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AN EFFICIENCY ANALYSIS OF COMPANIES OPERATING IN THE PHARMACEUTICAL INDUSTRY IN THE VISEGRAD COUNTRIES

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Abstract: *The primary aim of this research was to analyse the corporate performance of selected companies in the pharmaceutical industry in the Visegrad countries using the value added intellectual coefficient (VAIC) model. The secondary aim was to find relations between VAIC components and company profitability ratios by country. Data for analysis were downloaded from the EMIS database for the years 2016–2019. Several statistical methods (MANOVA, ANOVA, t-test, correlation analysis, panel model) were used to analyse and compare companies by country. Based on the analysis of variance and the pair-wise t-test, it can be concluded that there is no statistically significant difference between the countries selected concerning the VAIC ratio and its components. Furthermore, it can be concluded that there is a medium correlation between selected profitability ratios (OROS, ROA, OROA) and VAIC and its components, except for the capital employed efficiency ratio. It was determined that the components of the VAIC indicator impact the operating ROA using the panel model, except for in the Czech Republic. Based on a study of the literature on the application of VAIC and the evaluation of the results of the analyses,*

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it can be argued that the VAIC ratio is suitable for measuring corporate performance from a specific perspective.

Keywords: *corporate performance, intangibles, intellectual capital, value added intellectual coefficient, Visegrad countries, pharmaceutical industry.*

JEL Codes: *O34, M41, L25, L65*

1. Introduction

With the development and expansion of the knowledge economy and the information society, the hard-to-measure resources that can play an increasing role in corporate value-creating will grow. At present, so-called "invisible capital" plays an increasingly important role in company value creation. This capital is referred to as intellectual capital or intangible assets in the economic literature. Regardless of their name, these "assets" are not material goods but intangibles that companies try to measure and state in their respective accounting, and in their financial statements in a less successful way. Lev and Daum (2004) presented the increasing presence of intangibles in businesses. Companies' market value has increased significantly since the 1980s, and the difference between book and market value has also increased. The difference between these two values is the companies' intellectual capital, which is revealed in financial statements. The average value of the intellectual capital to intangible assets ratio calculated for companies in the S&P 500 Index increased from 38% to 62% over almost ten years, while their book values fell from 62% to 38%.

According to Damodaran (2012), the firm value is the sum of the present values of future free cash flows. This assumption is an implicit approach that utilises tangibles and intangibles to generate corporate cash flows. However, the question can arise as to whether any other value-creating sources are invisible and do not appear on the balance sheet. A large number of researchers have named these invisible goods as intellectual capital (Edvinsson, 1997; Lev, 2001; Sanchez-Canizares et al., 2007). Intellectual capital can include information, knowledge, intellectual property, experience, and relationships, making a company more successful. Now, intellectual capital has become more relevant than ever before. Many studies have tried to explain the difference between book value and market value, and the assumption prevails that it mainly stems from the invisible intellectual capital that companies cannot state in their accounting. Accounting tries to account for as much intellectual capital as possible, with more or less success depending on state regulation. Therefore, several studies and models have been developed that approach the value of intellectual capital from different perspectives (Stewart, 1991; Kaplan & Norton, 1996; Edvinsson, 1997; Sveiby, 1997; Pulic, 2004).

Intellectual capital has had various definitions, and each of them have had differing views. However, all of these studies agree that the recognition and continuous measurement of intellectual capital is difficult regarding these unique goods. Intellectual capital can be divided into three groups: human capital, structural capital, and relational capital.

In each group's case, the accounting system's goal is to account for most of these goods using various methods of measuring intellectual capital. In this way, some parts of invisible assets will become visible in accounting.

Although intellectual capital is difficult to measure, several researchers have developed a model to do so. One tool developed is the value added intellectual coefficient (VAIC) model used in many studies to measure intellectual capital. At the same time, this tool has some critics. One such critic was Bakhsha et al. (2017), who suggested that the model is not suitable for measuring intellectual capital. They believe that the model classifies total employee costs as human capital, not representing total human capital.

Furthermore, the opposite effect of human and structural capital can lead to a distortion of earnings. Andriessen (2004) stated that there is a problem with the principles of the model, which can lead to difficult-to-interpret results. Stahle et al. (2011) noted that VAIC can measure the efficiency of a company's labour and capital investments, and cannot measure intellectual capital well. The main reason for the lack of consistency in VAIC results lies in the confusion of capitalised and cash flow entities in the structural capital calculation.

At the same time, several studies have shown that the VAIC ratio and its components are one of the most favourable methods to measure corporate performance (corporate efficiency). Therefore, many researchers have considered this model to be suitable for measuring and determining the impact of intellectual capital on corporate performance, such as Chen et al. (2005), Kamath (2008), Zeghal and Maaloul (2010), and Ermawati et al. (2017).

The VAIC calculation is based on value added, and it is a measurement tool to reveal employees' and management's contribution to value creation. Using value added can determine how employees contribute to increasing wealth. Higher added value can ensure higher dividends for owners and higher investments for further developments. As a measurement tool, value added unifies all economic activity of participants considering one goal: to create the highest possible corporate value. The calculation of VAIC and its components is based on corporate value added. This method is easy to use because it uses publicly available data (financial statements).

The primary goal of this research is to measure the corporate performance of companies using VAIC in the pharmaceutical industry in countries in the Visegrad Group (Czech Republic, Hungary, Poland, and Slovakia), taking into account the opinion of Stahle et al. (2011). In the case of pharmaceutical companies, intangible assets and intellectual capital play a major role. Some intellectual capital can be capitalised under accounting regulations and recognised as an intangible asset (Sveiby, 1997), such as R&D that can be recognised as intangibles (IASB, 2020), yet other parts of the business are embedded as hidden capital. This research looks seeks to answer whether there are statistically significant differences among Visegrad countries considering intellectual capital efficiency (ICE) and corporate performance. The analysis applies several statistical methods for these examinations, using the packages of the R statistical system.

