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EDITORIÁL

Technologické zmeny a iniciatívy, akými je Industry 4.0, vytvárajú nové ekonomické perspektívy a možnosti pre ekonomiku krajiny. Ich pochopenie umožňuje ucelene chápať regionálne a odvetvové špecifiká determinantov ovplyvňujúcich podnikovú výkonnosť ako aj celkovú hodnotu priemyselných podnikov, čo výrazne napomáha tvorcom hospodárskych politík v racionálnom rozhodovaní o alokácií podporných prostriedkov v priemysle do inovácií a podpory znalostnej ekonomiky. Predložené číslo časopisu Acta Aerarii Publici je venované práve tejto problematike, ktorá je riešená v rámci projektu VEGA č. 1/0673/21 „Analýza ekonomických perspektív Industry 4.0 z pohľadu vplyvu nehmotných aktív na rentabilitu a trhovú hodnotu priemyselných podnikov“ kolektívom Ekonomickej fakulty Technickej univerzity v Košiciach.

Projekt rieši problematiku využívania jednotlivých zložiek nehmotných aktív a podrobne analyzuje ich vplyvy na rentabilitu a trhovú hodnotu priemyselných podnikov, ktoré sú práve najviac konfrontované s automatizáciou výroby ako aj výrobných procesov, obsiahnutých iniciatívou Industry 4.0.

Autori svojimi príspevkami prezentujú rôzne uhly pohľadu vnímania a spracovania témy. Skúmanie problematiky efektívneho zdaňovania v súčasnom období je zaujímavé nielen pre investorov. Analýza intelektuálneho kapitálu v ére Industry 4.0 a vplyvu organizačného nehmotného majetku na pridanú hodnotu, realizovaná na prípade výrobného sektora v SR, skúmanie implementácie blockchainu, ako aj výskum inovácií malých a stredných podnikov na Slovensku v kontexte Industry 4.0 sú prínosom do vedeckej diskusie. Analýza kompozitných predstihových ukazovateľov a predikčnej schopnosti v krajinách V4 finalizuje diskusiu predloženého čísla časopisu k predmetnej téme.

Publikované príspevky tohto špeciálneho čísla s prezentovanými výsledkami a zisteniami prispievajú k budovaniu solídnej teoretickej bázy skúmanej témy, nastoľujú nové otázky a otvárajú priestor pre výskum v ďalšej fáze riešenia projektu VEGA, a to v podobe deskriptívnej a kvantitatívnej analýzy automatizácie podnikov v odvetví priemyslu Slovenskej republiky.

Hosťujúci editor: doc. Ing. Jozef Glova, PhD.
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INTANGIBLE ASSETS OF MANUFACTURING SECTOR IN THE CONTEXT OF EFFECTIVE TAXATION IN SLOVAKIA

NEHMOTNÝ MAJETOK VÝROBNÉHO SEKTORA V KONTEXTE EFEKTÍVNEHO ZDAŇOVANIA NA SLOVENSKU

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Abstract

The effective tax rate is an indicator for potential investors in deciding which country to place their investment in. However, the level of the statutory tax rate does not reflect the overall tax burden in the country. The aim of the paper is to monitor, analyze and evaluate the effective corporate tax in Slovakia with regard to intangible assets. The paper performs a detailed analysis of effective corporate taxation through the effective marginal rate (to determine the amount of investment) and the effective average (to decide on the allocation of investment) rate and their relationship. The analysis compares the period of 2004 (accession of the Slovak Republic to the EU), 2015 and 2021. In conclusion, we state that intangible assets are assets that are interesting for investors in terms of tax burden.

Key words: The tax burden, Entrepreneurs, Intangible assets, ETR indicator

JEL Classification: H20

INTRODUCTION

Every year, there is an increase in capital mobility in EU countries. This capital mobility also applies to the Slovak Republic. The key factors are the level of taxation of individual types of property, where this taxation is influenced by the state. On the other hand, there are entrepreneurs who decide where to invest in each type of property that will bring them the highest return.

Taxation of business entities in EU countries is different. This difference causes great differences in these countries, where these differences result in tax competition. We have two views, where on the one hand there is the impact of the statutory tax rate, which is revenue to the state budget, but it does not give us an overall view of the taxation of the relevant type of property. The second view is that entrepreneurs decide where the level of taxation is the lowest, which can ensure taxation based on effective tax rates.

1. LITERATURE REVIEW

In terms of measuring the corporate tax burden, studies have confirmed that there is no accurate method for measuring tax efficiencies. Although there are some methods such as those of Devereux and Griffith (1999), which measures the effectiveness of taxation, the so-called EATR. The tax burden includes, as mentioned, direct taxes, which are understood in terms of marginal corporate and corporate tax rates and, of course, total taxes, together with all forms of direct and indirect taxation at government level, expressed as a percentage of GDP. The fiscal freedom component is composed of three quantitative factors, which are:

the highest marginal income tax rate for a particular individual,

highest marginal corporate tax rate,

the total tax burden, which is expressed as a percentage of GDP.

Tax rates have an important role in segmentation, as they indirectly affect tax revenues and the country‘s economic performance (Andrejovská and Puliková, 2018). We are talking mainly about GDP per capita. Other aspects that affect tax revenues are foreign direct investment, public debt, the unemployment rate and the inflation rate. These segments also play an important role in the decision-making of companies. But the key aspect is the tax rates and the very economic orientation of the country. Tax rates are divided into individual groups by which we can measure the corporate tax burden (Dias and Reis, 2018).

The economic literature knows a number of different methods for calculating the effective tax rate. Giannini and Maggiulli (2002) emphasize that it is not possible to calculate an effective tax rate that would be universal. This is because different methods pursue different goals. Which method of calculation is appropriate to use depends primarily on the goal we are pursuing by research, as well as how the method is used and what input data enters it. Effective tax rates can be calculated at the macro level, ie macroeconomic, and at the micro level, ie microeconomic. The second characteristic of effective tax rates is their ability to determine the effective tax burden retrospectively (ex-post) or prospectively (ex-ante). According to this aspect, their authors, such as Schratzenstaller (2005), Kubátová (2011) and others, divide it into fictitious indicators and real indicators.

2. MATERIAL AND METHODS

The main goal of the paper is to monitor, analyze and evaluate the effective corporate tax in Slovakia for intangible assets for the years 2004, 2015 and 2021. Currently, the most widely used methodology is the calculation of the effective corporate tax rate developed by Devereux and Griffith (2003). The effective average tax rate (EATR) is defined as the ratio of the current discounted value of taxes to the current discounted value of the project‘s profit (investment) before tax. The methodology also includes the calculation of the marginal tax rate (EMTR) as a special case where the economic rent after tax is zero. The original calculation is based on the investment of one capital unit, which is realized within one year and is subsequently sold at its remaining value $(1-\delta)(1+\pi)$, where δ is the actual economic impairment and π is the inflation. In order to examine tax holidays and other special schemes, which usually last longer than one period, it is necessary to adjust the calculation so that we look at a steady increase in share capital by one unit, which depreciates over time. The return on capital is exempt from tax during the tax holidays. Taxation occurs only after their end.

To calculate the EMTR, the economic rent R after tax must be zero (Devereux and Griffith, 2003). Subsequently, the required level of pre-tax net profit needs to be addressed. These changes are captured in the following relationship:

$$\tilde{p} = \frac{(1-A-\frac{F}{\gamma})(p-\pi+\delta(1+\pi))}{(1+\pi)\left(1-\tau'-(\tau-\tau')\left(\frac{(1-\delta)(1+\pi)}{1+p}\right)^{Y}\right)} - \delta \ , \tag{1}$$

where A represents the current discounted value of depreciation, F represents the additional costs of obtaining finance from own or foreign sources, τ represents the statutory rate of corporate tax, τ' is the tax rate in the special regime. The current discounted value of depreciation - A, is also called the tax shield. The relationship applies to the calculation of the tax shield:

$$A = \tau Ø \left\{ \left(\frac{1}{1+\rho}\right) + \left(\frac{1}{1+\rho}\right)^2 + \cdots + \left(\frac{1}{1+\rho}\right)^T \right\}, \quad (2)$$

where ρ is the shareholder‘s discount rate. Since there is no personal taxation in this model, then the shareholder‘s discount rate is equal to the nominal interest rate i, the value of which was determined on the basis of Fisher‘s formula:

$$i = (1 + r)(1 + \pi) - 1 = (1 + 0.05)(1 + 0.02) - 1 = 0.071 = 7.1\ \% \quad (3)$$

It follows that $\rho = i = 7.1\ \%$. The EMTR is then calculated as the ratio of the difference between the return on marginal investment before tax $\tilde{p}$ and the rate of return on investment after tax r to the rate of return on marginal investment before tax $\tilde{p}$:

$$EMTR = \frac{\tilde{p} - r}{\tilde{p}} \quad (4)$$

The EMTR includes in its calculation elements such as e.g. tax base, method of financing the investment, method of depreciation of fixed assets, but also the level of inflation and others (all calculations in the contribution were adapted to Slovak legislation). We call the indicator $\tilde{p}$ „the term“ cost of capital „. This indicator needs to be quantified for each investment separately, as investments may take different forms, financing or timing. If depreciated assets also enter the investment, it is necessary to include the depreciation rate in the equation for calculating the EMTR, which affects the amount of the tax base. Another element that can enter into the calculation is real estate tax e. After including the mentioned elements, the relationship has a (basic) form:

$$\tilde{p} = \frac{(1-A)}{(1-\pi)*(1-\tau)} \{\rho + \delta * (1 + \pi) - \pi\} - \delta * e \quad (5)$$

Another category according to Devereux and Griffith (2003) on the basis of which it is possible to determine the attractiveness of the site is EATR. The formula for calculating EATR is:

$$EATR = \frac{R^* - R}{p/(1+r)}, \tag{6}$$

where R^* is the current discounted value of the acquired untaxed economic rent, R is the current discounted value of the obtained economic rent after tax, p is the profit before tax (without depreciation) and r is the real interest rate. We must include in this expression the actual rate of capital depreciation, ie economic depreciation, provided that the net return on capital is constant and therefore the expression takes the form:

$$EATR = \frac{R^* - R}{p/(r+\delta)}. \tag{7}$$

First of all, it is necessary to calculate the current value of the return on investment. We calculate this value by discounting it at the real interest rate.

$$R^* = \frac{p-r}{1+r} \tag{8}$$

Since we know the values of p and r, because they are given quantities, we can calculate R^*:

$$R^* = \frac{0.20-0.05}{1+0.05} = 0.1429. \tag{9}$$

The discounted value of tax-free economic rent is 14.29 %. This economic annuity must be taxed according to the tax system in the country in order to obtain an economic annuity from the investment after tax. R. EATR represents the derivation of actual cash flows and the tax burden. The EMTR is used to assess savings and investment incentives. We can express the relationship between these two quantities through an equation:

$$EATR = \frac{\tilde{p}}{p} EMTR + \frac{p-\tilde{p}}{p}\tau \tag{10}$$

As we can see, the effective average tax rate is a broader concept than the effective marginal tax rate. The formula shows that EMTR is part of the effective average tax rate. This relationship indicates the location and size of the investment. The relationship is used when investment localization alternatives are mutually exclusive. It is important for the investor to know the tax rate in the country. We are talking about the value that the EMTR acquires. EMTR and EATR are referred to as tax wedges, which express the rate of return of a taxed and non-taxed investment.

3. RESULTS AND DISCUSSION

3.1 Tax shield

The tax shield represents the current discounted value of depreciation, so before the calculation itself, it is necessary to know what conditions for the depreciation of individual types of assets were valid in the year for which the calculation is performed. The tax shield is a tax reduction technique in which depreciation is deducted from taxable income. Since 2000, straight-line depreciation has been used for intangible assets and the depreciation period for this type of asset is 5 years. The annual depreciation rate is therefore 20 % of the total value.

Table 1: Tax shield for intangible assets in Slovakia in selected years.

Type of property	**Year**	**STR**	**Annual depreciation rate**	**Tax shield**
Intangible assets	2004	19 %	20.00 %	15.54 %
	2015	22 %	20.00 %	17.99 %
	2021	**21 %**	**20.00 %**	**17.17 %**

Source: own research according to ZEW (2020).

Table 1 shows the annual depreciation rates for intangible assets that have not changed over the years and the tax shield. The value of the tax shield for intangible assets was calculated according to relation (2). If we assume an investment in property in 2021 in the amount of EUR 1 million, so the tax saving in the form of a tax shield represents 17.17 % of the value of the asset, ie EUR 171,700. As intangible assets are depreciated over a period of five years, these savings are spread over five years of depreciation of assets.

3.2 Effective marginal tax rate

The EMTR, ie the effective marginal tax rate, represents the difference between the cost of capital incurred for a given investment and the rate of return after tax on the alternative investment. The higher the tax burden in a country, the higher the cost of capital, which affects the growth of EMTR. The higher the EMTR, the less likely it is that the investment will be made, as it is too costly for the investor. When the tax system is progressive, the marginal tax rate is higher than the average tax rate. EMTR values are monitored for the location of the investment. Investors demand that the EMTR value be as low as possible. The values of tax rates valid in individual countries for which the investor decides and the rate of return after tax on alternative investment are compared. The rate of profit after tax arises on the international capital markets and is therefore unlikely to be affected by one country. On the other hand, the tax burden is fully in the hands of the governments of the countries concerned.

Table 2: EMTR calculations for intangible assets.

Type of property	**Retained earnings and new deposit**			**Debt**		
	Year			Year		
	2004	2015	**2021**	2004	2015	**2021**
Intangible assets	13.14 %	13.80 %	**13.56 %**	-21.35 %	-30.29 %	**-27.09 %**

Source: own research according to ZEW (2020).

When financing through debt, the investment in intangible assets is -27.09 %. The cost of capital was 3.93 %. The costs are not very different from the 5 % required rate of return (maximum less than 1 %), but the investor could prefer an alternative investment for which the rate of return is guaranteed at a very low risk. The investment itself brings higher costs of capital, the investor has to take more risk, but the return on investment is expected to be much higher than with an alternative investment.

3.3 Effective average tax rate

In order for investors to know where to locate their investment, they use the calculated EATR values, which expresses the effective tax burden. Not only the statutory tax rate is included in its calculation, but also the financing of the investment, components of the tax base, or additional taxes and costs necessary for the implementation of the investment. This indicator is considered to be the most accurate for determining the tax burden, in terms of the number of variables that enter into the calculation.

Table 3: Economic rent of the project and EATR for intangible assets.

ECONOMIC RENT OF THE PROJECT						
Type of property	**Retained earnings and new deposit**			**Debt**		
	Year			Year		
	2004	2015	**2021**	2004	2015	**2021**
Intangible assets	0.0666	0.0564	**0.0598**	0.0792	0.0710	**0.0737**
EATR						
Type of property	**Retained earnings and new deposit**			**Debt**		
	Year			Year		
	2004	2015	**2021**	2004	2015	**2021**
Intangible assets	40.02 %	45.38 %	**43.62 %**	41.28 %	46.85 %	**45.02 %**

Source: own research according to ZEW (2020).

EATR values vary from year to year. The reason is the difference between the rates of accounting and tax depreciation. When calculating the EATR of intangible assets, we considered an accounting depreciation rate of 15.35 %, while annual tax depreciation in 2021 was at the level of 20 % for intangible assets.

3.4 Relationship between effective average and marginal tax rate

The relationship between the effective average tax rate and the effective marginal tax rate expresses where to place the investment and to what extent. The EATR expresses the effective tax burden and the EMTR the effective location of the investment. The combination of these two requirements of an investor who is determined to pay the lowest possible taxes in order to maximize his profit after tax is the relationship between EATR and EMTR. By comparing these two calculated indicators, we find out to what extent the profit after tax is reduced by tax.

Table 4: Relationship between EATR and EMTR for intangible assets.

Type of property	**Retained earnings and new deposit**			**Debt**		
	Year			Year		
	2004	2015	**2021**	2004	2015	**2021**
Intangible assets	17.31 %	19.62 %	**18.85 %**	10.69 %	11.97 %	**11.54 %**

Source: own research according to ZEW (2020).

It is the combination of the effective average rate and the effective marginal rate that is the most suitable way to realize your investment in the most efficient state in terms of taxes and the scope of the investment. The EATR ↔ EMTR relationship takes into account capital costs, accounting and tax depreciation, inflation rate, shareholder discount rate, but also the statutory tax rate. This relationship needs to be taken into account in terms of return on investment in order to be as optimal as possible. As most of the world's economies are open and the globalization of the world economy is expanding, investors face the difficult task of choosing the right country to place their investment. Many countries, even within the European Union, are trying to attract investors at low tax rates. As we have shown through calculations, effective tax rates are important for the efficient placement of investments to an effective extent. It is therefore necessary to look at corporate taxation in a broader context.

CONCLUSION

Corporate tax is one of the important revenues to the state budget. The statutory and effective corporate tax rate is an important factor for investors when deciding where to place an investment. Businesses are trying to find a country where they pay as little as possible in corporate tax. However, the solution is not to find the country with the lowest statutory tax rate, but with the lowest effective tax rate. For the company, this will mean not only the lowest percentage that the state will have to pay from the tax base, but also lower inflation, interest rates on foreign capital, more favorable depreciation conditions for fixed assets and other factors with which the company gets into contact every day. All this constitutes the calculation of the effective tax rate.

