THE «FIVE-HELIX» MODEL IS AN EFFECTIVE WAY TO DEVELOP BUSINESS IN INDUSTRY 4.0 OF SELECTED COUNTRIES

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ABSTRACT

This article aims to assess the potential of using the components of the five-helix model in countries with different levels of business development in Industry 4.0 for the US, Azerbaijan, Ukraine, and Poland. We determined the stimulators and not stimulators of the company development interacting with the participants of the innovation system: "business," "society," "state," "science," and "environment." We empirically evaluated the company's ability to use the potential of the five-helix model during the transition to Industry 4. These estimates, along with the development indicators of the five-fold spiral elements, were used to build a decision tree for choosing a practical scenario for business development and information transformation. It helped determine options for ensuring business efficiency, depending on the development of the five helix components and the company's ability to use their development potential.

Keywords: Industry 4.0, innovation system, five-helix model, companies, business, information transformation.

INTRODUCTION

The fourth industrial revolution (Industry 4.0) involves transforming the approach to doing business, the production process, based on the

mass introduction and use of information technology and intelligent control systems for forming a global industrial network (Xu, Xiong & Li, 2018). It is predicted that in 2030 there will be a decrease in production from human labor, and more than 60% of professions will be fully automated (Radionov & Gasiyarov, 2022). Industry 4.0 is changing the external environment for business, creating many benefits in obtaining reliable information and making a correct business decision. Numerous studies have empirically proven that digital transformation directly affects company profits.

For example, with the proper implementation of all elements of industry 4.0 (Fig. 1), a company can achieve an increase in earnings up to 22% EBIT by 19% (Deloitte, 2022). At the same time, the company can count on both a return on a significant amount of investments spent on digital technologies and a reasonably quick payback period for such investments. Already after two years of active use of digital technologies in business, we can state the positive results of digitalization (Döbler et al., 2020).
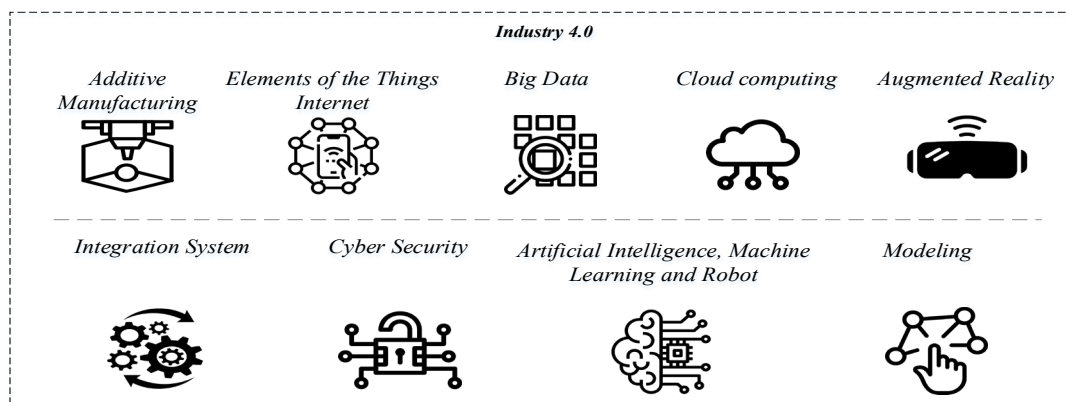

Figure 1: Structural elements of Industry 4.0

Source: Döbler et al. (2020)

Against the background of the development of information technology, there is a severe gap between the potential market opportunities of Industry 4.0 and readiness for digital transformation for generating a variety of sources of business income. A recent Deloitte Insights global study confirmed that the purpose of current business structures is primarily to protect the company from external risks and competitors' threats, and not to destroy old business models and achieve exponential growth (Deloitte, 2021).

The lack of qualified personnel for implementing information technologies seems to be one of the most significant destructive factors in business development during industry 4.0. For example, in the US, more than 89% of companies in the manufacturing sector cannot meet the need for relevant specialists in information transformation (Deloitte, 2018). In this sense, the education system is hugely important, which should be proactive and introduce effective educational programs to train

the necessary specialists for business development in industry 4.0.

The second significant obstacle to transformation is the complexity of implementation and the need for substantial funding. This factor underlies the digital divide between large and medium-sized small enterprises (SMEs). Large companies are characterized by a better ability to generate financial resources and have more opportunities to scale the digitalization of their business. The lack of clear strategies and opportunities for SMEs requires close cooperation with government agencies and scientific organizations. It can create the potential for an effective transition to industry 4.0 and respond in time to new market opportunities.