Several researchers have examined the effectiveness of intellectual capital and its impact on financial performance regarding companies in the pharmaceutical industry. In a study of Indian pharmaceutical companies by Smriti and Das (2017), VAIC had a significant positive correlation with return on assets (ROA). Zhang et al. (2021) found that VAIC and human capital efficiency (HCE) impact both ROA and return on equity (ROE) in terms of pharmaceutical companies in Vietnam. Chizari et al. (2016) found that VAIC had a significant impact on market performance variables of pharmaceutical companies in the Tehran Stock Exchange, and HCE and capital employed efficiency (CEE) had the greatest impact on the market.

The research hypotheses of this study are as follows:

H1: The countries examined differ statistically significantly in the VAIC ratio components.

H2: Companies differ statistically significantly within a country's ICE and VAIC ratios.

H3: There is a correlation between VAIC and its components and the selected profitability indicators.

H4: Relationships can be determined between value-added intellectual coefficients and companies' profitability ratios in the countries investigated.

This study examines a particular aspect of the pharmaceutical industry's performance in four countries with a very similar historical past that are still economically intertwined. No such comparative study has yet been carried out regarding the countries examined.

2. The concept and measurement of intellectual capital

2.1 The concept of intellectual capital

Intellectual capital is understood as the difference between a company's market value and book value. The book value of the market value is equal to the value of the company's equity. So, the difference between the two values is the "invisible value" recognised by the market, but only a part of it is shown in the balance sheet. Therefore, even though this does not appear in accounting, it can create significant value. The definition and adequate management of intellectual capital are essential because they make it easier to manage. Over the years, many authors have tried to define intellectual capital, and they all agree that it bears great value despite its rather difficult determination.

The following five authors defined intellectual capital in a very similar way. They all identified intellectual capital as an intangible, non-material, or non-financial asset that plays a role at a company in the generation of new value by participating in the production and sale of services or products (Brooking, 1996; Al-Ali, 2003; Kaufmann & Schneider, 2004; Wiederhold, 2014).

According to many authors, intellectual capital consists of three elements:

- human capital,
- relational capital,
- and structural capital (Saint-Onge, 1996; Edvinsson, 1997; Stewart, 1997).

Human capital includes the knowledge, skills, competence, and professional experience of employees. Human capital is "owned" by employees, and they "lend" their knowledge to the company. Structural capital includes the company's innovation capabilities, organisational structure, culture, and processes. Employees create these elements too, but the company owns them. Even if employees leave a company, these elements remain at the company. Relational capital means the network of contacts with customers and suppliers and their quality. Relational capital includes the company's business relationships with individuals and organisations. This value results from the resources invested in human and organisational knowledge.

In 1978, 80% of companies' assets were tangibles, and only 20% were intangibles. However, this changed entirely by the end of 1998, when companies had 80% intangibles and only 20% tangibles. The reason for this is that knowledge and information have become the driving force of society. As a result, companies have more and more knowledge, and their concepts change as they know more about the world around them (Sullivan & Sullivan, 2000).

Al-Ali (2003) stated that today's companies are using not only bricks but also intangibles to achieve their profits. Therefore, managing these assets is essential for companies' survival and long-term growth. Indeed, Central-Eastern European countries do not attach appropriate importance to this factor. Still, there is an increasing emphasis on its management to produce a clear picture of its intellectual capital and exploit its benefit (Kuzkin et al., 2019).

2.2 Methods for measuring intellectual capital

Why is it important to be aware of the value of a company's intellectual capital? Turner and Jackson-Cox (2002) declared three main reasons. First and foremost, companies should spend a significant amount of money improving their employees' skills and utilising their knowledge and work. This knowledge can also facilitate intellectual capital management. Lastly, this allows companies to monitor performance and improve its efficiency.

There is a need for models that evaluate corporate intellectual capital in intelligent, numerical, and comparable ways. This approach can solve many problems. At the same time, it is essential to keep in mind that intellectual capital's meaning can differ at the organisational and geographical levels (Tovstiga & Tulugurova, 2009; Andreeva et al., 2021).

Sveiby (2001) collected the following methods of measuring intellectual capital, which were categorised into four groups:

1. Based on the ROA ratio: first, the company's average pre-tax profits are calculated for several years. These values are divided by the average values of the tangible assets of the same period. Finally, the results (ROAs) are compared with the industry average and the difference is determined. If the difference is positive, the organisation has strategically important, unique intellectual capital in the industry.
2. Market Capitalisation Methods (MCM): intellectual capital is the difference between market value and book value.
3. Direct Intellectual Capital (DIC) measurement: intellectual capital is broken down into components, and the individual parts are evaluated separately in financial terms.

4. Scorecard type methods (SC): different ratios are determined to describe intellectual property and its change. The characteristic of these models is that assessing financial value is not a primary purpose.

These measurement methods provide different advantages. *Organisational-level financial measurement methods* – ROA and MCM – are primarily used to make fusion and stock market decisions. Furthermore, management can pay more attention by comparing companies within the same sector. Their disadvantages are that they only estimate capital and intellectual capital as a whole, and do not help owners to assess which part of the total capital they should manage. In addition, they may be inaccurate in converting different values into money. The problem with ROA methods is that they are sensitive to interest rates or discount rates. Scorecard methods shift the focus away from the components that compose a company's wealth and its effects.

The most common measurement method is market value and book value difference. However, it has been noticeable over the years that the market value of shares on stock exchanges has been valued higher than their book value. Many things can explain added value, but it has been concluded that intellectual capital could explain a large part of added value.

Market value can be calculated in two ways. First, multiplying the number of ordinary shares by the current exchange rate in listed companies gives market capitalisation value. Another method for unlisted companies is to sum the company's present values of expected future cash flows (Juhász, 2004; Lőre, 2011). However, calculating this value can cause inaccurate results, as the historical cost of tangibles or taxes can significantly affect the book value.

