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Original scientific paper

Factors Influencing Information and Communications Technology Usage

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Abstract: The paper investigates predictors of information and communications technology (ICT) usage in small and medium-sized enterprises (SMEs) among European Union member states - developed countries (EU-28) - and the Western Balkans developing countries (WB-5) in the period 2010-2018. It aims to suggest measures for the improvement of ICT usage among SMEs in WB-5 countries. Primary data for a thorough qualitative analysis of ICT use by the WB-5 SMEs were obtained through interviews at the firms' level. Secondary data were obtained from credible international business support organizations and relevant scholarly literature. The analyses were performed utilizing the regression analysis.The authors have identified many variables that influence ICT use through the literature review. From these, they selected ICT access, functional literacy, and gross domestic spending on research and development (R&D) as being vital to the improvement of ICT usage among SMEs in developing countries.

Keywords: ICT; digitalization; SMEs; South-Eastern Europe

1 INTRODUCTION

The use of ICT in small and medium-sized enterprises (SMEs) is associated with the adoption of digital technologies, the degree of digitalization of business processes, and the adoption of new (digital) business models.[1]The available evidence suggests that smaller and micro-enterprises that are not active in ICT-intensive sectors are significantly behind in terms of adopting digital technologies, business practices, and business models [1]. The fact mentioned above is especially meaningful for the Western Balkans (WB-5) region (region of developing countries), where the dominant business types are SMEs operating in the traditional sectors (e.g., wood, metal, agri-food, textile, and tourism). The WB-5 encompases the following countries: Albania, Bosnia and Herzegovina (BA), Montenegro, North Macedonia, and Serbia. The term EU-15 refers to the15 member countries of the European Union (EU) as of December 31, 2003, prior to the accession of 10 candidate countries on May 1, 2004.

The Fourth Industrial Revolution (Industry 4.0) is a historic opportunity for developing countries/regions to improve their economic performance and living standards. ICT provides new business opportunities for enterprises. Benefits from using ICT are multiple, for example it changes their business models, increases productivity, and provides access to larger markets [2]. Industry 4.0 is realized by using various ICTs (i.e. adaptive robotics, additive manufacturing, artificial intelligence, deep machine learning, cloud computing, augmented reality, the Internet of Things, etc [3, 4]. Regardless of the enabling technology, industrial transformation's primary purpose is to increase resource efficiency, productivity, and competitiveness. We live in the transformation era, which differs from others in that it drives change in main business processes and reveals completely new concepts [5].

The relevant literature dealing with ICTs emphasizes that digital transformation is fundamentally not about technology but mainly about strategy. Although it may require an upgrade of IT architecture, the more essential upgrade concerns strategic thinking and ICT literacy [6]. This research's motive arises from the fact that the ICT infrastructure is equally available across developed and developing countries in Europe. Nevertheless, its usage is not on the same level in specific countries/regions. Thus, the paper aims to suggest measures for improving ICT usage among SMEs in developing countries. The authors used the WB-5 countries as an example of developing countries and the EU-28 as an example of developed countries. Additionally, in the group of developed countries (EU-28), there are subgroups and models of more developed countries (EU-15) and less developed countries (EU-13). The authors structured the findings around two main research questions: "Which are the predominant indicators of ICT use?", and "How can ICT use be increased among SMEs in developing countries?".

2 LITERATURE REVIEW

The literature review was carried out by exploring journals that deal with ICT impact on economic, social, and human development. Also thoroughly studied and added to the selection were articles containing recommendations and/or implications for SMEs and policy makers. The former and the latter are introduced and contextualised in the introductory section on ICT use in SMEs.

2.1 ICT and Productivity

In the WB-5 region, there is a high level of ICT use among citizens for different purposes, predominantly for entertainment, but a lower level of use among the region's SMEs. This situation negatively affects SMEs' productivity and economic growth in the WB-5area [7]. Many articles deal with ICT's impact on the productivity of firms. Skorupinska, in her paper, evaluated the relationships among ICT, organizational practices, internationalization, innovation, and human capital in a sample of Polish companies [8]. She found that ICT innovation was the primary determinant of labor productivity among the companies. Seo and Soo Lee attempted to determine the roles the digital divide played in the dynamics of the growth of the gap among countries by looking at the relationship between ICT investment and

[1]For this study, SMEs are firms with less than 250 employees.

the evolution of total factor productivity in 38 countries [9]. The empirical results showed that global digitalization might have both negative impacts, manifested in a widening digital divide, and positive impacts reflected in the effects of knowledge spillovers. In their article, Alves de Mendonca et al. measured the effects of the adoption of IT tools on Brazilian workers' productivity in the manufacturing sector of South America's largest country. They concluded that IT adoption is in correlation with the utilization of information management systems by companies. The estimation of the econometric model is supported by the amplified Cobb-Douglas production function. The data provide crucial information on labor characteristics, sector of activity, the origin of controlling capital, technological innovation, company balance sheets, external performance, and region of the country where the company is located. The findings propose that IT adoption resulted in a positive effect on Brazil's labor productivity [10]. On the other side of the planet, among the WB-5 SMEs, the same situation exists. The WB-5 SMEs are aware of the importance of ICT, but they still lack ICT usage.

