

INTERRELATIONSHIPS OF ORGANIZATION SIZE AND INFORMATION AND COMMUNICATION TECHNOLOGY ADOPTION

Mladen CUDANOV¹

MTS, Teaching Assistant, Faculty of Organizational Sciences,
University of Belgrade, Serbia

E-mail: mladenc@fon.rs, **Web-page:** <http://www.linkedin.com/in/mladencudanov>



Ondrej JASKO²

PhD, Associate Professor, Faculty of Organizational Sciences,
University of Belgrade, Serbia

E-mail: jasko@fon.rs,

Web-page: <http://www.fon.rs/ofakultetu/nastavnici/CV/JaskoOndrej/index.html>



Gheorghe SAVOIU³

PhD, Associate Professor, Faculty of Economics,
University of Pitesti, Romania

E-mail: gsavoiu@yahoo.com,

Web-page: <http://ro.linkedin.com/pub/gheorghe-savoiu/16/337/b27>



Abstract: *This paper aims to describe interrelationships between size of the organization and adoption of information and communication technologies (ICT). We hypothesize that size of the organization is interrelated with ICT usage. By analyzing the data from 68 organizations we have classified to micro, small, medium-sized and large enterprises and calculated composite index of ICT adoption in each organization. Afterwards we have analyzed correlations between composite index of ICT adoption and size of the organization. Our results show that large enterprises which have potential to utilize ICT have highest values of composite index of ICT adoption, indicating high ICT usage. Theory considered in the discussion implies that ICT diminishes size of the organization, which complies with our findings because medium enterprises keep high values of composite index of ICT adoption. Small organizations, at least in transitional countries, in average do not show high level of ICT use, but especially in smallest, micro organizations extreme examples both of high and low ICT use indicated by high standard deviation values can be found. That could be explained by greater flexibility and orientation of small enterprises to new technologies, but also lack of resources or interest and implies that in small and micro companies ICT appliance is more dependent on other organizational factors than on size. Our conclusion is that ICT has the potential to diminish size of the company, but that still in average large and medium companies are leaders of ICT use in spite of extreme examples of good practice in small companies.*

Key words: *Organization size; ICT adoption; Composite index of ICT adoption; Organizational factors*

1. Introduction

This article aims to describe interrelationships between size of the organization and applications of information and communication technologies (ICT). Size can be observed as important factor of implementation of ICT. Small and medium enterprises can be important innovation factor in economy, and Van Dijk et al. (1997) observe them to be more open to applying innovations⁴. They also have better use of innovations developed in large organizations and scientific institutes (Audretsch & Vivarelli 1996).⁵ Common attitude is that small and medium enterprises are more open to ICT than large enterprises, and are ready to form alliances when size does not permit using technology advancements (Narula 2001)⁶. Increased implementation of ICT can be consequence of such alliances of small and medium enterprises.⁷ Small and medium enterprises can lower the costs of ICT appliance by using open source alternatives, and even in developing and underdeveloped countries illegal copies of expensive software (Van Belle&Ellis 2009).⁸

On the other hand, large enterprises have its own factors that facilitate implementation of information and communication technologies, and most important can be critical financial mass that enables access to expensive technologies and management requirements that imply larger demand for ICT use. The potential of large enterprises to use ICT is described in detail by many authors, such as Cisler(2005)⁹, Marmaridis(2005)¹⁰, Trimi(2005)¹¹ or Kramer et al (2007)¹². That assumption is justified, but it is important to observe that it influences only potential for use, but not always the real use of information and communication technologies.

The idea that size of the organization can influence implementation of information and communication technologies comes from theoretical view that the size of the enterprise is important organizational factor (Blau and Schoenherr 1971¹³; Mintzberg 1980¹⁴). Other organizational features, such as decentralization, work division, departmentalization and coordination are related to information and communication technologies (Bloomfield & Coombs 1992¹⁵; Čudanov 2007)¹⁶, so it is rational to create hypothesis that organizational size can be related to ICT.