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THE ROLE OF INTELLECTUAL CAPITAL IN THE ERA OF INDUSTRY 4.0: A THEORETICAL APPROACH

ÚLOHA INTELEKTUÁLNEHO KAPITÁLU V ÉRE PRIEMYSLU 4.0: TEORETICKÝ PRÍSTUP

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Abstract

Nowadays we are facing substantial economic and social challenges due to the new era of technological transformation associated with Industry 4.0. This ongoing technological revolution has led to a new stage of economy based on value-added innovative business models where the intangible assets management has become one of the crucial issues behind the ubiquitous digitalization. In order to respond to the challenges of the new technology revolution, companies accumulate valuable knowledge assets and raise the level of employee´s intellectual capabilities. In this way a company becomes a knowledge-creating dynamic entity that interacts with its environment, reshapes the environment and even itself through the knowledge creation process. Smart factories, smart manufacturing with build-in intelligent cyber-physical systems are the consequence of Industry 4.0 which enhances efficiency in interactions between humans and physical objects, machines, and materials in real time. This phenomenon of interactions between tangible and intangible assets now determines a success of a company in terms of ongoing fourth industrial revolution. For this reason, it is extremely important to clearly define the role of intellectual capital in the era of digital transformation.

Key words: Intellectual capital, Industry 4.0, knowledge management, intangible assets

JEL Classification: M21, O33, J24

INTRODUCTION

In today´s fast-changing global environment, knowledge is recognized as one of the most important factors, besides financial and material resources, determining a success and sustainability of a company in terms of ongoing fourth industrial revolution. Since 2011, when the term Industry 4.0 was firstly publicly introduced, we have been witnessing a technology revolution that has led to a new era of economy based on value-added innovative business models. Knowledge and intellectual capital management has thus become one of the crucial issues behind ubiquitous digitalization in a contemporary society. In this context, innovation is considered as the main catalysts for structural changes in many industries transforming traditional business models based on an ever-larger number of factory workers, tangible assets, as well as financial resources to dynamic models set up on the efficient utilization of knowledge. Hence, the success of today´s enterprises in a global business environment is highly determined by the extent to which its managers can develop intellectual capital through the knowledge creation and knowledge-sharing, as stated by Nonaka & Kazuo (2007). At this point, arises the question of what is "intellectual capital" within a company and how it contributes to the higher performance and better competitiveness in terms of Industry 4.0. The next section of this paper discusses the definition and role of the intellectual capital in the new age of technological advanced called "Industry 4.0".

1. DEFINITION OF INTELLECTUAL CAPITAL WITHIN A COMPANY

The term "intellectual capital" was first coined by the economist John Kenneth Galbraith in 1969, who described intellectual capital as a dynamic kind of capital, or asset, comprised of creative mental processes. Intellectual capital is thus considered to be another essential source of company´s competitive advantage besides physical and financial capital (Nahapiet & Ghosal,1998; Subramaniam & Youndt, 2005). The conceptual framework of IC has been developed through different lines of approaches and across diverse disciplines, what is reflected in the definition provided by Edvinsson (1997) as he describes intellectual capital as a multidimensional relationship issue between humans, ideas and knowledge, which enables to measure the unmeasurable, and is considered for a renewable, recyclable resource, that needs to be cultivated in a context. Taking a closer look at the concept from a perspective of a firm, the intellectual capital can be simply defined as "combined intangible assets which enable the company to function", as suggested by Brooking (1998). In a very similar manner, Moore & Craig

(2008) characterize intellectual capital as intellectual assets that can create value, drive the development of business and provide economic growth. From a strategic perspective, a concept of the intellectual capital can provide an answer to the core strategic questions in the relation to the future source of profitability (Marr, 2012).The source of sustainable success, according to the Marr (2012), is in ability of an organization to make knowledge resources available and accessible for the whole company. The concept of intellectual capital is often used to identify the intangible assets within an organisation and to formulate a framework for their meaningful classification. Exploring its diverse components enables the decision-makers to understand how knowledge can be profitably transformed into the valuable outputs within enterprise. The most sophisticated classification of intellectual capital components has been proposed by Edvinsson (1997) as a technique for quantifying intangibles assets of a company. The model is comprised of several blocks, which represent a range of firm´s non-financial values and can explain a gap between company´s book and market value. The company´s capital structure starts with identifying of two core components of the stock market value, being: financial capital and intellectual capital. Intellectual capital itself consists of two main elements: human capital and structural capital. Human capital is represented not only by the employees within a company, but also by the tacit and explicit knowledge, moral values, educational skills and vocational qualities, as well as individual ability to perform at a higher level. The specific attribute of human capital is that unlike other types of company´s intangible assets, human capital cannot be owned by anyone, because employees are not a property of a company they are working for (Brooking, 1998). Moreover, no one can separate a person from his or her knowledge, skills, capabilities and experiences, however effective management of human capital enables a company to become an owner of knowledge embodied in its employees. Therefore, human capital is very important source of value in every company, because only through humans the company gains an ability to create and add value, as stated by Sullivan (1998). The value created by human resources is reflected in intangible assets of the company. Sullivan points out that creation of intangible assets is not easy, and it requires managing the company´s human capital in the way that encourages people to codify their knowledge. Once the company codifies tacit knowledge embodied in its employees, it becomes the only owner of the information. In this context, intangible assets are codified, tangible descriptions of individual knowledge to which company can exercise ownership rights. Intangible assets include data, documents, processes, inventions, drawing and programs. Once they are legal protected, they become intellectual property being, for instance, trademarks, patents, copyrights, and trade secrets. However, as pointed out by Kaplan et al. (2004), intangible assets almost never can create value by themselves, therefore they need to be combined with other assets. To deliver a greater value there must be created an infrastructure that company provides to support its human capital. The value derived from the human capital is structural capital which refers to the documented knowledge of the employees and other company related persons. Structural capital includes all components related to the organizational structure, routine methods and intellectual property of the company, as stated by Marr (2012). Structural capital is comprised of internal processes, methodologies, structures and systems, as noted by Cabezas (2008), and it also includes financial assets, buildings, machinery and other "hard" assets to be found on the balance sheets, as pointed out by Sullivan (1998). However, it should be noted that the structural capital also encompasses intellectual property and other intangibles owned by a company, which may not appear on its balance-sheets. Unlike human capital, structural capital belongs to the company and provides an environment that stimulates the human capital to create and leverage its knowledge. The two important dimensions of structural capital, according to the model proposed by Edvinsson (1997), are customer and organizational capital. Customers have been always considered for another important source of wealth in every organization and for a crucial element in achieving competitive advantage (Horibe, 1999). In these terms, customer capital refers to a long-term relationship between a company and its customers which is reflected in a customer satisfaction and loyalty to the products and services offered by the company (Iordache-Platis, 2017). The significance of the customer capital has been emphasized by Roos (1998) as he claimed that the value extracted from the long-term customer relationship is much more important than the value derived from the knowledge and skills accumulated within a company. Organizational capital is defined as institutionalized knowledge and codified experience and is to be found within and used though databases, patents, processes, systems and structures. According to the Foss & Knudsen (1996), organizational capital enables linking organizational structure to the competences of the firm´s employees. Sullivan (1998) describes the organizational capital as the way of how a company and its employees are organized to attain the best competitive advantage in the market conditions. The structure of organizational capital is comprised of two crucial elements: innovation capital, being an ability of a company to generate new ideas, create new products and take its inventions to the market (Chesbourgh, 2006); and process capital, being methods and know-how that company uses to manage its business. As stated by López Saez (2010), the innovation and process capital enable synchronization between all components of intellectual capital. Altogether, the diverse components of structural capital enable human capital to create market value and contribute to a higher financial performance of the enterprise.

2. THE MEANING OF INTELLECTUAL CAPITAL FOR INDUSTRY 4.0

The ongoing era of knowledge economy, accompanied by scientific and technological advance, has led to a reassessment of the role of traditional sources in the value creation process of companies (Dosso and Vezani, 2019). Over the past decades we have been witnessing a massive increase in investments in intangible assets and R&D related projects (Andersson and Saiz, 2018). This may be partly associated with the rise of the phenomenon of the Fourth Industrial Revolution (Industry 4.0). The concept of the Industry 4.0 has originated from a project in the high-tech strategy introduced by the German government in 2011. The main idea of this strategic plan was a vision of a global industrial network built on the cyber-physical systems and Internet of Things (IoT) which should serve to enhance efficiency in interactions between humans and physical objects, machines, and materials in real time. Altogether the Industry 4.0 promotes the combination of the IoT, Big Data, social media networking, cloud computing, embodied sensors in physical objects, artificial intelligence and robotics and the implementation of these technologies in production, distribution and consumption of goods and services.

Many companies in different industries have already realized that employees and their unique capabilities are the most valuable assets of a company and therefore they should be treated with utmost care. However, the role of an employee has also changed within Industry 4.0. Employees are now faced with the task to meet requirements of the company to be actively engaged in the learning process and implement their personal knowledge into new applications and innovative products.

However, this new industrial revolution places further demands not only on technological readiness of companies but enhancing the benefits of the digital era means also challenges for treating and accounting intangible assets. According to IFRS/IAS38 intangible assets are non-monetary corporate assets without tangible or physical substance. The set of criteria must be fulfilled to recognise and disclose intangible assets on the company´s balance sheet. In accordance with the principles of IFRS / IAS38, a corporate intangible asset must be identifiable and separable from other assets, and only then disclosable or reportable. Where an intangible asset is identifiable, it may be treated as a separate asset that may be traded, transferred or licensed to it. Examples of separable assets are: computer software, licenses, trademarks, patents, films, copyrights and import quotas. An exception is goodwill acquired in a business combination that does not fall within the scope of IAS38 Intangible Asset Accounting Standards. On the other hand, goodwill generated internally by an enterprise‘s own operations is within the scope of IAS 38 but cannot be recognized as an intangible asset because it cannot be separated from the business to which it relates. The condition for the recognition of intangible assets is the fulfilment of the criteria of identifiable, controllable, and provable future benefits. The intangible nature of digital solutions poses unprecedented challenges that call for new thinking on how to manage and regulate issues that affect the accounting principles of intangible assets. It should be noted that the ubiquitous digitalisation impacts not only companies and their employees but also stakeholders and other subjects associated with a business. This development requires an appropriate regulation for preparation of financial statements to enable to disclose the level of digitalisation and its share on the company´s value in the most appropriate way.

CONCLUSION

Industry 4.0 encompasses a promise of a new stage of the knowledge economy based on digitalisation and technological advance. Therefore, it is crucial for companies to implement new technologies and smart solutions in reasonably short time so they can maintain competitiveness in a long-term perspective. Moreover, active entrenchment of modern technologies in companies would improve the overall performance, ensure further production growth, and enable to access new markets and customer segments. Successful integration of companies into Industry 4.0 paradigm should be accompanied by investment in research and development on a regular basis, particularly by small and medium-sized enterprises. Research and development expenses (R&D) are associated not only with innovating products and production pro successes, but R&D should also foster human capital development by adopting education of employees and renewing management systems in response to requirements of Industry 4.0 concept. Although the Industry 4.0 promises a wide range of benefits for companies and business related subjects, there are several challenges and downsides of the digitalisation of economy. Not only is digitalisation a major cost to consider, but also the expertise in enabling the technology to be implemented successfully. This requires highly skilled labor to ensure understanding among all parties involved in the process of digitalisation. Another point is how to treat and disclose digital solutions in companies accounting? We encounter a known problem of reporting the true value of intangible assets. There is still a need to adjust not only the accounting methods and principles but also to reassess the whole methodology for measuring the value of intangible assets and the way they contribute to the market value of the company.

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THE EFFECT OF ORGANIZATIONAL INTANGIBLE ASSETS ON DOMESTIC VALUE ADDED: THE CASE OF SLOVAK MANUFACTURING SECTOR

VPLYV ORGANIZAČNÉHO NEHMOTNÉHO MAJETKU NA PRIDANÚ HODNOTU: PRÍPAD SLOVENSKÉHO VÝROBNÉHO SEKTORA

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Abstract

Intangible assets determine what makes firms competitive The same is true for countries competitiveness. Production process requires both, traditional factors (labour and capital), technological progress and innovation associated with intangible assets. The paper analyses the relationship between the accumulation of intangible assets and the growth and productivity of domestic value added share of gross export (DVA) in the Slovak manufacturing sectors. The analysis is focused mainly on the organizational intangible assets and distinguish between two types of organizational intangible assets - purchased and own-accounting organizational intangible assets. The findings of panel model techniques suggest that this type of intangible assets has a strong positive impact on DVA and the own-accunting organizational assets has a more significant effect on DVA than purchased organizational intangible assets.

Key words: intangible assets, organizational capital, domestic value added, productivity

JEL Classification: A2, A20, A290, A230

Introduction

The OECD member countries are shifting towards knowledge-based economy in the last two decades. We observe dramatic increase in the share of intangible assets over the total firm's investment as well as in the whole economy. The country's competitiveness is incsreasingly driven by the ability of countries to foster productivity. In the context of the globally organized production, we define productivity as DVA. Domestic value added in Slovak manufacturing sector increase from 3 678 millions EUR (2000) to 22 461 millions EUR (2015). An increase in DVA is accompanied by an increase in productivity and growth. Future growth in advanced economies is assumed to be dependent on productivity raising innovation OECD, (2013). Fostering knowledge creation is crucial i.e. accumulation of intangible assets.

The aim of this paper is to analyse the potential impact of specific types of organizational intangible assets (own or purchased) on DVA of Slovak manufacturing sectors. To achieve this aim it is important to correctly describe the current knowledge in the field of intangible assets and their impact on productivity, growth and DVA. This paper is structured as follow: in the first section we describe the theoretical literature review, in the second section we present, data and method used, in the third section we show results of econometric analysis and the subsequent discussion. Finally, the last section is conclusion, where we summarize the results and describe our findings.

1. LITERATURE REVIEW

The productivity is influenced, among other factors, by capital intensity and the accumulation of intangible assets. Corrado, Hulten, Sichel (2005) include three basic asset types in economic competencies: *1:* brand names, *2:* firm-specific human capital and *3:* organizational structure. The important type of intangible assets is economic competencies. According to Corrado and Hulten (2013) intangible assets are mainly investment to innovation, new products or processes including organizational development. Pekarčík, Ďurčová and Glova (2022) analyses the impact of intangible assets on global value chains participation. In our analysis we pay attention to organizational development which increase the organizational and management efficiency. The analysis of intangible assets are focuses almost on domestic supply and production within a country because so much of this intangible investments are primarily produces on own-account. The accumulation of intangible assets are strategic investment in the long-run growth and productivity growth of individual companies and economy. The production process requires not only classical factors such as labour, capital but also a technological and innovation factors. In our analysis we take account as a capital input the intangible organizational assets which are also influencing this technological progress and innovations through upgrading the organizational structure and processes.

According to Martin-de-Castro et al. (2005) and Lev et al. (2009) organizational capital is defined as the combination of formal and informal knowledge which is an effective and efficient way structure and develop the organizational activity of the firms. It is the knowledge used combine human skills and physical capital into systems for producing and delivering the quality product. That includes organizational learning, knowledge process, skills upgrading, processes of operating, investment and innovation capabilities that are enable to generate the outputs. On the microeconomic level Atkeson and Kehoe (2005) present a methodology for measuring organizational assets and demonstrate at the firms level the role and impact of investments in these assets within the plant's life cycle. Marrocu, Paci and Pontis (2009) also analyses the impact of organizational capital on the productivity at the microeconomic level.

We use two types of organizational assets. There are *1.* own – accounting and *2.* purchased organizational assets. The own-accounting component is represented and estimated by the value of executive time spent on developing business models and corporate culture. The purchased component is represent by management consultant fees. The effect od organizational assets on productivity according to sectoral level Niebel et al (2016) identified the manufactuing as the sector in which intangible assets are the most productive. On firm level Marrocu, Paci, Pontis (2012) evaluate the role of internal intangible assets on firm's productivity. Thum-Thysen et al (2017) confirm that knowledge- based industries tend to achieve higher productivity by combining the accumulaton of fixed capital, intangible assets to create among others results the organizational structure. Improvement of organizational structure is posible by accumulation of organizational intangible assets. Such as Management consulting, own organizatioanl investment or by purchasing. At macroeconomic level analysis of regional economic performance there are the strong relevance of local intangible endowments. Mohnen and Hall (2013) report the evidence of the impact of technological (product and process) and organizational innovation on productivity growth.

2. DATA AND METHODS

For the purpose of econometric analysis we gather panel dataset of sector-level variables of labour productivity, capital stock of intangible assets, total factor productivity (TFP), backward linkages global value chains participation index (BL). There is a problem of data availability for organizational intangible assets and BL participation. The final panel of dataset contain 12 Slovak manufacturing sectors (Tab.1.) over the period 2000- 2015.The selected time series and time period is limited by data availability. We use a specialized database EUKLEMS that collects data on the accumulation of intangible assets at the aggregated and sectoral level. Data on the country's participation in the GVCs are drawn from the OECD Trade in Value Added database (OECD-TIVA), where the data was available until 2015. This is also a limitation of our research.

