EXPLORING THE RELATIONSHIP BETWEEN ICT DEVELOPMENT AND ENVIRONMENTAL PERFORMANCE

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Abstract

Industry 4.0, industrial digitalization, robotics, sustainability, circular economy, eco-efficiency – these are all hot topics for researchers and professionals, as well. Since we are in the era of fourth industrial revolution, companies invest more and more money in tools and solutions that make it possible to connect all their processes, machines, workers and even products into a single network, and to gather data about them and through analyses, achieve high performance and improvement. Keeping up with technological innovation especially in ICT is vital for companies all around the world. Another important issue is sustainability and the concept of circular economy. The greatest challenge of our society is to change our operations in order to live within the limits of our planet. This expectation for change usually emerges from stakeholders of companies, but in order to gain competitive advantage it is important to improve environmental performance and their capability to create and prosper within the circular economy concept.

In this paper we would like to explore if there is a connection between ICT development and environmental performance. Could these concepts work together, do companies develop both aspects and use the advances? We investigate how the application of advanced ICT tools effect companies' environmental performance, which will be tested on a database of 300 companies by statistical analyses. The database was collected by the Hungarian Competitiveness Research Centre in 2013.

Preliminary results say that the companies in the sample, which are advanced in use of ICT tools both in meaning of extension of usage and variety of tools, lay significantly higher emphasis on auditing environmental activity, introducing an accounting system which is capable to assess environmental expenses, and formulating environmental criteria for suppliers than those who are less advanced in ICT.

Key words: ICT, Industry 4.0, environmental performance

1. INTRODUCTION

Industry 4.0, industrial digitalization, robotics, sustainability, circular economy, eco- efficiency – these are all topics move researchers and professionals as well and the success of the concepts determines our future.

Managers of our time have to adapt to a highly dynamic business environment. According to the concept of dynamic capability (Eisenhardt and Martin, 2000) in order to cope with the highly dynamic environment, businesses need to acquire relevant knowledge, then transform them into capability and finally use this capability to gain and sustain competitive advantage (Zahra, 2002).

Part of this environment, there are two concepts: sustainability - as a demand from stakeholders at large (Sheth et al, 2011) - and digitalization which has the potential to boost efficiency and better customer service of the companies (Becker et al, 2009; Nagy et al, 2018). Both of these concepts add to the overall competitiveness of companies and demand new capabilities and attitudes e.g. high level of willingness to innovate and cooperate with stakeholders.

In our paper, we narrow digitalization to the extensive use of Information and Communication Technologies (ICT) in companies. The extension of ICT usage will be analyzed by Pham's (2010) maturity model, which states that the development of ICT in a company depends on the policies, infrastructure, applications and human resources.

The analyses of environmental performance is based on the multidimensional environmental performance model suggested by Schulze and Trommer (2011). This model was chosen because environmental performance of an organization is determined by several factors, not exclusively by CO2 emissions.

Using statistical analysis methods, we point out, that the companies with higher ICT development can achieve better environmental performance.

The paper is structured as follows: in the literature review we summarize the role of ICT in companies and its effect on environment. We also formulate our hypotheses and research questions to analyse the topic. In the methodology chapter we introduce the Hungarian Competitiveness Study and its extensive questionnaire we used to test our questions, and the exact methodology we chose. The Findings parts summarizes the results of the analysis, while chapter Discussion presents our new results and their relevance for science and industry. The Conclusion sums up the most important results and deals with the limitations of the study and future research directions.

1.1 Literature review and hypotheses development

Information and communication technology has gone through intense development and spread over the past decades. We use the definition of Weber and Kaufman (2011, p.684) in which ICT is understood "as technologies that support data and information processing, storage and analysis, as well as data and information transmission and communication, via the Internet and other means." We cannot imagine either our homes or workplaces without the presence of various ICT tools, and numerous software are here to help our lives and work.

ICT technologies in supporting business processes became inevitable in companies and can be source of competitiveness (Becker et al, 2009). The level of ICT development, maturity can be described many ways (Pham, 2010; Chesher et al, 2000), and there are indices to measure it, too (Digital Opportunity Index and ICT Opportunity Index by International Telecommunication Union).