2. Methods

Most common enterprise size indicators are total number of employees, total assets and enterprise income. For the purpose of this article we accepted all three indicators and started from classification of small, medium sized and large enterprises, according to Serbian law that uses:

- Average number of employees
- Total income
- Assets value stated in financial report in last business year¹⁷

This division has been widened by "Micro" category, that have two out of three conditions: less than 10 employees, total income less than 50 million od RSD (circa 500,000 EUR) and assets under 10 million of RSD (Circa 100,000EUR). Small enterprises are those that comply with two out of three conditions: number of employees is between 10 and 50, income between 50 and 225 milion of RSD (circa 500,000-2,25milion EUR) and assets between 10 and 90 million of RSD (circa 100,000-900,00EUR). Medium enterprises are those that comply with two out of three conditions: between 50 and 250 employees, income

between 225 and 900 million of RSD (circa 2,25-9 million EUR) and assets between 90 and 450 million of RSD (circa 900,000-4,500,000EUR). Large enterprises are those that comply with at least two of three conditions: more than 250 of employees, income above 900 million of RSD (circa 9 million EUR) and assets value above 450 million of RSD (circa 4,5 million EUR).

This division resulted in following distribution of enterprises, with organizations sorted into industries:

Table 1. Structure of the sample of organizations used in analysis

Size/industry	ICT	Production	Commerce	Services	Total
Micro	6	7	3	5	21
Small	3	8	2	4	17
Medium	2	7	8	3	20
Large		7	1	2	10
Total	11	29	14	14	68

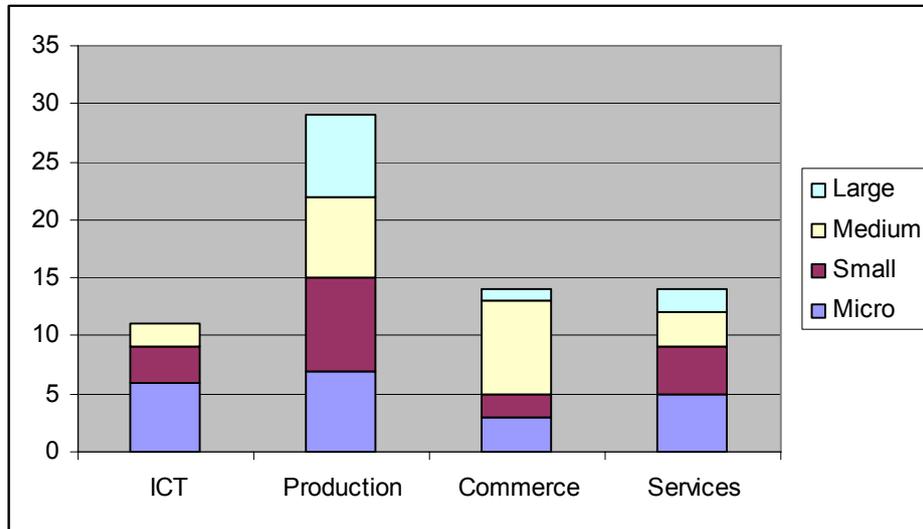


Figure 1. Structure of the sample used for analysis

As a second factor in analysis, we have used Composite index of ICT adoption. As an alternative to subjective assesment several indicators connected to the use of ICT in the company were selected from quantitative data gathered. Selected indicators, different in nature, were combined and a composite index of ICT adoption (abbreviated CICT in tables) was formed. This formula has already been used to asses implementation of information and communication technologies in the enterprise (Čudanov et al. 2009)¹⁸.

