An Empirical Study
of the Development of Information and
Communication Technology in Hungary

PÉTER SASVÁRI, Ph.D.
ASSISTANT PROFESSOR

e-mail: iitsasi@uni-miskolc.hu

SUMMARY

As I could not find a reliable mathematical and statistical method for studying the effect of information communication technology on businesses in the literature, I proposed a new research and analysis method that I also used to study the Hungarian economic sectors.

An essential question for enterprises is what factors have an effect on their net income.. First, I studied the potential indicators related to economic sectors, then I compared those indicators to the net income of the enterprises surveyed. The data resulting from this comparison showed that the growing penetration of electronic marketpalces contributed to the change in the net income of enterprises in various Hungarian economic sectors to the extent of 37%.

Among all the potential indicators, only the indicator of electronic marketplaces has a direct influence on the net income of enterprises. However, the effect of electronic presence is also significant as it has a huge effect on the potential indicator of electronic marketplaces.

It was practical to determine two clusters based on the potential indicators. Eight economic sectors have been placed in the first, while five sectors have been placed in the second cluster. Only the money which is spent on professional training has a more significant effect on what cluster a sector belongs to.

Key words: information society, information and communication technology, ICT, economic branch, electronic presence, electronic marketplace.

INTRODUCTION

The current age is often referred to as the Information Age. This concept was first introduced by Manuel Castells, the best-known theoretician of the information society. The information society is a new, special variant of existing societies in which producing, processing and distributing information has become a fundamental source in the economy.

According to the related literature data, the Information Age began in the second half of the 1950s when, for the first time in history, the number of white-collar workers (engineers, administrative employees etc.) exceeded the number of blue-collar workers.

One of the main driving forces of the Information Age is the phenomenon called the Information and Communication Revolution. Its significance is often compared to the agricultural and industrial revolutions which have taken place in the history of mankind. In important fields of high-end technology (computer technology and telecommunications) not only the robust growth of quality, quantity and performance parameters

can be observed but the approximation of these two fields along with the appearance of compound applications can also be detected. These phenomena of the information society can not only be seen as one of the results of the development of technology but also as a coherent system affecting the society as a whole.

THE CHARACTERISTICS AND IMPACTS OF INFORMATION AND COMMUNICATION SYSTEMS

Information and communication technology can be regarded as a universal technological system, which is closely linked to all of the previous systems and which creates new, more complex technological systems. ICT's main characterizing function is to ensure the acquiring, storing, processing, delivering, distributing, handling, controlling, transforming, retrieving and using of information.

ICT has a different effect on the actors of the economy, including companies, employees and consumers.

Nowadays we are witnessing a change of paradigm in the operation of enterprises. They have become a rapidly changing system of independent work groups and projects. Enterprises characterized by flexible operation demand a flexible labour force. In this new situation, employees have to abandon traditional patterns and develop a new kind of mentality. If they want to stay afloat in the labour market, they have no choice. This is because enterprises are no longer strongly interested in developing the professional knowledge of their employees.

Beside the changes experienced in the attitudes of enterprises and employees, the behaviour of consumers has also been fundamentally changed by the effect of ICT. As the Internet has freed consumers from their isolation, they have become active and conscious actors in the economy. The relationship between buyers and sellers has changed, as it has become harder for sellers to recognize and influence the trends in demand and consumers are better informed than ever before.

Information and communication technology has brought about a deep change in the opportunities for consumers, compared to the opportunities provided by industrial capitalism. This change is as profound as the one caused by the Industrial Revolution earlier. The new generation of consumers is, first and foremost, well informed, due to them collecting and using other consumers' existing experiences. Companies (especially corporations previously focused on products and markets) nowadays concentrate on consumers. It is not enough to recognize consumers' problems, but identifying the problems in order to solve them is also necessary. The opportunities provided by ICT identify actual consumers, based on the actual problems which occur during the use of a product.

Companies can keep pace with the speed of the development of ICT only by introducing job enrichment. The requirement of versatility can be met only by employees with a high-level general education.

The decrease in the number of strictly defined positions along with the changing requirements of the remaining ones allows employees to acquire new skills whilst also widening their responsibilities. Cross-training sessions are also organized for the group of employees in order to enable them to perform various tasks.

