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ANALYSIS OF THE POTENTIAL OF THE VISEGRAD GROUP COUNTRIES IN SELECTED AREAS OF THEIR ACTIVITIES

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Purpose: The aim of this article was to assess the potential of the Visegrad Group countries in terms of conditions determining the readiness for cooperation between science, business, and administration sector.
Design/methodology/approach: The article uses qualitative and quantitative research methods. The article presents a review of Polish and foreign literature and an analysis of desk research based on public statistical data (Eurostat, OECD, The World Bank) covering 2017-2022. A statistical method in data mining was used to make statistical observations using diagrams called classification trees. To assess the countries' potential for readiness to develop cooperation, the Potential Index (PI) was calculated.
Findings: The influence of variables determining the level of countries' potential was selected and their classification was made.
Originality/value: The research results indicate a high degree of differentiation in the potential of the Visegrad Group countries and point out that it is an essential factor positively influencing their development.
Keywords: Visegrad group, potential level, gender pay gap, cooperation of science, business and administration, human resources in science and technology.
Category of the paper: research paper.

1. Introduction

The conditions for the functioning and development of modern enterprises are diverse and multidimensional, resulting from, among others, the ongoing globalization process, the dynamic development of ICT technologies, socio-cultural transformation, and changes in the methods of organizing and conducting resource management processes. The freedom of movement of human, material, financial and information capital that accompanies the globalization process significantly influences the transformation of the economic, socio-cultural, political, and legal spheres, contributing to the development of many countries worldwide.

Economic growth and technological progress cause specific consequences that should be considered and assessed from different perspectives. Wide possibilities of access to modern tools, devices, and technologies constitute a means of providing society with high comfort in work, living, and traveling (Motowidlak, 2017). In another approach, it is a consequence of civilization development, based, among others, on consumerism, is the deterioration of the natural environment, posing a threat to current and future generations (Kiełczewski, 2008). The increase in social awareness of the positive and negative consequences of economic development emphasizes the need to ensure consensus between the implementation of economic, social, and environmental goals.

The idea and principles of cooperation between actors of innovative processes in the context of society's expectations and the challenges of the modern economy are explained by various models, including the triple helix and quadruple helix models (Łącka, 2018). The concept of the Triple Helix model developed by L. Leydesdorff and H. Etzkowitz (2001) is a model of innovation covering the relationships occurring in the process of knowledge transfer between three separate environments - science, industry, and administration. The Triple Helix model is generated in the knowledge infrastructure in relation to overlapping institutional spheres, each of which plays its role and, at the same time, enters into relationships with other entities (Etzkowitz, Leydesdorff, 2000). The cooperation between the university and the business community is crucial. It influences the development of innovation, knowledge transfer, and the development of countries. On the other hand, the government plays a crucial role in developing financing policies and leveraging these relationships to increase capacity (de Lima Figueiredo, Fernandes, Abrantes, 2023).

Based on economic changes and the changing expectations of stakeholders, the quadruple helix model was proposed. The fourth element in this model is a civil society with a media and culture-based community (Carayannis, Campbell, 2012). The quadruple helix model draws attention to the fact that the science, business, and administration environment, while creating conditions for introducing innovations, should be open to broadly understood social needs. In other publications, some disputes can be found regarding the validity of creating a quadruple helix model because civil society is not an institutional sphere at the same level as universities, industry, or government (Cai, Lattu, 2022).

Based on socio-economic changes, the issue of social responsibility is increasingly and more strongly emphasized, meaning the responsibility an organization bears for the impact of its decisions and activities on society and the natural environment (Pfajfar, Shoham, Małecka, 2022). This responsibility is ensured by transparent and ethical behavior that contributes to sustainable development, considers stakeholder expectations, is consistent with applicable law, integrated with the organization's activities, and practiced in its relationships (Anam, Zygier, Saczuk, 2020).

