between them. Although a number of review papers on the level of DD among citizens, households and nations have been published ; review papers dealing with DD among firms are scarce. This paper aims to overcome the gap by presenting a review of published papers on the DD among firms. Papers extracted from the journals indexed in the Web of Knowledge have been studied in terms of the geographical area, type of firms, time frame of the study measurement of DD, and impact, order and determinants of DD.

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1. Introduction

The notion of the digital divide (DD) was first introduced in the 1990s when researchers wanted to explain the difference between having or not having, using or not using computers and Internet (Yu, 2006). Early research on the DD was oriented towards infrastructure, availability and affordability of computers and Internet usage (Barzilai-Nahon, 2006; van Dijk, 2006). Present-day studies measure the DD using indicators such as: ICT sector development, ICT market development, ICT penetration and ICT usage in households, ICT usage in

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enterprises, ICT education development, and ICT government (Cilan, Bolat & Coskun, 2009). Barzilai-Nahon (2006) reports on a number of studies dealing with the DD and prominent integrated indices for measuring the DD: SIBIS (a project of the European Commission), DIDIX (Digital Divide Index), Digital Access Index (made by International Telecommunication Union), and Network Readiness Index (part of the Global Information Technology Report).

There are many definitions of the DD, but the term refers to the gap between individuals, companies, regions and countries when accessing and using information and communication technology (Cilan, Bolat & Coskun, 2009). The notion of the DD can be used to explain the socioeconomic differences arising from ICT use (Vehovar, Sicherl, Husing & Dolnicar, 2006; Barzilai-Nahon, 2006), and social, demographic and economic characteristics of the users (Mason & Hacker, 2003; Zoroja, 2011).

The notion of the DD is very important because it can reveal inequalities across global information society (van Dijk, 2006) which affect the economic growth and development of individual countries (Vu, 2011). The DD can be measured using a framework of questions to determine who, with which user characteristics, connects how and to what (Hilbert, 2011). The data obtained also showed the level of the economic development of the country.

Developed and developing countries alike are trying to create information societies where people can use information and communication technology to share ideas and information, to improve their quality of life, and foster the economic development (Cilan, Bolat & Coskun, 2009; Vehovar, Sicherl, Husing & Dolnicar, 2006). European Union countries launched the action plan “eEurope 2005: An Information Society for All” in order to ensure the development of modern online public services. Differences between countries and unequal growth and development lead to different levels of using ICT between countries.

The results of the analysis made in 2008 confirm the existence of the DD between EU15 countries and the countries which were the candidates in 2004 (Romania, Bulgaria and Turkey) (Cilan, Bolat & Coskun, 2009). The data for Croatia and Malta were incomplete and they were left out of the analysis. The research showed that some EU15 countries, e.g. Greece and Portugal, have the same Information Society level as the countries which joined the European Union in 2004. Cyprus and Slovenia, which became European Union members in 2004, have the Information Society level similar to other EU15 countries. Some EU15 countries lag behind in information and communication technology usage and some new member states are a step ahead. We can conclude that the DD exists between the European Union countries and all the members should take the necessary steps and actions to reduce the current DD.

The DD has also become an important issue of the EU Digital Agenda for Europe, which aims to maximise social and economic impact of information and communication technology, especially in doing business. Specifically, some of the goals are that 50% of the population should be buying online by 2015 and that 33% of SMEs should establish an online shop by 2015 (European Commission [EC], 2011). Such pressure arises from the fact that among Financial Times Global 500 ICT companies only 10% are European.

ICT has a positive impact on productivity and economic success of the firms (Mason & Hacker, 2003; Yu, 2006; Hernaes, Pejić Bach & Bosilj Vuksic, 2012; Skrinjar, Bosilj Vuksic & Indihar Stemberger, 2010) and ICT drives positive changes in firms' structure (Spanos, Prastacos & Pulymenakou, 2002). Firms which are not electronically interconnected lag behind. Especially small and medium enterprises can benefit from using new technologies because they can easily connect with larger corporations and become part of their business, as well as with other small firms which are geographically distant. Firms operating in rural areas are much more ready to implement and use ICT, especially in e-commerce (Forman, 2005).