Team-based companies have better problem-solving skills, higher productivity, more efficient use of human resources, more creativity and more innovations when compared to traditional non-team based organizations. Nowadays, when digital information is regarded as the chief means of production, the efficiency of production is highly dependent upon obtaining and processing information. Based on the achievements of ICT, companies have improved the infrastructure they use to obtain and process information. The companies also help their employees to co-operate in this process by compressing time and space.

The intention of raising efficiency allows the possibility of virtual teams. By being part of a virtual team,

employees do not have to work under the same roof and other employees from outside the company can take part in its work.

Nowadays, the majority of changes in work organization, decision mechanisms and corporate organization structures require enhanced flexibility. Flexibility means quick reactions, the removal of strict limits and – as frequently mentioned – job enrichment, as well as openness to innovations and unconventional answers to newer and newer challenges. The environmental impulses do not link the operators of the assembly lines or the workers of call centers in a long chain. Companies were operated centrally from a single headquarters earlier, but nowadays managers and workers try to find answers to the current challenges in many local corporate decision nodes. The coordination of numerous independent units is generated by the company as a self-organizing system, and the company's philosophy is determined by the self-organization of independently operating units based on market principles.

THE AIM OF THE RESEARCH

Based on the considerations presented above, it is not the subject of my examination to answer whether there is a need for ICT or for creating the necessary conditions for the information society. The real subject is to measure what economic, social, cultural and environmental effects it has on the society. The rich literature on the information society discusses these aspects in detail. During my work, I take the information society as a normative future plan for Hungary, and I am looking for the answer of what progress has been made in building the information society in the Hungarian economic branches. I examine the following issues:

➢ to what extent we can speak about the information society in Hungary nowadays
➢ what is the development level of the information society in several economic branches and company sizes compared to each other and to the member states of the European Union?
➢ how this development level can be measured and calculated
➢ how the development level of information and communication technology increases in companies of certain sizes
➢ what trends can be observed in the development process in the individual economic branches and company sizes?

My examination extends to the static, momentary state of the development level of the ICT devices used in the economic branches, as well as to their dynamic analysis, expected pace of growth and their qualification.

When establishing the aims of a piece of research, there is always the question of how to position the individual parts of the subject. Should they be positioned in a broader subject [8] or should they be selected for further

and deeper examination? The former possibility means that we aim to make suggestions by putting the practical analysis into a broader structure. The aim of my research is exactly this, as the information society represents a new stage in society's development, and the changes caused by information and communication technology can be observed in every part of our life nowadays.

THE RESEARCH METHODS

Similar problems are raised by the quantification of the various components of the information society to those raised by the definition of its concept. There is a wide range of variables that can be measured: a great number of explanatory variables can be listed. These range from the perhaps more easily measurable infrastructural components to the more difficult components related to knowledge and the willingness to use information. That is

why most analyses use sets of variables and complex indices as there is no easily measurable (one-dimensional) index that would characterize the information society.

The examination of the subject is interdisciplinary as it has social and scientific references, so a complex approach was needed when I started processing the literature. I needed to study literature on economics, law, sociology and technology connected to the information society.

Considering this subject's complexity, I selected several analytical methods and approaches. During the data collection, I relied upon the Hungarian and the international literature on the subject. Thus, I was able to process a large quantity of information (nearly 6000 figures). I also extended my literature research to printed and electronic publications on the Internet.