From environmental perspective, ICT development has controversial effects. On one hand, the spread of ICT tools and the increase of their capacity and performance enhance the need for energy, and the large amount of electronic waste burdens the environment (Yi-Thomas, 2007). On the other hand, improvement of ICT and consequently the efficiency increase of the company and/or production processes might save us energy, waste, pollution or workload. ICT contribution to productivity and economic growth is admitted (Ishida, 2015; Higón et al., 2017). ICT also take main role in economy transformation and become vital source of competitive advantage. Although Ollo and Aramendia (2011) discovered no relationship between ICT and company competitiveness, they found that advanced ICT favour innovation, launching new products and services and implementing new processes which can enhance firm competitiveness eventually.

We can see pro and con examples on ICT's environmental effects in the literature. Matthews (2002) compared on-line and offline book retailers, and concluded that it cannot be decided which is more energy efficient. Lee and Brahmasrene (2014) explored ASEAN countries to find relationship among ICT, economic growth and CO_2 emission. They found that ICT has significant positive effect on both. However, Melville (2010) emphasizes that ICT tools can enable organizational practices and processes that improve environmental and economic performance. Ishida (2015) and Yi and Thomas (2007) state that ICT supports economic growth, social development and environment protection, although computers contain parts that are toxic, and to produce semiconductor wafers manufacturers use a lot of water and energy. Toffel and Horvath (2004) analysed two ways the effects of ICT on environment. First, the compared the economic effects of reading printed newspapers versus on the Internet via PDA, second, using cell phone conferences as business meeting instead of traveling. In both cases they explored that the ICT-supported version of the activity – i.e. reading online newspaper and tele-conferencing – produces less emissions than the traditional ways, even if we consider the production and material needs of a PDA or a cell phone, or the energy need of batteries and wireless internet.

In this paper we would like to investigate the possible connection between digitalization and sustainability - in the narrower sense between the use of information and communication technologies and environmental performance. Could these intensely researched concepts work together, support each other and provide a more sustainable future? Do companies with more developed ICT have better environmental performance? Our hypothesis (H1) is that higher level of ICT development in a company results in increasing environmental performance. To analyse this hypothesis, we formulated three research questions (RQ) as follows:

RQ1: Do companies which use ICT on a more advanced level, have better environmental performance?

RQ2: What kind of environmental performance can be expected from companies with developed ICT system?
RQ3: What characteristics do companies with advanced ICT and advanced environmental performance have?

The next chapter introduces the methodology with which we aim to analyse the research questions.

2. METHODOLOGY

The research questions will be tested by quantitative methods, using statistical analyses. We think that quantitative method and the large sample helps us to reveal if there is correspondence amongst the phenomena what we suspect and what are the most interesting problems and correlations that are worth to investigate further.

The database we use belongs to Hungarian Competitiveness Research Centre (HCRC) which operates at Corvinus University of Budapest and surveys the companies' competitiveness in approximately every five years. The first Hungarian Competitiveness Survey was carried out in 1995 and since then, five others followed that. The results of the latest survey (HCRC, 2013) will be analysed in this paper.

The questionnaire of the survey is almost 100 pages long and can be divided into four blocks. Within each blocks, chapters cover wide range of management topics. First block is dedicated to the CEO and the board, touching issues like the basic data about the firm, the internal and external environment, strategy and management structure of the company. The CEO block also deals with human resources management and controlling topics. The second block is dedicated to the CFO, reviewing the finances, investments and controlling issues. Third block targets the production (or service) managers, requesting data about the production or service processes, the supporting hardware and software infrastructure, the innovation, the logistics and supply chain management and the environment protection. The fourth block is dedicated to the sales or marketing directors, aiming to gather data about the general market position of the company, the long-term relationships, the marketing activity, its assessment and effectiveness. Questions were answered mainly by multiple choice or Likert-scale methods, but in case of data requests short answer or a number was also accepted. In our analysis, we used questions of the CEO and production blocks (see Table 1 and 2). We applied cluster analysis to separate companies in the sample which are good from ICT perspective, and which are not. After having the clusters, we describe their state of ICT development, and we give a description about their environmental performance and the green practices, environmental management tools they apply.

As a first step we selected 12 questions from the questionnaire which we think reveals if the respondent company is developed in ICT or not. Since the questionnaire was made for different purposes, finding appropriate questions was not easy. During selection, we had to consider the variables and scales and standardize them, where necessary. It was also a problem that in case of many questions so many answers were

missing that it distorted the results or made it impossible to interpret. Consequently, we need to exclude them. Table 1. shows the final questions used for the analysis.