Some research focuses on the first and second order of the DD (Dewan & Riggins, 2005). Research on first order DD is dealing with population groups as characterised by access to ICT and second order DD refers to inequality in the ability to use ICT among users who have access. Both first and second order of the DD can be analysed at three levels: individual level, organizational level and global level. Individual level refers to people who are ready to integrate ICT into their everyday life and those who are lagging behind in accessing and using

new technologies. Organizational level refers to organizations which gain competitive advantage by implementing ICT into their core business processes and organizations which are left behind because they are not ready to use all of the benefits of ICT. Global level refers to countries who adapt their policies to promote ICT and which are investing in it, and countries which still do not realize the positive impact of ICT, so they are left behind.

DD research is mostly focused on individuals and countries and there are many empirical studies which investigate the existence of the DD between countries and within a society (Yu, 2006; Mason & Hacker, 2003). Following a review of DD research published in the first ten years of the 21st century, Wang et al. (2011) has proposed several conclusions: DD research focuses mostly on technological diffusion, and different cultural practices. There are, however, no review articles about the DD on firm level. The goal of this paper is to assess the level of the DD among firms based on published research papers.

This paper consists of five sections including Introduction part as first one. Research methodology is explained in the next section, including literature-selection process and analysis process. Results are presented in the third section. Discussion part explains our findings. Section five concludes the paper.

Nomenclature	
ICT	information & communication technologies
DD	digital divide

2. Methodology

In this section we described which data we have used and how we have analysed it. Therefore, we present literature-selection process and analysis process of the journal articles incorporated in the research.

2.1. Literature-selection process

Literature selection was performed in several stages. Web of knowledge was searched using the phrase: “digital divide” AND (firm OR corporation). The period from 2000 to 2012 was set as the time frame for the research. Only articles published in peer-reviewed journals were included in the review. The search also revealed articles on the DD at the individual, household, and national levels. In order to eliminate such articles, additional filtering was applied based on the full-text investigation. This approach resulted in 25 articles, published in a variety of journals, such as: European Planning Studies, Government Information Quarterly, International Small Business Journal, Information Economics and Policy, Information Systems Research, International Journal of Production Economics, International Journal of Information Technology and Management, Internet Research, Information Technology and People, Information Society, Journal of the Association for the Information Systems, Journal of Theoretical and Applied Electronic Commerce Research, Management Science, Journal of Productivity Analysis, Management Research Review and Online Information Review.

2.2. Analysis process

In accordance with the goal of the paper to investigate the levels of DD among firms, a rigorous analysis process was applied. In order to analyse papers dealing with the DD on the organizational level, we have applied a research framework based on the following characteristics: (1) geographical area, firm type and time frame, (2) measurement, impact and order of DD, ICT adoption cycle, inequality type, and (3) data collection, data source, sample size and methods. Using this approach, we were able to overcome the limitations of earlier research on the DD: i.e. lack of theory, conceptual definition, interdisciplinary approach, qualitative and longitudinal research (van Dijk, 2006).

3. Results

Table 1 presents the data on geographical area, firm type and time frame. The data were derived from 25 studies. Most of the firms examined are from Europe. Different types of firms are included in the studies: small and medium enterprises, small exporting firms, manufacturing firms, small and medium enterprises which are oriented towards tourism, firms in the insurance industry, firms in the financial and services sectors and agribusiness. The majority of researcher studies have been conducted after year 2000.