The literature on the development of ICT distinguishes five development stages [Figure 1].
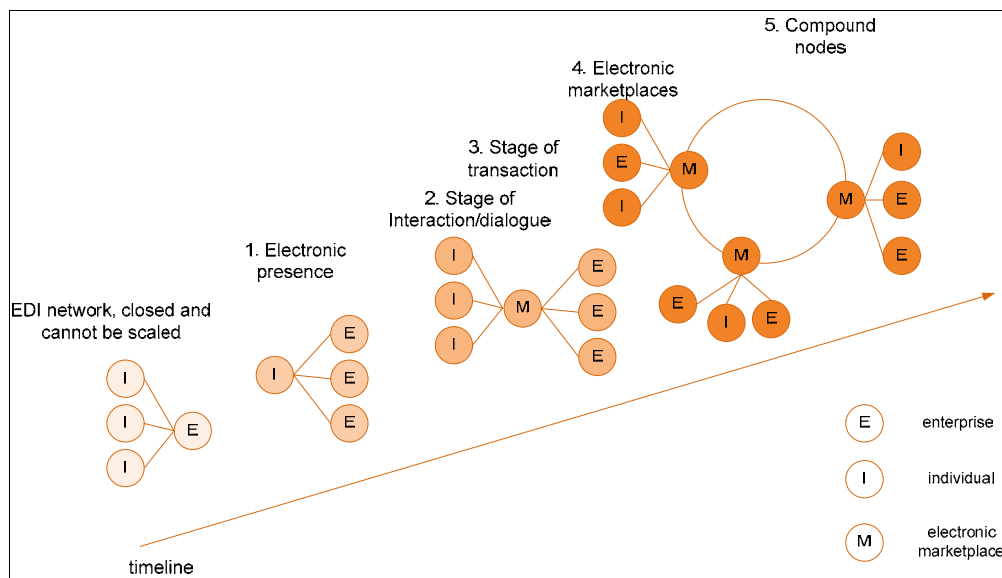
Source: Kápolnai A.-Nemeslaki A.- Pataki R.: eBusiness stratégia vállalati felsővezetőknek
(E-business strategy for senior management)

Figure 1. The development stages of information and communication technology

These stages are built upon each other. With the help of the model shown above, I measured the individual development stages. By averaging the data of the first three development stages, I examined the enterprises' willingness for adaptation.

With the help of my own model, which comprises five elements, I analyzed the development and growth of the size categories and economic branches.

Its steps are as follows:
- ➣ Processing the data of the primary and secondary research
- ➣ Assigning single indicators to individual development stages, calculating potential indicators
- ➣ Calculating the values of potential indicators from single indicators

- ➣ Studying potential indicators
- ➣ Determining potential indicators at the individual development stages

Then, with the help of the resulting indicators, I performed a cluster analysis, a compound regression analysis, and, finally, a discriminant analysis on the economic sectors surveyed.

THE RESULTS OF THE ANALYSIS OF INFORMATION AND COMMUNICATION TECHNOLOGY

Clustering is the division of a set of observations into subsets so that observations in the same cluster are

similar in some sense. The clustering process is successful when the subsets are similar to each-other and different from the elements of other subsets at the same time. Based on theoretical considerations, I decided to make groups of economic activity categories from the five previously defined potential indicators.
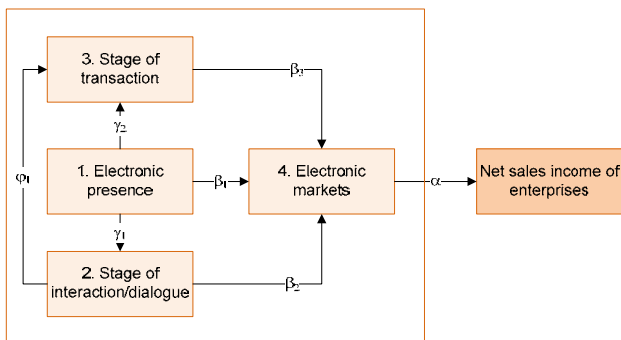

Source: Individual primary research using SPSS 16.0 statistical package

Figure 2. Two-cluster model of the national economic sectors

To summarise the results of the cluster analysis, it can be stated that the sectors "Electricity, gas and water supply", "Transport, storage and communications", "Mining and quarrying", "Manufacturing" and "Financial intermediation" belong to the second cluster because of better average values.

I used the path model to study how the potential indicators influence one another and what direct or indirect effect they have on the average net income of the individual economic sectors. (thousand HUF/enterprise).