ICT development was analysed along four aspects suggested by Pham (2010): ICT policy, infrastructure, applications and human resource. ICT policy refers to written or unwritten rules, procedures and ways of doing business in an enterprise. Infrastructure covers the devices and services which help the company in storing, processing, communicating and sharing information. Applications refer to the software which help doing business. Human resource issues concern ICT literacy, skills and also innovation skills. We think the following questions represent the level of ICT development at companies. Table 1 summarizes the questions selected from the HCRC survey.

Table 1. Selected questions for assess ICT maturity

Maturity dimension (Pham, 2010)	**Questions**	**Answer options**	**Question ID**
ICT Policy	Is there written ICT strategy at your company?	Yes/No	T38_var
Infrastructure	Do you use server virtualization in your company?	1: we use it 2: it is under implementation 3: we plan to implement within 2 years 4: we are not planning at all	T45a
	Do you use cloud in your company?		T45b
	Do you use Open source system(s) in your company?		T45d
	Do you use mobile phones and/or tablets in your company?		T45c
Applications	Do you use ERP system in your company?	1: we use it 2: it is under implementation 3: we plan to implement within 2 years 4: we are not planning at all	T45e
	Do you use Business Intelligence system in your company?		T45h
	Do you use Expert system in your company?		T45k
	Do you use workflow / groupware in your company?		T45i
HR	The output of the company contains high level of innovation	1: the statement is not valid for the company at all 3: the statement is valid more or less 5: the statement is valid in every case	T47a
	To plan and design our products we use innovative IT tools.		T47b
	To manufacture our products we use innovative IT tools.		T47c

Source: own edition, along Pham (2010) maturity dimensions

3. ANALYSIS

The analysis is based on cluster analyses. We used the selected 12 questions from the questionnaire which reveal whether the respondent company is developed in ICT or not.

ICT policy was measured by whether there is a written IT strategy at the company or not (T38_var). Infrastructure was captured by innovative solutions like cloud (T45b) and the server virtualization (T45a), which means, that companies hire data storage equipment and space at server operators who have huge server parks with different performance characteristics and can offer customized portfolio, fitting to the actual needs. Application of open source (T45d) systems allow companies to have updates frequently and if they have the own ability, to customize the software on their own. It is even more common at companies to represent the results of analyses in user-friendly way, on mobile phone or tablet application (T45c). The spread of these devices within a company might also indicate the development stage of ICT.

The most basic selected ICT application was the ERP system (T45e) since the use of this is essential to have processes under control within a company, and be able to analyse and give structured reports on them. ERP is also important because many other IT tools and solution are built on it and interconnected with it. Using workflow and groupware (T45i) indicate that a company has well defined administration, problem solving routes, the tasks are allocated to workers clearly. On the way of digitalization, the most important thing is to start collecting data on core processes and to analyse them. Having rapidly growing databases at companies increased the need for alternative data storage systems, which can substitute and disencumber corporate data warehouses and servers. The data also have to be analysed and used in decision making properly. To do these the application of business intelligence and expert systems are developed solutions. Business intelligence (T45h) assure that the data for different business areas are analysed and reported. Expert systems (T45k) use algorithms maybe artificial intelligence to interpret the information gathered form the data, and help top management in making right decisions The latter question mainly support the technological background of developed ICT activity in a company. All T45 questions were multiple choice, where respondents needed to mark whether they use it actually, it is under implementation, they plan to implement it within 2 years or not planning at all. The other group of questions used for classification was T47. In this question group we investigated the innovation content of the companies' products or services (T47a), whether they support the design and planning of products and services by IT (T47b) and how much the manufacturing process of the products/services is supported by IT (T47c).

After selecting the appropriate questions, cluster analyses were run. By using SPSS statistics program, a hierarchical cluster analysis was carried out (between-groups linkage method) which produced two clusters, with population of 43 and 124 companies. Hierarchical methods can be used easily and can provide reliable results on large sample (Sajtos-Mitev, 2007). To test the results of the hierarchical cluster analysis, we run a K-mean cluster analysis, too. We got two clusters again with population of 66 and 101 companies, and the membership of the clusters almost overlap, 17 companies changed place between clusters. As ultimate results, the cluster

memberships were defined by where the two methods agreed. This way, first cluster contains 43, the second 103 companies.