Corporate social responsibility is implemented through various activities, both in the codification of legal provisions and practices used by individual organizations. It is believed that corporate social responsibility is the manufacturing sector's response to the challenges

posed by the principles of sustainable development (Gadomska-Lila, Wasilewicz. 2016). According to J. Adamczyk, sustainable development and corporate social responsibility were created as two independent concepts; however, in the implementation of the principles of social responsibility and sustainable development recommendations, there is a process of their diffusion. It is possible to observe the process of interpenetration of principles, goals, areas of implementation, instruments, and measures for assessing these two concepts (Adamczyk, 2017). Corporate social responsibility can be treated as a tool for implementing sustainable development (Płachciak, 2015).

2. Characteristics of the Visegrad Group (Group V4)

In the face of profound political and economic changes taking place in the early 1990s in the countries of the former communist bloc, an initiative was created to establish a forum for regional cooperation between Poland, Czechoslovakia, and Hungary. On 15th February 1991, the Visegrad Declaration was signed by the Presidents of the three countries, inaugurating the Visegrad Triangle (Kużelewska, Bartnicki, 2017). On 1st January 1993, as a result of the breakup of Czechoslovakia, the name was changed to the Visegrad Group (V4), bringing together four sovereign states: the Czech Republic, Poland, Slovakia and Hungary (Jankiewicz, Pietrzak, 2020). Member states initially initiated the V4 group to increase security and stability in the region (Braun, 2020). The factors positively influencing the development of cooperation within the Visegrad Triangle and then the Visegrad Group include similar potential and level of economic development of the member states, advancement of economic changes, universality of democratization processes, geographical proximity, common civilizational roots, similarity of the latest historical experiences, common priorities in foreign policy (Kupich, 1993/1994). Over several decades of operation, the Visegrad Group has proven its usefulness in influencing the decision-making process in the European Union, and the V4 format has become embedded in the political space and practice of the countries of the region and the opinion of Western politicians (Czyż, 2018).

The Visegrad Group countries have been an essential point on the map of Central and Eastern European countries for over thirty years (Grodzicki, 2023). The collapse of real socialism and the departure from the centrally planned economy initiated a number of profound changes in the Group V4 countries, resulting in new paths of social, political, and economic development. The economic and political transformation that took place after 1989 in Poland, the Czech Republic, Slovakia, and Hungary enabled the construction of democratic state structures, the creation of a free market economy, as well as an orientation towards increasing national security and European integration (Jasiecki, 2020).

The Visegrad Group countries are similar in many economic and social respects (Kochanek, 2021). This fact is influenced by the similar structure of the economies of the V4 countries and the historical and economic conditions of their cooperation and development. On the other hand, the economies of these countries are interconnected, both in terms of trade and ownership, with enterprises of the leading economies of the European Union (Samborski, 2019).

Economic models shaped by over three decades of transformation in the V4 countries have contributed to a high and stable pace of economic development in these countries. Poland, the Czech Republic, Slovakia, and Hungary have managed to build economies with similar characteristics, such as a high level of openness industrialization, as well as solid and stable economic connections – both mutually and with the German economy. This allowed the V4 group to become a place of dynamic economic growth, high international competitiveness, and low debt levels (Popławski, 2021).

3. Research methods

To assess the potential of the Visegrad Group countries in terms of conditions conducive to cooperation between science, business, and administration, a statistical method was used in data mining, i.e. classification trees. To assess the potential of the V4 countries for readiness to develop cooperation, was calculated the *Potential Index* (PI). The authors were inspired by the *Human Development Index* (HDI).

Three variables were used to construct the Potential Index:

1. *GDP per capita* (*current US$*) – GDP per capita is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for the depreciation of fabricated assets or for the depletion and degradation of natural resources. Data are in U.S. dollars (The World Bank, 2023)
2. *Human resources in science and technology* – as a share of the active population aged 25-64. The data shows the active people in the age group 25-64 that is classified as HRST (i.e., having completed an education at the third level or being employed in science and technology) as a percentage of the total active population aged 25-64. HRST is measured mainly using the concepts and definitions in the Canberra Manual, OECD, Paris, 1995 (Eurostat, 2023).
3. *New businesses registered (number)* - the number of new limited liability corporations (or its equivalent) registered in the calendar year.