EVA (Economic Value Added) is based on a simple logical concept that has no direct aim of evaluating intellectual capital, but rather of measuring a company's value creation. EVA can be calculated using a relatively simple formula:

$$EVA = (ROIC - WACC) * CE \tag{1}$$

where

ROIC is the return on invested capital,

WACC is the weighted average cost of capital,

and CE is the amount of capital employed.

MVA (Market Value Added) is also derived from the economic profit concept, which is the difference between the company's market value and the capital entrusted to the company by lenders and shareholders. It follows that its intrinsic value is much more than the sum of its equity and debts. If this value is positive, the company can increase its capital; if it is negative, it reduces it.

$$MVA = \text{market value of debt} + \text{market value of equity} - \text{total assets} \tag{2}$$

In another approach, MVA is the sum of the present values of expected future EVA values.

Baruch Lev's model is based on the fact that the company's economic activity is determined by three factors: financial, physical, and intangible assets. Therefore, this method divides the profit realised by the company among the assets which generated it. Namely, this method divides the annual profit among physical, financial, and intangible assets (Daum, 2001).

This method deducts the average profit of tangible and financial assets from normalised profits. The income retained in this way shows the contribution of intangible assets to corporate profits, as illustrated in Figure 1. Intangible capital is determined by calculating the present value of the future income stream generated by intangible assets (Daum, 2001).

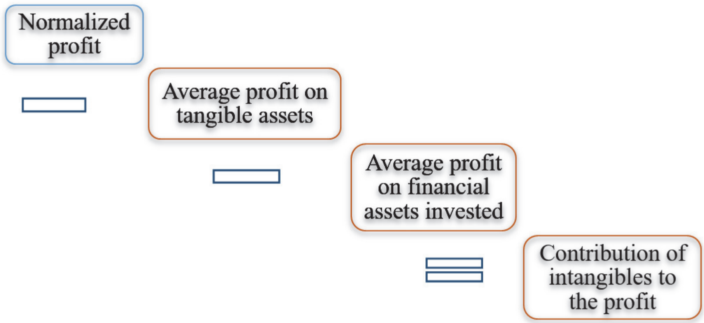

Figure 1: *Determining Baruch Lev's knowledge capital return*
Source: own editing based on Tarnóczi and Fenyves (2010)

Future earnings can be estimated using the average growth rate. For a given year, the normalised profit is equal to the average of the previous year's normalised profit adjusted by the inflation rate and the profit after tax for the current year. The yields were calculated using an estimated expected yield rate. The profit generated by intangible assets is the difference between normalised profit and the profits on tangible and financial assets (Tarnóczi & Fenyves, 2010). This calculation requires the requested yields on tangible and financial assets.

First, the intangibles' contribution is determined by estimating the rate of return on physical and financial assets and deducting them from corporate profits (the product of the expected rates of return of the financial and tangible assets and their actual values). Then, the value of intellectual capital is determined by dividing profit on intangibles by the expected rate of return.

The VAIC method was developed by Alan Pulic, and its purpose is to measure the effectiveness of a company's essential resources. Pulic (2000) stated that traditional accounting focuses on cost control, but, presently, there should be a focus on value creation and management. Indicators measuring conventional business success, such as income, cash flow, profit, and market share, disregard a company's value creation for shareholders and owners.

As value creation is a new condition for success, intellectual resources have become the leading investment area. The value-creating process depends on the efficiency of tangibles and intangibles to no small extent. The quality of customer relationships and the ability to invest in human resources influence the amount of profit. VAIC is an efficiency indicator that measures the efficiency of the company's key assets, considering the requirements of a modern economy.

VAIC is calculated based on the added value associated with intellectual capital. The VAIC indicator has three components: HCE, structural capital efficiency (SCE), and CEE. The detailed calculation of the VAIC ratio is presented in the next chapter.

Considering the research aim and the previous studies assessed during the processing of the literature, the following hypotheses were established:

H1: The countries examined differ statistically significantly in the VAIC ratio components.

H2: Companies differ statistically significantly within a country's ICE and VAIC ratios.

H3: There is a correlation between VAIC and its components and the selected profitability indicators.

H4: Relationships can be determined between value-added intellectual coefficients and companies' profitability ratios in the countries investigated.

3. Data and methodology

3.1 Database for analysis

This research aimed to measure intellectual capital using the VAIC model in selected companies within the Visegrad group (Czech Republic, Hungary, Poland, and Slovakia). Companies were chosen from the pharmaceutical industry, and were selected based on revenues in 2019. Only companies with revenues of more than 1,000,000 Euro were included in the research. Analysis was performed using the public data of 211 companies. The distribution of selected companies is shown in Table 1.

The data used for the analysis were downloaded from the EMIS database (Market Research Database – emis.com) for 2016–2019. The companies' balance sheets and income statements were used for the analysis. The value of VAIC components and the VAIC ratio were calculated for all companies, years, and essential statistical characteristics. These fundamental statistical indicators can help form a broader picture of the countries investigated. The simple (ANOVA) analysis of variance was used to compare the countries. The *t*-test was used to provide a pair-wise comparison. This analysis also examined how VAIC and its components changed over the years studied. Finally, analyses were carried out to determine differences in companies' intellectual capital between countries.

Table 1: The number of companies examined by country

Countries	Number of companies
Czech Republic	33
Hungary	55
Poland	105
Slovakia	17

Source: *compiled by the authors based on their analysis*

The VAIC method facilitates the measure of IC and its components, and is regarded as an objective and transparent method because the data used for the calculations are derived directly from financial statements. Despite some limitations, VAIC can be successfully used for economic analysis. The limitations of the analysis include the fact that a different number of companies operate in the analysed sector in different Visegrad countries, and a significant proportion of the total sample of Slovakian companies (with the smallest sample size) contained outliers, which distorted the values of the regression coefficients. In both business practice and in research, this method can be used to report intellectual capital synthetically and to measure intangible assets.