We assume, that the growth of the share of DVA in Slovak export is associated with the growth of productivity and economic growth. DVA in export represents an important measure of income from trade and we can consider it as a crucial guideline for development policy and competitiveness VRH (2018). Accorind to Yu, Luo (2018) DVA in the export generated by a country or industry is a gain of the country participating in GVCs, no matter how the value added is absorbed in the end.

Table 1: Classification of manufacturing sectors.

1.	C10-C12	Food products, beverages and tobacco
2.	C13-C15	Textiles, wearing apparel, leather and related products
3.	C16-C18	Wood and paper products; printing and reproduction of recorded media
4.	C19	Coke and refined petroleum products
5.	C20_21	Chemicals and chemical products and Basic pharmaceutical products and preparations
6.	C22_C23	Rubber and plastics products, and other non-metallic mineral products
7.	C24_C25	Basic metals and fabricated metal products, except machinery and equipment
8.	C26	Computer, electronic and optical products
9.	C27	Electrical equipment
10.	C28	Machinery and equipment n.e.c.
11.	C29_C30	Transport equipment
12.	C31-C33	Other manufacturing; repair and installation of machinery and equipment

Source: processed by author.

Today it is already possible to econometrically analyze the impact of the accumulation of intangible assets on various indicators at the economy level. Corrado, Hulte, Sichel (2005) define a methodology approach for quantifying the accumulation of intangibles. In this case we analyze the impact of organizational assets on DVA.

We assume that intangibles play a crucial role in technological progress, productivity growth and growth of DVA, confirmed in several studies: O'Mahony, Timme2009); Thum-Thysen et al (2017) and Vrh (2018). We expect that organizational assets has a strong positive impact on DVA in the Slovak manufacturing industries. We also assume that participation in BL does not increase the volume of DVA but will have a negative effect. BL participation is characterized by import of intermediates (foreign value added - FVA) which is used primarily in manufacturing industries. Average share of FVA used in Slovak manufacturing industries increase from 42% (2000) to almost 57% (2015). The interest of Slovak manufacturing industry should be part of globally organized production within GVCs, but it depends on the form of participation. Thus maximaze the volume of DVA and reduce imported FVA content of gross export.

Based on these assumptions, we formulate following hypothesis:

Accumulation of intangible organizational assets has a strong positive impact on DVA.

Own- accounting organizational assets has a stronger positive impact on DVA than purchased organizational intangible assets.

We estimate the econometric model as follow:

$$\Delta \ln DVA_{i,t} = \alpha_1 \Delta lnL_{i,t} + \sum_{q=1} \beta_q \Delta lnK_{q,i,t} + \alpha_2 \Delta lnBL_{i,t} + \delta_i + \varepsilon_{i,t} \quad (1)$$

Where $\boldsymbol{\Delta \ln DVA_{i,t}}$ is Slovak manufacturing domestic value added share of gross export, $\boldsymbol{\Delta lnL_{i,t}}$ is the labour input - labour services, $\boldsymbol{\Delta lnK_{q,i,t}}$ is capital input - capital stock of intangible organizational assets and $\boldsymbol{\Delta lnBL_{i,t}}$ is backward linkages global value chains participation. BL GVC participation index is define as a share of the imported foreign value added in manufacturing exports because Slovak manufacturing industry are strongly connected in globally organized production. And the control variable is total factor productivity (TFPindex).

3. RESULTS AND DISCUSSION

Fixed effect regression analysis is used to examine whether the selected Slovak manufacturing industry variables have an impact on DVA. The industry level approach show that accumulation of organizational intangible assets have strongly association with the growth of the DVA. Possible explanation is that organizational assets can increase the innovation and production productivity and can positively influence DVA.

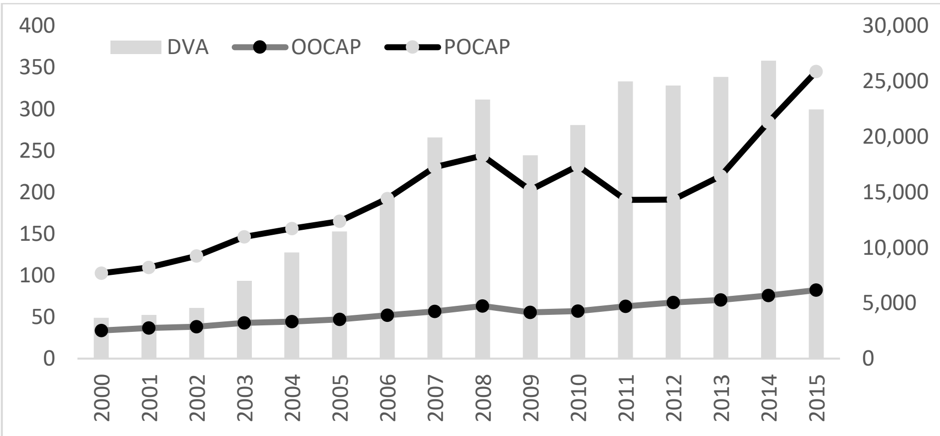

Fig. 1: Domestic value added (DVA), Purchased organizational intangible assets (POCAP), Own-accounting organizational intangible assets (OOCAP) in Slovak manufacturing sector industries in million EUR.

Source: processed by author.

In Figure 1 there is a development of DVA, purchased organizational intangibles (POCAP) and own-accounting organizational intangibles (OOCAP) for manufacturing sector in total millions EUR. DVA in manufacturing industry increased from 3 678 millions EUR (2000) to 22 461 millions EUR (2015). But the share of manufacturing DVA to total manufacturing export decreased between 2000- 2015 by 18%. The share of exports to the GDP is in average 70%, the highest value was recorded in 2013 (106%). Therefore, it is important to analyze not only the overall structure of exports, but also the development of its structure – share of DVA and FVA to total gross export. The share of manufacturing gross exprort to GDP increased from 21% (2000) to 64% (2015). It confirms that manufacturing industry has a crutial position in Slovak economy.

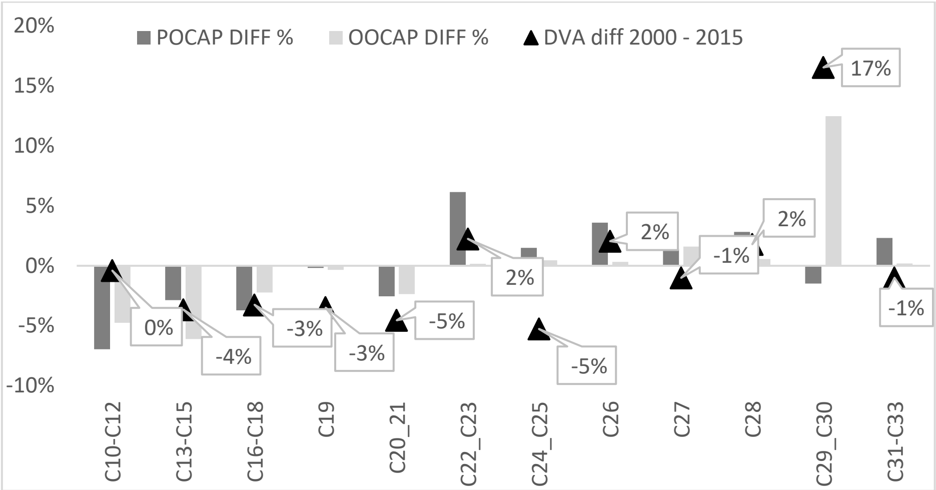

Fig. 2: Domestic value added (DVA), Purchased organizational intangible assets (POCAP), Own-accounting organizational intangible assets (OOCAP) in Slovak manufacturing sector industries.

Source: processed by author.

In Figure 2 we show DVA, POCAP and OOCAP in Slovak manufacturing industries (ISIC, REV. 4.) used in analysis in %. DVA decreased in 6 manufacturing industries, the highest recorded decreased is in industries C20_C21 and C24_C25 (-5%) between year 2000-2015. This decline in DVA in these manufacturing industries is also accompanied by a decline in OOCAP and POCAP. On the other hand we observe the highest increase of DVA in industry C29_C30 (+17%). At the same time, we record the highest increase in OOCAP (+12%). This increase indicates to us that industrial companies created their own organizational capital in the monitored period. So they preferred it to buing or importing from abroad.

Table 2 shows the estimation results using fixed effect.The depend variable is $\Delta \ln DVA_{i,t}\Delta \ln DVA_{i,t}$ of the Slovak manufacturing sector. We also show the estimation results of depend variable DVA/TOT_H. We present deeper lags (1 year and 2 years)(Tab.2.) of the accumulation of intangibles variables as a robustness check yields very similiar results. For robustness check we used two variables for DVA. First is $\Delta \ln DVA_{i,t}\Delta \ln DVA_{i,t}$ which expres the index of growth of DVA, 2010=100. The second variable DVA/TOT_H is the ratio of DVA to total hours worked. In both variables we confirm the similar results.

Table 2: Effect of organizational assets on domestic value added.

Dependent variable	DVA_ln			DVA/TOT_H		
	(1)	(2)	(3)	(1)	(2)	(3)
D LAB_SERV_ln	-1,294***	-0,927***	-0,375***	-2,113***	-1,781***	-1,276***
	(0,183)	(0,186)	(0,220)	(0,189)	(0,191)	(0,222)
D POCAP_ln	0,838***			0,848***		
	(0,093)			(0,096)		
D OOCAP_ln	1,410***			1,196***		
	(0,168)			(0,174)		
Δ POCAP_ln$_{t-1}$		0,575***			0,576***	
		(0,097)			(0,099)	
Δ OOCAP_ln$_{t-1}$		1,422***			1,202***	
		(0,175)			(0,180)	
Δ POCAP_ln$_{t-2}$			0,407***			0,398***
			(0,115)			(0,116)
Δ OOCAP_ln$_{t-2}$			0,974***			0,800***
			(0,195)			(0,196)
D BL_ln	-2,049***	-1,593***	-1,239***	-2,199***	-1,820***	-1,482***
	(0,251)	(0,253)	(0,296)	(0,260)	(0,261)	(0,298)
D TFPindex_ln	0,077	0,071	0,087*	0,073	0,066	0,082*
	(0,055)	(0,054)	(0,059)	(0,057)	(0,055)	(0,059)
Balanced	YES	YES	YES	YES	YES	YES
Observation	192	180	168	192	180	168
ADJ R2	0,677	0,637	0,437	0,671	0,631	0,444
F_stat	***	***	***	***	***	***

NOTE: *, **, *** indicates statistical significance at the level 10%, 5% and 1% levels. The dependent variable is DVA/TOT_H is ratio of DVA to total hours worked.

Source: processed by author.

We use agregate variable for labour productivity $\Delta lnL_{i,t}$. It is the result of connection of hours worked and the labour composition ($\Delta lnL_{i,t} = \Delta lnLC_{i,t} + \Delta lnH_{i,t}$). We expect the negativ impact of the variable D LAB_SERV productivity (value added per worker) which is overwhelmingly associated with the stagnation and decline in labour productivity. This is also confirm in KOZ SR (2020). According to Adarov and Stehrer (2020) the negativ impact of growth of labour services is associated with the negativ impact of the growth in the hours worked, which confirms the conjecture of diminishing marginal returns to labour inputs. The sluggish productivity growth is a major challenge for many advanced countries.

As we expect the organizational intangibles has strong positive impact on domestic value added (Tab. 2. row 2 and 3, column 1). We observe a significant positive coefficient for own accounting and purchased organizational intangibles. The estimated coefficient for POCAP is 0,838 which indicate a 10% rise of intangible POCAP assets in manufacturing industry is *ceteris paribus* correlated with 0,83 % rise of DVA and estimated coefficient for OOCAP is 1,410 which indicate a 10% rise of intangible OOCAP assets in manufacturing industry is *ceteris paribus* correlated with 1,41 % rise f DVA. We confirm that depends on the form of participation in the GVCs. As we expected backward participation (BL) does not increase the domestic value added share in gross export since this participation in the GVCs lead to an increase in the of intermediate products, i.e. foreign value added. Therefore, we observe a negative coefficient. BL participation in the GVCs for Slovak manufacturing industry bring reduction in the share of DVA in gross export. An overall increase of the TFP index will ensure an increase of DVA. It is interesting to observe that own-accounting organizational assets is in all cases more associated with the DVA, so we can conclude that support for the accumulation of own accounting organizational intangibles in Slovak manufacturing sectors will lead to an increase of creation of domestic value-added and its productivity.

We confirm the first hypothesis, that organizational intangibles has a strong impact on domestic value added share of gross export. And also the second hypothesis, the own- accounting organizational intangibles has stronger positive impact that purchased organizational intangibles even though the purchased organizational itnangibles is many time higher than own- accounting.

CONCLUSION

The accumulation of intangibles has a strong positive effect on the whole economy. The way how to ensure growth of the productivity in advanced economies is to support the investment in intangibles. The transmission channels through which investement in intangibles affect technological progress and processes are indeed manifold. They could work towards reducing existing inefficiencies in the economy. The manufacturing industry represents a significant part of the structure of the economy. In Slovakia, it has the largest relative comparative advantage and creates the largest volume of DVA. The manufacturing indsutry also accounts for the largest share of the created DVA as well as imported FVA. Slovak manufacturing industry thus creates more than three quarters of exported value added.

The empirical part of the article is focused on analyzing the impact of organizational intangibles on the creation and productivity of domestic value added in

Slovak manufacturing industry. We distinguish organizational intangible assets based on their origin. That is, whether they are the results of own accounting activity or wheter they are purchased. With this distinction, we want to analyze to what extent organizational intangibles influence the creation and productivity of Slovak manufacturing DVA and wheter there is a difference between the impact of own accounting and purchased organizational intangibles. Throught econometric analysis, we confirm that both, own accounting and purchased organizational intangibles have a positive impact on the creation and productivity of DVA. We find that own organizational intangibles are more positively associated with DVA than purchased. Our results indicate that Slovak manufacturing industry can generate its own organizational assets, which have a significant impact on their productivity. We contribute to the discussion regarding the impact of intangibles, specifically organizational intangibles, on the creation and productivity of DVA. Where we contribute to discussion, where the value added is hidden.

Analysis of the impact of intangibles on the creation and productivity of value added is very important and requires further research. Today, it is not a question of wheter to participate in a globally organized production, but how to draw the greatest possible benefits from participation in GVCs. Increasing the share of DVA is a key objective for policy makers to ensure and imporve global competitiveness of manufacturing industry. The limitation of the research is the availability of data on the accumulation of intangibles and the structure of the created DVA. Further research should be aimed at analyzing the impact of different types of intangibles specifically economic competences, at the sectoral level, as we have shown that there are significant disparities between individual manufacturing industries in Slovakia.

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POTENTIAL OF BLOCKCHAIN IMPLEMENTATION WITHIN THE FRAMEWORKS OF INDUSTRY 4.0

POTENCIÁL IMPLEMENTÁCIE BLOCKCHAINU V PODMIENKACH INDUSTRY 4.0

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Abstract

The term and concept of Industry 4.0 have become known in the last decade and from 2011 Beier et al. (2020) it is a more and more discussed topic in the economy. Industry 4.0 is a name for current ongoing industrial changes that are related to data exchange, automation, and digitization in manufacturing technologies, including the Internet of Things (IoT), cyber-physical systems, cloud computing, smart factories design and development, artificial intelligence and many more digital technologies with the goal to increase an efficiency of manufacturing processes what eventually affects the profitability of involved sides. The huge potential to increase productivity and efficiency in Industry 4.0 has Blockchain technology. The Blockchain technology is constantly evolving and might find its place in many fields. In our paper, we describe Blockchain and its related technologies as Smart Contracts with relation to leverage in Industry 4.0. We discuss possible adaptation in supply chain, especially in Letter of Credits (LC) digitization, supply/buyer chain and goods and material tracking field. We chose several implementations (Provenance, Skuchain, TracrTM, HSBC (Shenzhen Branch) LCs implementation) and describe their place in field.

Key words: industry 4.0, Blockchain, technology, smart contract

JEL Classification: M10, M16, M19

INTRODUCTION

The Industry 4.0 represents so called fourth industrial revolution. The first industrial revolution was related to steam power and began at the end of 18th century. The second industrial revolution is related to electrification and started at the beginning of 20th century. In 1970s began third industrial revolution which was related to automatic production based on electronics. Currently, we are witnesses of ongoing fourth industrial revolution (Industry 4.0). The ongoing revolution is based on foundations of cyber physical systems production and data/knowledge integration. The main goal is to fulfill spirit of agile and highly dynamic requirements in production and increase efficiency. The five major features of Industry 4.0 are digitization, optimization, and customization of production; automation and adaptation; human machine interaction; valueadded services and businesses, and automatic data exchange and communication (Lu, 2017). These features are connected to to internet, algorithmization and knowledge management.