Formula of the composite index is presented in following:

$$CICT = \frac{NoC}{NoE} + \frac{NoCC}{NoE} + \sum_{i=1}^{i=8} Cf_i + \prod_{i=1}^{i=8} \left(\sqrt{\frac{NoCC}{NoE}} + Cf_i \right) + CDB + DBA$$

Where mentioned

factors mean:

CICT	=	Composite index of ICT adoption in company;
NoC	=	Number of computers in the company;
NoE	=	Number of employees in the company;
NoCC	=	Number of computers connected to internal network in the company;
Cf _i	=	Coverage of enterprise function by ICT, where for different values of <i>i</i> functions are: 1 - human resources, 2 – accountancy, 3 – financial, , 4 – technical, 5 – commercial, 6 – administrative, 7 – legal, 8 – protection; Coverage of business function was estimated by IT staff, functional staff and top managements as percentage of usual job in that function supported by ICT existing in the organization
CDB	=	Existence of integrated company database (0=no, 1=yes)
DBA	=	Database administrator present (0=no, 1=yes)

After that, average values and variance has been analyzed to observe differences between groups. Additional descriptive statistics have been analyzed, also. Further sample has been analyzed by ANOVA method of variance analysis, tolerant for small variations of sample from normal distribution. In this case those variations were result of larger number of groups in total sample.

3. Results

First group of enterprises that has been distinguished by the value of composite index of ICT adoption consists of 17 small enterprises with very low value of that index - 4,12. This value can be explained by lack of resources needed for coverage of small business by information and communication technologies. Business of small enterprise is significantly more complex than in micro enterprises, although sole number of employees does not lead to such conclusion. It must be valued that complexity of such systems is more exponentially than linearly rises in accordance with rise in number of employees. Companies with up to 50 employees are in average much more complex systems compared to companies with up to 10 employees, because such companies represent heterogeneous business systems, that most often cover all basic business functions, like finance, production (or services) and sales, and such complexity demands significant support of information and communication technologies compared to micro enterprises. Low values of standard deviation give us good confidence about small variations of low value of composite index of ICT adoption.

Micro enterprises have significantly larger value of composite index of ICT adoption. Its value is 20,86, but high standard deviation of 41,95 implies that appliance of information and communication technologies has much more oscillations in such systems. It is assumed that such oscillation is due to large differentiation in micro business orientation toward ICT, that is largely dependable on industry and attitude of the owner towards ICT. High value of that index originates in simplicity of coverage of micro business with information and communication technologies. In accordance to division presented in methods section, micro enterprises are often organizations or even single entrepreneurs that perform single business function, without structurally differentiated departments that increase complexity of the system. Such business can be supported by simple patterns that can be created in mass accessible software. In simple business systems large number of administrative tasks can be performed sut ICT support from MS Office®¹⁹ applications or similar software alternatives, among which some are distributed free of charge as "open source" software. So it is reasonable to say that Cfi, or "Coverage of enterprise function by

ICT" can be fully or mostly covered in most of the human resources, accountancy, financial, technical, commercial, administrative, legal, protection functions of micro business. Further study of such potentials can improve communication and collaboration, within organization or outside its boundaries.

Third group of enterprises is consisted by medium and large enterprises. Those enterprises have high and very similar values of composite index of ICT (respectively 34,28 and 34, 65). Standard deviation is very high, respectively 79,30 and 86,62. Such values imply relatively better position that medium and large enterprises have in appliance of ICT, but such results should be observed with reserve, because sample is consisted of transitional companies, and some conclusions might be different in developed economies, where small and medium enterprises have large tradition and stronger resource support than in transitional countries. In context of transitional countries, however, like Serbia, Bulgaria or Romania, such results are largely confirmed by business practice. Medium and large enterprises have enough resources to try to achieve competitive advantage, and often include ICT as a tool for such goal, while small and micro enterprises resort to comparative advantage, local scope and small market niches, that do not demand implementation of ICT. Following table represents results of descriptive statistical analysis of our sample.