3.2 Determination of VAIC

Pulic developed the VAIC method to determine the effectiveness of intellectual capital (Svanadze & Kowalewska, 2015). According to Pulic (2004), companies invest in two essential resources in the 21st century: traditional resources (tangible and financial) and intellectual capital. Edvinsson and Malone (1997) divided intellectual capital into human capital and structural capital. According to Jarboe (2007), human capital comprises workers' experiences, skills, and the abilities that workers take with them when they leave the company. Structural capital can include the processes, organisational culture and routines, strategies, information systems, and procedures that operate at a company (Boisot, 2002; Ordonez de Pablos, 2004). Structural capital remains with the company even after workers leave (Jarboe, 2007).

Pulic (2000) describes the VAIC model in 5 steps:

1. Value Added (VA)

Value added is equal to the difference between inputs and outputs. Outputs are sales revenue, while inputs are costs incurred to generate revenue – except for human capital and depreciation expenses. Calculating value added can start from operating profit, and gives the same results if we add employee costs and depreciation/amortisation expenses to operating profit (Fijalkowska, 2014). Value added is generated by working capital, human capital, and structural capital (Pulic, 2000).

2. CEE

This ratio shows how much added value has been invested in unit capital investment, and can be calculated as the ratio of value added to capital employed (CE):

$$CEE = \frac{VA}{CE} \tag{3}$$

3. HCE

This ratio can be used to determine what added value is associated with investing in one unit of human capital. The ratio considers employee costs (EC) as human capital, thus determining the efficiency of human capital.

$$HCE = \frac{VA}{EC} \tag{4}$$

4. SCE

According to Edvinsson (1997), intellectual capital is the sum of human capital and structural capital (SC). Pulic (2000) defined structural capital as the difference between human capital and value added. Human capital and structural capital are complementary; if less human capital is involved in value creation, it is necessary to apply more structural capital. Therefore, the calculation of the SCE ratio reflects this complementary nature:

$$SCE = \frac{SC}{VA} \tag{5}$$

5. VAIC calculation

The final step is to determine VAIC, which summarises the effectiveness of capital employed and intellectual capital (human capital and structural capital):

$$VAIC = CEE + HCE + SCE \tag{6}$$

An advantage of this indicator is that it is additive. A higher value means more efficiency, which shows the added value created by intellectual capital.

3.3 Regression with panel data

In the countries examined, multiannual, cross-sectional (companies), and time-series (years) company data was available. Multicollinearity and heteroscedasticity are the most common problems of cross-sectional data with linear regression analysis. Moreover, autocorrelation can cause time-series data problems (Sheather, 2009). Given the above, it was decided to use the panel regression model. According to Baltagi et al. (2013), the panel model allows controlling individual heterogeneity, utilising more significant variability for more exact estimation, determining effects that cannot be identified from cross-section data, and enhancing measurement precision. Croissant and Millo (2019) remarked that the panel model technique should answer a broad problem from a statistical modelling aspect: unobserved heterogeneity, the supervision of unobserved variables, and possible estimation bias. They used the R statistical system to present panel models. Using panel models is very widespread in social science research, and many examples of using the method can be found in the conference volume edited by Tsounis and Vlachvei (2018).

The panel model was applied to analyse VAIC in several cases to determine the relations between its components and profitability ratios. Tiwari and Vidyarthi (2018) used the fixed-effect panel model to measure the impact of intellectual capital on Indian banks' performance. They used the size and leverage of the banks and the interaction of intellectual capital components as independent variables. ROA and ROE were used to measure bank performance, and 3–3 models were created for both.

Tran and Vo (2018) used the panel model's fixed and random effect methods to analyse the Thai banking sector. They created four models that included value-added intellectual coefficients and components alongside three other banking ratios: credit risk, liquidity, and size.

Nadeem et al. (2017) applied the panel regression model to examine whether ICE affects the performance of companies in BRICS countries.

Using panel regression models, Yao et al. (2019) examined the relationship between intellectual capital and profitability for 111 Pakistani financial institutions in 2007–2018.

ROA, net operating margin (NOM), and assets turnover (ATO) were used as dependent variables. In addition to the indicators used to measure intellectual capital, size, leverage, organisation age, revenue diversifications, operational efficiency, economic growth, and financial crisis were used as independent variables.

Haris et al. (2019) examined the impact of intellectual capital on Pakistani banks' profitability. They also used a panel model to apply corporate governance, bank-specific, industry-specific, and country-specific variables.

The panel model enables the determination of heterogeneity across the distribution of the dataset, and identifies essential relationships among datasets and their determinants that may not be apparent, focusing on average effects. In contrast with the linear regression methods, which use conditional mean restrictions, panel models enable different features of data distributions to be analysed while accounting for possible unobserved heterogeneity (Kato et al., 2012). The panel model can describe the entire conditional distribution of the output variables, be more robust regarding outliers and mis-definition of error distribution, and provide more extensive statistical modelling than the conventional mean-based regression method (Huang et al., 2017).

4. Results and discussion

VAIC was determined for the companies examined in the Visegrad group countries by applying the 5-step model. This calculation was based on the descriptions in section 3.2.

Analysis of variance (ANOVA) was performed to test any statistically significant differences between years. The ANOVA results showed no significant differences among years (Table 3), so the yearly averages can be used for further calculations.

Table 1. *P*-values (%) of ANOVA, analysing the differences among companies by year

Countries	HCE	SCE	ICE	CEE	VAIC
Czech Republic	93.0215	93.6876	85.0632	93.4981	83.3989
Hungary	83.5336	23.9051	79.3534	66.1896	67.1941
Poland	60.1931	77.0384	99.8730	60.3087	63.3837
Slovakia	96.7445	98.4467	89.8196	96.8925	94.9556

Source: *compiled by the authors based on their analysis*

4.1. Analysis of VAIC components by country

Table 2 shows the average VAIC values and their components by country and year for the companies examined in the pharmaceutical industry.

Multivariate analysis of variance (MANOVA) was used to analyse companies by country in the countries studied. The variables in this calculation were HCE, SCE, and CEE. This method used the Pillai test to determine the significance level of differences. The results of this analysis are shown in Table 3, with a significance level of greater than 5%. This value means that the countries do not differ statistically significantly when the three variables are considered together. When the multivariate analysis of variance does not show a statistically significant difference, it makes little sense to analyse variance by variable.