The variables presented in the path model are linked with arrows to one another showing the direction of their relationships. I assumed in my causal model that the potential indicator of electronic presence is the exogenous variable. Based on the arrows leading from it, the potential indicator of electronic presence has an effect on the other potential indicators. It also has an indirect effect on the average net income of enterprises in several economic sectors. These paths are called indirect paths by the literature. In my model, they show how the effect of the potential indicator of electronic presence manifests itself through the potential indicators of interaction/dialogue, transaction and electronic markets. The potential indicators of interaction/dialogue and transaction became endogenous variables. Endogenous variables are variables with causal links leading to them from other variables in the model. In other words, endogenous variables have explicit causes within the model. The dependent variable in my model is the average net income of enterprises in economic sectors: the arrows leading from the other variables point to this one but it has no arrow or link pointing back to the other variables. The aim of setting up a path model was to divide the zero linear correlation between the independent and the dependent variables into two parts. The first part is the effect that the independent variable directly has on the dependent variable, while the second part shows the effect being had on the dependent variable by the independent variable through other endogenous variables.

Only the potential indicator of electronic markets has a direct effect on the average net income of enterprises [Source: Individual primary research Figure 4] However, the effect of the potential indicator of electronic presence is significant as it influences the potential indicator of electronic markets to a great extent. The value of the indirect effect of electronic presence was (87.4%*60.5%) 56.2%. In the table below, a new arrow also appears with a value of 70%, showing the effect of non-specified variables from outside the model on the average net income of enterprises.

Source: Individual primary research

Figure 3. The scheme of the path model of the potential indicators
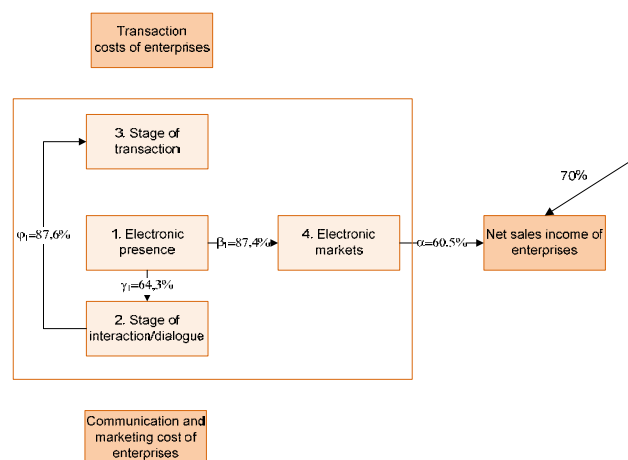
Source: Individual primary research

Figure 4. The final path model of the potential indicators

Electronic presence has no direct effect on the potential indicator of transaction. The value of the strength of its indirect effect was (64.3%*87.6%) 56.3%, according to my computation. The model verified the hypothesis that electronic presence largely determined interaction/dialogue. Electronic presence had an indirect effect on transaction and it had the strongest correlation with electronic markets. Before creating the model, I assumed a direct correlation between transaction and electronic markets, but I could not verify the existence of the relationship between them. However, the new result of my research was that there was a direct correlation between electronic markets and the average net income of enterprises.

In the early phase of my research, I encountered the problem that there were no explanatory variables in the typology created by cluster analysis. Typologies are different clusters of a low measurement level so the explanation of their development status is impossible with previously used techniques. Discriminant analysis is a useful method to explain a low measurement level variable with another variable of high measurement level. Discriminant analysis is a technique where dependent variables are not metric and are classified as belonging to

two or more categories whereas independent variables (predictors) are measured on a metric scale [Figure 5].

Figure 5. Partial summary of the methods used for structure analysis, along with discriminant analysis

After completing the cluster analysis, I found that the economic sectors surveyed could be classified into two, then four ICT development levels or clusters [Figure 6].
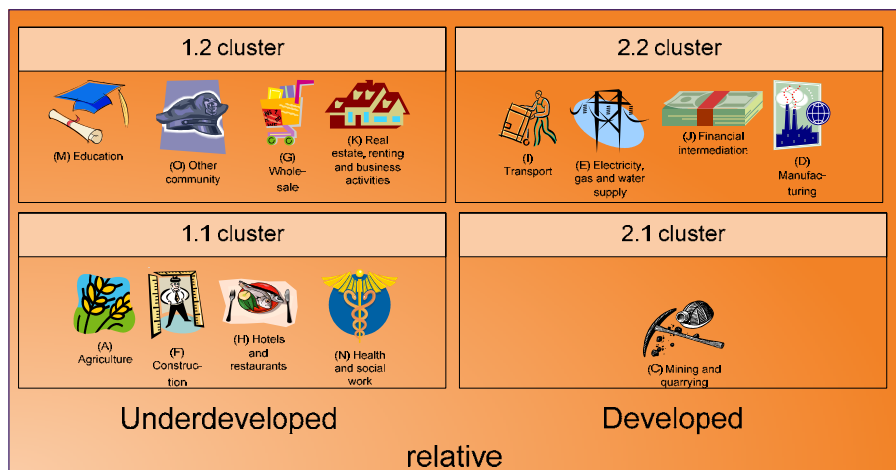
Source: Individual primary research using SPSS 16.0 statistical package