The potential Index was calculated by creating indexes for each of the three indicators.

The values of each indicator were normalized to an index value from 0 to 1. Taking into account the actual value for a given country as well as the maximum and minimum, the index value for each variable was calculated as:

$$Potential\ Index = \frac{current\ value - minimum\ value}{maximum\ value - minimum\ value}$$

The dimension index is 1 for the country that reaches the maximum value and 0 for the country that gets the minimum value. To interpret the classification trees, the target variable was a potential index higher than 0.5. The values of the variables used to build the potential index are presented in Table 1.

Table 1.
Indicators characterizing the Visegrad Group countries in 2017-2022

	2017	2018	2019	2020	2021	2022
Slovakia						
GDP per capita (current US$)	17585,2	19486,39	19383,48	19545,74	21391,93	21258,1
Human resources in science and technology	35,2	36,9	38,1	39,7	41,9 b	42,8
New businesses registered (number)	19813	19723	20566	18969	*	*
Poland						
GDP per capita (current US$)	13815,62	15504,58	15699,91	15816,99	17999,91	18321,3
Human resources in science and technology	44	45,2	46	46,6	47,0 b	47,4
New businesses registered (number)	38 903	36 879	40 248	41 143	*	*
Hungary						
GDP per capita (current US$)	14621,24	16425,1	16782,95	16120,99	18728,12	18463,2
Human resources in science and technology	36,5	37,3	38,2	39,9	41,7	42,0
New businesses registered (number)	22783	24252	25376	25608	*	*
Czech Republic						
GDP per capita (current US$)	20636,2	23424,48	23664,85	22992,88	26821,25	27638,4
Human resources in science and technology	39,6	39,9	39,8	40,6	42,0	41,9
New businesses registered (number)	31 195	30 336	28 758	26 024	*	*

* - No available data.

Source: own study based on: Eurostat database: https://ec.europa.eu/eurostat/data/database, OECD database: https://data.oecd.org/, The World Bank database: https://data.worldbank.org/, 20.10.2023.

Table 2.
The dynamics of changes in the values of potential indicators for the Visegrad Group countries

	Wskaźniki potencjału	2018/2017	2019/2018	2020/2019	2021/2020	2022/2021	2022/2017
Slovakia	GDP per capita (US$)	110,81	99,47	100,84	109,45	99,37	120,89
	Human resources in science and technology	104,83	103,25	104,20	105,54	102,15	121,59
	New businesses registered	99,55	104,27	92,23	*	*	*
Poland	GDP per capita (US$)	112,22	101,26	100,75	113,80	101,79	132,61
	Human resources in science and technology	102,73	101,77	101,30	100,86	100,85	107,73
	New businesses registered	94,80	109,14	102,22	*	*	*
Hungary	GDP per capita (US$)	112,34	102,18	96,06	116,17	98,59	126,28
	Human resources in science and technology	102,19	102,41	104,45	104,51	100,72	115,07
	New businesses registered	106,45	104,63	100,91	*	*	*
Czech Republic	GDP per capita (US$)	113,51	101,03	97,16	116,65	103,05	133,93
	Human resources in science and technology	100,76	99,75	102,01	103,45	99,76	105,81
	New businesses registered	97,25	94,80	90,49	*	*	*

* - No available data.

Source: own study based on: Eurostat database: https://ec.europa.eu/eurostat/data/database, OECD database: https://data.oecd.org/, The World Bank database: https://data.worldbank.org/, 20.10.2023.