However, it should also be noted that there may still be differences between countries, but these differences cannot be considered statistically significant. The differences between countries for the three indicators (HCE, SCE, CEE) are shown in Table 2 and Figures 2–4.

Table 2. *The average values of VAIC and its components in the examined companies in the pharmaceutical industry by country and year*

Countries	Years	HCE	SCE	ICE	CEE	VAIC
Czech Republic	2017	1.670	0.337	2.008	0.604	2.611
	2018	1.663	0.346	2.009	0.676	2.685
	2019	1.718	0.354	2.073	0.663	2.736
	Yearly averages	1.684	0.346	2.030	0.648	2.677
Hungary	2017	2.155	0.486	2.641	0.508	3.150
	2018	2.048	0.392	2.440	0.555	2.995
	2019	1.986	0.366	2.352	0.497	2.849
	Yearly averages	2.063	0.415	2.478	0.520	2.998
Poland	2017	2.108	0.395	2.503	0.642	3.145
	2018	1.906	0.327	2.233	0.642	2.875
	2019	1.802	0.357	2.159	0.638	2.797
	Yearly averages	1.939	0.360	2.298	0.640	2.939
Slovakia	2017	2.671	0.475	3.146	0.622	3.767
	2018	2.663	0.481	3.143	0.615	3.758
	2019	2.482	0.467	2.948	0.561	3.509
	Yearly averages	2.605	0.474	3.079	0.599	3.678

Source: *compiled by the authors based on their analysis*

Table 3. *The results of MANOVA comparing VAIC components by country*

Factor of MANOVA	*Df*	Pillai-test	Approx. of *F*-test	*Df* of num.	*Df* of denom.	Pr (>*F*)
Country code	1	0.0135	1.8015	3	395	0.1463
Residuals	397					

Source: *compiled by the authors based on their analysis*

Pair-wised comparison was also used to examined whether there was a statistically significant difference between companies in these countries. The results of the pair-wise *t*-test are shown in Table 4. These results are separately evaluated per indicator in the following parts of this chapter.

HCE shows the amount of added value that can be created for a company with one unit of human capital. Since human capital is reflected in employee costs, the average expense of the labour force in the examined sector of a country and its relevant labour code affect the efficiency ratio. Therefore, the higher the cost of employees, the lower this ratio will be. Figure 2 shows the development of the HCE of analysed companies split by years and by country.

Table 4. *Yearly averages of VAIC components by countries and p-values (%) of pair-wise t-test comparing country averages*

Statistical indicators	Countries	HCE	SCE	CEE
Mean value of ratio in	Czech Republic	1.684	0.346	0.648
	Hungary	2.063	0.415	0.520
	Poland	1.939	0.360	0.640
	Slovakia	2.605	0.474	0.599
P-values of *t*-test sign. level comparing	The Czech Republic and Hungary	7%	14%	7%
	The Czech Republic and Poland	24%	80%	30%
	The Czech Republic and Slovakia	14%	5%	12%
	Hungary and Poland	63%	31%	55%
	Hungary and Slovakia	38%	36%	37%
	Poland and Slovakia	29%	11%	26%

Source: *compiled by the authors based on their analysis*

Based on Table 2 and Figure 2, it can be concluded that Czech companies performed worst in terms of the HCE indicator, but only in this case can an increase be observed during the three years examined. It can also be stated that, on average, Slovak companies performed best in all three years examined. At the same time, the performance of Slovak companies shows a declining trend. The indicators of the companies of the other three countries approached each other at the end of the period. However, Table 4 shows that a statistically significant difference can only be established between the Czech Republic and Hungary at the 7% significance level with this indicator, which is only acceptable if the significance level requirement is reduced to 10%.

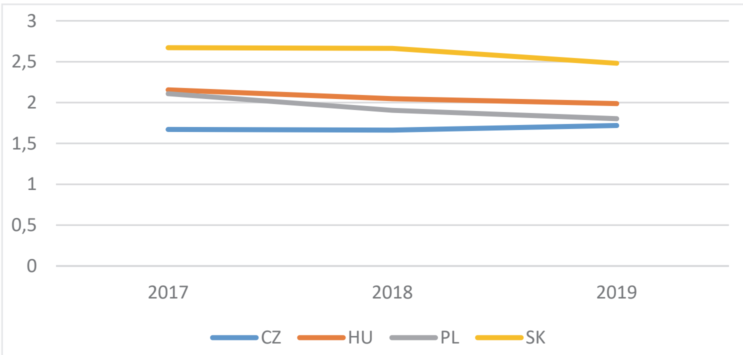

Figure 2. *The average HCE ratio values of the analysed companies*

Source: *compiled by the authors based on their analysis*

The average hourly labour costs in the Visigrad countries in 2020 are shown in Table 5 (The average hourly labour cost in the EU in 2020 was 28.5 EUR). Slovak companies are likely to outperform the HCE indicator because of the country's relatively high average hourly labour cost. Contrary to this, the Czech Republic has a 5% higher hourly wage cost, yet it is the worst-performing among the four countries. Therefore, it is likely that, besides the costs of labour, its use may also play a role in efficiency.

Table 5. *Average hourly labour cost in countries examined (in EUR)*

Country	Average hourly labour cost	100% = Czech Republic	100% = EU average
Czech Republic	14.1	100%	49%
Slovakia	13.4	95%	47%
Poland	11.0	78%	39%
Hungary	9.9	70%	35%

Source: *compiled by the authors based on https://www.statista.com/statistics/1211601/hourly-labor-cost-in-europe/*

The next component of ICE is SCE. Since structural capital and human capital are complementary (Edvinsson, 1997; Pulic, 2000), the ratio will be in terms of structural capital to value added. Thus, structural capital is the difference between value-added and human capital. The SCE values of the examined companies are presented in Figure 3.