Figure 6. Four-cluster model of the national economic sectors

The following four economic sectors were placed in the 1.1 cluster: 'Agriculture, hunting and forestry', 'Construction', 'Hotels and restaurants' and 'Health and social work'. The average of the potential indicators to electronic presence, interaction/dialogue, transaction and electronic markets was the lowest in the four clusters.

Four economic sectors were classified into the 1.2 cluster as well: 'Wholesale and retail trade; repair work', 'Real estate, renting and business activities', 'Education' and 'other community, social and personal service activities'. Examining the data of this cluster, it could be observed that its average values were higher than those of the 1.1 cluster but were lower than the average values of the other two clusters.

Only the 'Mining and quarrying' sector was classified into the 2.1 cluster. In terms of electronic presence and electronic markets, this sector was the most developed compared to the other sectors. This cluster produced the second highest ICT values based on the values of the other potential indicators.

'Manufacturing', 'Electricity, gas and water supply', 'Transport, storage and communications' and 'Financial intermediation' could be found in the 2.2 cluster. The values of interaction/dialogue and transaction were the highest in this cluster compared to the other ones.

My aim was to become acquainted with the human resource demand of enterprises (the number of the employees regularly using computers), the cost of ICT services or availability (cost of computer-related

services), and the amount spent on professional training (the total expenditure on professional training).

These three explanatory variables jointly indicate the different ICT development stages. In this case, the discriminant analysis predicts whether an enterprise belongs to a specific development stage or not.

Based on the primary research, it can be stated that education expenses have a more significant effect due to the fact of belonging to various clusters. As the aim of the discriminant analysis is the classification of cases into groups, the classification table is one of the most important results of the analysis.

The table below consists of two parts: the first presents the scores before the grouping took place. The chance of being classified into a cluster is 25% in each group and each cluster's weight was different.

Table 1. Classification Results b,c

Cluster	Prior	Cases Used in Analysis	
		Unweighted	Weighted
1.1	,250	36	36,000
1.2	,250	82	82,000
2.1	,250	4	4,000
2.2	,250	58	58,000
Total	1,000	180	180,000

		Cluster	Predicted Group Membership				
			1.1	1.2	2.1	2.2	Total
Original	Count	1.1	19	17	0	0	36
		1.2	30	51	1	0	82
		2.1	2	1	1	0	4
		2.2	24	30	0	4	58
	%	1.1	52.8	47.2	0.0	0.0	100.0
		1.2	36.6	62.2	1.2	0.0	100.0
		2.1	50.0	25.0	25.0	0.0	100.0
		2.2	41.4	51.7	0.0	6.9	100.0
Cross-validateda	Count	1.1	16	19	0	1	36
		1.2	32	48	1	1	82
		2.1	2	2	0	0	4
		2.2	24	30	1	3	58
	%	1.1	44.4	52.8	0.0	2.8	100.0
		1.2	39.0	58.5	1.2	1.2	100.0
		2.1	50.0	50.0	0.0	0.0	100.0
		2.2	41.4	51.7	1.7	5.2	100.0

a. Cross validation is done only for those cases in the analysis. In cross validation, each case is classified by the functions derived from all cases other than that case.

b. 41.7% of original grouped cases correctly classified.

c. 37.2% of cross-validated grouped cases correctly classified.