As a second step we analysed the environmental performance of the two clusters. The description of the clusters from an environmental performance point of view is based on the multidimensional environmental performance model suggested by Schulze and Trommer (2011). This model was chosen because environmental performance of an organization is determined by several factors, not exclusively by emissions. The recent literature and public opinion gives great emphasis to greenhouse gas emissions and CO_2 emissions (Hilty et al, 2011, Wang et al, 2015). On the other hand environmental performance can be indicated by strategic decisions (e.g environmental policy, sustainability reporting, auditing), the material and resource input, the process management and the outputs of operations as well.

Table 2. The questions used in the HCRC survey according to multidimensional environmental performance model suggested by Schulze and Trommer (2011)

Environmental performance indicators	**Questions**	**Answer options**	**Question ID**
Operational indicators			
Input oriented indicators			
Energy	Resources spent on the reduction of energy use of production	Yes/No	T51 a
Water	Resources spent on the reduction of water use of production	Yes/No	T51 b
Material use	Resources spent on the reduction of material use of production	Yes/No	T51 c
Process indicators			
Recycling	Resources spent on the reuse of waste materials within the company	Yes/No	T51d
Reuse of materials	Resources spent on the reuse of products	Yes/No	T51 f
Elimination of hazardous materials	Resources spent on the elimination of hazardous input materials	Yes/No	T51 e
Packaging recycling	Resources spent on the recycling of packaging	Yes/No	T51g
Reduction of packaging	Resources spent on the reduction of packaging materials for product units	Yes/No	T51h

Environmental criteria for suppliers/supplier evaluation	Existance of written environmental criteria for suppliers	Yes/No	T50b
Output oriented indicators			
Environmental performance measurement system	Is environmental performance measurement present by the company?	Yes/No	V80b
Environmental accounting	Is environmental accounting system present by the company?	Yes/No	V80f
Outcome oriented indicators			
Training of employees	Is an environmental training program in place for employees?	Yes/No	V80c
Environment-related criteria in employee performance measurement	Is there environment-related criteria present in employer evaluation?	Yes/No	V80d
Environmental auditing	Is there regular auditing of the environmental management practices?	Yes/No	V80e
Strategic indicators			
Manager/department responsible for environmental issues within the organizational	Is at least middle managerial level responsible for environmental issues within the organization?	Yes/No	V63 var
Environmental policy, goal setting	Does the organization have a written environmental policy?	Yes/No	V80a
Sustainability reporting	Does the oragnization have a publicly available environmental or sustainability report?	Yes/No	V80g

Source: own edition

In this framework environmental performance refers to corporate behaviour and give a reliable and valid picture of a company's attitude towards environmental sustainability.

4. FINDINGS

In the following section, the ICT characteristics of clusters 1 and 2 will be revealed. In order to have reliable results, crosstable analysis was run to compare the

results of the two clusters, and difference was tested by Cramer's V on a 5% significance level. Differences of the clusters' results proved statistically significant.

Regarding ICT policy, in Cluster 1 70% of companies have conscious IT strategy, while in Cluster 2 only 36% has (T38_var).Considering infrastructure issues, application of cloud technology is actually present or will be in two years at 27% of Cluster 1 while only at 12% of Cluster 2 companies. Server virtualization is a little bit more spread amongst the companies, maybe they keep it more reliable than cloud: 53% of Cluster 1 companies uses it or will be in two years, but in Cluster 2 only 11% plans the same. Open source systems are applied at 58% of Cluster 1 companies, and 15% of Cluster 2 companies. The employment of mobile phones and tablets to run corporate applications is present at 79% of Cluster 1 companies, while only 33% of Cluster 2 companies.