The technology tightly related to expansion of internet as medium used in Industry 4.0 is a Blockchain. The very important concept of Blockchain is its transparency and higher security related to any transactions. Nowadays, Blockchain is mostly known for its usage as back-bone technology of cryptocurrency, which represent quiet controversial topic in economic. However, it might be adapted it very different fields and there exists several concepts of usage in finance, healthcare, logistics, automotive technology and many others. It might be one of the options how to increase efficiency of processes, decrease necessity of human presence in some processes; thus decrease potential costs and eliminate human errors. The main goals of our paper is to briefly search and bring relation of the Blockhain technology to the Industry 4.0, pick and describe some currently working implementations and describe main technologies that are crucial for integration.

1. BLOCKCHAIN

The Blockchain technology is represented from the higher point of view as tamper evident and tamper resistant digital ledger implemented usually without central authority and also without central repository (in distributed form). The data in such database are stored across the network on nodes and information is stored in digital form. The technology allows users to add information in manner agreed in given protocol. The key aspect is that there is no a central authority which might control and tamper data. Once the data are written in Blockchain, they can not be changed. The data in the ledger are cryptographically signed and stored in chain of blocks in which each upcoming block is linked to previous block (tamper evident). The block is added to the chain after validation and protocol consensus decision. With adding a new block, it became harder and harder to modify data in chain (tamper resistant). The new blocks are replicated across the network and possible conflicts are resolved based on rules in protocol (Yaga et al., 2018).

The Blockchain technology is notoriously known for its application in implementation for non-centralized cryptocurrency and payment system BITCOIN founded by pseudonym known as Satoshi Nakamoto in 2008 (Lemieux, 2013). Ever since, there were founded huge amount of other cryptocurrencies based on similar technologies which differ in purpose and in implementation details. An another well know cryptocurrency is Ethereum (Ether). The main goal of Ethereum is provide so called Smart Contracts (Tikhomirov et al., 2018). The concept is briefly described in next section of the paper. The importance of Ethereum and Smart Contracts is possibility to use such technology in creation, automation and enforcement of real contracts between two or more involved sides; thus change old and ossified approach in many different parts of industry. The Blockchain is one of the technologies capable to play an important role in processes of Industry 4.0.

2. SMART CONTRACTS

The Smart Contract represents digital complex contract between involved sides which are automatically enforced when conditions of given contract are satisfied. The main structure of smart contract is show in Fig. 1. The code used in contracts are usually Turing complete programs (Jansen et al., 2020).

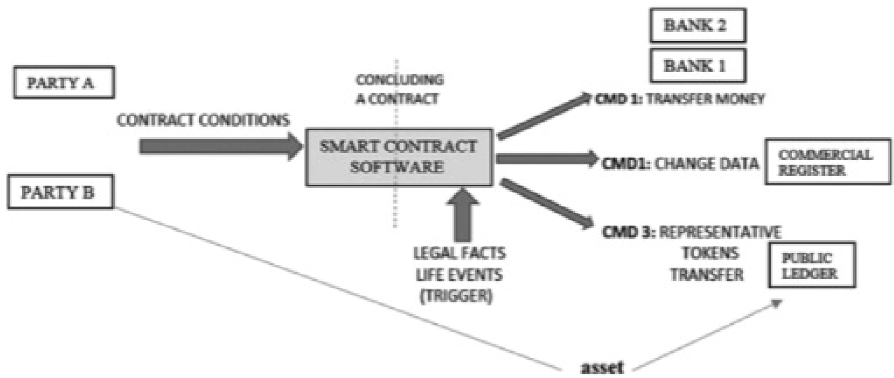

Fig. 1: Visualisation of smart contract.

Source: Kerikmae (2017).

Such programs are executed in a decentralized network and the goal is to digitally fulfill content of given contract. In the real world, the contracts contain agreements of involved sides. Transform them to smart contracts requires transform text to code, but not only parts of agreements but also all acts and statements of intent and such code has to be sufficient to enforce the contract. As described by Kerikmae (2017), such code might created in fashion that commands are send to the bank and Land Register, changing the balance of sellers and buyers accounts and making the entry for new owner of property. The parties sign contract digitally and trigger the process when all conditions are satisfied.

The smart contracts are naturally a crucial part of technology when we want to use a Blockchain in many different parts of industry.

3. RESEARCH IN THE FIELD

The research of ideas to use Blockchain as backbone technology in supply chain supporting applications is quiet (Dujak & Sajter, 2019). In this work, based on academic science papers portals is shown, that first related paper in Web of Science and Scopus appeared in 2016. The table Tab. 1) shows comparison of available publication from time when paper Dujak & Sajter (2019) was published with current situation. We also added a separate searching for keywords related to Blockchain and Industry 4.0 since this is a topic of our main interest. In the Tab. 1), there are missing data for current status of available papers and studies from portal EBSCOhost. The reason is that we were not able to replicate results up to the date provided by authors in their paper Dujak & Sajter (2019). The number of studies from the portal EBSCOhost that we were able to obtained was significantly lower than mentioned in paper Dujak & Sajter (2019). We were not able to find reason and we rather do not provide current numbers. Even though, there was an increasing trend to do a research in field of Blockchain and Blockchain in supply chain, there is not so many papers directly related to Blockchain and Industry 4.0 what makes it interesting topic to study.

Table 1: Number of results for keywords related to resources.

Search term	Article repository							
	Academic database						Google Scholar	
	Web of science (searched within: topic)		Scopus (searched within: article, title, abstract, keywords)		EBSCOhoot (searched within: title)			
Blockchain	372	15490	787	25831	4273	-	16100	30100
Blockchain and Supply chain	14	1543	36	2197	70	-	2870	44700
Blockchain and Industry 4.0	389		478		4		19100	

Source: own elaboration.

In the table, we show a comparison of the number of publications (left part of each multicolumn) related to blockchain and Industry 4.0 published in a time when paper Dujak & Sajter (2019) was published with the current situation (right number in each multi-column). The row on the bottom (Blockchain and Industry 4.0) is our search for a given keyword since this is a topic of our main interest. We omitted data for the current status of available papers and studies from the portal EBSCOhost. The reason is that we were not able to replicate results up to the date provided by authors in their paper Dujak & Sajter (2019).

4. SUPPLY CHAIN AND BLOCKCHAIN

The Blockchain as technology undeniably offers more secure and more transparent monitoring of ongoing as well as past transactions. We have in the real world transactions and moving of supplies between suppliers or/and wear-houses. The main goal of so called supply chain is to transfer goods from one geological location to the another. The series of such transactions necessarily creates a chain (supply chain); thus the idea that naturally pops up from such problem is adaptation and usage of Blockchain in such process. Blockchain might help with recording of all transactions in supply chain, moreover keep all records in decentralized manner. The transparent network of supply chain in Blockchain might theoretically decrease delays in supplies, decrease risks of human errors as well as decrease costs. The Blockchain as part of internet related technology; thus possibly as the chain of Industry 4.0, is a technology which requires our attention to study its possible economics impacts. There is currently several startups that work on integration and leveraging of Blockchain in supply chains, for example we might mention Provenance, Hijro, Skuchain RUZ (2017) and TracrTM Tracr Ltd. (2021).

4.1. Blockchain in International Buyer/Seller Chain

The Blockchain might be integrated in supply chain in many ways (as a tamper resistant database of transactions, as a payment method, as a digital form of contracts between sides and many many more). In the following paragraphs we discuss very concrete implementation which might help with old and slow technique of letter of credit (LC) and trustiness between two independent sides of supply chain. We discuss an approach of Skuchain as well as possible implementation of Blockchain in LCs and its possible advantages and disadvantages that authors approached in paper Zakhiri bin Md. et al. (2020).

The firm Skuchain works, on solutions for global supply chains with main goal to save costs. They pay attention to payment processes, finance solutions and visibility with emphasis to bring trust between links in the chain where trust would be otherwise missing. The current solutions of global supplies is built on ossified techniques which involve massive amounts of intermediaries and financiers. Such approach requires and keeps hundreds of millions of dollars and still relies on old paper-based methods such as letter of credit (Alrabei, 2017) and factoring. The hard copies of documents are couriering around the world and banks keeps huge amount of people that pays attention to review those documents. The process is slow, requires financial resources and it is also prone to human errors. Skuchain sees possibilities to transform current system to faster one and also cheaper, while making financing available to small and medium-size business. The motivation of parties should be changed from decreasing of cost/increasing of incomes to the creation of high quality products. This might occurs when parties in emerges economies would have better access to finance provided by Blockchain (RUZ, 2017).

The issue of trust involved in buyers/seller process is in LCs mitigated by banks in between the process. Despite of mitigated risk in trustworthiness there still remains issues related to implementation of letter of credits law in given countries since buyer/seller are usually located in different geological locations. The Blockchain can be also used in already running letter of credits system, but make it more modern and faster (Zakhiri bin Md. et al., 2020). Since Blockchain is database of consecutive transactions with higher level of transparency, it is usually taken as trustless. On the other hand, it is reliable public ledger of information, so everyone has access to it, but any of involved sides is capable to control it. However, even though it is necessary to keep in mind, that such sys tem is not a bulletproof for invalid entries given by users. The Blockchain helps to involved sides of business share an information and deals might be automatically completed based on predefined smart contracts. The parties are capable to review states of their businesses. Technology allows immediate updates and eliminates long times created by back-and-forth communication required in letter of credits process. The Blockchain is used to create documents as bill of lading in LCs (Southurst, 2017). Blockchain is simple way how to treat and track with such documents. As shown in work (Zakhiri bin Md. et al., 2020), there is several benefits related to the involving Blockchain in LCs as well as some disadvantages. The benefits, directly related to the Industry 4.0 and its demands are following:

Blockchain might decrease the possible risks of documentary fraud and will reduce the cost of the transaction;

Blockchain has the potential to make the payment methods in international trade more effective, more trusted, and way easier for all parties.

Based on conclusions from paper Zakhiri bin Md. et al. (2020), the Blockchain might be used in different phases of LC processes, from credit opening to its re-payment. It has potential to make transactions faster and more secure. The one of the disputable disadvantages is that its pros are more relevant in close cross border business than in overseas. The issue lies in the time comparison that is needed for material shipment and time needed for LC process. In cross border is an old paper-base LC process a bottleneck and goods might be stacked due to unfinished transactions. On the other hand, there is plenty of time to finish transaction when shipment takes more time. The mentioned standpoint is not looking in costs that are spent in LC processes.

Nowadays, we already have a proof of advantages in real used Blockchain technology (HSBC, 2021) and its implementation of LC. One of the pioneers in the filed is HSBC (Shenzhen Branch). Shenzhen MTC Co. in assistance of HSBC completed world very first cross-border RMB-denominated Blockchain-based LC transaction. The process involved transport of raw material from Hong Kong-based MTC Electronic Co Limited to its parent company. The transaction was done via Blockchain technology V (oltron Sabourin & Aka-Brou, 2021). The digitalized LC was issued and processed within 24 hours. The same paper-based transaction would otherwise took from 5 to 10 days. This represents a real world proof that use of digital technologies is making trade finance transactions simpler, faster and more transparent with very strong affect on industry.

4.2. Material and Goods Tracking

Provenance provides Blockchain implementation for materials and goods tracking. The idea is to provide to the end-customer an information and digital history of product. The history should be extracted from Blockchain and Blockchain is created during path from mining/creation material, manufacturing, shipment up to selling. The implementation provides overall information of state of product to the business as well as information to the end-customer (Project Provenance Ltd., 2015).

The traceability of goods is a topic discussed also in several science papers. The importance of traceability of goods as described by Hastig & Sodhi (2020) is in idea to be able to check ethical products, compliance with sanctions as well as be able to determine a safety of products. The paper describes traceability in two industries, cobalt mining and pharmaceuticals. The authors of papers came with implications for another research and analysis of Blockchain usage in supply chain as well as with implications for practise and obstacles that might occur during implementation. The authors pay high attention to Business requirements that should Blockchain-based system fit and also to Critical success factors. The business requirements incorporates demands related to Industry 4.0, namely Increasing Operational Efficiency and Enhancing Supply Chain Management. The article represents a comprehensive source of information that might be useful in design and development of Blockchain based supply chain tracking tool.

Despite many of obstacles in design and development of Blockchain based material and goods tracking tool, there is working tools that is already integrated across the industries related to diamonds. The tools is called TracrTM Tracr Ltd. (2021). As claimed by in Tracr Ltd. (2021) the tool is developed in spirit of Industry 4.0. The goal was implement and leverage the internet of things, artificial intelligence, Blockchain and high-grade security and privacy and bring tool to trace diamonds from mining, manufacturers, jewelers to final customer. At the end of the chain, customer can do a data driven decisions about a future purchase. As claimed by De Beers Group, the leader of development for TracrTM De Beers Group (2021), they proven that TracrTM is able to track goods from miners up to final customer.

From this short elaboration about current status of some existing implementations of Blockchain in supply chain, there is slowly raising movement that relies on Blockchain in different manner than simple use/abuse of technology as a part of cryptocurrencies. For such reason, it is necessary continuously observe a development in the field.

CONCLUSION

In our paper, we made a brief look at possibilities and current implementations of Blockchain in relation to the Industry 4.0. Industry 4.0 is an stage of industrial revolution. It is mainly represented via digitization, automation, augmentation of production processes, automatic data exchange and integration of data or knowledge within systems with main goal to bring more efficiency to industry. It is closely connected to internet and especially internet of things (IoT). One of the known technologies that pops up as possible leverage in Industry 4.0 is a Blockchain. Blockchain is technology that gives us a tamper evident and tamper resistant database which is not prone to manipulation by individuals. In our search, we find an evidence that Blockchain has a huge potential to improve processes and make them more efficient and hence it is in strong correlation with goals of Industry 4.0. We especially took a look at relation of Blockchain in supply chain. In the Tab. 1 you can see increasing demand in research of Blockchain related usage in supply chain and also attempts to investigate effects of Blockchain in Industry 4.0; thus it seems like new branch of research that is necessary to pay an attention to.

We discus a possible solution of efficiency increase and money saving possibilities in ossified paper-based field of Letter of Credits. We simplified proposals with their relations to Industry 4.0. The topic is related to part of supply chain problem that we named as Buyer/Seller Chain. We searched and found that implementations of the Blockchain in given field is already made by several parties and event there was already completed transactions in assistance of HSBC (Shenzhen Branch) that involved digital solution for LCs based on Blockchain Voltron. They shown that via such digitization of paper-based methods can be saved huge amount of time in processes. In this particular case the Blockchain based transaction was completed within the day instead 5 - 10 days.

The Blockchain as a tamper resistant and tamper evident database has a lot of potential in the field of goods and material tracking. Such property of the technology might leads to data driven decision making of final customers as well as intermediate companies and avoid exploitation of child and slave labor. The design and development of such applications requires to met several requirements previously elaborated by some other authors. Some of them are in full cover of demands Industry 4.0 (namely Increasing Operational Efficiency and Enhancing Supply Chain Management), what is another point to necessity of research in relation of Industry 4.0 to the Blockchain. Even claimed complexity in design and development, there are some tries in implementation, namely mentioned Provenance and also TracrTM.

The Blockchain technology seems to have potential for future and companies that want to keep up with evolving technologies and evolving of market and customer demands. Due to possible implementation of blockchain, the business players might become more transparent, decentralized, more efficient and last but not least, they can reach higher level of security with system which is not prone to interventions of individuals. The possible implementations are still under development but there is already some demands as well as working solution as we shown in this paper.

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INNOVATION: A MAJOR CHALLENGE FOR SMES IN SLOVAKIA AND EU COUNTRIES

INOVÁCIE: VEĽKÁ VÝZVA PRE MSP NA SLOVENSKU A V KRAJINÁCH EÚ

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Abstract

Small and medium-sized enterprises are the cornerstone for ensuring economic growth, innovation, social inclusion and job creation in the economies of the European Union. Industry 4.0 is based on digitization and exponential technologies to connect human capital, machinery, equipment and logistics systems. The rapid pace of technological and innovative progress places high expectations on the implementation of efficient processes in small and medium-sized enterprises. Companies are increasingly implementing solutions that deliver results in optimizing work, increasing productivity and reducing costs. The article emphasizes the importance of innovation in small and medium-sized enterprises in Slovakia and the EU. The article aims to study the knowledge and the dissemination level of Industry 4.0 and compare the experience of Slovak companies in implementing innovations in the context of the fourth industrial revolution. A web-based survey was conducted, and 84 companies were interviewed. The results can be helpful for creators of innovation policies and provide impactful insight into innovation policy research in the SME environment, intending to positively transform social and technological innovation in enterprises towards the position of innovation leader.