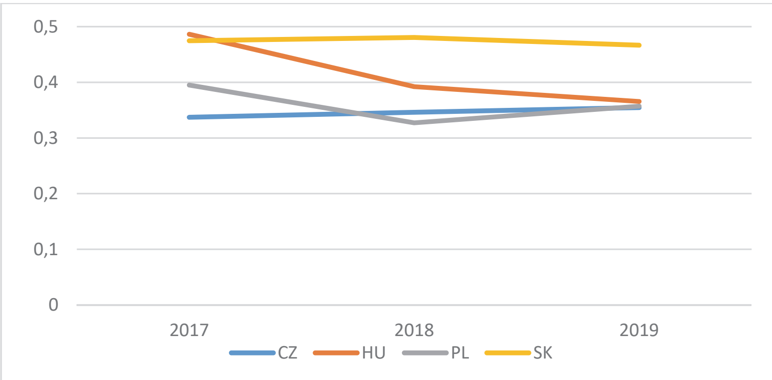

Figure 3. *The average SCE values of the analysed companies*

Source: *compiled by the authors based on their analysis*

According to SCE, Hungarian companies occupied first place in 2017, but a decrease was evident in 2018 and 2019. In the average positions of all three years, Slovak companies occupied first place, followed by Hungarian companies. Polish companies occupied third place, with Czech companies in last. The performance of Hungarian and Polish companies decreased in 2018, and their SCE ratios were almost identical in 2019. Slovak companies' SCE ratio was 30.67% higher than the ratios of the other three countries' companies in 2019. HCE ratios followed the same tendencies, since the Slovakian companies had a 26.28% higher HCE ratio value than second-rank Hungary did in terms of yearly average. Although companies in Hungary had a 44.25% higher SCE in 2017 than the Czech companies, their value was almost the same in 2019.

In the ranking of yearly SCE averages, it can be observed that companies in Slovakia had the highest ratio values, followed by Hungarian companies with a 0.415 value. Polish companies occupied third place, and the lowest SCE was found in Czech companies. As such, the ranking remained the same as HCE ratios.

With pair-wise *t*-test comparisons (Table 4), only companies in the Czech Republic and Slovakia showed a statistically significant difference at the significance level of at least 5%, which is reflected in the average values in Table 4 and in the previously discussed analysis

The CEE ratios are shown in Figure 4. According to Pulic (2004), the CEE ratio shows how physical and financial assets create value added for the company. Czech companies achieved the highest CEE ratio in 2019 compared to other examined countries. Therefore, Czech companies, with a lower CEE ratio, created more value added. Table 2 shows that Polish companies closely followed Czech companies with a difference of only 0.007 units. Slovak companies occupied third place, with Hungarian companies in last. Czech companies had a 24.53% higher CEE ratio than Hungarian companies.

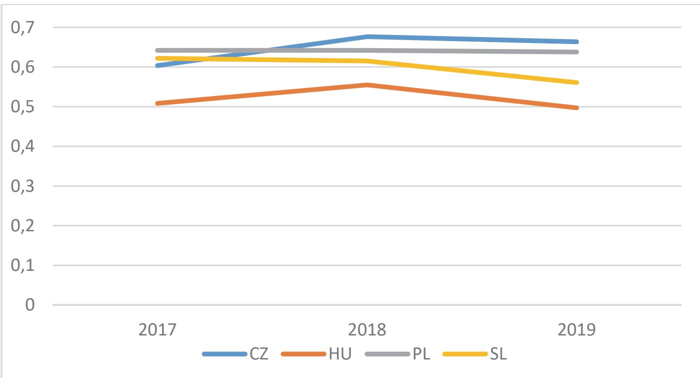

Figure 4. *The average CEE values of the analysed companies*

Source: *compiled by the authors based on their analysis*

Based on Table 4, it can be stated that there was only a statistically significant difference between the Czech Republic and Hungary, but only at a significance level of 7% in the case of CEE. Therefore, there was the same significance level between the CEE of the two countries as there was with HCE, but whereas the latter was in favour of Hungary, the former was in favour of the Czech Republic.

Overall, there were no statistically significant differences between the investigated countries in terms of VAIC components. Consequently, H1 is rejected; i.e., the countries examined did not differ statistically significantly in the components of VAIC.

4.2. Analysis of ICE and VAIC by country

For the ICE and VAIC indicators, the pair-wise comparisons of the countries examined were also performed using the *t*-test, as shown in Table 6. This table shows that there was also no statistically significant difference between the countries according to the two ratios.

ICE is the sum of the HCE and SCE ratios; therefore, the ICE ratio most likely shows the same ranking as the VAIC components. Furthermore, as the companies of the examined countries were ranked in almost the same order in both years, a similar ranking was expected for this ratio. The above is also supported by the values in Tables 2 and 4, as shown in Figure 5.

Even though the Czech companies had the lowest average ICE during the examined period among countries investigated, they had the highest average CEE ratio. In the case of Slovak companies, the opposite trend can be observed: they had the highest ICE ratio, but the lowest CEE ratio. However, by looking into the yearly averages, it can be observed that Slovak companies had a 51.70% higher ICE ratio than Czech companies, who ranked last.