Regarding the applications, in Cluster 1, 65% of companies uses ERP system, and within 2 years 95% of them will have one, while in Cluster 2 actually 17,5% of firms have ERP and in a 2-year horizon this share will increase until only 31%. 65% of Cluster 1 companies already helps or will within two years the intrafirm collaborations with workflow and groupware systems, in Cluster 2 the same is true only for 7% of firms. Regarding the analysis of the gathered data, business intelligence systems proved to be a big difference between the two clusters. In Cluster 1 93% of firms already uses it or plan to implement it within two years, while none of the Cluster 2 companies uses the technology actually, and only 7% plans to implement it in the following two years. Spread of expert systems shows similarly big gap between the clusters. 72% of Cluster 1 companies already uses it, and within two years, 93% will. In Cluster 2 none of the companies uses expert system, and only 8% plans to implement within two years. Operational and strategic dimension results are summarized in Table 3.

Table 3. Results of clusters' environmental performance

Maturity dimension (Pham, 2010)	**Questions**	**Question ID**	**Cluster 1 Advanced ICT**	**Cluster 2 Lagging ICT**	**Sig.**
ICT Policy	Written ICT strategy	T38_var	70%	36%	.000
Infrastructure	Server virtualization	T45a	53%	11%	.000
	Cloud	T45b	27%	12%	.026
	Open source system(s)	T45d	58%	15%	.000
	Mobile phones and/or tablets	T45c	79%	33%	.000
Applications	ERP system	T45e	65%	17.5%	.000

	Business Intelligence system	T45h	93%	7%	.000
	Expert system	T45k	72%	0%	.000
	Workflow / groupware	T45i	65%	7%	.000

Source: own edition

To test how innovative companies are in their products and services (T47a), whether they use advanced IT technology in product/service design and planning (T47b) as well as in manufacturing (T47c), we used ANOVA F-probe to compare the cluster means. Cluster 1 outshines Cluster 2 in all aspects, as it can be seen in Table 4.

Table 4. Compare of means with ANOVA[1]

	Cluster 1	**Cluster 2**	**Sig.**
Innovative product, service	3.21	2.15	0.000
IT-aided product/service design and planning	3.26	2.12	0.000
IT support of manufacturing	3.28	2.28	0.000

Source: own edition

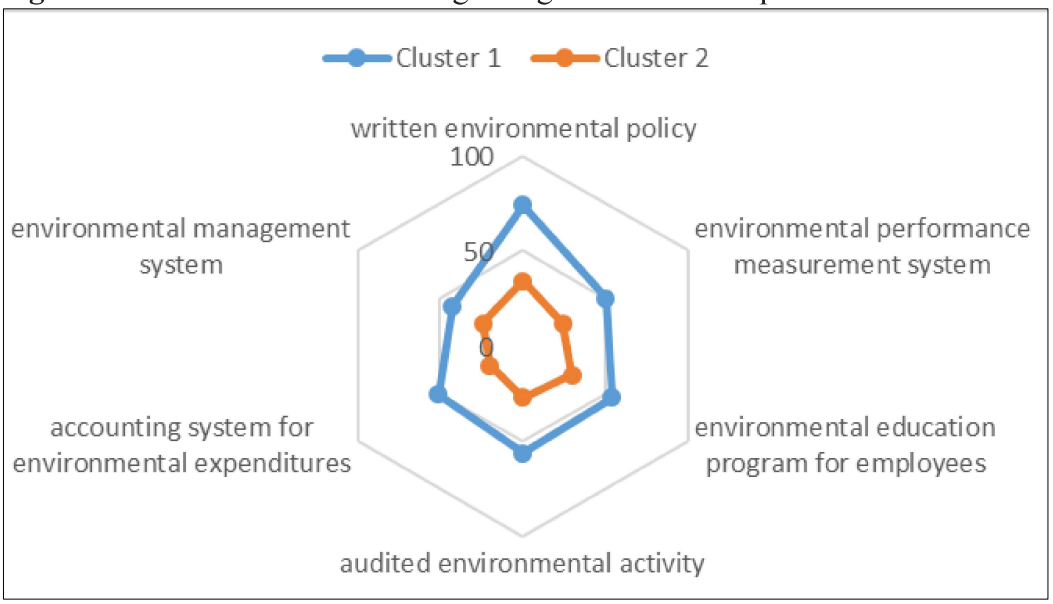
As we can see, there are significant difference in ICT usage between the two clusters. Based on these differences, we named Cluster 1 Advanced in ICT and Cluster 2 Lagging in ICT.

The next section shows, how the two clusters differ in environmental performance. Results of the clusters were compared by SPSS, applying 5% significance level and reliability was tested by Phi and Cramer's V. All the results are statistically significant (if not otherwise marked).