The third common barrier to a successful business transition to Industry 4.0 is data security, human-machine interactions, and not understanding the benefits. Most likely, this factor is a consequence of the lack of a qualified workforce for digital business transformation.

This study aims to assess the potential for businesses to use the quintuple helix model as an effective way to move towards Industry 4.0 using the example of the US, Azerbaijan, Ukraine, and Poland. The study aims to assess the development of the participants (components) of the innovation system in the countries, and to determine the development potential for cooperation business and innovation system participants using the five-helix model.

LITERATURE REVIEW

Scientists have long proved the cyclical development of the economic system conditioned by changes in innovation processes and technological transformations (Geiger, 2014). The concept feature was the study of economic growth using an evolutionary approach. Technical mode is a system of interconnected industries characterized by the same level of technological development developing synchronously (Xu, Xiong & Li, 2018). Within the framework of this theory, many concepts have appeared explaining the fundamental factors of long wave-like fluctuations in the economy: migration and demographics (Freeman, Clark & Soete (1982)), innovative technological (Mensch (1979), Glazyev (2012), Kleinknecht (1986), Perez (2002), **Kuznets (1973)**), socio-institutional (Baaske, Hussain & Millendorfer (1987)), financial (Fisher (1933)) and the theory of world economic structures (Glazyev (2012)).

Technological development occurs due to the interaction of participants in the innovation system: business, government, universities, and research organizations (Brunet-Thornton, Cramer & Jirsák, 2019). The transition from one technological mode to another provocates decreasing productivity growth potential, which changes the interaction model between the participants in the innovation system (state, business, science, and education), and is described as a spiral (De la Vega, Puente & Sanchez, 2019).

In the administrative economy, with the absolute dominance of the state, there was no partnership (Peeters, 2020). In industrial development, interaction according to the double helix model was characterized by pairwise interaction with feedback (Xu, Xiong & Li, 2018). In the post-industrial economy, overcoming the decline of productivity is possible with the network interaction of all four participants using a triple helix (Etzkowits & Leydesdorff, 1995; Lysiuk & Britchenko, 2020; Lysiuk & Britchenko, 2021).

Nowadays, countries with developed economies have long used the triple helix model for economic development, while many emerging markets still operate on a partnership between the state and business (Byrne, 2020).

With the development of nano- and biotechnology, nano-energetics, molecular, cellular technologies, the personalization of production, the onset of the sixth technological order is observed, based on the concept of the fourth industrial revolution by Klaus Schwab (Industry 4.0) (Fig. 2) (World Economic Forum, 2022).
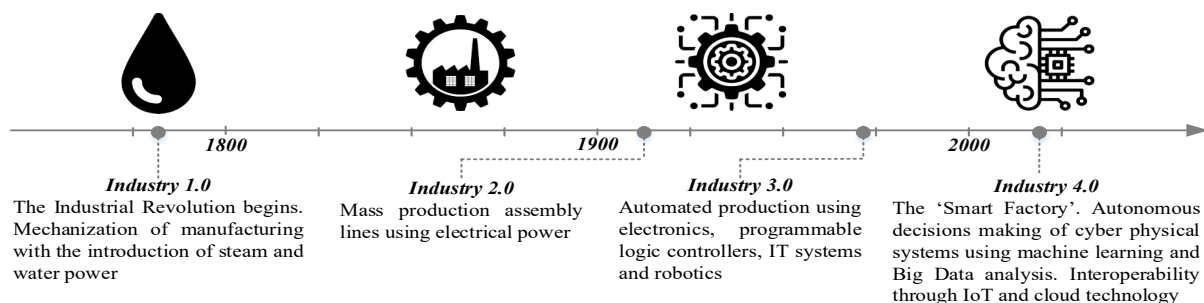

Figure 2: Stages of socio-economic development under influencing innovations

Source: World Economic Forum (2022)

In developed countries, industrial sectors are faced with the problem of diminishing returns on invested capital and an overabundance of fixed assets. The steady decline in productivity forms the risk of a decrease in demand for products of the innovation and technology sector and indicates the inefficiency of traditional technologies (Xu, Xiong & Li, 2018; Megits,

Neskorodieva & Schuster, 2020; Vasiljeva et al., 2020). In addition, non-industrial sectors such as agriculture, social services, health care, and education are also approaching productivity limits (Brunet-Thornton, Cramer & Jirsák, 2019). Therefore, the main priority of developed countries today is implementing an effective industrial and technological policy for stimulating the transition to Industry 4.0.