Source: Individual primary research using SPSS 16.0 statistical package

The actual hit ratio can be seen in the second part, it is given as a percentage, its value ranges from 0 to 100. Instead of the lowest possible value, it needs to be compared to the expected hit ratio. The expected hit ration means the hit ratio that results from random categorization; its value is 25% in the case of four groups. The classification table is suitable for the evaluation of the results of the discriminant analysis as it shows the ratio of the adequately categorized group membership. The rows make up the categories of the dependent variables and their initially observed values, while the columns of the table constitute the values predicted by the independent variables.

The table can be divided into two parts: the upper part of it shows the initial analysis, while its lower part presents the cross validation values. The data are presented in the same way in both parts of the table: they are expressed either in absolute value or as a percentage. When analyzing the absolute values of the table, it can be observed that only 19 cases were placed in the 1.1 cluster from its original 36 cases, while 17 of them were placed in the 1.2 cluster. Expressing this data as percentages, it means that the rate of the adequately categorized cases is 52.8% in the 1.1 cluster, 25% in the 2.1, 6.9% in the 2.2 and 62.2% in the 1.2 cluster. Consequently, the procedure was successful only in the cases of the 1.1 and the 1.2 clusters.

SPSS identifies values as adequate hit ratio on the diagonal: if the prediction equals the value of the initial sets of observations then the prediction is perfect and every value is situated on the diagonal. Enterprises were adequately categorized in 41.7% of cases and 37.2% of predictions based on the given variables.

In summary, it can be stated that the first and the fourth clusters are significantly different from the other two clusters, as their hit ratio is above 50% in the case of three independent variables. Examining the results, it can also be observed that these two clusters can hardly be divided in the case of three independent variables.

CONCLUSIONS AND SUGGESTIONS FOR THE PRACTICAL USE OF RESEARCH FINDINGS

The most important step of the cluster analysis is to determine the number of clusters. The data show that it is expedient to form two clusters based on the potential indicators. The first cluster comprises eight, while the second comprises five economic activities. As a consequence, those economic branches that use ICT devices less frequently than the national average belong to the first cluster, while the second cluster contains those economic branches that can be seen as developed ICT-users.

The multiple regression analysis is the series of regression models built upon each other. Using the regression model, I studied the direct and indirect effect of the potential indicators on each other and the companies' net income in several economic branches.

The only potential indicator affecting a company's net income is the indicator of electronic marketplaces. However, the effect of the electronic presence is significant, since it has a great influence on the potential indicator of electronic marketplaces. During my primary research, I found that the effect of the non-specified variables out of the regression model on a company's net income is 70%.

The typology carried out by cluster analysis does not contain independent variables. The discrimination analysis helps to explain the values of dependent variables with the help of independent variables. With the clusters showing the given development stages, my aim was to get a better idea of the companies' needs for human resources, and of how much is spent on training and ICT services by the given company. Expenses which are exclusively devoted to training have a more significant effect on which cluster a company belongs to. It was possible to classify the companies into clusters based on the three independent variables in 42% of the cases.

I could not find a reliable mathematical and statistical method for studying the effect of information communication technology on businesses in the literature. That is why I proposed a new research and analysis method that I also used to study the Hungarian economic branches.

The primary possibility of utilizing the proposed method appears in situation report. I managed to measure the relative (economic branches correlated to each other) and the absolute (economic branches correlated to the same ones in a different country) development level of the information communication technology with the help of creating development stages and quality categories, and with the adaptation willingness belonging to the given development stages.

The secondary possibility for utilization lies in following patterns. The development of ICT is different in several countries, regions and economic branches. The European Union proposed a strategic framework for its member countries. The main aims of establishing a strategic framework are:

- a single European information space
- boosting investment and innovation in ICT research
- establishing a receptive European information society

The economy of the United States is regarded as a model economy where two-third of the employees were dealing with information processing during working hours in 2000. One of the causes of the massive economic performance of the United States is highly-developed information processing. If we manage to measure this level of development, a strategy can be formulated in the European Union and in the individual member states in order to catch up with the most developed countries.

The general object of this study is to find ways of analysing the national economy of a given country. With the help of the method I have worked out, it is possible to analyze and assess the sections, subsections, divisions, groups and classes of a given national economy. In addition, the economic branches, company sizes and organization forms can also be studied.

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