Table 2. Descriptive statistical analysis for composite index of ICT adoption in selected groups

	N	Average	Std. deviation	Std. error	95% interval of confidence for average value		Min.	Max.
					low bound.	high bound.		
Micro	20	20,86	41,95321	9,38	1,22	40,49	,14	173,31
Small	17	4,12	3,25391	,79	2,44	5,79	,24	10,72
Medium	20	34,28	79,30483	17,73	-2,83	71,40	1,36	322,15
Large	10	34,65	86,62009	27,39	-27,31	96,62	1,39	280,43
Total	67	22,68	59,12052	7,22	8,26	37,10	,14	322,15

Further analysis by ANOVA is did not confirm that observed differences are statistically significant, but non-parametric test have indicated statistical significance. That directs us toward possible repetition of such experiment on larger set of enterprises. Mixed results have also been observed by Lee and Xia (2006)²⁰, and they explained such results by unclear definition of factors of IT innovation, that is only part of ICT implementation in organization

4. Discussion

Results of this study indicate that size of the organization and implementation of ICT in that organization are connected. Usual approach regarded average number of employees as independent variable, while the other indicators are regarded as dependent. The situation which changed by automation, reengineering and „dot.com“ boom caused the change of such attitude, and excessive agitation of influence that information and communication technologies have on the size of the enterprise, but the crash of dot.com concept that among other propagated flat and small organizations partly moderated that

attitude. However, positive examples of companies which survived dot.com crash indicate the change of traditional relations of these values.

Information and communication technologies appliance and change in company size can be observed in the light of other global economic shifts. Shifting the focus of from the manufacturing to service economy caused appearance of great number of new trends, like making values in services is often possible with less human work then in manufacturing. Many enterprises that do business on Internet are totally based on information and communication technologies and have unusually small number of employees. Virtual enterprise concept enabled by ICT change classical definition of organization, like there is no building with offices in which these workers work. A few people can maintain the web site at home or sit in a rented business premise, achieving business results which are in clusters with enterprises which have several tenths times more employees. Influence of information technology to the size of enterprise is realized indirectly through better interior communication, bigger inter-organizational cooperation and more possibilities of outsourcing.

Nevertheless, our consulting experience concluded that there is no significant long term reduction in number of required employees in particular company as a result of information and communication technologies adoption. Osterman (1986) believes that information technologies have tendency to increase number of required employees for a period of several years after it's introduction.²¹ In such case information and communication technologies use potential of increased productivity not to reduce the number of required workers but to cope with increased amount of work. In some cases information and communication technologies complement rather than replace work force, in particular white collar work force.

Theoretical approaches that connect information technology with all indicators of enterprise size date from the period of the first half of 1970's of last century, before boom of Internet and information technologies utilization. Even in 1973 Arrow regarded market and enterprises like entities which at the first place analyze information,²² what Galbraith (1977) clearly confirmed in his studies²³. This stand point implies that information and communication technologies must have important influence to all parameters of the enterprise. It was noticed the tendency that size of the enterprise shown in the number of employees significantly decrease from 1970's of last century, while until the 1970's, this trend was opposite (Piore & Sabel, 1984)²⁴. It is interesting that this trend linearly is not followed by other indicators of growth, especially total revenue of enterprise. A lot of studies connected ICT related factors with organizational performance (Weil 1994;²⁵ Wilcocks 1999²⁶; Čudanov et al. 2007²⁷). It was announced by the American bureau for job statistic that from the period of 1980 until 1986, enterprises with less then 100 employees created more then six million new jobs, while the enterprises with more then 1000 employees dismissed more then one and the half million workers. From 1980, many studies which have been published examine correlation between the facts that, in global, enterprise size is considerably decreasing, but the enterprise profit share invested into information technologies is considerably increasing.