2.2 ICT and Literacy

As noted by Kowal and Roztocki, a high living standard is heavily influenced by the education of the population, computer use, as well as the ability to innovate. Nevertheless, it is somewhat surprising how, despite comparable education levels of developed countries, economies in transition can only produce a fragment of the national incomes of developed countries [11]. When we discuss literacy, it is crucial to distinguish between general and functional literacy. The United Nations Educational, Scientific and Cultural Organization (UNESCO) stipulates that literacy is an ability "to identify, understand, interpret, create, communicate, and compute, using printed and written materials associated with varying contexts". Literacy encompases a continuum of learning which in turn enables individuals to broaden their scope of knowledge, achieve their goals, and be an engaging, productive member in their community and wider society [12]. According to UNESCO, the literacy rate among the population aged 15 years and older in the WB-5 is close to 98% [13]. However, modern literacy and ICT literacy are significantly more than that. ICT literacy means using ICT technology, communication tools, and networks to access, manage, integrate, evaluate, and create information to function in a knowledge society [14]. Literacy, which enables learning and employment, is transforming into a digital experience, and while the technological context is reshaping the definition of literacy, the education sector's response must be based on evidence identifying how ICT technologies offer opportunities to raise literacy levels [15].

As stated two decades ago, Determining the actual, as opposed to the possible, impact of the new technology on literacy could be one of the most interesting research challenges in this field [16]. One of the widely accepted measuring approaches to comparing functional literacy and education systems is the OECD's Programme for International Student Assessment (PISA). This test measures 15-year-olds' ability to use their reading, mathematics, and science knowledge and skills to meet real-life challenges. The results of the PISA test will be used as an indicator in this research.

3 DATA AND METHODOLOGY

3.1 Dataset

The data were obtained by credible international business support organizations and the countries' national statistics (see Tab. 1). Following a thorough analysis of the selected literature, the authors identified the following research variables, presented in Tab. 1.

Table 1 List of the observed variables

Symbol of indicator	Description of indicator	Data source
ICTU	ICT use	[15]
ICTA	ICT access	[15]
HDI	Human Development Index	[21]
UIC	University–industry collaboration	[22]
GRD	Gross domestic spending on R&D	[22]
PISA	Programme for International Student Assessment	[5]
GDPP	GDP per capita	[23]
SPR	SMEs' productivity	[23]

For the correlation analysis, the authors used the data from the World Intellectual Property Organization (WIPO), Cornell University,World Bank, Eurostat, and the OECD, grouped by the WB-5 countries and the EU-28 countries from 2010 to 2018. The ICT Data and Statistics Division within the International Telecommunication Union (ITU) measured the performance within the said countries. By doing so, they produced a brief, yet comprehensive overview of the status of the ICT markets in 192 economies worldwide, including government policy, initiatives facilitating the access to and use of ICTs, as well as significant infrastructural developments. Three primary areas define each assessed country's profile: government policy; fixed services; and mobile services. Comprehensive tables with data on the access and use of ICTs, as well as crucial indicators of 3G, long-term evolution (LTE)/WiMAX population coverage, and mobile and fixed subscription penetration rates supplement the profiles. The ITU data were collected through the (1) short World Telecommunication/ICT Indicators (WTI) questionnaire and (2) the brief questionnaire on ICT access and use. The authors also considered the data provided in official documents in both physical and digital form, the latter having been found online (i.e. the websites and/or databases of national statistics offices, telecom. operators, relevant ministries and regulatory authorities. The information society reports for the period 2010-2018 were prepared by the ICT Data and Statistics Division within the ITU [17].

3.2 Variables

A data series for the period 2010-2018 is available for all variables except functional literacy. In all the analyses, variables were compared by year, considering their values for the WB-5 and the EU-28 countries (33 countries in total). The ICT use index is a composite index that weights three ICT indicators (33% each):

(1) Percentage of individuals using the Internet;
(2) Fixed (wired)-broadb and Internet subscriptions per 100 inhabitants;
(3) Active mobile broadband subscriptions per 100 inhabitants [17].