Table 6. *Yearly averages of VAIC and ICE by countries and* **p***-values (%) of pair-wise* **t***-test, comparing country averages*

Statistical indicators	Countries	ICE	VAIC
Mean value of ratio in	Czech Republic	2,030	2,677
	Hungary	2,478	2,998
	Poland	2,298	2,939
	Slovakia	3,079	3,678
P-values of *t*-test sign. level comparing	The Czech Republic and Hungary	25%	20%
	The Czech Republic and Poland	95%	32%
	The Czech Republic and Slovakia	72%	14%
	Hungary and Poland	15%	85%
	Hungary and Slovakia	50%	32%
	Poland and Slovakia	73%	29%

Source: *compiled by the authors based on their analysis*

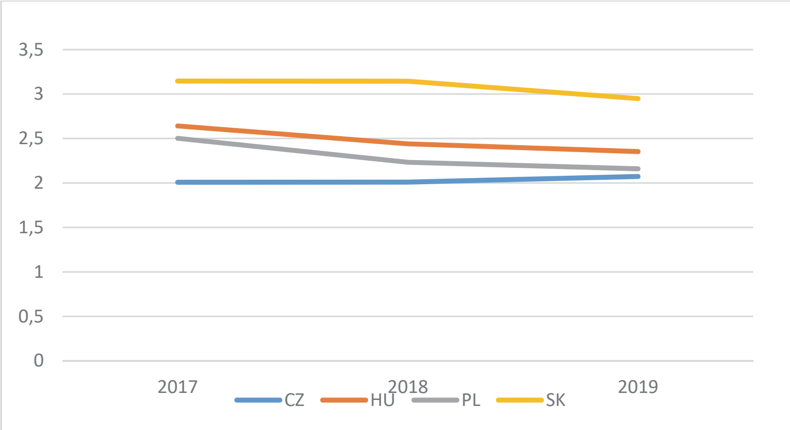

Figure 5. *The average ICE values of the analysed companies*
Source: *compiled by the authors based on their analysis*

The VAIC ratio calculation was the last step in the VAIC analysis. The results of this are provided in Table 2, and the development of values per year is shown in Figure 6. Slovak companies achieved a 22.69% higher VAIC than Hungarian ones, which ranked in second place. Some improvement can be seen with Czech companies, as there were increases in their yearly values. The companies of the other examined countries either had values that decreased or stagnated. The values of all the results were higher than 2.50, but lower than 4.00. In 2017, Slovak companies achieved a 44.28% higher VAIC ratio than the lowest value in that year. Polish and Hungarian companies had almost the same average values considering the VAIC ratios. A higher value added alongside low labour costs and low value of capital employed can provide reason for the high value of the VAIC ratio.

Based on the calculations for ICE and VAIC, H2 was rejected because there was not a statistically significant difference between the countries' ICE and VAIC ratios.

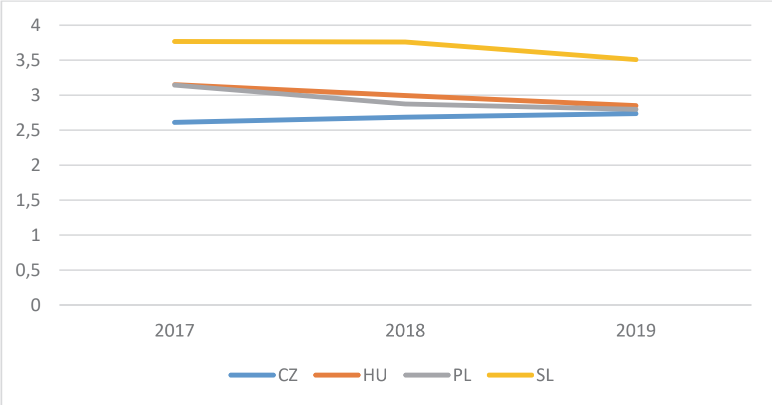

Figure 6. *The average VAIC values of the analysed companies*
Source: *compiled by the authors based on their analysis*

4.3. Correlation analysis on VAIC and its components with profitability ratios

Operating ROS and operating ROA were used for profitability indicators because the countries' performance is more comparable when using these indicators as they do not include differences in debt costs and taxes per country.

First, the correlation coefficients were calculated, measuring the linear relationship between the profitability ratios and the VAIC and its components. The results of the correlation calculation can be seen in Table 7.

Table 7. *Correlation between the profitability ratios and the VAIC and its components*

Profitability ratios	Ratios of Pulic's model				
	HCE	SCE	CEE	ICE	VAIC
ROA	0.5541	0.4110	0.2493	0.5724	0.6239
OROS	0.5047	0.3733	0.0383	0.5212	0.5152
OROA	0.5533	0.4206	0.3206	0.5738	0.6451

OROS – Operating Return on Sales, OROA – Operating Return on Assets
Source: *compiled by the authors based on their analysis*

In terms of HCE, there is a medium, positive, linear relationship with ROA, OROS, and OROA. However, it can also be seen that there is no significant difference in the relationship between HCE and the profitability indicators examined. In the case of SCE, the correlation with profitability ratios was less than 0.5 in all cases. However, a weak, medium, positive correlation with ROA, OROS, and OROA can be observed. The weakest correlation coefficients can be seen in terms of CEE.

By examining ICE, a medium, positive correlation between ICE and ROA, OROS, and OROA can be observed, which is evident as ICE is the sum of HCE and SCE. The last results are the correlation between VAIC and profitability ratios. The correlation between VAIC, ROA, and OROA is a moderate, almost strong, positive correlation. The strongest correlation can be found between profitability indicators and VAIC.

The values in Table 7 show a correlation between VAIC and its components and the selected profitability indicators. Accordingly, H3 is accepted because the correlation coefficients exceed 0.3 in all cases, except CCE. As the standard deviation of the data is generally high for economic data, a value above 0.3 is already considered acceptable.

4.3. Regression analysis of VAIC and its components with profitability ratios

The significance test for correlation coefficients was greater than 5% in 1 case: OROS – CEE (46.02%). In all other cases, the significance level was less than 0.1%.

Because the correlation calculation showed a relationship between profitability indicators and VAIC and its components, a panel regression was performed to determine the extent of the relationship. In panel models, the dependent variables were OROS, OROA, and ROA, and the independent variables were HCE, SCE, and the CEE. These results can be seen in Table 8. Both fixed and random effect panel models were calculated, but the Hausmann test found the random effect model to be higher quality, so it was used in the calculations.