For the Visegrad Group countries, the *GDP per capita* dynamics indicator calculated in the period 2022/2017 reached the highest value in the Czech Republic (133.93%) and Poland (132.61%), while the lowest value was in Hungary (126.28%) and Slovakia (120.89%). In 2017-2022 year-over-year, the dynamics indicator showed an increasing tendency only in Poland, ranging from 100.75% to 113.80%.

The second indicator included in Table 2 for the V4 countries was the *Human Resources in Science and Technology* dynamics indicator, which in three countries (Slovakia, Poland, Hungary) in 2017-2022 year-over-year, showed a slow increasing tendency. The highest increase in the value of the index calculated for 2022/2017 was observed in Slovakia at 121.59%. In the Czech Republic, as the only country in the V4 Group, in the period 2017-2022 year-over-year, the dynamics of the *Human Resources in Science and Technology* indicator reached values below 100% twice.

The third indicator in Table 2 for the Visegrad Group countries was the *New businesses registered* dynamics indicator. Due to information gaps for 2021 and 2022, only three values were calculated. Among the four countries of the V4 Group, the dynamics rate of *New businesses registered* achieved an upward trend calculated in the period 2017-2020 year-over-year only in Poland and Hungary. A decreasing dynamic of this indicator in the same period was observed in the Czech Republic and Slovakia.

When presenting the dynamics of the indicators mentioned above for the Visegrad Group countries (Table 2), the causes of fluctuations in the values of these indicators were not analyzed due to their diverse micro- and macroeconomic background. The social and economic policy pursued by the governments of the V4 countries and the occurrence of the COVID-19 pandemic undoubtedly have a significant impact on the value of the indicators mentioned above, which should be the subject of further research on this issue.

Variables based on the Eurostat database were used to analyze and prepare classification tree No. 1 https://ec.europa.eu/eurostat/data/database, OECD https://data.oecd.org/, The World Bank https://data.worldbank.org:

1. Research and development expenditure (% of GDP).
2. Patent applications, residents.
3. Graduates by education level, program orientation, completion, sex, and age.
4. School enrollment, tertiary (% gross).
5. Research and development expenditure, by sectors of performance, percentage of gross domestic product (GDP).
6. Human resources in science and technology, percentage of the population in the labor force, From 25 to 64 years, sex: total.
7. Share of mobile students from abroad enrolled by education level, sex and country of origin, Tertiary education, sex total, d - definition differs (see metadata), in %.
8. Employment rates of recent graduates in the country.

Among the variables listed above, the predictors that explain the dependent variables to the greatest extent were distinguished (they had the highest percentage of correctly classified cases). Based on the data obtained, classification tree No. 1 was constructed. The dependent variable is a high potential index set higher than 0.5. The first division was made according to the variable countries: Czech Republic, Poland, Hungary, and Slovakia. The second division distinguished predictors: variables that explain the values of the dependent variable to the greatest extent. The first classification tree is Human Resources in Science and Technology, while the second is the *GenderPay Gap*. In both classifications were estimated risk and standard error. The predictive accuracy measure of a classification tree represents the percentage of cases misclassified by the proposed type. The presented classification trees have a zero rate of misclassified cases, meaning the percentage of correctly classified cases is 100%. The classification trees were constructed using the CHAID method[1]. At each step, CHAID selects the independent variable that has the strongest interaction with the independent variable. Chi-square values show the strength of the association between the predictor and the dependent variable (Kass, 1980).