What is more, the said index weights five ICT indicators (20% each):

(1) Fixed telephone subscriptions per 100 inhabitants;
(2) Mobile cellular telephone subscriptions per 100 inhabitants;
(3) International Internet bandwidth (bit/s) per Internet user;
(4) Percentage of households with a computer (including firms); and
(5) Percentage of households with Internet access (including firms) [17].

The provided data represent ICT access at the firm level in the observed countries.

We have seen a great many studies which tackle the single relationship between HDI on the one side, and patent applications in developing countries on the other [22]. The HDI, developed by the United Nations Development Program, is a statistic composite index of per capita income indicators, life expectancy and education, and functions as a standard international development measure. It places countries into 4 tiers of human development. Insead University, Cornell University, and the World Intellectual Property Organization (WIPO) in the Global Innovation Index 2018 provide a separate index, which measures the university/industry research collaboration. Innovation linkages and public/private academic partnerships are, so says the report, essential to innovation. To measure them, it draws on both quantitative and qualitative data. It includes business-university collaboration on research and development. The authors have implemented a separate variable - the average gross domestic spending on R&D for the EU-28 and the WB-5 countries. This variable has a predominant influence on ICT usage [24]. The data on functional literacy among the included countries was taken from the OECD's PISA test results for 2012, 2015 and 2018. To present the importance of ICT use on a macro- and microeconomic levels in developing countries, the authors used SMEs' productivity as well as GDP per capita.

3.3 Methods

As there exists no single method which could provide a credible solution to the two research questions, the authors made use of various methods to collect, process, and analyze data. They were grounded in soft modeling concepts/ideas [18].

Our report on the research starts with a thorough, in-depth analysis of secondary data, whereby data from respected organizations were used to present the economic situation in the WB-5, EU-15, and EU-13 countries. Also presented in this part is the degree of ICT literacy and ICT access in the observed countries. In the subsequent second part, the regression analysis is applied to investigate the relationship between ICT use on the one hand and productivity on the other, measured by value added per employee in SMEs. Additionally, the links between gross domestic product (GDP) per capita and ICT ranking among the target countries are explored. Furthermore, the statistical analysis provides data on the correlation between ICT use and the variables that influence ICT use.

Multiple linear regression allows a response variable, y, to be modeled as a linear function of two or more predictor variables. Although the correlation analysis proves the links between all observed variables, the authors in this part exclude the university/industry collaboration and the Human Development Index. The main reasons for this are the structures of the excluded variables (which are composed of the indicators that represent functional literacy and gross domestic spending on R&D). Such a model allows for the investigation of the relationship between ICT use (dependent variable y) and ICT access (independent variable x_1), functional literacy (independent variable x_2), and gross domestic spending on research and development (independent variable x_3).

4 EMPIRICAL RESULTS

4.1 The Correlation Analysis

The correlation between observed variables for the period 2010-2018 is examined based on the set questions. This is a simple model, but it provides information for decisions about using more complex methods. In the first step, the importance of ICT use for SMEs is proved by the very good correlation between ICT use and SME' productivity, measured by added value per employee. It can be concluded that the correlation between ICT use and SME productivity amounts to 0.7184, which shows a very good to excellent correlation between the variables. The correlation coefficient obtained is statistically significant at 0.01, i.e., there is a statistically significant linear relationship between the variables. The correlations are presented in Tab. 2, with significance at the 0.01 level.

In the subsequent step, influence variables were calculated. A correlation coefficient of 0.841 between ICT access and ICT use is examined. Such a coefficient suggests that there exists a firm correlation between the ICT infrastructure and ICT use, albeit being incomplete. Moreover, it is known that countries with moderately poorer ICT infrastructure can gain better results in terms of ICT use than those with state-of-the-art ICT infrastructure and access. The strong correlation between the HDI and ICT use proves the importance of Human capital. Here, the correlation coefficient is 0.792. We can conclude that Human capital's role in ICT use is paramount. Having considered the significance of universities in the endeavour of countries to develop new technologies, the authors also observed the correlation between university/industry collaboration and ICT use. The calculated correlation coefficient is 0.5701, which confirms a strong linear relationship between the university/industry collaboration and ICT use. The proven results show the calculated correlation between gross domestic spending on R&D and ICT use. The correlation coefficient is 0.601, which is a good to very good correlation between the variables. At this stage, it could already be said that an increase in the gross domestic spending on R&D leads to a rise in ICT use.