Table 1. Geographical area, type of firms and time frame

Study	Country	Firms	Year of study
Arbore & Ordanini (2006)	Italy	SME	2003
Arora, Forman & Yoon (2010)	USA	>100 employees	1998-2000
Atzeni & Carboni (2008)	Italy	Manufacturing firms; 11–500 employees; >500 employees	2003
Bapna, Goes, Wei & Zhang (2011)	Global	Firms	2005
Billon, Ezcurra & Lera-Lopez (2011)	EU-25 countries	Firms	2006
Chong, Ooi & Sohal (2009)	Malasya	Manufacturing firms	2008
El-Gohary (2012)	Egypt	Tourism SMEs	N/A
Forman & Gron (2011)	USA	Firms in insurance industry	1996, 1998, 2000, and 2002
Forman (2005)	USA	Financial and services firms	1996-1998
Galliano & Orozco (2011)	France	Agribusiness >20 employees	2002
Galliano & Roux (2008)	France	Manufacturing firms	2002
Galliano, Roux & Soulie (2011)	France	Manufacturing firms that use Internet	2002
Galve-Górriz & Castel (2010)	Spain	Manufacturing firms	2002
Gargallo-Castel & Ramírez-Alesón, (2008)	Spain	Manufacturing firms	2002
Grimes, Ren & Stevens (2012)	New Zeland	Firms	2006
Hinson & Sorensen (2006)	Ghana	Small exporting firms	2005
Ifinedo (2011)	Canada	SMEs	2007-2008
Ifinedo (2011)	Canada	SMEs	2007-2008
Labrianidis & Kalogeressis (2006)	Greece, Portugal, Germany, Poland, UK	Rural innovative firms	2004
Lee, Kim& Ahn (2011)	Korea	Firms	2004
Middleton & Byus (2011)	USA	Hispanic owned SMEs	N/A
Middleton & Chambers (2010)	USA	SMEs	N/A
Nurmilaakso (2008)	EU	Firms	2003-2005
Pighin & Marzona (2008)	Italy	Firms	N/A
Rodriguez-Ardura & Meseguer-Artola (2010)	Spain	Firms	1996-2005

Table 2 presents the data on measurement, impact and order of the DD, ICT adoption cycle and determinants of the DD. A number of indicators can be used to measure the DD. In the studies examined, the DD was measured using the following indicators: broadband adoption, Internet applications, electronic payment systems (EPS), website adoption, adoption of e-Collaboration tools in supply chain, investments in ICT, e-Government service and WiFi. In most of the studies inequality type refers to the second order, i.e. the differences in the ability to use the information and communication technology among users who have access. Determinants of the DD are different for each study included in our analysis.

Table 2. Measurement, impact and order of DD, ICT adoption cycle and determinants of DD

Study	Phenomena used as the	Inequality type / ICT	Determinants of DD
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	indicators/measure of DD	adoption cycle	
Arbore & Ordanini (2006)	Broadband adoption	First Order / ICT Access	Size, geographical area, and ICT strategies
Arora, Forman & Yoon (2010)	Internet applications / LAN	Second Order / ICT Use	Internet application adoption and LAN adoption are complimentary
Atzeni & Carboni (2008)	Adoption of ICT	First Order / ICT Use	Public assistance
Bapna, Goes, Wei, Zhang (2011)	Electronic payment systems (EPS)	First Order / ICT Use	Firm size, region and industry type
Billon, Ezcurra & Lera-Lopez (2011)	Website adoption	Second Order / ICT Use	GDP per capita, population density, sectoral composition and education
Chong, Ooi & Sohail (2009)	E-Collaboration tools in supply chain	Second Order/ ICT Access	Trust, product complexity and product volume
El-Gohary (2012)	Electronic marketing	Second Order / ICT Innovation	Both external and internal factors
Forman & Gron (2011)	ICT for distribution & communications	First Order/ ICT Access	Vertical integration enforces Internet applications that distribution relationships.
Forman (2005)	Internet access	First Order/ ICT Access	Prior investments in client/server networks
Galliano & Orozco (2011)	Electronic traceability systems (ETS)	Second Order / ICT Use	Firm size, group, e-business, contracts with suppliers/customers, industrialization
Galliano & Roux (2008)	Internet adoption; intensity of Internet use	First Order / Second order / ICT Use	Spatial disparities affect intensity of Internet use
Galliano, Roux & Soulie (2011)	Intensity of usage of ICT	First Order / ICT Use	Geographical dispersion of the firm, belonging to a group, and the competition
Galve-Górriz & Castel (2010)	Investments in ICT	First Order / ICT Use	Educated and trained workers, specific training and higher wages
Gargallo-Castel & Ramírez-Alesón, (2008)	Adoption of ICT	Second order/ ICT Access	Higher employee qualifications, related technology and firm size
Grimes, Ren & Stevens (2012)	Internet access	Second order / ICT Use	Firm size, firm's general management capability, foreign owner, knowledge intensity, R&D, industry, firm age
Hinson & Sorensen (2006)	E-business	Second Order / ICT Use	Perception of the strategic value of e-business
Ifinedo (2011)	Internet and e-business technology adoption	Second Order / ICT Use	Relative advantage, management, support, and competition's pressure
Ifinedo (2011)	Internet/e-business technology's acceptance	First Order	Perceived benefits, management support, external pressure
Labriani & Kalogeressis (2006)	Use of ICT	First Order/ ICT Access & ICT Use	Geographical position of the firm, industry, firm size, network intensity
Lee, Kim & Ahn (2011)	e-Government service	Second Order / ICT Use	Timeliness, responsiveness, service quality
Middleton & Byus (2011)	ICT adoption and usage	Second Order / ICT Use	Non-Hispanic ethnicity
Middleton & Chambers (2010)	WiFi	Second Order / ICT Use	Non-Hispanic ethnicity and age
Nurmilaakso (2008)	E-business	Second Order / ICT Use	Number of subsidies, usage of ERP, SCM and CRM, exchanging standardized data
Pighin & Marzona (2008)	ICT usage	Second Order / ICT Innovation	Knowledge, training, participation
Rodriguez-Ardura & Meseguer-Artola (2010)	E-commerce	Second Order / ICT Use	Consumer and competitive pressure, technological readiness, global scope and innovations