Key words: innovation, small and medium enterprises, innovation process, innovation activity, intangible assets

JEL Classification: O30, O32, O34

INTRODUCTION

In recent years, we have seen the emergence and constant progress of the development of new technologies that, historically, can be defined as periods of several industrial revolutions. New technologies are gradually reaching every aspect of the individual's life, including in every business sector, affecting the economy and society in the world. This has become an issue of great importance recently due to the fourth industrial revolution (Industry 4.0), which presents new opportunities to work with technologies and is built on the use of minimal resources to maximize efficiency. Industry 4.0 poses a challenge in particular for small and medium-sized enterprises (SMEs), which are key to the European economy as they form the vast majority of businesses in EU countries. Competition is very high, so if a company wants to succeed, it must introduce and exploit new innovations and technologies. Companies have different incentives to innovate, and they also face various obstacles and problems that slow them down in their development (Matt et al., 2020). For companies to compete in the long term, new innovative and digital production strategies need to be put in place. Production should be linked to addressing various global challenges, such as sustainability, energy efficiency, and strengthening the competitiveness of enterprises. The life cycle of production within Industry 4.0 is built to improve data exchange, which gives more possibilities for the customer, but also suppliers. Data exchange is more flexible, transparent, and global (Matt et al., 2020).

The paper aims to examine the innovation landscape of SMEs in Slovakia and evaluate the importance level of Industry 4.0 technologies. Conducted research showed significant obstacles in the implementation of innovation strategy and concludes for potential improvements and further insights to policymakers.

To achieve the aim, we organise the paper as follow. In section 2, we provide a review of the relevant literature. We describe materials and methods in section 3 and section 4 presents main findings, results and discussion. In the last part of the paper we conclude main limitations of the study and suggestions for future research.

1. LITERATURE REVIEW

Stentoft et al. (2020) state the reasons for the arrival of the fourth industrial revolution and the associated implementation of IT systems, such as change of legislation, cost reduction, competition in practice, shortage of skilled labor, implementation of advisory systems, and more others. Another important constraint on all the work discussed in this area is the implementation of these IT systems, for example, lack of legal standards, lack of understanding of Industry 4.0 strategy, low financial resources, lack of human resources, data security, and focus on operations, not on the development of society (Benešová et al., 2019; Kurt, 2019; Duman & Akdemir, 2021; Enrique et al., 2021).

The effects of the new industrial revolution should have a positive impact on global income levels and on improving the quality of life of people around the world, as in previous industrial revolutions. This is still under debate with several studies suggesting positive impacts in various countries. Poverty is being reduced in China, and in India, where we can see a reduction in poverty gaps, but the impact of Industry 4.0 is not as positive as expected, and the country still has much to catch up on in education, health or sustainability (Kandaswami & Majumdar, 2020; Focacci, 2021). However, consumers benefit most from digitization. From an economic point of view, we can expect changes in the labor market, and based on previous industrial revolutions, this can produce positive, but also negative effects (Sova Group, 2020; Abbasabadi & Soleimani, 2021; Duman & Akdemir, 2021).

Information and communication technologies have a major impact on the labor market. New jobs require increasingly demanding professional skills. New jobs are gradually being created in different sectors, such as various IT analysts. The work of financial and business analysts, behavioral psychologists, or providing cyber insurance is becoming increasingly important (Eberhard et al., 2017). Ingaldi & Ulewicz (2020) refer the employee resistance to these changes as a problem when introducing new technologies, but also a lack of specialists in areas such as IT, automation, or robotics. Another problem is the impact of automation on employment. Kovacs (2018) states that there is a presumption that the introduction of automation will result in huge job losses. According to calculations, up to 47% of jobs in the US and 54% of jobs in Europe can be replaced by computer technology (Kovacs, 2018; Novakova, 2020). Bonekamp & Sure (2015) point out that the existence of about half of jobs, characterized by low skills, is threatened by automation. On the other hand, a large number of new jobs will be created, where specialized technical skills and knowledge will be needed. Industry 4.0 expects to eliminate standardized jobs and increase the number of specialized work requiring continuous training and flexibility. Each industrial revolution meant a shift in the efficiency of production processes, so the assumptions about huge job losses may not be real (Rajnai & Kocsis, 2017).

1.1. Innovation performance of SMEs in the EU

Industry 4.0 and the associated digitization of businesses are currently affected by the Coronavirus pandemic. Digital Economy and Society Index (DESI)

2020 is an index that assesses Europe's digital performance and follows developments in the digital competitiveness of EU Member States. According to this index, data on the integration of digital technologies showed major differences between EU countries. Large companies are going through digitization to a greater extent, with more than a third of them using cloud services and Big Data. However, most SMEs do not yet use these technologies. E-commerce expanded during the Coronavirus pandemic, but in 2019 only 17.5% of SMEs sold online, as opposed to large companies where 39% of them used online sales (European Commission, 2020a). The sub-dimension e-commerce consists of three indicators: SMEs total turnover from e-commerce (%), SMEs selling online (%) and % of SMEs that carried out electronic sales to other EU countries. The sub-dimension business digitisation describes four indicators: electronic information sharing, social media, big data and cloud. Detailed description of indicators is defined in methodological note of DESI Index (European Commission, 2020a). The evaluation of the dimension of integration of digital technologies is shown in Figure 1. The companies in Finland, Denmark, and Ireland have the highest level of business digitization, and companies in Ireland, the Czech Republic, Denmark, and Belgium have the highest shares in e-commerce. By contrast, countries such as Bulgaria, Hungary, Greece, and Romania have reached the lowest values in the digitalization of business. E-commerce has the lowest values in Bulgaria, Greece, and Luxembourg.

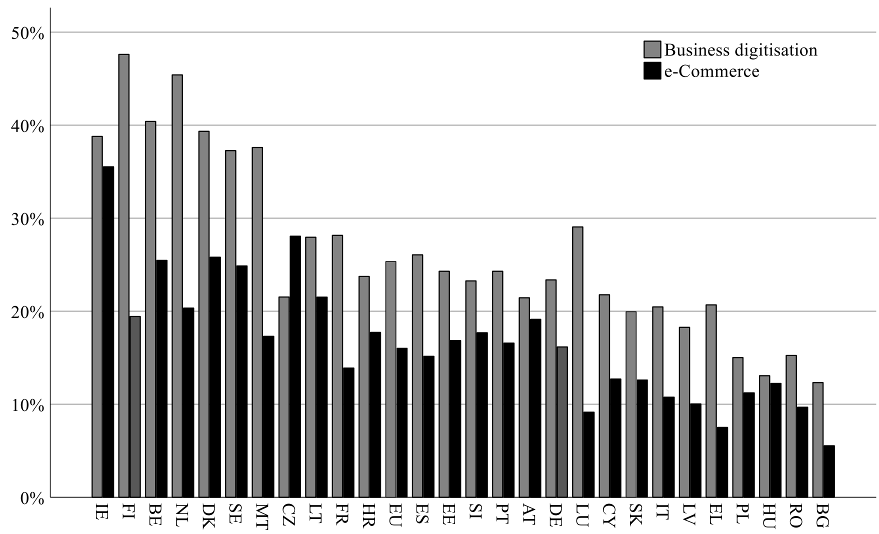

Fig. 1: The integration of digital technologies among EU countries.
Source: prepared by author based on DESI 2020 (Dutta et al., 2020).

In 2020, only 7% of companies in the EU with at least 10 employees used artificial intelligence. Ireland has the largest share of artificial intelligence businesses in the EU (23%), followed by Malta (19%) and Finland (12%). Latvia (2%), Slovenia, Hungary, and Cyprus (3%) have the lowest proportions of artificial intelligence enterprises. Slovakia reached 6% of companies using artificial intelligence in 2020 (European Commission, 2021b).

Within the EU-28, the shares in the innovation activity of businesses differ. In 13 Member States, SME innovation is slightly more than 50%. This includes countries such as Austria, Belgium, Germany, Greece, France, Italy, the Netherlands, the United Kingdom, Ireland, Finland, Sweden, Portugal, and Luxembourg. The share of innovation is less than a third in 7 EU countries – Bulgaria, Hungary, Latvia, Malta, Poland, Romania, and Slovakia. If we compare SMEs and large businesses in the EU, SMEs account for 28% and large enterprises only account for 18% of innovation. This difference is linked to the greater sensitivity of SMEs to the innovation environment (Muller et al., 2019).

Figure 2 shows the percentage of enterprises that have either introduced innovation or have any type of innovation activity in individual EU countries.

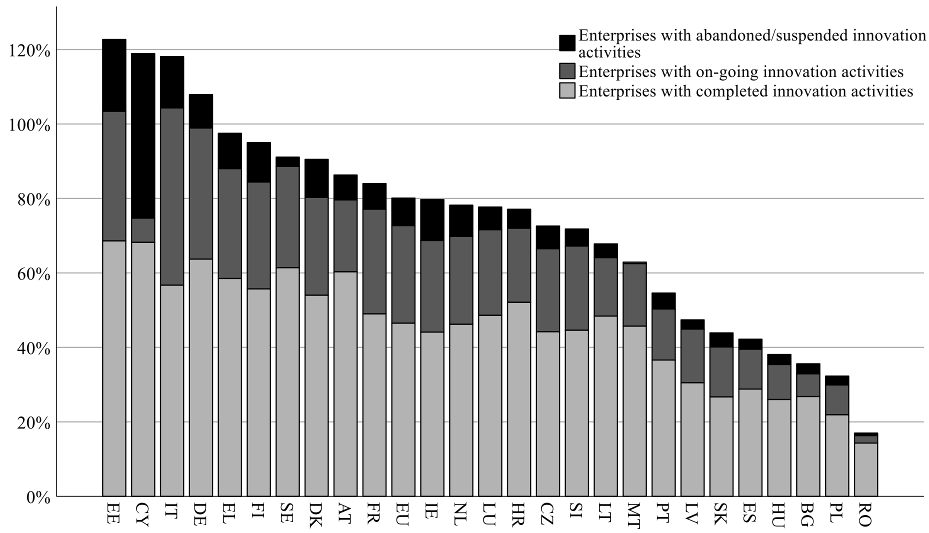

Fig. 2: Innovation activity in EU countries in 2018.

Source: prepared by author based on European Commission (2021c).

The EU average is around 50%, which means that about half of businesses in the EU are engaged in some innovative activity. The most innovative enterprises are in Estonia, Belgium, Portugal, Finland, and Cyprus. The most lagging companies in innovation are in Romania, Poland, Hungary, and Bulgaria (European Commission, 2021c).

Small and medium-sized enterprises in Slovakia employ approximately three-quarters of the active workforce. According to the Statistical Office of Slovakia, the number of active SMEs in 2019 was 595,371. Slovakia is characterized by a high proportion of micro-enterprises, which accounted for up to 96.9% of the total number of active entrepreneurs.

Table 1: Numbers of SMEs in Slovakia.

Number of employees	**2015**	**2016**	**2017**	**2018**	**2019**
0 - 9	515,236	541,719	550,016	542,525	577,827
10 - 49	12,984	12,662	14,159	14,328	14,601
50 - 249	2,843	2,741	2,956	2,988	2,943
SMEs in Slovakia in total	**531,063**	**557,122**	**567,131**	**559,841**	**595,371**

Source: prepared by author according to Statistical Office of Slovakia.

From a regional point of view, most SMEs are in the Bratislava region, almost 22% of active business entities. In Slovakia, innovative businesses are increasingly supported, but they are still lagging behind other EU countries.

2. MATERIAL AND METHODS

For this study, the key data is obtained through the use of a questionnaire aimed at small and medium-sized enterprises in Slovakia. The questionnaire was prepared based on similar surveys conducted in the EU and based on theoretical knowledge obtained from the systematic review of the literature. The questionnaire aimed to find out the current state of innovation and use of new technologies of enterprises in Slovakia. We also specifically focused on motivation and barriers in the implementation of innovations, as well as the impact of the current pandemic situation on the innovation level of enterprises in Slovakia.

2.1. Research questions

In order to address the aim of the study outlined above, we explore here research questions (RQ), that implies considerable attention:

- RQ1: What is the level of investment in innovation in SMEs in Slovakia?
- RQ2: What are the main obstacles to foster innovation and use of new technologies for SMEs in Slovakia?
- RQ3: What are the main obstacles to foster innovation and use of new technologies for SMEs in Slovakia?

2.2. Definition of innovation, sample size and data collection

The questionnaire was available to enterprises during February and March 2021 and was addressed to small and medium-sized enterprises in Slovakia, as these companies constitute the vast majority of enterprises in Slovakia. The questionnaire was sent directly to the entrepreneurs through email. Since the criteria for the size of the company was determined, we used the database of companies finstat.sk to find suitable respondents. The choice of the company addressed was random. The reply to the questionnaire was anonymous, names or other personal identifiers were not recorded anywhere in the questionnaire´s data. The processes were put in place to ensure the confidentiality of the participants. By completing the survey, respondents gave their consent to the publication of the partial results covered by this work. In total, more than 950 e-mails were sent to various companies in Slovakia, while the questionnaire was filled out by 91 companies, representing approximately 9,5% response rate. Since it was also completed by several large firms, after sorting according to the size of the enterprise, the sample consisted of 84 companies.

The questionnaire focused mainly on the innovation level of SMEs. Based on several questions using the importance scale we focused also on a calculation of the average importance score for each type of innovation. Since the concept of innovation is very broad, for our questionnaire it means the introduction of any innovation in the company. By the concept of innovation, the respondent could understand a new or improved product, intended for customers, or a process taking place in the enterprise. We also did not distinguish between innovations as a result of long-term, short-term or one-off innovation activity.

3. RESULTS AND DISCUSSION

Innovation is very important for more than 45% of respondents and another nearly 48% said it is fairly important for them to innovate. This implies that for most entrepreneurs, innovation is an important part of their business. The average importance level (3.36 out of 4) suggests that innovation activity plays a crucial role in the company.

In the next part, we describe the results from the section of the questionnaire, which was addressed only to companies that indicated that they were innovating. After sorting out the appropriate responses, 73 companies were included among the innovative companies. Among respondents, we have identified in which areas innovation activity is an important element. We identified 10 business-related areas and the questions asked participants to respond using a 4-point Likert scale ranging from very important to not at all important. The importance of innovation has been expressed by each respondent for each of the 10 areas, so all or only one of these areas may be important for 1 enterprise.

Table 2: The importance level in individual areas of business in SMEs.

Type of innovation	Average Score	Standard Deviation
Services	3.38	0.70
Product Performance	3.21	0.90
Brand	3.29	0.92
Customer Engagement	3.21	0.78
Process	3.14	0.82
Logistics	3.03	0.88
Marketing	3.22	0.82
Work culture & management	3.29	0.83
Channel	3.05	0.83
Network & synchronization	2.90	0.90

Source: prepared by author.

Table 2 shows the average score of the importance of innovation in individual business areas. The highest score, around 3.4, reached the service area, which means that for most respondents this area is very important. Other important areas are work management, brand, and marketing. The average score achieved for all areas is 3.17, which means that it is important for most businesses to innovate in almost all areas of business and to pursue innovation in these areas. Respondents consider a rather not important network & synchronization area that has reached the lowest score.

3.1. Actual and expected expenditure to innovation and digital technologies

We measured the estimated level of expenditures related to innovation activities over the next 2 years based on the 5-point scale, where respondents could indicate whether their expenditure would certainly increase/decrease, or probably increase/decrease or remain unchanged. More than half of respondents are planning an increase in spending on innovation activities in the next 2 years. Another 27.4% of companies estimate that their spending will certainly increase. Almost 18% do not plan to change their spending on innovation activities. Not even 3% of companies plan to cut expenditure. These results can be viewed positively, as innovation activities require financial resources. The increase in planned expenditure for most SMEs suggests that companies will innovate more and more.

In a questionnaire, we focused on Industry 4.0 technologies to determine their relevance among Slovakia´s SMEs. We have examined whether companies have invested in the last 2 years, plan to invest in the next 2 years, or whether the technologies are relevant or not yet used (Figure 3). This was followed by another question, by which we found out what benefits the technologies bring to society or what they expect from the implementation of the technologies. The questions were intended only for innovative companies, and each respondent could have identified several benefits that the technology brings or could bring. The figure below shows the percentages for individual technologies and processes, depending on whether companies have already invested in them, plan to invest in them, are relevant to them but are not yet used, or are completely irrelevant. Respondents could also identify some options for each category.

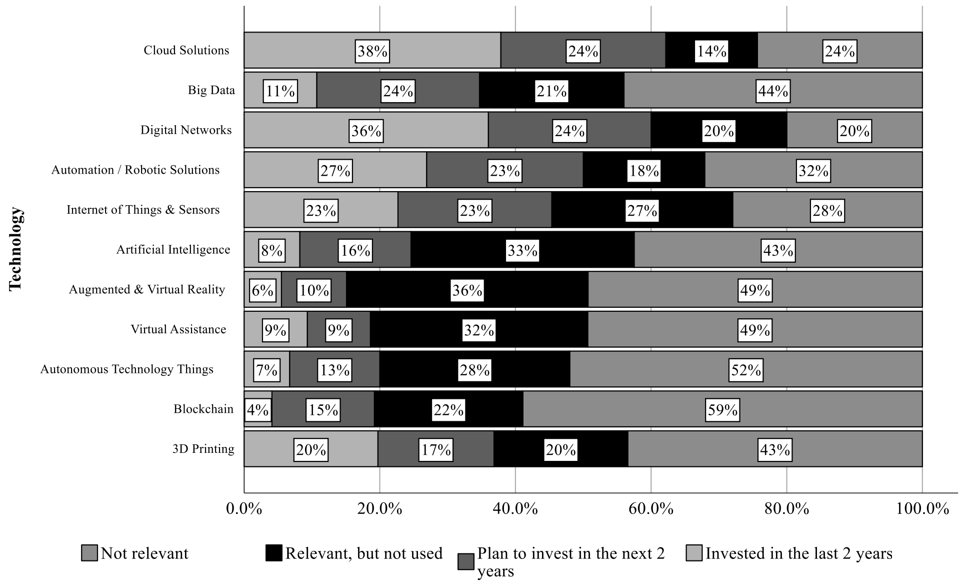

Fig. 3: The relevance of Industry 4.0 technology.