Table 2 Correlation between the observed variables for the period 2010-2018

Variables*	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) ICTU	1.000						
(2) ICTA	0.850	1.000					
(3) HDI	0.792	0.838	1.000				
(4) UIC	0.570	0.647	0.715	1.000			
(5) GRD	0.601	0.632	0.754	0.767	1.000		
(6) GDPP	0.707	0.756	0.767	0.646	0.534	1.000	
(7) SPR	0.716	0.748	0.806	0.789	0.708	0.889	1.000
(8) PISA	0.738***						

** ICTU – ICT use; ICTA – ICT access; HDI – Human Development Index; UIC – university–industry collaboration; GRD – gross domestic spending on R&D; PISA – Programme for International Student Assessment; GDPP – gross domestic product per capita; SPR – small and medium-sized enterprises' productivity.*
*** Correlation is significant at the 0.01 level.*
**** PISA test was conducted in 2012, 2015, and 2018.*

The authors conclude that there exists a correlation between ICT use and functional literacy in the WB-5, EU-13, and EU-15 economies, the calculated correlation coefficient being 0.738. The correlation between the variables is very good to excellent. The correlation coefficient obtained is statistically significant at 0.01, i.e., there is a statistically significant linear relationship between the observed variables.

4.2 Regression Analysis

4.2.1 Regression Model and Assumption Checklist

Multiple linear regression allows a response variable, y, to be modeled as a linear function of two or more predictor variables. Through the model, the authors investigated the relationship between ICT use (dependent variable) and ICT access (independent variable x_1), functional literacy (independent variable x_2), and gross domestic spending on R&D (independent variable x_3). An assumption checklist is provided before the authors performed a multiple regressions analysis: *Checking normality of residuals* - the authors used the Shapiro-Wilk W test for normal data. The p-value assumes that the distribution is normal. In this example, it is substantial (.78), indicating that it cannot be rejected that the distribution is normal; *Checking homoscedasticity* - the authors used the Breusch-Pagan/Cook-Weisberg test for heteroscedasticity; H0 - constant variance; Variables - fitted values of income.

$$\text{chi2}(1) = 0.15 \quad (1)$$

$$\text{Prob} > \text{chi2} = 0.7026 \quad (2)$$

In the model, the chi-square value was small, indicating heteroscedasticity is not a problem. *Checking for multicollinearity* - the authors used the Stata 15.0 software's "vif" command to check for multicollinearity, and the variance inflation factor (VIFs) with a listed score of 1.86 look fine; *Checking linearity* - in the regression, the predictor variables have a straight-line relationship with the outcome variable. The residuals are normally distributed and homoscedastic, so there were no issues about linearity.

4.2.2 Multiple Linear Regression Analysis

By using the Stata 15.0 software instruments, the authors could estimate the model parameters through the least-squares in method. Further, they tested the model's validity and degree of reliability, as well as the statistical significance of included parameters. The results are presented in Tab. 3.

Table 3 The results of the regression model parameter estimate

ICTU	Coef.	St. Err.	t-value	p-value	[95% Conf	Interval]	Sig
ICTA	.565	.151	3.74	.001	.256	.874	***
GRD	1.942	1.533	1.27	.215	-1.193	5.078	
PISA	.035	.014	2.40	.023	.005	.064	**
Constant	-24.858	18.425	-1.35	.188	-62.542	12.825	
Mean dependent var		71.267	SD dependent var			10.196	
R-squared		0.710	A number of obs.			33.000	
F-test		23.631	Prob > F			0.000	
Akaike crit. (AIC)		213.071	Bayesian crit. (BIC)			219.057	

Variables: ICTU – ICT use; ICTA – ICT access; GRD – gross domestic spending on R&D; PISA – Programme for International Student Assessment.
**** p<.01, ** p<.05, * p<.1*

The coefficient of determination (R^2), as a square deviation, is 0.710, and it represents the square deviation of the correlation coefficient. The coefficient shows that this analysis explains 71.00% of the variables, while the remaining 29.00% are influenced by unknown factors. The authors note that an increase in the PISA functional literacy by exactly one point leads to an increase in the ICT use coefficient by 0.035. Also, in the case of an increase in the coefficient of ICT access by one-point, the ICT use coefficient increases by 0.565. Finally, it is noted that the coefficient of average gross domestic spending on R&D is statistically not significant to the prediction:

$$p < .05 \text{ (Wald test: F (1, 29) = 1.60; Prob > F = 0.215)} \quad (3)$$

5 DISCUSSION

The study demonstrates that, at the level of individual firms, ICT access and ICT use are positively associated with an increase in productivity, which is also explained through examples. Next, the correlation between gross domestic spending on R&D and ICT use is calculated. The correlation coefficient is 0.601, which in terms of variables' correlation is a good to very good correlation. Further, there is a very good to excellent correlation between ICT use and functional literacy in the WB-5 and EU-28 economies, with a correlation coefficient of 0.738. The achieved correlation coefficients are statistically significant at 0.01, i.e., there is a statistically significant linear relationship between the observed variables. Finally, throughout the multiple regression model, a direct connection between ICT use and ICT access (independent variable x_1), functional literacy (independent variable x_2), and gross domestic spending on research and development (independent variable x_3) is confirmed. From the calculation provided by the software Stata 15.0, the discussed multiple regression model can be written as:

$$\text{ICT use} = 0.565 \cdot \text{ICT access} + 0.035 \cdot \text{PISA} \quad (4)$$

The PISA test reflects the needs of modern literacy, as well as ICT literacy. Comparing the aggregate results of the PISA 2012, 2015, and 2018 test among European countries, the authors showed that there is a strong correlation between PISA ranking and ICT use ranking.

As the WB-5s do not lag significantly behind the EU-28 in ICT infrastructure, the low level of ICT literacy is identified as the most likely reason for the lower level of ICT use. A low level of ICT literacy among WB-5 is linked to the current systems of education. Traditional literacy always involves social and cultural elements [19]. That fact is proved through the example of the WB-5 region, which is still under the negative influence of the Ottoman Empire heritage, which has harmed the culture, education, and economy in the region [20, 21].

To increase the performance of the WB-5 economies, firms from all sectors have to implement the opportunities that ICTs provide. Consequently, we can deduce that digitalization is the driving force of new business models, which in turn facilitate the scaling of SMEs (often with only a handful of employees, few tangible assets and/or geographical market presence), [7]. To this end, the governments of the WB-5 have a crucial role to play in

increasing ICT literacy and ICT adoption by businesses and citizens. In the past few years, the governments of WB-5 countries have, in general, begun to take advantage of the benefits and opportunities provided by ICTs, in particular those which have a lasting positive impact on the operational environment of SMEs. ICT could allow for the digitalization of the public services of government institutions. These would then become available to SMEs via e-government portals. These would facilitate the procedures for SMEs' routine services, and provide lasting benefits also to public institutions. Open government data-publishing initiatives and digital one-stop shops are prime examples of intuitive, effective digital policies for SMEs. What is more, such solutions also discourage corruption, while simultaneously promoting accountability, transparency, and inclusiveness [7].

5.1 Conclusions and Recommendations

The authors have identified many variables that influence ICT use on a firm-level through the literature review. From these, they selected ICT access, functional literacy, and gross domestic spending on R&D as being vital. Furthermore, the authors investigated ICT literacy as an essential variable for increasing ICT use among SMEs in developing countries. It is hard to provide statistically significant quantitative evidence for this statement. Thus, the authors based their research on the qualitative analysis of ICT literacy in developing countries by reviewing the literature and the conducted interviews. In so doing, this research has proved that ICT literacy is one of the influential predictors of ICT use in developing countries.

As to improving the economic situation in the region, the WB-5countries should, in the long run, revise their education systems and invest more money in the functional literacy and business skills of employees in all sectors of business. Based on both public and private initiatives, these investments will have a lasting positive impact on companies' productivity, as well as their profit. Also, in the short run, they should follow successful examples from the EU-15 and the EU-13 and launch specialized programs to increase ICT literacy. When we discuss long-term ICT literacy, the authors emphasize the importance of educating the young population. The authors suggest Austria as the best model country for the WB-5, which, in many fields is, historically, the best example country for the WB-5 economies to follow. Based on a nearly thirty-year history of introducing digital education in Austrian primary and lower secondary schools, the Ministry of Education implemented a new curriculum entitled Basic Digital Education. The goal is to give teachers the skills needed to employ digital media as tools in all subjects, with an emphasis on bringing technology into the classroom in a way that enriches learning.

To exploit the potential of ICT and gain a more significant piece of the ICT market, the WB-5s have to start working on ICT literacy with children in primary schools. Moreover, all the generations should be included through the adjusted ICT literacy programs. It is also critical to raise ICT literacy levels among SMEs' top and middle management, as they create the firms' development strategies.

The research limitation lies in the lack of data on ICT use among the WB-5 countries at the firms' level. Thus, for a better understanding of this topic, it is essential to conduct further research. Due to the situation with the data among the WB-5 countries, the authors suggest using an interview as a research instrument to provide a deeper understanding of this topic.

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