Table 3 presents data collection, data sources, sample size and methods. The data were mostly collected through surveys. Exceptions are two studies which collected data by in-depth interviews and from transactions recorded in the database. Different data sources were used. Most authors collected data, but some authors also used data collected by institutions: e.g. 2002 ICT Survey/French National Institutes of Statistics, Spanish Survey on Business Strategies and Harte Hanks CI Technology Database. The sample size varied from 100 to 30000. Methods used are as follows: regression (multiple regression, logit model and binomial-logistic regression), multivariate (Mann-Whitney, Wilcoxon tests), and machine learning models (Structural equations modelling, continuous-time survival model, discrete choice model and tree-based technique).

Table 3. Data collection, data source, sample size and methods

Study	Data collection	Data source	Sample size	Methods
Arbore and Ordanini (2006)	Survey	Author	920	Tree-based technique, binomial-logistic regression
Arora, Forman, Yoon (2010)	Survey	Harte Hanks CI Technology Data	19860	Discrete-choice model
Atzeni, Carboni (2008)	Survey	Survey of Manufacturing Firms (SMF) carried out by Area Studi of Capitalia Bank	2290	Matching estimator
Bapna, Goes, Wei, Zhang (2011)	Transactions	The billing data from one of the top Fortune 100 companies	4,922 transactions	Finite mixture model
Billon, Ezcurra, Lera-Lopez (2011)	Survey	ESPON Project Indicators	N/A	Econometric methods
Chong, Ooi, Sohal (2009)	Survey	Authors	109	Correlation and multiple regression analysis
El-Gohary (2012)	Survey	Authors	163	Structural equations modelling
Forman, Gron (2011)	Survey	Harte Hanks CI Technology Database	100	Continuous-time survival model
Forman (2005)	Survey	Harte Hanks CI Technology Database	6156	Discrete choice model
Galliano, Orozco (2011)	Survey	2002 ICT Survey / French National Institutes of Statistics	2821	Probit model
Galliano, Roux (2008)	Survey	2002 ICT Survey / French National Institutes of Statistics	5200	Probit model
Galliano, Roux, Soulie (2011)	Survey	2002 ICT Survey / French National Institutes of Statistics	4434	
Galve-Górriz, Castel (2010)	Survey	Spanish Survey on Business Strategies	1296	Mann-Whitney, Wilcoxon tests
Gargallo-Castel, Ramírez-Alesón, (2008)	Survey	Spanish Survey on Business Strategies	1685	Probit model
Grimes, Ren, Stevens (2012)	Survey	Statistics New Zealand's Business Operations Survey 2006 (BOS06); Statistics New Zealand's prototype longitudinal business database	6051	Propensity score matching
Hinson, Sorensen (2006)	Survey, in-depth interviews	Author	60	Descriptive, ANOVA
Ifinedo (2011)	Survey	Author	214	Partial Least Squares
Ifinedo (2011)	Survey	Author	214	Partial Least Squares
Labrianidis, Kalogeressis (2006)	Survey	Future of Europe's Rural Peripheries	996	Logit model
Lee, Kim, Ahn (2011)	Survey	Korean e-Government research project	836	Logit model
Middleton, Byus (2011)	Survey	Author	158	Principal components analyses
Middleton, Chambers (2010)	Survey	Author	158	Principal components analyses
Nurmilaakso (2008)	Survey	e-Business W@tch	4570	Linear regression model
Pighin, Marzona (2008)	Survey	Author	58	Descriptive statistics
Rodriguez-Ardura, Meseguer-Artola (2010)	Survey	Survey on the Use of ICT and E-commerce in Spanish Companies, Spanish Survey on Technological Innovation	28880	Multiple regression