Confirmation of such trend can be found in vivid example of Google inc. which was founded in 1997. After eight years, specific philosophy of doing business lead the company from total number of employees of 2 to 3.021 employee in December 2004 (which was sudden increase compared with 2.668 in September 2004), with total assets of

3,313,351,000USD and total revenue of 1,032,000,000USD. In 2008, company earned 21,795,550,000USD of total revenue, owned 31,767,575,000USD of total assets²⁸ but increased number of employees only on 19,665. The reduction of the size of organization influenced by information and communication technology is trend which is also noticed in the companies not directly linked to the e-business or Internet. Development of information and communication technologies automated many processes. The reduction of participation of human labor increased productivity and ranked ICT among the strategic advances of the company. These enterprises have less employees compared to the industrial average. Re-engineering of many processes in classic branches of doing business enables finishing more work with less people. ERP systems, automatic systems of purchase or some instruments of e-business additionally automate supporting systems, further reducing need for administrative and supportive staff. Information and communication technologies are also one of the factors which enabled virtual and network organization structures.

Major influence paths of ICT on size of the enterprise includes outsourcing and automation. First is largely connected to distribution of added value among several smaller entities, while second aims at increasing efficiency and decreasing input of human work in processes. Potentials of the information and communication technologies improve the practice of the outsourcing of some activities. Analyzing the costs of transactions described by Williamson (1979)²⁹ enables us to determine effective limits of the company, and the general trend of their reduction is explained through the factors of reducing the expenses of the external coordination, which is in fact influenced by ICT. On the other hand, information systems are usually made with the purpose of improving the internal, not the external coordination, and improving the internal coordination is one of the factors that should result in lower costs of these activities, and in the larger companies, which rather decide on production than on purchase of goods and favors. Reducing the costs of the external coordination is easily correlated with the decrease of an average size of the company. Even though the ICT cannot eliminate opportune behavior, they can diminish the problems created by such opportunism, and, primarily, can decrease the rational limitations that participants in the market have. Reducing the costs of activities related to gathering valid information and administrative activities that are affected by coordination with external suppliers, informational technologies cut down the costs of the external transactions.

If the products or services are specific, despite of the positive influence of the information technology, at some limit external coordination becomes inefficient and leads to the practice of expanding the effective limits of the company. But ICT can reduce the expenses of the external coordination through the change in the specifications of the goods that are objects of the trade. If the techniques that are enabled by the development of the information and communication technologies are used, costs for specifications of the goods and external coordination are diminished. Significant examples for this can be found in the car manufacturing industry, which was, for a longer period of time, in the first plan of the automation. When Nissan, for example, built their new factory in Sunderland, in north England, they invited their biggest suppliers to build their own factories in the circle around Nissan's factory area and in that way become a part of Nissan's production control system. The goal that illustrates trend of smaller enterprise by outsourcing was that suppliers deliver their parts directly to the production line, in order to save on the storage space and handling expenses. Not only that information system imposed reduced size of one large car

manufacturing entity to web of interconnected companies, but also size of those companies was reduced due to new collaboration technologies that were not so work intensive.

As global trend, compensation of the reduction of the costs of internal coordination could be explained through the process of globalization, which is also partly backed by modern information and communication technologies. Even though the costs of finding the supplier, negotiating, contracting and payment can be higher than the costs of internal coordination, growth of the range of requests can give the supplier the economic advantage. Reducing both internal and external expenses of the transactions reduces the importance of the dimension that favors the production within the company's own limits. The impact of these two factors in practice manifests itself by reducing the size of the company, but also by reducing the average added value by company, which is easily experimentally verified in the countries that base their tax systems on added value. Correlation has been confirmed in many empirical analyses which deal with both global changes in these values during the past period, and the connection of these values with the information and communication technologies in the company.

Second main path of relation between size of the organization and application of information and communication technologies is automation. The automation is the concept driving economic development since the beginning of Industrial revolution, and most often defined as a decrease of participation of human labor in manufacture, and increase of machine automatic performance (Dulanović & Jaško 2006)³⁰ Although clearly separated from mechanization, automation has connections with it, and its roots are from mechanical automation which wider use started with Industrial revolution. Information and communication technologies have potentials of automation of different tasks that include handling and processing data. Since this description covers wide range of organizational tasks, it could be said that the majority of business can be improved by information and communication technologies intermediary, through the supporting tools, and great number of tasks would be totally or partly automated or eliminated in accordance with the reengineering approach (Hammer 1990)³¹.