Many scientists have noted that overcoming the decline in productivity growth and the transition to Industry 4.0 is possible due to the new model of interaction between the innovation system participants: a five-helix model - the interaction of five participants (component) (business, society, government, science/education, and ecology) (De la Vega, Puente & Sanchez, 2019).

Countries such as the US, Great Britain, China, Germany, South Korea, and Japan actively use the five-spiral model in socio-economic development. They have confirmed its effectiveness (Kitsios, Kamariotou & Grigoroudis, 2021). These countries are leaders in digital transformation globally (E-Governance Academy, 2022). For emerging market countries, Industry 4.0 is seen as one of the prime ways to solve the issue of depleted productivity potential, competitiveness, and digital divide with developed countries (De la Vega, Puente & Sanchez, 2019). But the prospects of such countries are much lower, which exacerbates the existing digital transformation problems and the practical implementation of the five-helix model. (Kitsios, Kamariotou & Grigoroudis, 2021).

Considering that the application of the quintuple helix model is new and not developed in the scientific literature, especially concerning developing economies, there is a need to study the potential for developing effective cooperation in emerging markets and Industry 4.0 development.

METHODOLOGY

The development indicators of the five helix components have been presented in Table 1 (De la Vega, Puente & Sanchez, 2019; Kitsios, Kamariotou & Grigoroudis, 2021; Shapran & Britchenko, 2021; Megits, Neskorodieva & Schuster, 2020). We estimated the values of indicators for Azerbaijan, Poland, Ukraine, the US for 2010-2020 (World Bank, 2022a; Heritage Foundation, 2022; E-Governance Academy, 2022).

Table 1: Indicators of the development of the quintuple helix model components

Business	Society	State	Science/Education	Environment
Ease of doing business; Foreign direct investment, net inflows (USD per capita); Index of economic freedom; Gross Domestic Product (USD per capita)	Human Capital Index; Social Progress Index; Economically active population, % of the total population	Voice and accountability; Political stability and absence of violence/terrorism; Government effectiveness; Regulatory quality; Rule of law; Control of corruption	Government expenditure per student, tertiary (% of GDP per capita); Research and development expenditure (% of GDP); Charges for the use of intellectual property, receipts (BoP, current US$ per capita); Digital development level	Share of renewables in electricity production; Energy intensity (koe/$)

Source: Authors' finding

We used the ease of doing business indicator to assess the development of the "business" component, which determines the opportunities for business development. The availability of financial resources necessary for running a business is reflected in this indicator through the Availability of credit sub-indicator. We assessed Foreign direct investment too. In addition to

having opportunities for business development, economic freedom is vital for their practical use. GDP per capita has been used as a generalized indicator of business development.

To analyze the "society" component, we used indicators of demand (Social Progress Index) and supply: the availability of labor resources (Economically active population, % of the total population), and labor productivity, innovation, labor mobility (Human Capital Index). The Social Progress Index characterizes well-being, the satisfaction of needs, inclusiveness, personal freedom, and security. The Human Capital Index reflects the availability of knowledge, skills, and health, allowing realizing labor potential.

Voice and accountability, political stability and absence of violence/terrorism, government effectiveness, regulatory quality, rule of law, and control of corruption were used to assess the public administration effectiveness and its impact on business development. These indicators characterize the participation in elections and freedom of decision-making, political stability, the presence/absence of terrorism in the country, the effectiveness of the state's regulatory policy, the rule of law, and the presence/absence of corruption. Measured in the range "-2.5" - "+2.5" (World Bank, 2022b).

To develop the scientific, public expenditures on higher education, research activities costs, and intellectual property proceeds were analyzed. In the context of industry 4.0, the focus on science is shifting in favor of digital technologies development and implementation. Therefore, we used the Digital development level indicator.

Environmental development has been assessed using the Share of renewables in electricity production and Energy intensity to analyze the potential of a business to minimize ecological damage.