Regarding input and process-oriented indicators, question T51 measured whether the companies spent on different projects to reduce emissions between 2009 and 2012. Both clusters made efforts: 97% of Cluster 1 and 82% of Cluster 2 companies reduced the energy consumption of manufacturing (service) process, which is a statistically significant difference (5% significance level) but high share anyway. Many companies spent on reusing the waste material, 75% in Advanced ICT cluster and 54% in Lagging ICT cluster. They also spent money on triggering dangerous inputs, 86% in Cluster 1, and 51% in Cluster 2. Between 2009 and 2012 82% of Cluster 1 companies financed projects to reuse the materials or the product itself, while in Cluster 2 only 31% did so. Packaging material per item was reduced at 72% of Cluster 1, and 45% of Cluster 2 companies. 74% of Cluster 1 companies spent on environmental audition of their suppliers, while only 29% in Cluster 2 did so.

Analysing the output and outcome-oriented indicators, large share of advanced IT cluster companies have written environmental policy, apply environmental management and accounting system, measure the environmental performance and train their employees in environmental issues (Figure 1).

Figure 1. Difference of clusters regarding environmental performance[1]



The consciousness of handling environmental issues differs significantly in the two clusters. Regarding the strategic indicators, environmental leader appears in the company hierarchy in 70% of Cluster 1 firms, while in 56% of Cluster 2 companies employ no one being responsible for the area. Cluster 1 companies set environmental targets for themselves (79%) while in Cluster 2 only 30% sets own targets. 34% of Advanced ICT cluster companies have sustainability/CSR report, while in Cluster 2 only 19% does so (this result is significant only on 7% level).

This section represented the results of our analysis, following the structures of ICT maturity model of Pham (2010) and environmental performance model of Schulze and Trommer (2011). The following section will reveal our remarks on the results.

5. DISCUSSION

In this part we interpret our findings and answer our research questions. In our paper we analysed the development of ICT and also the environmental performance along two theoretical models. Both model gave us a very good structure and allowed us to apply more dimensions at a time.

In case of ICT literature focused on mainly the technological background (Weber-Kaufmann, 2011; Ishida, 2015), the model applied pointed out that ICT has important role in organization and innovation (Ollo-Aramendia, 2011; Pham, 2010). The environmental performance model was even more important. In the literature we found only process (material and energy consumption) (Yi-Thomas, 2007; Higón et al, 2017) and output (GHG and/or CO_2 emission) oriented measures (Lee-Brahmasrene, 2014), although there are many other factors which are important and relevant about a company's environmental performance and which also can be an indicator (existence of environmental management system, environmental accounting

and performance management, etc.). This way we were able to complete Schulze and Trommer's model and interpret environmental performance in a wider meaning.

For research question 1, whether companies which use ICT on a more advanced level, have better environmental performance we can answer yes. We concluded that the Cluster 1 companies, which use ICT on a more advanced level have significantly better environmental performance according to our results in 16 dimensions. The result corresponds with Melville (2010) who emphasizes that ICT tools can enable organizational practices and processes that improve environmental and economic performance

Research question 2 dealt with that what kind of environmental performance can be expected from companies with more developed ICT. To answer this question we introduce the results in more detail. According to the environmental performance we can create 3 groups within Cluster 1. Companies in Cluster 1 already have better environmental performance than the ones in Cluster 2, but we can still find different environmental profiles amongst Cluster 1 companies, and we can split them into three groups (since the population of Cluster 1 is only 43, we did not use any statistical methodology to split up the cluster, this is an observation which might be worth to be studied in further studies on a large sample). There are 9 companies with 'excellent' environmental performance, 26 with 'very good', 7 with 'good' performance (1 was not classified). Differences of groups is presented in Table 4.

Table 4. Comparison of Cluster 1 companies along environmental performance level

Groups along environmental performance Questions	Excellent environmental performance (9 companies)	Very good environmental performance (26 companies)	Good environmental performance (7 companies)
V80a: written environmental policy	8 (89%)	18 (69%)	3 (43%)
T51a: decreasing energy consumption of manufacturing processes	9 (100%)	19 (73%)	2 (28%)
T51b: decreasing water consumption of manufacturing processes	8 (89%)	14 (54%)	1 (14%)
T51e: decreasing the use of hazardous materials	9 (100%)	13 (50%)	2 (28%)
V63_var: There is environmental manager in organizational hierarchy	8 (89%)	19 (73%)	3 (43%)

Source: own edition. Note: cells contain the number of companies having or using the environmental performance management method

The Table 4 compares environmental performance profiles within Cluster 1 along several selected questions, related to both operations and strategic oriented

indicators. These profile might be analysed in further research since the actual sample is not big enough to draw statistically reliable conclusion from it.