Source: prepared by author.

We can see interesting results with Cloud solutions that can open doors to previously unattainable scenarios (Tao et al., 2019). The popularity of cloud services is growing also among SMEs in Slovakia. According to our results, almost 38% of companies have invested in these services and 24% of companies plan to invest in them. They are not yet used by around 14% of respondents and are not relevant for around 24% of entrepreneurs. However, their use does not depend on the amount of the company's turnover, which confirms that they are available due to lower costs for most business entities. Digital networks are also an interesting area for SMEs. Companies around the world are investing heavily in digitalization and education in this area. According to the questionnaire, 36% of respondents invested in digital networks in the last 2 years. 24% of companies plan to invest in them and are relevant to 20%. The third most widely used technology in our survey was robotization and automation. Almost 27% of respondents have already invested in robotic solutions and about 23% plan to invest. On the contrary, technologies, and solutions such as blockchain, autonomous technologies, augmented and virtual reality, and virtual assistance are the least relevant for companies. As we can see in Figure 3 for a large proportion of respondents, these technologies are rather not relevant, and a very small number of companies have invested or plan to invest, which is a negative finding in terms of the advantages they bring to an organization and the position that SMEs have in the Slovak economy.

Table 3: SMEs invested in the last 2 years.

Technology	**Increased in productivity & Optimized processes**	**Stay pioneer in the market**	**Reduced headcount & reduced production cost**	**Increased sales revenue**	**Improved customer satisfaction, products & services**	**Not relevant**
Cloud Solutions	50.0%	5.3%	10.5%	7.9%	23.7%	2.6%
Big Data	62.5%	0.0%	0.0%	0.0%	25.0%	12.5%
Digital Networks	35.3%	0.0%	5.9%	8.8%	47.1%	2.9%
Automation / Robotic Solutions	41.7%	5.6%	16.7%	11.1%	19.4%	5.6%
Internet of Things & Sensors	33.3%	12.5%	4.2%	16.7%	25.0%	8.3%
Artificial Intelligence	33.3%	0.0%	0.0%	22.2%	33.3%	11.1%
Augmented & Virtual Reality	20.0%	0.0%	40.0%	0.0%	20.0%	20.0%
Virtual Assistance	37.5%	12.5%	12.5%	0.0%	37.5%	0.0%
Autonomous Technology Things	33.3%	11.1%	11.1%	22.2%	22.2%	0.0%
Blockchain	25.0%	0.0%	0.0%	50.0%	0.0%	25.0%
3D Printing	29.2%	4.2%	25.0%	12.5%	25.0%	4.2%

Source: prepared by author.

Table 4: SMEs plan to invest in the next 2 years.

Technology	Increased in productivity & Optimized processes	Stay pioneer in the market	Reduced headcount & reduced production cost	Increased sales revenue	Improved customer satisfaction, products & services	Not relevant
Cloud Solutions	15.0%	5.0%	15.0%	5.0%	50.0%	10.0%
Big Data	15.8%	5.3%	10.5%	5.3%	52.6%	10.5%
Digital Networks	25.0%	0.0%	15.0%	15.0%	35.0%	10.0%
Automation / Robotic Solutions	25.8%	6.5%	29.0%	19.4%	16.1%	3.2%
Internet of Things & Sensors	16.7%	5.6%	22.2%	11.1%	38.9%	5.6%
Artificial Intelligence	30.8%	0.0%	15.4%	23.1%	23.1%	7.7%
Augmented & Virtual Reality	28.6%	0.0%	0.0%	14.3%	42.9%	14.3%
Virtual Assistance	28.6%	28.6%	14.3%	0.0%	14.3%	14.3%
Autonomous Technology Things	33.3%	13.3%	6.7%	26.7%	20.0%	0.0%
Blockchain	27.3%	0.0%	9.1%	36.4%	18.2%	9.1%
3D Printing	12.5%	12.5%	25.0%	31.3%	12.5%	6.3%

Source: prepared by author.

Table 3 and Table 4 show benefits by enterprises that have already invested in technology (Table 3) or plan to invest over the next 2 years (Table 4). Respondents who have already invested in Cloud solutions consider increasing productivity and optimizing processes as a major benefit. Those planning investments in the near future expect that Cloud solutions will bring about increasing customer satisfaction and improving products and services. For firms, the main incentive to invest in digital networks is to increase efficiency and reduce costs (PWC, 2016; Terek et al., 2018). Companies have invested or plan to invest in digital networks to increase customer satisfaction, improve products and services, increase productivity, and optimize processes. What is interesting about the data in those tables is that businesses perceive precisely benefits from the creation of digital networks. For companies that have already invested in robotization and automation, productivity gains and process optimization are a benefit. Companies planning to invest over the next 2 years also see a reduction in production costs and a reduction in the number of employees as an advantage.

3.2. Main obstacles and barriers pursuing innovation

Another part of the questionnaire focused on barriers to the use of innovations and technologies. This was also completed by non-innovating enterprises, so the number of respondents was 84, of which 42 were included in micro-enterprises, 28 were small-sized enterprises, and 14 medium-sized enterprises. In this section, we assess the main barriers that are significant in fostering innovation within SMEs (Table 5). In this case, the opinion of the enterprises that do not innovate at all is also important. We have included them in this comparison. Respondents have identified several barriers they encountered. Companies in all three categories see the lack of government support for innovation as the major obstacle. More than half of small-sized companies face uncertainty in the demand for new goods and services. Medium-sized enterprises see the major obstacle in the lack of time to develop new updates and ideas. More than 35% of companies in all categories have problems with access to finance. Only a minimum of companies has a problem with data security.

Table 5: The obstacle pursuing innovation in Slovakia.

Main obstacles	**Micro**	**Small**	**Medium**
Lack of government support for innovation activities	61.9%	64.3%	57.1%
Uncertain demand for new goods or services	23.8%	53.6%	35.7%
Lack of access to finance	38.1%	35.7%	35.7%
Resistance to change	9.5%	17.9%	21.4%
Resistance to risk-taking and failing	21.4%	14.3%	14.3%
Lack of time for developing new updates and ideas	42.9%	25.0%	64.3%
Lack of technical skills	16.7%	10.7%	21.4%
Availability of training workplaces	28.6%	3.6%	21.4%
Lack of opportunities for prototyping and experimentation	21.4%	17.9%	21.4%
Data security	7.1%	3.6%	7.1%
Immaturity of technology standards	9.5%	10.7%	7.1%
Lack of leadership and management skills	0.0%	3.6%	14.3%

Source: prepared by author.

Table 6 presents the average importance score of those areas to which the government should pay particular attention to spur innovation in Slovakia. Among all categories of enterprise, investment in education is very important, with an average score of 3.7, as well as tax incentives for R&D and innovation, with an average score of 3.6. Most companies consider it important to implement the access of long-term financing through venture capital.

Table 6: Slovakia‘s needed actions to spur innovation.

	Average Score	Standard Deviation
Investment in education	3.69	0.49
Tax incentives	3.57	0.60
Venture capital	2.94	0.82
Deregulation	2.65	0.91
Research alliances	2.68	0.93
Strengthening cluster policy	2.56	0.92

Source: prepared by author.

3.3. Covid pandemic and the innovation in the era of Industry 4.0

The introduction of new technologies can have a huge impact on the country's society and economy in the near future. Progress in technology has always been a cause for concern about socioeconomic changes, job losses, and changes in the labor market (Vacek, 2017). In recent years, companies have started to innovate to a greater extent and make use of newly introduced technologies and processes. The introduction of innovations is also supported by a number of programs within individual economies or programs at the European Union level. The introduction of innovations before the COVID-19 crisis has meant the possibility for companies to reduce costs, increase productivity, gain competitive advantages or create a sustainable society. They aimed to improve already functioning businesses. Currently, a large number of companies are trying to survive and reduce the damage caused by the Coronavirus pandemic. The planned investments within Industry 4.0 are postponed and considered unnecessary by entrepreneurs, but new technologies can help companies to fight the current situation (Czifra & Molnár, 2020). According to our survey, in most cases, the pandemic has not affected access to finance through credits from banks, and almost 29% said that access to public financial assistance has been improved.

Technology is dramatically changing this world – the social, economic, ecological, and cultural life of each individual. We can see transformations in education, health, and other sectors. Modern society faces the most crucial issues such as climate change, chronic illnesses, and inequality of life. These problems could help to address new technologies, which would be useful for society as a whole (Morrar et al., 2017; Kergroach, 2017).

CONCLUSION

Contributions and Implications

The aim of the new industrial revolution is to implement highly efficient and automated production processes, which are mainly used in mass production, for individual products, and for specific products that will be produced according to mass adaptation. Innovation is important for SMEs in Slovakia, and in order to compete, it is necessary to introduce new innovations. The importance of innovation for entrepreneurs has also been confirmed, as most respondents said that they innovate and others are also aware of the importance of innovation, which is a positive finding. Among Slovak SMEs, there is a significant lack of awareness of the possibilities for introducing new innovations. Few SMEs have already invested in some new technology or are planning to invest. Cloud solutions and digital networks are interesting for businesses. About half of entrepreneurs have invested or plan to invest in robotic solutions. Other technologies currently seem resistant, in some cases not relevant. The perception of the benefits of introducing new innovations and technologies is quite individual for each enterprise. The major barrier for SMEs is the significant lack of state support for innovation. For medium-sized enterprises, the major obstacle is the lack of time to develop new updates and ideas. More than 30% of SMEs have a problem with access to finance. The coronavirus pandemic has postponed innovation activities.

Limitations and further research

This article contributes important and especially up-to-date information on ongoing innovation activity in the environment of small and medium-sized enterprises in Slovakia. It is fundamental to note that the data was collected at a time of the global pandemic crisis. On the other hand, it is precisely this situation that may have affected the companies' ability to react and to answer questions objectively. In the future, it might have been more persuasive to carry out a similar survey, but on a larger sample of companies, which could provide a deeper and more comprehensive picture of Industry 4.0 in Slovakia. The use of specific models to monitor the socio-economic impacts of innovation in Industry 4.0 is an undisputed scope for improvement and extension of the analysis presented in this work.

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OECD COMPOSITE LEADING INDICATORS AND THEIR PREDICTION ABILITIES IN V4 COUNTRIES

KOMPOZITNÉ PREDSTIHOVÉ UKAZOVATELE A ICH PREDIKČNÉ SCHOPNOSTI V KRAJINÁCH V4

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Abstract
This paper is focused on analysis of components and prediction abilities of composite leading indicator (CLI) OECD in case of V4 countries in period 2001-2021. For verification of these prediction abilities of CLI we used methods as seasonally adjusted time series, Hodrick-Prescott filter and cross correlation between CLI and cyclical components of monthly data of GDP. On the results of cross correlation, we can define prediction abilities of CLI OECD. The result is than in the case of CLI Slovakia this indicator cannot predict the development of GDP and acts as coincident indicator. CLI for Hungary and Czech Republic can predict business cycle of these countries about a few months. Prediction ability of CLI Poland is weak: in the case of CLI Slovakia and Poland is necessary to change the components of composite leading indicators.

Key words: Composite leading indicator, business cycle, cross correlation, GDP, V4 countries

JEL Classification: E 30, E 32, E 37

INTRODUCTION

The new wave of interest in the economic cycle, mainly in possibilities of its prediction, came with the World Financial Crisis in 2007 which hit mostly the developed world countries. Many economists started to study not only the causes of this crisis, but also the possibilities of its prediction through the different econometric models. There are indicators in the economic practice which are able on a certain level provide a short-term prediction of the development of the economic cycles and accordingly warn to the possible negative development of the economy [22]. The composite leading indicator is one of these indicators. The composite indicator is created by the aggregation of individual indicators into one complex index which is measurable. Its main characteristic is the ability to describe a selected economic area in more detail than individual indicators by themselves [17]. The composite indicator of cyclical development of economy, which consists of partial indicators of the economic cycle, belongs to one of the most used composite indicators. This complex indicator reflects the economy development and its cyclical behaviour better than individual indicators by themselves. The selection of cyclical indicators creating the composite indicator is not random, but it depends on their economic significance, their explanatory value, their predictive ability and so on [17]. Creating of the composite indicator of cyclical development of economy is a relatively difficult process and it requires a precisely specified sequence of individual steps [14]. To be able to create this indicator, it is necessary to identify the leading cyclical indicators, whose main task is to predict the turning points in the economic activity and at the same time provide the information on probable rate and amplitude of fluctuations in the reference data row at any phase of the economic cycle. These indicators are considered to be the most important out of the entire group of cyclical indicators, due to their predictive ability [13]. The first leading indicator was developed by the American economist Moore from the Economic Cycle Research Institute. Later in 1960, this indicator was refined into the form of index of leading economic indicators (LEI) [6]. Presently, there are more opinions on the composition of the composite indicators of cyclic development of economy. The OECD is of the opinion that the economies are different and therefor the composition of the composite indicators varies depending on the country. On the other hand, the Eurostat states that the economic cycles can be traced through the composite indicators with the same composition.

1. LITERATURE REVIEW

The methodology of the OECD arises from the growth cycle and the time series can be split into random, trend, seasonal and cyclical components. The OECD used the modified method phase-average trend (PAT) of the American National Bureau of Economic Research (NBER), for the trend prediction until 2008. This method is relatively mathematically and statistically difficult [3]. To simplify its description, the calculation of the trend is based on summing the moving averages of the time series [15]. The OECD decided to replace the PAT method by Hodrick-Prescott (HP) filter, starting from December 2008. The main reason for this change was that the HP filter was able to eliminate the trend component in one operation and at the same time smooth the time series [20]. Before the HP filter was used, it was necessary to add the Months for cyclical dominance method to the PAT method, which smoothed the series by using the moving averages [16]. The main advantage of the HP filter was its modesty on input data [2]. Beneš and N´Diaye considered the HP filter to be the simplest variant of the modern filtration techniques [1]. The HP filter can be relatively easily applied to any time series [10]. Besides this, it is necessary to input only an entry parameter λ, which optimizes the smoothing of the trend [7]. The HP filter's disadvantage is the fact that its results are devious at the beginning and at the end of time series. It is called a problem of „end-points" [23]. The time series are supplemented with the predictions to mitigate this problem [25]. The OECD uses the monthly data for the calculation of the composite leading indicator, and starting from March 2012 as the reference range are used monthly data of GDP. Before this date OECD used index of industrial production as reference series for calculation CLI. The OECD is the only institution, which uses parameters of external economy, such as foreign trade, mainly the development of export and the exchange rates. In its approach, it combines both soft and hard data. The individual indicators have the equal weights. The reason for this is the fact that the application of different weights could lead to the minimization of the impact of those indicators, which do not show the required concurrence with other indicators. A reduced reliability of the composite indicators could be the consequence, as some of the indicators have a greater explanatory ability in one cycle and other indicators in other cycles [8]. Based on the Nilsson's studies, the indicators used by the OECD have a greater explanatory ability than the indicators used by the European Union [15].

In March 2012 OECD changed the reference series for CLI OECD formation from index of industrial production to GDP. Main reason of such a change was creation of methodology which enabled to disport quarterly GDP data to GDP predictions based on monthly periodicity. Each of the reference series included particular advantages and disadvantages of economic cycle prediction. Constant-price gross domestic product is an indicator used to monitor cyclical development of the economy and it is generally considered as the widest indicator of economic activity [4]. However, it is not applied in the state of rough data. GDP time series is adjusted and only its cyclical component is chosen and analysed consequently [5]. GDP indicator is treated as a high quality economic indicator which is able to describe the cyclical behaviour of an economy accurately and on its basis it is possible to state the points of reversal which indicate an economic growth or an economic decline [19]. On the long term basis, the time accessibility of GDP used to be considered as main disadvantage of GDP [21]. Ideally, GDP indicator, which is used to monitor economic cycle of countries, should be expressed in constant prices [24]. In the past, it was available only in a form of quarterly data which were delayed by one or two quarters. It was a kind of problem in case of predictions of cyclical behaviour of particular economy [9]. The index of industrial production is another indicator used to observe cyclical development of the economy. Main reason to use the index of industrial production is that significant part of most economies is created by industry; hence, it creates an extensive part of GDP indeed. In comparison with GDP, it is possible to gain the indicator on monthly basis (in case of GDP the data can be only estimated) what enables us to make more detailed analyses and forecasts since it is possible to observe the cycle change signals on monthly basis [16].