Table 8: *Panel data regression results*

Dep. var.	Indep. variables	Czech Republic		Hungary		Poland		Slovakia	
		Regr. coeff.	Sign. level	Regr. coeff.	Sign. level	Regr. coeff.	Sign. level	Regr. coeff.	Sign. level
Operating ROS	Intercept	–0.0675	-	–0.0639	*	0.0043	-	–0.1358	**
	HCE	0.0721	-	0.0756	***	0.0430	***	0.0087	-
	SCE	0.0730	-	–0.0302	-	0.0403	***	0.4329	***
	CEE	–0.0029	-	0.0373	-	–0.0036	-	0.0511	-
	R^2	0.0496		0.4391		0.5347		0.6597	
	Adj. R^2	0.0165		0.4253		0.5223			
Operating ROA	Intercept	–0.0569	-	–0.0977	***	–0.0545	**	–0.1626	***
	HCE	0.0275	-	0.0444	***	0.0699	***	0.0221	*
	SCE	0.1877	-	0.0397	*	0.0436	**	0.3406	***
	CEE	0.0422	-	0.1829	***	0.0414	*	0.1291	***
	R^2	0.0882		0.5978		0.6833		0.6952	
	Adj. R^2	0.0564		0.5880		0.6748			

Dep. var.	Indep. variables	Czech Republic		Hungary		Poland		Slovakia	
		Regr. coeff.	Sign. level	Regr. coeff.	Sign. level	Regr. coeff.	Sign. level	Regr. coeff.	Sign. level
ROA	Intercept	−0.0586	-	−0.0672	***	−0.0383	*	−0.1532	***
	HCE	0.0204	-	0.0419	***	0.0609	***	0.0172	.
	SCE	0.1736	-	0.0262	-	0.0461	**	0.2950	***
	CEE	0.0352	-	0.1209	***	0.0039	-	0.1142	**
	R^2	0.0734		0.4959		0.5920		0.6515	
	Adj. R^2	0.0411		0.4835		0.5812			

Source: *own editing based on calculated data*

The regression coefficients describe the impact of dependent variables on the independent variables. The signs of regression coefficients show the direction of the effects of the independent variables. There were no significant regression coefficients for the Czech Republic alone in the three panel models. Table 6 also shows that the coefficients of determination (R^2) for the Czech Republic were less than 0.1 for all three models, so the profitability ratios examined cannot be explained by independent variables. For the panel models of the other three countries, there were at least one or two significant regression coefficients per model, and the coefficient of determination also exceeded 0.4 in the worst case. Except for the Czech Republic, the second model shows the best relationships, where the operational ROA is the dependent variable. All explanatory variables and the intercepts were significant, at least at the 5% significance level. In the second model, except for the Czech Republic, the corrected coefficient of determination was acceptable (between 0.5880 and 0.6748), which can be considered suitable for economic data.

Based on the results in Table 6, it can be concluded that a fairly strong relationship can be detected between the operating ROA and the VAIC components, and that the components of the VAIC impact the operating ROA. However, the previous finding is not valid for the Czech Republic, where no relationship could be established between the profitability indicators and the VAIC components. This may be because of the high variance of Czech company data. On the contrary, in the case of Hungary, Poland, and Slovakia, the strongest relationship was found between the operating ROA and VAIC components. For these countries, the coefficient of determination was close to or above 0.6, which is suitable for economic data. Moreover, the coefficient of determination of 0.6 corresponds to a correlation coefficient of 0.7746, which already indicates a close correlation. In this case, the regression coefficients had a statistically significant value, with at least a 5% significance level.

However, the magnitude of these effects varies by country, and each explanatory variable positively impacts operating ROA. Table 6 table also shows that the intercept was negative for all three countries. It can also be stated that, in the case of Hungary, CEE had the greatest impact, while in Slovakia this was exerted by SCE. In Poland, the impact of the components of VAIC was not significantly different. The regression results also show that the effect of HCE was the largest in Poland and the smallest in Slovakia.

Based on the obtained results, H4 can only be partly accepted because, in the case of the Czech Republic, the effect of VAIC components on profitability indicators cannot be demonstrated.

Conclusion

Intangibles have always been a major challenge for investors, accounting professionals, and corporate evaluators. Accounting systems cannot account for all intangibles, so companies may have some items that are not included in the company's balance sheet. Most accounting systems try to present a company's assets at real value, but the invisibility of these goods can cause difficulties. Most investors want to know why the market and book value gap can create intellectual capital.

This study's primary aim was to examine whether the performance of pharmaceutical companies in the Visegrad countries differs statistically significantly in terms of VAIC. The second aim was to establish whether the components of the VAIC indicator impact the profitability indicators of companies. Pharmaceutical companies were selected because it is likely that intellectual capital may play a significant role in research and development in the case of these companies.

Based on the results and conclusions of this analysis, there are no statistically significant differences among the average values of the companies in the countries investigated. At the same time, there were some differences at the level of VAIC and its components in the analysed countries, but they were not statistically significant. The countries studied used to operate within the framework of the socialist system, after the overthrow of which they switched to a market economy. These countries have undergone significantly similar developments in recent decades. Likely, these similar development paths have not yet led to significant differences between them.

There is usually a medium correlation between the selected profitability indicators and VAIC and its components, which is acceptable for economic data. Because cross-sectional and time-series data are also included in the database, a panel model was selected to determine the extent to which the components of the VAIC indicator could influence the development of the values of the profitability indicators. Relationships can be determined between VAIC components (HCE, SCE, and CEE) and companies' profitability ratios in the case of three countries (Hungary, Poland, and Slovakia). Relationships cannot be determined between VAIC components and profitability ratios in companies in the Czech Republic. It can be stated that, except for the Czech Republic, the components of VAIC impact the development of operating profit.

Based on a study of the literature on the application of VAIC, it can be argued that this indicator is suitable for measuring corporate performance from a specific perspective. Furthermore, this indicator takes a more noteworthy account of intellectual capital's impact, but is not ideal for measuring it.

In the future, it would be useful to extend this analysis toward comparing the results obtained with other performance measures, which different parametric and non-parametric methods can determine. For example, a hierarchical panel model could be used to explore the complex effects of factors. In addition, these investigations could be extended to other countries.

The current research findings can be used in education, can help with further research, and can provide support to various decision-makers.

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