Research question 3 investigated that what characteristics do companies with advanced ICT use and advanced environmental performance have. To answer this, we also apply the three-split Cluster 1.

The companies with excellent, very good and good environmental performance can be compared by ownership structure, industry, company size and whether they have environmental policy, IT strategy or ERP system.

Excellent companies mostly are in Hungarian private ownership (5 of 9), operate mainly in processing industry (6), especially in machine industry (3) and energetics (2). Most of them are middle-size companies (6). 8 of 9 have formal environmental policy, 5 have formal IT strategy and 8 uses or currently implements ERP system.

Firms with very good environmental performance are owned mostly by Hungarian (14) and foreign (10) private owners. These companies also operate mainly in processing industry (19) – within that: machine (9), food (5) and light industries (3) - and commerce (3). Very good companies are rather middle-size (15) or large (9) ones. 18 of 24 have formal environmental policy, 18 have formal IT strategy and 23 uses or currently implements ERP system.

Firms with good environmental performance work in processing industry (2) and commerce (2) as well, are owned dominantly by Hungarian private owners (4) and are mainly middle-size companies (5). 3 of 7 have formal environmental policy, 6 have formal IT strategy and all uses or currently implements ERP system.

Regarding the results, it can be stated that private ownership – even if it is Hungarian or foreign – has a good effect on caring about environment. Consciousness about environment is not the privilege of large companies, as we can see, middle size companies are also dealing with this important issue. Industry affiliation influences environmental performance awareness, too. At processing industry firms it is applied the most frequently, especially in sector which considered to be very polluting: machine, energetics and food. Common in each profiles, that conscious environmental performance management cannot be carried out without the transparent operation of the company, which is supported by ERP systems in almost all profiles.

As a summary we can conclude, that our original hypothesis on higher level of ICT development in a company results in increasing environmental performance is supported by the results, although those are not generalizable.

6. CONCLUSION

The topic of sustainability and digitalization are among the most important and most researched topics nowadays. The paper contributes to the current discussion (Hilty et al. 2011; Ollo and Aramendia, 2011; Melville 2010; Wang et al. 2015; Evangelista et al. 2018; Kayikci, 2018) on the use of digitalization and its effects on environmental performance. However, our viewpoint is different from the current articles, since we explored the relationship between the use of ICT and environmental performance and not measure the effects of the two on one another. We used Pham's ICT maturity model and tested it with HCRC Study questionnaire questions, which

provided us two clusters with significantly different ICT development level. We than applied Schulze and Trommer's model and completed it with concrete analysable aspects in each dimensions. This way our theoretical contribution is dual: we tested a model, and completed an other one.

The results can be useful for professionals as well. According to our results, the companies which are advanced in ICT it is worth to make analyses on environmental performance too, because they probably have all the data necessary to do so, and it might help to make their operations more transparent. Transparency may support convincing investors, stakeholders and customers, not to speak about a good reputation and corporate brand.

For further researches, the environmental performance profiles distinguished within Cluster 1 companies are worth to investigate, which are at an advanced level in ICT and environmental performance. Another research project can be that what motivating factors can be discovered for furthering the connected use of the two concepts for gaining further competitiveness.

Our research has limitations. The database we used was edited for different purposes we were able to use a questionnaire which was already polled. It was hard to find questions suitable to measure different dimensions. Since we have promising results, it would be a good further study to edit a questionnaire exclusively to discover the relationship of digitalization, environmental performance and sustainability. The other cause of limitation is the sample population. The original sample contained 300 companies, but due to exclusions, only 146 remained, and have been classified into advanced ICT cluster (43 companies) and lagging ICT cluster (103 companies). These cluster sizes, since they are not even representative, cannot allow us to draw generalizable conclusions. The result helped us to reveal interesting new research ideas which we are intended to continue.

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