2. MATERIAL AND METHODS

The aim of the article is to verify the prediction ability of OECD composite leading indicator, in V4 countries. It is important to realize cross correlation of cyclical components of GDP and CLI OECD in V4 countries and to compare the gained results consequently. The monthly data of GDP, and CLI, which are available from OECD databases within the period January 2001 – April 2021, will be the source of data. The time series adjustment was accomplished to acquire cyclical components of GDP. The adjustment included three steps. First step is seasonal adjustment of time series (seasonal indices) – seasonal indices enable us to adjust the time series and gain a cyclical component from original data. We apply smoothed seasonal adjustment method which uses seasonal indices. Second step is trend elimination (Hodrick-Prescott filter) – one of the reasons to choose the HP filter is that it eliminates the trend component in one operation and it smooths the whole time series in the same step [20]. It is rather easy to apply HP filter to any time series. It only remains an input parameter λ to enter. The λ parameter optimalises the trend smoothing [7]. Following values are recommended by literature: $\lambda = 100$ for annual data time series, $\lambda = 1600$ for quarterly time series, and λ =14 400 for monthly periodicity time series [12]. HP filter was applied because it is able to eliminate the trend component and to smooth whole time series in one operation [20]. When cyclical component of GDP is gathered it is important to realize the cross correlation using Pearson correlation coefficient. Ten months shifts backwards are realised and we bargain for the highest value, which was reached in advance. The minimum value of cross correlation can be considered as a leading element when it reaches the level 0.7.

3. RESULTS AND DISCUSSION

3.1 Composite leading indicators of V4 countries and their components

The most important step for a successful CLI build is the selection of a support component. Table 1 lists the most commonly used components and the countries that contain this component in their CLI.

Table 1: Leading cyclical indicators in CLI OECD of European Countries used most frequently.

Leading cyclical indicators (component of CLI OECD)	**Countries**
Production (manufacturing): tendency (% balance)	Belgium, Czech Republic, Denmark, Norway, Poland, Switzerland, Slovenia, Finland
Production: future tendency (% balance)	United Kingdom, Portugal, Netherlands, Italy, Hungary, Greece, France
Consumer confidence indicator (% balance)	Belgium, Czech Republic, Denmark, Finland, France, Italy, United kingdom
Share prices index	Netherlands, Czech Republic, Estonia, Finland, Hungary, Portugal, Slovakia, Spain, France, Ireland, Norway, Sweden, Switzerland, United kingdom, Ireland, Norway
Manufacturing - Export order books: level sa (% balance)	Estonia, France, Germany, Portugal
Order books: level (manufacturing) (% balance)	Italy, Netherlands, Portugal, Slovenia, Sweden,
CPI All items (2010=100) inverted	Finland, Italy, Norway, Slovenia, France, Czech republic
Finished goods stocks (manufacturing) (% balance) inverted	Finland, Germany, Netherlands, Sweden, Switzerland, United Kingdom

Source: processed by author on the base of OECD, 2021.

In the case of V4 countries we can find differences in composition of CLI. Table 2 shows the component series of CLI OECD.

Table 2: Component series of CLI OECD in V4 countries.

Country	Components of CLI OECD
Slovakia	Retail trade - Confidence indicator sa (% balance) Total retail trade (Volume) sa (2015=100) Consumers - Expected economic situation sa (% balance) Share prices: SAX index (2015=100) ITS Imports c.i.f. total sa (USD)
Czech Republic	BOP Capital account, debit (czk) Services - Demand evolution: future tendency sa (% balance) Manufac-turing - Production: tendency sa (%) CPI HICP All items (2015=100) *inverted* Consumer - Confidence indicator sa (% balance) ITS Exports f.o.b. total sa (czk) Share prices: PX-50 index (2015=100)
Hungary	Manufacturing - Production: future tendency sa (% balance) Registered unemployment: level (all persons) sa Monthly hours worked: manufacturing sa (hours) Monetary aggregate M1 sa (HUF) Share prices: BUX index (2015=100) Central bank base rate (% per annum) ITS Imports c.i.f. total sa (HUF)
Poland	Real effective exchange rates - CPI Based (2015=100) *inverted* 3-month WIBOR (% per annum) *inverted* Manufacturing - Production: tendency sa (% balance) Job vacancies: unfilled sa (number) Production of coal (tonnes)

Source: OECD, 2021.

The CLI of V4 countries differs in both composition and number of components. While CLI Slovakia has only 5 components, Poland and Hungary have seven each. We can see differences in composition of CLI but we also can find the same components. For example, share index is in CLI in case of Slovakia, Czech Republic and Hungary. Indicators of manufacturing we can find in Czech Republic, Hungary and Poland.

3.2. Prediction abilities of CLI OECD in V4 countries

After application of seasonal adjustment of time series and HP filter we had the cyclical time series of GDP. Then we used cross correlation at the time where we analysed ten months back and two months forward. The results of cross correlation between cyclical component of GDP and CLI we can see in the Table 3.

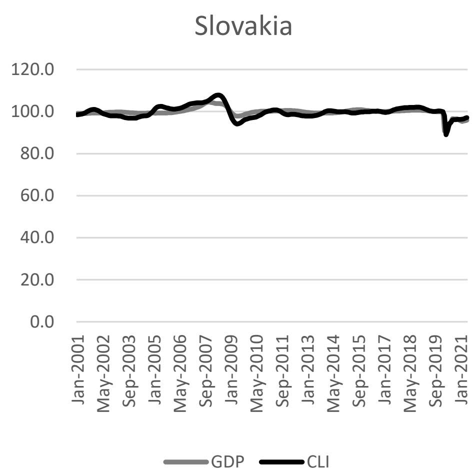
Table 3. Results of cross correlation between cyclical component of GDP and CLI OECD.

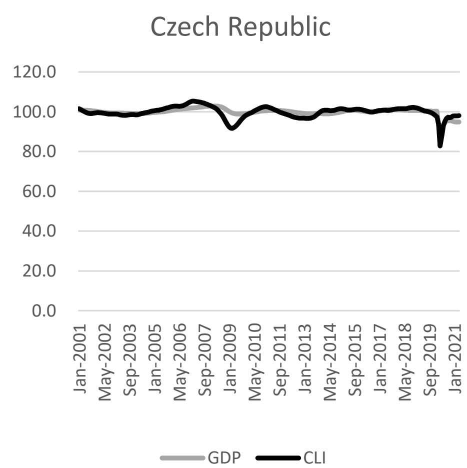
Country	t-10	t-9	t-8	t-7	t-6	t-5	t-4	t-3	t-2	t-1	t	t+1	t+2
Slovakia	0,37	0,42	0,46	0,50	0,54	0,58	0,61	0,66	0,71	0,76	0,79	**0,80**	0,73
Czech Republic	0,61	0,64	0,65	0,67	0,68	0,68	0,69	0,69	**0,70**	0,70	0,68	0,62	0,49
Poland	0,53	**0,53**	0,52	0,51	0,48	0,45	0,40	0,36	0,32	0,28	0,24	0,17	0,07
Hungary	0,45	0,50	0,55	0,59	0,63	0,66	0,69	0,72	0,75	**0,78**	0,77	0,69	0,60

Source: processed by author.

Table 3 shows us the different predictave abilities of the CLI in the V4 countries. In the case of Slovakia, the CLI does not have the characteristics of a leading indicator at all. The highest value of cross-correlation was reached at time t + 1 and the second largest value at time t. This means that CLI Slovakia is developing in parallel and in advance with GDP. In the case of the Czech Republic and Hungary we can see different situation. The CLI can predict the development of GDP in these countries. CLI in the Czech Republic can predict the development of the business cycle two months in advance. In the case of Hungary it is only one month. The Polish CLI does not have predictive abilities as the results of cross-correlation reach the highest values around 0.5.

Figure 1 shows the development of the CLI and the cyclical component of GDP in the V4 countries over the period under review January 2001-April 2021.





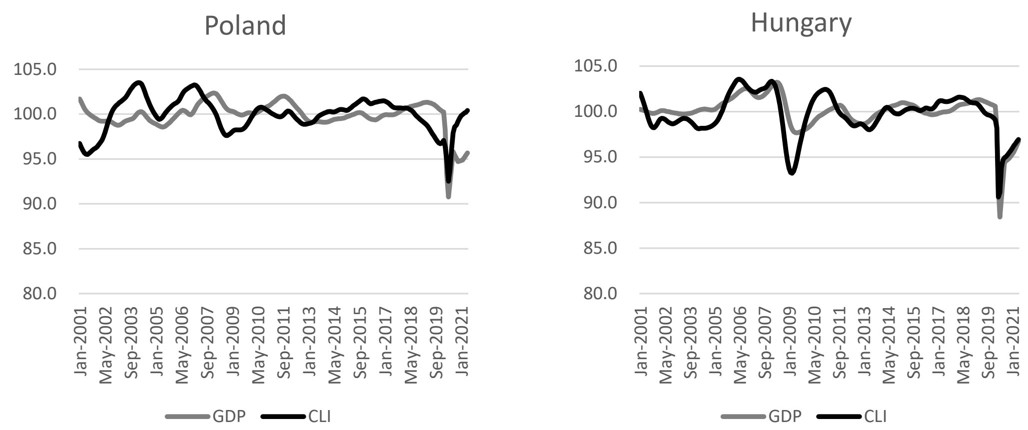


Figure 1: CLI OECD and cyclical components of GDP for V4 countries.

Source: processed by author.

Based on Figure 1 we can see that in the case of Slovakia, Czech Republic and Hungary the CLI is developing in parallel rather than ahead of schedule. In the case of Poland we can see periods when the CLI is ahead of GDP, but also periods when it is developing late. This is also indicated by the low value of cross-correlation in the case of this country.

CONCLUSION

The analysis of the cyclical component of GDP and the CLI in the V4 countries showed that the composition of the CLI does not meet the economic cycle forecast in some countries. In the case of Slovakia, the monitored CLI had the character of a coincident to lagging indicator. The cross-correlation value was 0.8 but at time t + 1. In the future, it is necessary to proceed to the overall change in the composition of the CLI of Slovakia. The CLI of the Czech Republic was able to predict the development of the economic cycle by two months with a cross-coefficient value of 0.7. The CLI of the Czech Republic therefore fulfilled the condition of the minimum value of cross-correlation. A similar case is also in Hungary where the value of cross-correlation reached the level of 0.78 and a prediction of only one month, which is quite a weak lead. The CLI of Poland did not reach a value above 0.7 in cross-correlation. The result was only 0.53 at time t-9. For the purposes of prediction, this is a very weak value of correlation and therefore the CLI of Poland does not meet the basic conditions for us to consider it as a quality leading indicator.

Overall, we can evaluate that by changing the reference series from the index of industrial production to GDP, it was necessary to proceed to a change in the composition of the OECD CLI. If we monitor economic cycles using the cyclical component of monthly GDP, at the same time the composition of the CLI for the V4 countries can be considered unsatisfactory. CLIs achieve low cross-correlation values or a weak transition time.

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INDUSTRY 4.0 – AWARENESS AND EXPECTATIONS OF SMES IN EASTERN SLOVAKIA

INDUSTRY 4.0 – POVEDOMIE A OČAKÁVANIA MSP NA VÝCHODNOM SLOVENSKU

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Abstract

We found ourselves on the next generation of industrial revolution, Industry 4.0, which brings advanced interconnection and autonomous interaction of technologies involved in manufacturing process resulting in smart manufacturing. This state of art empowers companies position on the market with additional benefits. Companies that do not become one with the trend, refuse to adopt required changes are going to face professional fate in long term run. Based on these assumptions, the main goal of this paper is to evaluate theoretical premises of desired condition of Industry 4.0 in small and medium enterprises (SME). Based on the deductive approach we collect the data about the actual situation and expectations of SME´s regarding the I4.0. To achieve that, we applied personal expert interview with the respondents coming from the top management of the company. Our results suggest relatively high level of overall knowledge regarding the Industry 4.0 and related terms, however negative expectations towards costs considered inevitable from transition process perspective.

Key words: Industry 4.0; Internet of Things; Small and medium enterprises; Enterprise resource planning systems

JEL Classification: L60, D20, O30, A230

INTRODUCTION

Industry is an integral part of the economy, where products are produced on the basis of sophisticated mechanization and production automation. From the very beginning of the process of industrialization, every technological advancement has been paradigmatically described, now ex-post, as the "Industrial Revolution." The first stage consisted in the implementation of mechanical machines powered by a steam engine. The second stage is characterized by the extensive involvement of electricity in the production process as well as in people's everyday lives. In the third stage, digitization, globalization and automation using the Internet and advanced computer technology are involved in production, which is becoming a common part not only in industry. Based on the advanced digitization of the production process connected by the Internet and advanced smart technologies, the industry of manufacturing companies is entering the next stage - the so-called Industry 4.0. The vision of advanced production of the future lies in modular and efficient production and characterizes the scenarios in which products control their own production process.

Thanks to Industry 4.0, physical products and services can be enhanced with digital capabilities that increase their value (Schwab, 2016). In practice, this means the production of individualized products in larger quantities, provided that the economic nature of mass production is maintained (Lasi et al., 2014), while the effectiveness of manufacturing processes increases hand in hand with decreasing production costs.

Based on theoretical assumptions and analysis of the current state of art worldwide and in Slovakia, we formulate basic assumptions with aim to evaluate the degree of implementation of Industry 4.0 in SMEs in Slovakia, more concretely in less developed eastern part of the country. The paper should reflect a realistic picture of the shortcomings and opportunities from companies´ perspective regarding the implementation of technologically advanced solutions, aiming to achieve a fully integrated concept of Industry 4.0.

1. LITERATURE REVIEW

The fourth wave of technological progress is primarily based on the integration of IT systems in production and their interconnection. Complex interconnection of cyber-physical systems that work together and collect data, which is then evaluated to optimize processes to streamline them, increase quality, flexibility and reduce costs (Rüßmann and Lorenz, 2015). Many of these digital technologies have been available before, but the change in affordability and reliability has increased their industrial application. Industry 4.0 has the potential to turn isolated production into an automated, optimized, fully integrated network in the global value chain. (Strange and Zucchella, 2017)

The next step in industrial evolution, or rather a strategic initiative originally introduced in Germany called Industry 4.0, is a concept where the product production process is integrated in one line together with supply companies and customers within one supply chain. Technically, it ensures the implementation of the so-called Cyber - Physical Systems (CPS) and Internet of Things (IoT)

Industry 4.0 is perceived in the economic sphere as a path to an innovative economy. The digital connection has the potential to improve efficiency, accelerate innovation, discover new business models that will lead to faster development and greater efficiency. Manufacturers will be able to generate revenue from sharing equipment or selling their spare capacity. Taking into account connectivity, products will be able to be directly enriched with various services directly from the manufacturer. Personalized products will be made available to a wider range of consumers due to the economic demands at the same level as mass production. The complexity and sophistication of production machines will increase the work of workers in manufacturing companies. Repetitive manual operations will disappear and be replaced by coordinating operation of individual machines in order to maximize the continuous operation of the production process. Known production, sales and demand patterns will lose their validity over time because they fail to cope with emerging variables such as energy, environment, demography and other social and economic impacts. The Industry 4.0 concept also has the potential to solve these problems and thus maintain the economic situation on the market in the long run. Each revolution has historically proved its downs, especially over time. Economists Erik Brynjolfsson and Andrew McAfee (2016) pointed out that the revolution could bring about greater differences among the people, especially by disrupting the labour market as we know it today. Robotization tends to increase the share of capital at the expense of labour and thus the wages of employees. The decisive factor for companies will be the talent of the employee, from which it can be deduced that skilled workers will increase their financial value in the labour market compared to the low-skilled. The result will be a deepening of wage imbalances and social tensions. The dynamics of information sharing for the purpose of using information for the production and sales model of companies is already on the verge of public acceptance and lays at the level of interference with the privacy of human rights and freedoms (SOVA Group, 2018).

Undoubtedly, these are managerial decisions that triggers such changes, due to inevitable initial costs linked to such new technological equipment. Schröder et al. (2015) put open question, whether, especially for SMSs, it is even worth to implement I4.0, which is in the contrast with broad consensus we find among authors addressing reduced costs and more efficient processes and environment because of I4.0 implementation. Such dynamics within the industries should be examined deeply, and not only economic point of view but also various elements of sustainable development should be evaluated (Kovacs, 2018; Eberhard et al., 2017). Quite opposite to widely mentioned cost-saving and cost-reducing benefits is initially needed significant financial expenditure, which are on many occasions out of reach for companies, especially SMEs.

Since most of the research has been conducted in the field of needed modernization, (especially with respect to the SMEs) to successfully transform towards Industry 4.0, we would rather point out the necessity of having potential labour force ready to such transformation. It is therefore considered that awareness of I4.0 needs to be continuously promoted and expanded, as confirmed by several authors (Matt and Rauch, 2020; Burgess, 2001; Kagermann, 2015). As Nimawat and Gidwani (2020) add on, there is only a limited number of studies focusing on data collection based on empirical foundations. Only a small percentage of research is devoted to verifying the current state of Industry 4.0 in companies, where SMEs fall behind large companies, which is why they emphasize the need to verify the level of awareness of the benefits of Industry 4.0 implementation and the readiness of mainly manufacturing companies for this implementation. Wagire et al. (2019) clearly formulated the need to test theoretical concepts with empirical data from the field.