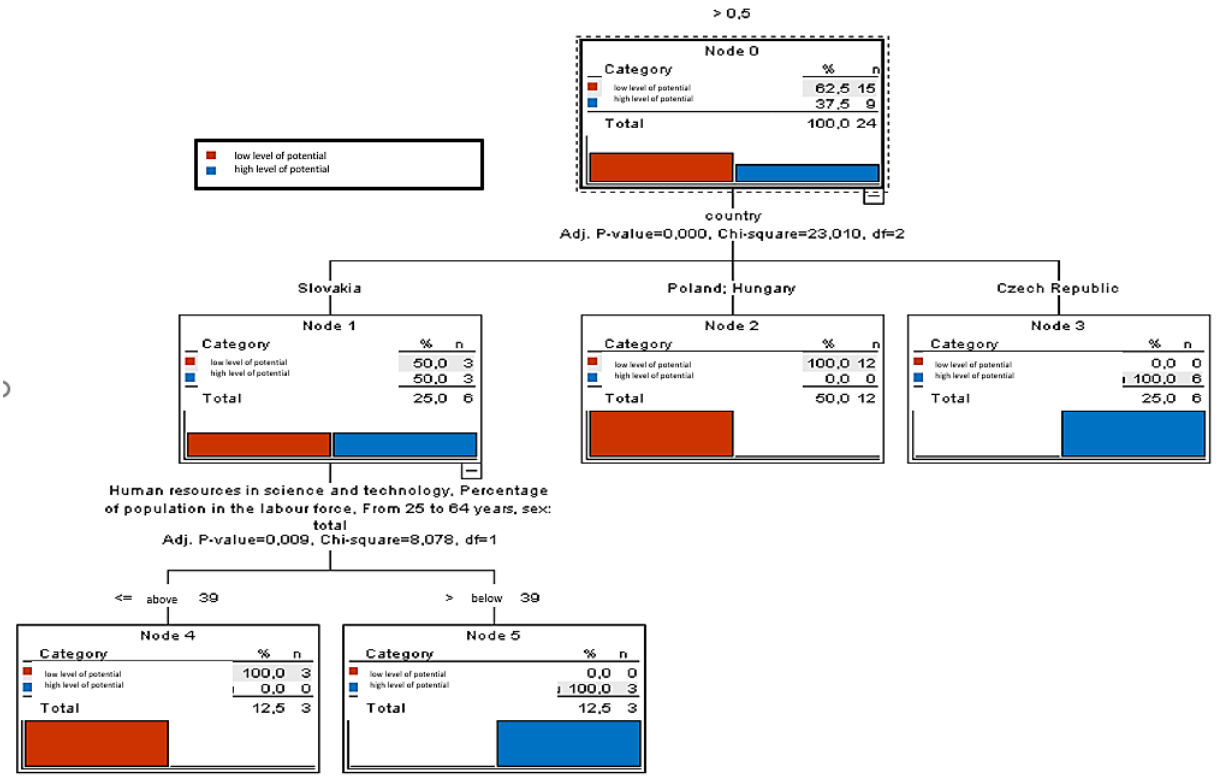

Figure 1. Classification Tree No. 1.

Source: own study.

[1] CHAID - Chi-squared Automatic Interaction Detector. Author: Kass, 1980.

Among the Visegrad Group countries, the Czech Republic has the highest potential (1.0), Hungary and Poland have low potential. At the same time, Slovakia is characterized by high or low potential due to the level of *Human Resources in Science and Technology* indicator. This depends on the independent variable level, which is above the value of 39 positioning Slovakia at a high level of potential, and below the value of 39 positioning Slovakia at a low level of potential[2].

Variables based on the Eurostat database were used to analyze and prepare classification tree No. 2 https://ec.europa.eu/eurostat/data/database, OECD https://data.oecd.org/, The World Bank https://data.worldbank.org:

1. The minimum wage (EURO).
2. Labor force.
3. General government expenditure by function (COFOG).
4. Graduates by education level, program orientation, completion, sex, and age.
5. Share of mobile students from abroad enrolled by education level, sex, and country of origin.
6. Tertiary education, sex total, in %.
7. Annual enterprise statistics for special aggregates of activities.
8. Manufacturing, value added (% of GDP).
9. Cost of business start-up procedures (% of GNI per capita).
10. Gender pay gap (in %).

The second division distinguished the predictor, which is the level of the *Gender Pay Gap* index. This allowed for classification into countries with low or high potential. The level of the *Gender Pay Gap* index in the Visegrad Group countries is presented in Table 3.