Original appliance of computers in automation was based on text processing, calculations and reporting, as well as request processing. Dominate direction was automation of simple, routine tasks. That kind of automation routine is actually the most important part of any system based on computer – even of the systems which seems to deal with different matter. The systems based on the computer generally connecting specific routines on two levels: closed routines «hidden» in functions of inside applied program and opened routines which incorporate dialogues with users and structure their work. Potentials of the first group are often much smaller then the potentials of the other group, where attained synergy value of human factor extremely fast computer routine implementation.

Among numerous examples of automation aided by ICT is Fujicu factory which covering 20 000 square meters with 82 employees in daily shift, and only one operator in control room during night. His only task is to supervise industrial robots and automatic machine tools from control room. Traditional factory of the same size would employ ten times more workers. The automation of services gives even more possibilities. Particularly, works which as service include information – and this kind of works dominate in modern global economy, represent very good basis for automation. Administrative work in all companies, regardless of industry, is also automated. That complies with the claim that information and communication technologies significantly aid automation both in material

production (especially factory production), non-material production or services – every product or service which consists of information, data procession or data forwarding and internal trade administration (Groth, 1999)³² but also connected to outsourcing path automation of external and internal transactions as consequence of wider appliance of network models.

5. Conclusion

This research concludes that although theoretical and empirical researcher have shown that ICT reduces size of the company, medium and large companies adopt ICT with highest intensity. Size reduction is best described by the studies of Brynjolfsson et al. (1994).³³ The impact of information and communication technologies has also been studied through the total income of sales by companies that manufacture, which is expressed in the net sales price, including all the discounts. If the capital invested in informational technologies doubles, and all other values are observed as constants, the sale of the company reduces by 13%. Also there is significant correlation with 99,9% certainty, by which double value of the capital invested in informational technologies means 12% of reduction in added value of a company. This does not mean that investing in informational technologies negatively affects company's business. In the context of these results, we can recognize that this impact of the informational technology is directly linked to creating network models of organization and separating large vertically integrated companies into the smaller, more flexible entities.

It is logical that large enterprises which have potential to utilize ICT become leaders of ICT adoption, but also to decrease size toward medium enterprises, that keep high ICT adoption. Small organizations, at least in transitional countries, do not show high level of ICT use in average, but especially in smallest, micro organizations there can be extreme examples both of high and low ICT use, which is in such companies more dependent on other organizational factors.

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¹Mladen CUDANOV got his magister degree at Faculty of organizational sciences in 2006 and is working on his PhD thesis. Currently he is in assistant position at Faculty of Organizational Sciences, Organization of Business Systems department, University of Belgrade. He has been visiting for one semester as an assistant professor in joint programs of iVWA from Germany and Jiangsu College of Information Technology from Wuxi and Zhuhai City Polytechnics from Zhuhai in China. His major research interests are ICT and organizational design, restructuring of business systems and organizational change.

²Ondrej JASKO has graduated at the Faculty of Organizational Sciences, University of Belgrade, in 1989. He got his master degree at the same Faculty in 1995 and PhD degree at the same Faculty in 2000. Currently he is in professor position at Faculty of Organizational Sciences, Organization of Business Systems department, University of Belgrade. He was in position of vice dean, and in editing boards of our leading Journals in Management. His major research interests are organization theory and design, business systems, restructuring of business systems and organizational change.

³(Co)Author of the books: *Exploratory Domains of Econophysics. News EDEN I & II (2009)*, *Statistica - Un mod stiintific de gandire (2007)*, *Populatia lumii intre explozie si implozie demografica (2006)*, *Cercetari si modelari de marketing. Metode cantitative in cercetarea pietei(2005)*, *Universul preturilor si indicii interpret (2001)*.

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