4. Discussion

Most of the studies were conducted in developed countries, like the USA, Italy, France, New Zealand, and Canada. There were only three international studies (EU, EU-25, global). Researchers mainly focused on specific groups of firms, like SMEs, manufacturing firms, tourism firms, or rural firms. Only one research study (Labrianidis & Kalogeressis, 2006) selected firms based on the ethnicity of the owner (Hispanic owned firms). Research time frame of most studies was only one year, with only a small number of studies covering longer periods, which indicates the cross-sectional nature of the studies.

The phenomena used as measures of the DD could be divided in three groups. The first group comprises general ICT usage, like the adoption of ICT (Atzeni & Carboni, 2008), intensity of usage of ICT (Galliano, Roux & Soulie, 2011), and investments in ICT (Galve-Górriz & Castel, 2010). Within that group, most

researchers found First Order DD, and focused on ICT use. The second group of measures included the adoption of Internet (Forman, 2005; Galliano & Roux, 2008) and broadband adoption (Arbore & Ordanini, 2006). Researchers in this group predominantly investigated First Order DD and ICT Use. The third group investigated ICT usage for specific business purposes, e.g. e-collaboration (Chong, Ooi & Sohal, 2009), electronic marketing (El-Gohary, 2012), and e-Government services (Lee, Kim & Ahn, 2011). The authors proved that Internet and e-business activities improve business processes in several ways: (1) automated transactions enhance the efficacy, (2) reducing the number of intermediaries results in increased economic growth, (3) demand and supply processes are connected, and (4) production results improved (Ifinedo, 2011).

Determinants of the DD could be divided into external and internal factors. External factors include firms' characteristics like size, geographical area, region and industry. Internal factors involve specific actions of the firm management: e.g. vertical integration, education of employees, and usage of other technologies. Investment in ICT on firm level depends mostly on three factors: size of the firm, the level of the human capital and the presence of large firms in the local environment (Atzeni & Carboni, 2008). The general conclusion of our research is that the adoption of ICT in firms depends upon several factors: location size, complexity of the information and communication technology, the importance of the technology in business processes of the corporation, demographic characteristics of the employees, and the dependence of the corporation processes on ICT (Forman & Goldfarb, 2006).

In most cases the data were collected by questionnaire surveys on samples of varying sizes, ranging from 58 firms in one in-depth study (Pighin & Marzona, 2008), to 28880 firms that participated in one large national study (Rodríguez-Ardura & Meseguer-Artola, 2010). Secondary surveys were used as a data source in approximately half of the papers, while the rest used the data collected by authors. Research methods used were linear and multivariate regression, structural equation modelling, and machine learning models like continuous-time survival model.

5. Conclusion

The main goal of the paper was to review papers dealing with the level of the DD in firms. In order to accomplish that goal, we examined articles retrieved from the Web of Knowledge. However, when considering the results of our research one should be aware that only Web of Knowledge database was used as the source of papers dealing with the DD in firms. Furthermore, a number of papers reported on the determinants of ICT adoption in firms, but did not use the term "digital divide" to refer to the phenomenon.

The rapid growth of information and communication technology plays an important role in everyday life, politics, economy and society (Cilan, Bolat & Coskun, 2009). Since access to and usage of ICT have positive effects on global interaction, commerce, economic growth and social welfare (Dewan & Riggins, 2005), DD shrinkage is of highest importance. Many national and international corporations and governments are trying to implement information and communication technology in their business (Weber & Kaufmann, 2011). They have developed strategies, initiatives and programs in order to improve and enhance the usage of ICT. Our research, however, revealed that ICT strategy was found to be a determinant of the DD level in only one case (Arbore & Ordanini, 2006). Future research in the area of the DD in firms should therefore be oriented towards active policies for the elimination of DD gap. Such policies could be undertaken by the firms themselves and/or by governments and even the European Commission, which would broaden the scope of future research. Finally, further studies should also take into account qualitative studies, which could provide additional information on internal determinants' of the DD in firms.

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