Table 3.
The level of the Gender Pay Gap index (in %) in enterprises employing at least 10 employees in the V4 countries in the period 2017-2021

V4 Group countries	2017	2018	2019	2020	2021
Slovakia	20,1	19,8	18,4	15,8	16,6
Poland	7	8,5	6,5	4,5	4,5
Hungary	15,9	14,2	18,2	17,2	17,3
Czech Republic	21,1	20,1	19,2	16,4	15

Source: Eurostat database, https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Gender_pay_gap_statistics, 22.10.2023.

[2] Ranked quantitative variables were used for the classification trees, i.e. the quantitative variable was transformed into a nominal variable according to the Ntyle method. In the Ntyle method, ranks are assigned based on percentile groups, with each group containing approximately the same number of observations. For example, a value of 4 Ntyles (quartiles) assigns a rank of 1 to cases below the 25 percentile, a rank of 2 to cases between the 25 and 50 percentile, a rank of 3 to cases between the 50 and 75 percentile, and a rank of 4 to cases above the 75 percentile. Result: each variable was assigned 4 levels (ranks), where 1 - means the lowest level, 4 - the highest level.

Table 4.
Dynamics of changes in the level of the Gender Pay Gap index in the Visegrad Group countries

V4 Group countries	2018/2017	2019/2018	2020/2019	2021/2020	2021/2017
Slovakia	98,51	92,93	85,87	105,06	82,58
Poland	121,43	76,47	69,23	100,00	64,28
Hungary	89,31	128,17	94,51	100,58	108,80
Czech Republic	95,26	95,52	85,42	91,46	71,09

Source: Eurostat database, https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Gender_pay_gap_statistics, 22.10.2023.

The Gender Pay Gap index determines the difference between the average gross hourly wages women and men receive for their work (Parlament Europejski, 2020). Based on the data in Table 3, the Gender Pay Gap index among the four Visegrad Group countries is the lowest in Poland, and its value in 2021 was 4.5%. In the V4 countries, the dynamics of the Gender Pay Gap indicator calculated for 2021/2017 decreased in three countries - Poland, the Czech Republic, and Slovakia. In Hungary, the Gender Pay Gap dynamics index calculated during the same period increased and reached 108.8%. The analysis of the data contained in Table 4 indicates that in Poland and Czech Republic, there was a tendency to reduce the level of the pay gap, while only in Hungary, among the other V4 countries, the disproportions in the earnings of women and men are becoming more significant, reaching the level of the wage difference amounting to 17.3% in 2021. The gender pay gap is a common phenomenon. Statistical data indicate that in many European Union countries, the average salary of women is significantly lower than that of men (Eurostat, 2021). The occurrence of the pay gap is influenced by many factors relating to objective differences about human capital, such as employees' skills, profession, employee involvement in their work, and length of service (Blau, Kahn, 2017), as well as stereotypes regarding women in the labor market (Lips, 2013). Due to the number and diversity of factors influencing the size of the Gender Pay Gap in individual countries of the Visegrad Group, this article only shows the course of changes in the wage gap in the period 2017-2021.

Many factors determine the changes taking place in the economy of many countries. One of them is the level of the pay gap, which allows us to classify countries into those with a low or high level of potential.