2. MATERIAL AND METHODS

In line with the aim of the paper, analytical part focuses on evaluation of the current state of awareness and expectations of Industry 4.0 in small and medium enterprises in Eastern Slovakia. In order to achieve that, questionnaire together with interview been adopted. The target group for determining the awareness, expectations and current status were small and medium-sized enterprises. Since authors and literature tends commonly address small and medium enterprises together (according to European Commission recommendation of 6 May 2003 concerning the definition of micro, small and medium-sized enterprises – notified under document number C(2003) 1422), we will follow this practice. The empirical relevance of the obtained data is secured by the form of data acquisition

– expert interview, conducted with a person directly from the company's management environment.

The process of obtaining answers from the respondents took 21 days (during July and August in 2021) and was carried out at 10 companies with which a personal interview was conducted, in order to ensure the most relevant answers to the issue. The number of companies contacted was 20, of which 12 companies were willing to provide a personal interview. Due to the workload of the respondents, authors were able to conduct 10 interviews. In the table below we present basic information about questioned companies.

Table 1: Responding companies' description.

	Sector	Number of employees	Annual turnover	Market concerned
Company A	Trade	200	25 000 000 €	SR
Company B	Manufacturing	180	11 000 000 €	EU
Company C	Manufacturing	120	5 500 000 €	EU+outside
Company D	Manufacturing	40	1 300 000 €	EU
Company E	Trade	10	1 400 000 €	SR
Company F	Manufacturing	15	800 000 €	EU
Company G	Trade	6	3 000 000 €	EU
Company H	Manufacturing	6	200 000 €	SR
Company I	Manufacturing	22	1 500 000 €	EU+outside
Company J	Manufacturing	15	700 000 €	EU

Source: processed by authors.

The first part of the questionnaire consists of closed questions with a binary answer "yes" or "no". The aim of the questions formulated in this section is to indirectly address the basic questions on the topic of Industry 4.0, therefore to find out if the respondents are familiar with the I4.0 related terms and processes (awareness).

To measure the respondent's opinion and attitude (expectations), we decided to use scaling using the Likert method. Our goal is not to find out whether the given phenomenon occurred as it is in the first part, but the degree of evaluation of the given phenomenon. For our case, we chose an odd number of categories, and we offer respondents to take a neutral position. The order of the questions in this section is influenced by the content itself, questions with the same topic are grouped.

In the following table, we have formulated hypotheses, which we have defined as factors identifying the state of Industry 4.0 in companies. The table also lists other studies that have included similar hypotheses or specific questions used with aim to accept or reject hypotheses.

Table 2: Hypotheses and related questions.

1	***Hypothesis***	The motivation to implement innovations associated with Industry 4.0 comes from the management of the company.
	Reference	*Thong et al., 1996; de Sousa Jabbour et al., 2018*
	Questions	1.1 Are we working in the company to adapt the Industry 4.0 concept? 1.2 Is the implementation of the principles of Industry 4.0 in the company at a high level? 1.3 Do employees in the company initiate the adaptation of new technological solutions to implement the principles of Industry 4.0?
2	***Hypothesis***	In connection with the implementation of Industry 4.0 elements, the company expects primary benefits.
	Reference	*Ooi et al., 2018; Shrouf et al., 2014*
	Questions	2.1 Can Industry 4.0 adaptation give a company a comparative / competitive advantage in the market? 2.2 Will process automation affect the overall performance of the business?
3	***Hypothesis***	Industry 4.0 requires more highly qualified employees.
	Reference	*Türkes et al., 2019; Nimawat and Gidwani, 2020*
	Questions	3.1 Will the required qualification of employees change due to automation in the company?
4	***Hypothesis***	Implementing Industry 4.0 requires significant investment.
	Reference	*Erol et al., 2016; Rennung et al., 2016; Nicoletti, 2018*
	Questions	4.1 Will the introduction of Industry 4.0 affect investment planning in the company? 4.2 Is it desirable to change the technological equipment in your company to implement Industry 4.0?

Source: processed by authors.

We accept or reject hypotheses based on the evaluation of individual questions assigned to the given hypothesis. We evaluate the question as true with a left-sided t-test. The null hypothesis is defined as the sample mean is greater than or equal to the hypothesized mean. The alternative hypothesis means that the sample mean is less than the hypothesized mean. Confirmation of the null hypothesis means a positive opinion of the respondents on the given question. Based on the respondent's agreeable opinion on the question, we also confirm the formulated hypothesis.

3. RESULTS AND DISCUSSION

Firstly, we present responds to dichotomic question in Figure 1 below. From awareness perspective, we consider positive that all respondents are convinced that we are in the age of the Fourth Industrial Revolution. We can evaluate positively the fact that up to 80 percent of respondents have already encountered the term Industry 4.0 and are familiar with this term. The concept of IoT, on the other hand, was unknown to 90% of responded managers. This result suggests that the concept itself is in the consciousness of the respondents, but crucial terms associated with this concept are still unassessed.

Each of the addressed companies is actively involved in streamlining its production process. Up to 80% of respondents use automation in any form. The same percentage of them evaluate and look for technologies to improve the efficiency of processes in the company. A high percentage of respondents said they were working to automate the company's processes. Except for one respondent, each company uses an ERP system in the company. When asked if they know the company where they are actively working on the implementation of Industry 4.0, the respondents remained indifferent.

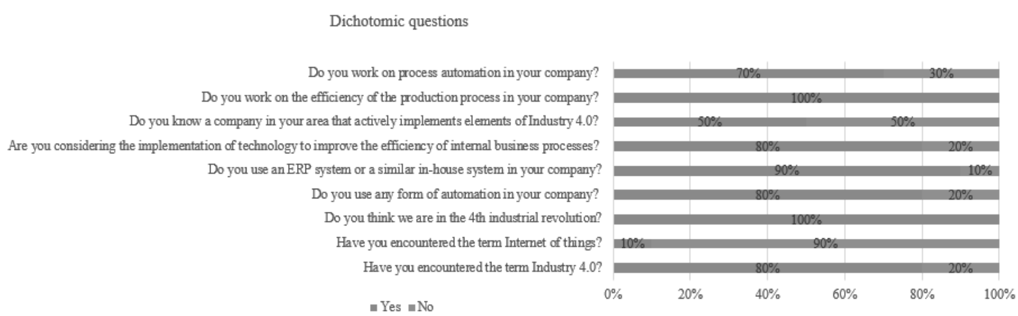

Fig. 1: Responses to the dichotomic questions.

Source: processed by authors.

Figure no. 2 shows us how the respondents answered the individual questions 1.1, 1.2 and 1.3 from the questionnaire. Five respondents said they were not working on an adaptation of Industry 4.0 in the company before, and the other two decided not to. The respondents also have a negative attitude when assessing the level of implementation of Industry 4.0. Based on the statistical t-test, we were able to confirm a negative opinion in all three cases and reject the hypothesis "The motivation to introduce innovations associated with Industry 4.0 comes from the management of the company."

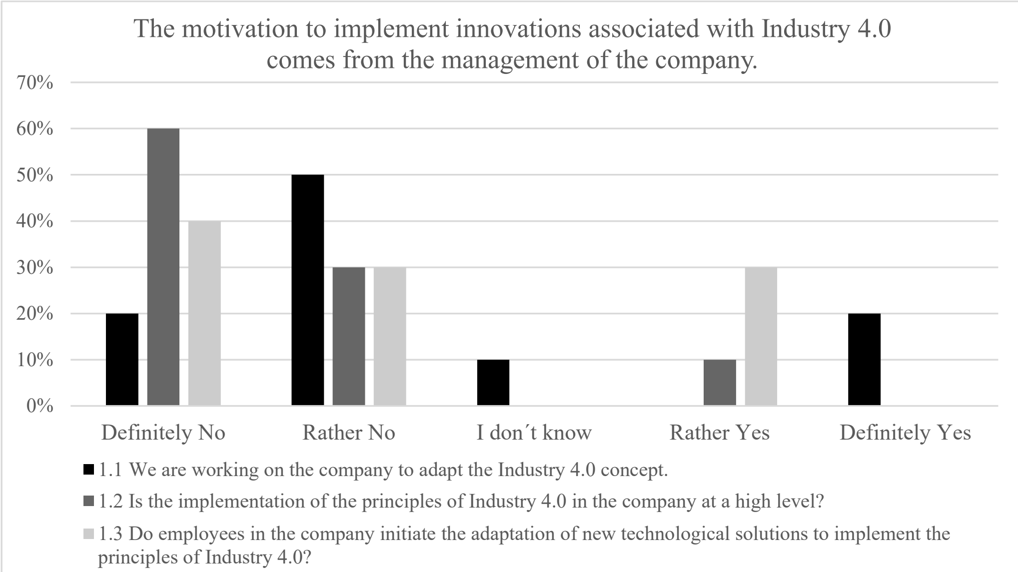

Fig. 2. Responses related to the hypothesis No. 1.

Source: processed by authors.

Figure no. 3 shows the distribution of answers to questions 2.1 and 2.2, which we chose to support or refute the hypothesis "In connection with the implementation of elements of Industry 4.0, the company expects primary benefits." as many as 90 percent of respondents clearly agreed. We can assume that in the case of the implementation of Industry 4.0, automation will be the primary choice for the respondents. The statistical t-test in both cases does not reject our hypothesis.

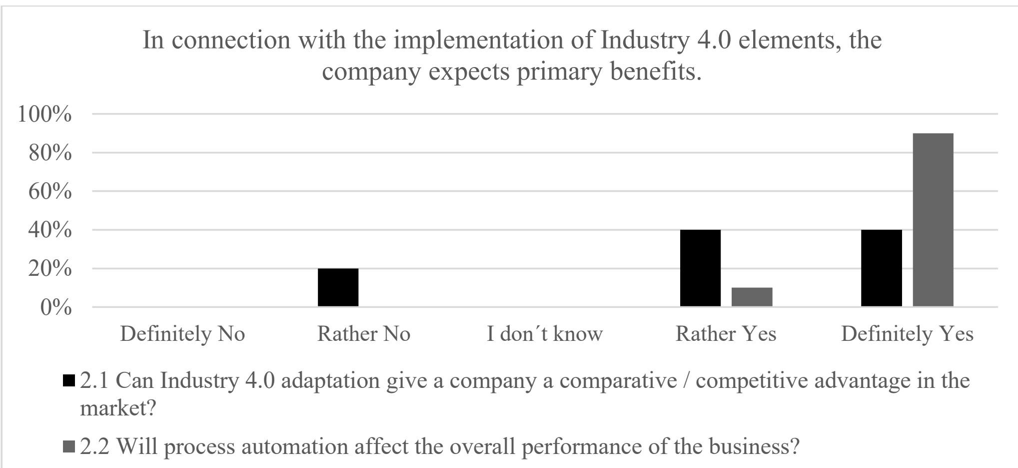

Fig. 3: Responses related to the hypothesis No. 2.

Source: processed by authors.

As presented below in Figure No. 4, we are able to confirm the hypothesis "Environment 4.0 environment requires employees with higher qualifications." by a statistical t-test, which confirms this hypothesis that the qualifications of employees will change, and based on theoretical principles, companies will need more qualified personnel. Based on additional questions during the interviews, we found that some respondents, by introducing better technology, expect that a less qualified worker will be able to do the job. Based on quantitative results, we can confirm the hypothesis. Qualitative research has shown that the hypothesis is not formulated correctly.

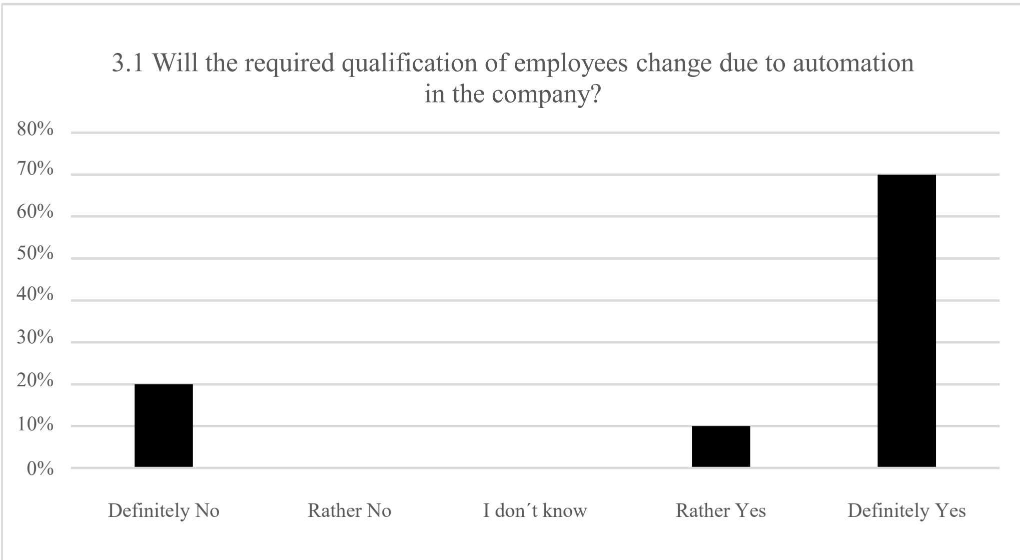

Fig. 4. Responses related to the hypothesis No. 3.

Source: processed by authors.

Graphical display of answers to questions 4.1 and 4.2 in Figure no. 5 below does not give us a clear idea whether we can reject the formulated hypothesis at first glance. According to the respondents, the introduction of Industry 4.0 in the company will affect the financial planning in the company. Fifty percent of respondents think they need to change the technological equipment. The other half of the respondents replied "rather not" and one of the respondents has technological equipment in his company that does not limit him in the implementation of Industry 4.0. Replacing or modifying technology in a business is a costly affair. The statistical t-test evaluated the hypothesis in both questions as true.

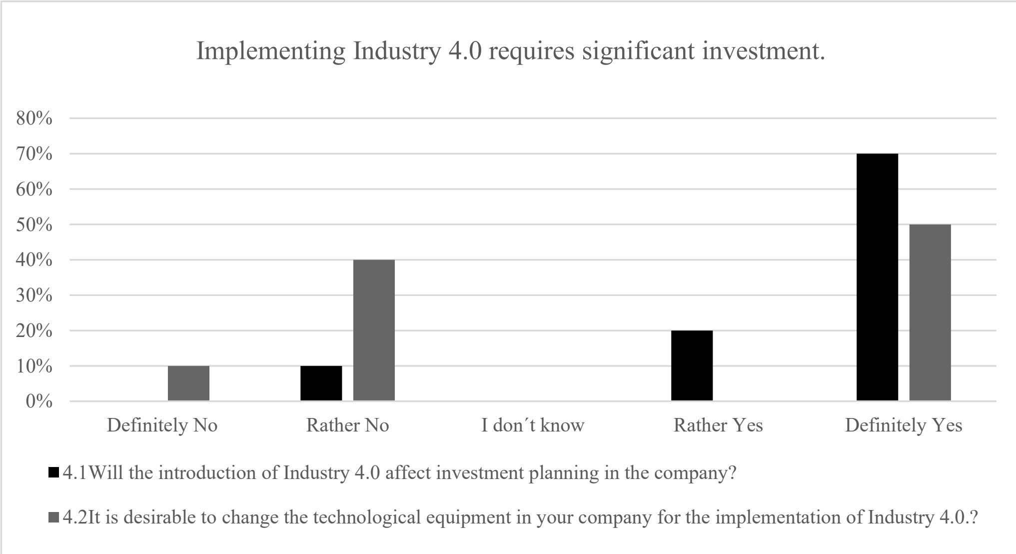

Fig. 5. Responses related to the hypothesis No. 4.
Source: processed by authors.

CONCLUSION

The way in which goods and services are ordered, manufactured, delivered and sold is changing radically in the 21st century due to elements of the Industry 4.0 concept in various areas. The topicality of the I4.0 prompted us to review the current situation in Slovakia, especially in less developed eastern part of the country. The motivation for the review was also then current situation of the global pandemic, which emphasizes the need to implement modern technologies for companies in terms of long-term sustainability in the market. Based on theoretical assumptions, the implementation of Industry 4.0 elements in SMEs is in its infancy, as is the whole Industry 4.0 concept, which tends to continue to evolve.

We mapped the current awareness and expectations in SMEs in Slovakia through a questionnaire survey, in the form of a personal expert interview. The result of the analysis is the confirmation of three out of four hypotheses formulated on the basis of theoretical background about the state and readiness of SMEs for Industry 4.0.

Respondents' view of the implementation of Industry 4.0 from an economic perspective can be evaluated from several perspectives. In general, respondents believe that the implementation of Industry 4.0 elements will affect financial planning in the company. However, this fact does not imply an increase in costs. The current trend defined by the respondents is the declining cost of technology compared to the rising cost of human capital. The theoretical assumption is that the higher integration of Industry 4.0 elements in the company will translate into higher labour costs. Some respondents agree with this statement. The second part is motivated to introduce more technologically advanced solutions in the company in order to simplify work performance, and they can be performed by less qualified workers for a lower salary. Based on this situation, the respondents realize that technologies represent the element of difference in the company's ability to adapt to the current dynamic market situation.

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