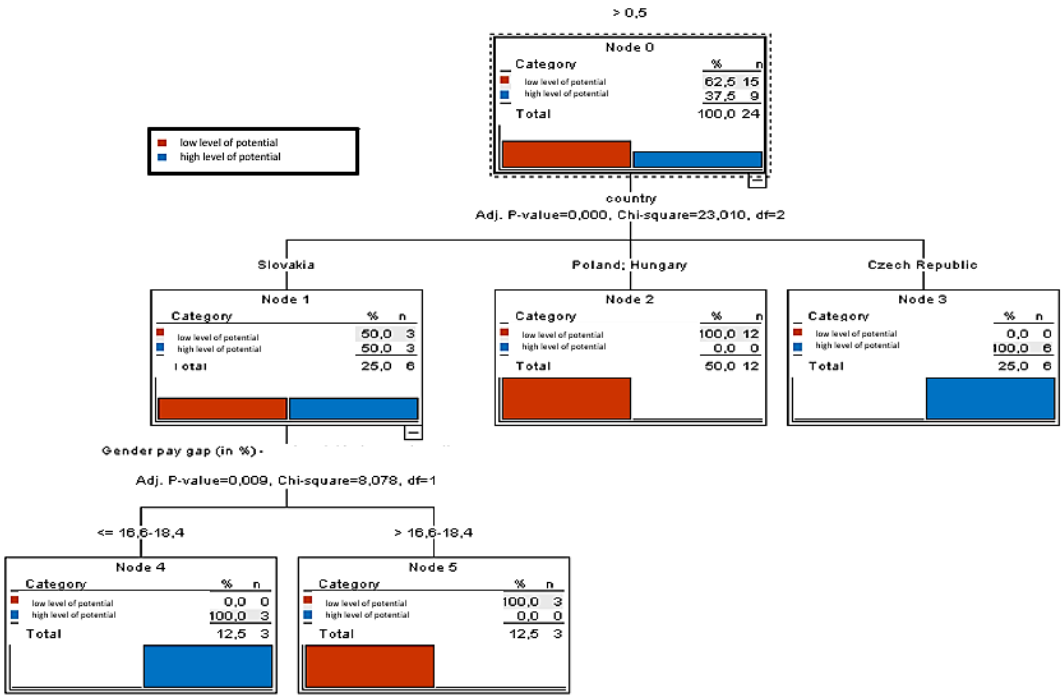

Figure 2. Classification Tree No. 2.

Source: own study.

Among the Visegrad Group countries, the Czech Republic has the highest potential (1.0), Hungary and Poland have low potential. At the same time, Slovakia is characterized by high or low potential due to the level of the Gender Pay Gap. This depends on the level of the independent variable, which in the range of values of the content (<=16.6-18.4) places Slovakia at a high level of potential, and above the value of the content (16.6-18.4)[3] places Slovakia at a low level of potential.

4. Conclusions

The conducted research enabled the analysis of the potential of the Visegrad Group countries in selected areas in the period 2017-2022. Due to the orientation of the conducted research on stakeholders such as government, science, and administration, the focus was on analyzing the potential of the Visegrad Group countries related to indicators from these areas. Autors used to analyze the factors that determine the readiness for cooperation between science, business, and administration have been identified as GDP per capita, Human resources in science and technology, and New businesses registered. Due to the differences in potential in

[3] Ranked quantitative variables were used for the classification trees, i.e. the quantitative variable Gender Pay Gap was transformed into a nominal variable according to the Ntyle method. 4 compartments have been created: 1 – less than 10; 2 – 10-16,6; 3 – 16,6-18,4; 4 – over 18,4.

these economies, the complexity of micro and macroeconomic conditions affecting their potential should be emphasized. One of the variables that determine the level of potential index is the level of human resources involved in developing science and technology. On this basis, it can be concluded that among the Visegrad Group countries, the Czech Republic has the highest potential index, while Hungary and Poland have the lowest potential. The same dependence occurs when taking into account the pay gap index. The Czech Republic has the highest potential index, while Poland and Hungary have the lowest potential index. Among the Visegrad Group countries, Slovakia is characterized by a heterogeneous classification, strictly dependent on the level of the independent variable. The results of the conducted research indicate a high degree of differentiation in the potential index of the Visegrad Group countries. They also prove that it is an essential factor positively influencing their economic development. Individual stakeholders involved in the cooperation process should ensure the development and use of appropriate instruments that would increase the level of potential of the V4 countries and their use.

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