Business efficiency is also affected by the ability to use the component's potential development - the effectiveness of business interaction with the spiral members. To obtain data on this group of indicators, we conducted a survey using Google Forms (2022) during September-December 2021 among small, medium, and large businesses in Ukraine, the US, Azerbaijan, and Poland. The questionnaire contained five groups of questions, and each characterized the development potential of a specific component of the fivefold spiral. The

evaluation was carried out according to the 5-point Likert scale. For each group, the arithmetic mean score was calculated. 1,942 heads of companies in Ukraine, 1,528 heads from the US, 1,380 heads from Azerbaijan, and 1,469 from Poland took part in the survey, which indicates the sufficiency of the sample (Taherdoost, 2017).

We modeled the business development scenario in interaction with the components of the five-helix model, and the decision tree method in the program Deductor Studio Academic 5. We formed the data sample from dependent variables (the level of business efficiency (return on assets (ROA)) for companies whose managers took part in the survey) and independent variables (indicators of the five helix components development and the efficiency of using in business). To determine the business's levels of efficiency (profitability), a t-test was calculated for independent samples. The efficiency levels were formed according to statistically significant differences at $p=0.05$ in the values of the ROA indicator.

RESULTS

Using Ease of Doing Business at the end of 2020, the United States ranks 6th globally (Fig. 3a). High rating positions are associated with the primary role of the insolvency assessment mechanism (2nd place) and obtaining a loan (4th place).

The duration of bankruptcy proceedings in the US is 1 year, in Azerbaijan - 1.5 years, in Ukraine - 2.9 years, in Poland - 3 years. Costs associated with court proceedings in the US amount to 10% of the value of the debtor's assets, in Azerbaijan - 12%, Ukraine - 40.5%, Poland - 15%. The judicial procedure in the United States is primarily focused on restoring the debtor's solvency. In Ukraine, it is aimed at liquidation. High rating positions ease obtaining a loan in the US due to its legal regulation and the depth of credit information.

The main destructive impact on the potential for business development in the United States is the complexity of the procedure for obtaining a permanent connection of a business to electricity supply and the highest price of electricity among the countries studied. In terms of getting electricity, the United States ranks 65th.
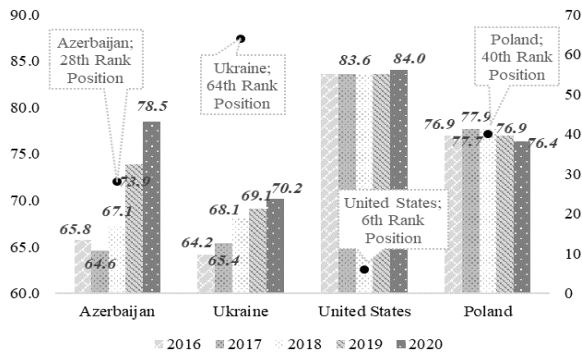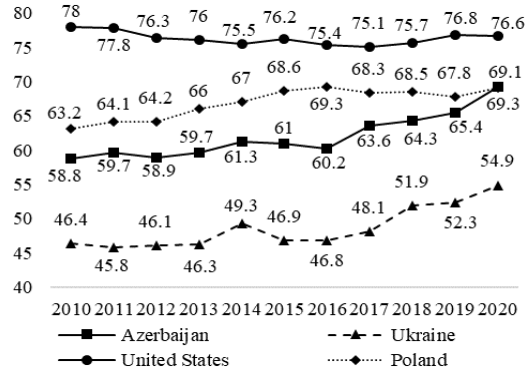
Figure 3a: Ease of doing business   **Figure 3b:** Index of economic freedom

Figure 3: Business Development Indicators for Azerbaijan, Ukraine, US, Poland

Source: Authors' finding

Azerbaijan is characterized by the simplified procedure of obtaining a loan (1st place in the world in 2020) due to legislative regulation and compliance with the law the completeness of information about the borrower in the credit bureau. According to other sub-indicators of Ease of doing business, the country occupies 13-105 positions. The most urgent problems are the insufficient protection of minority investors: the difficulty of holding directors liable in case of violation of investors' rights; and the lack of access for investors to internal corporate information in the event of a lawsuit. In the Ease of doing the business rating, Azerbaijan took 28th place. In 2020, Poland ranked 40th in the Ease of doing business ranking, characterized by the most favorable conditions for transcoded trade (1st place in the order in terms of Trading across borders): minimal material costs and time spent on exporting importing goods. The development of the E-commerce market facilitates the expansion of transcoded trade. The growth rate in Poland in 2020 is the highest in Europe (All Retail, 2021).

The lower positions of Poland in the overall Ease of doing business rating compared to the US and Azerbaijan are due to time and financial costs for starting a business; strict requirements for the minimum paid-in capital (128th place in the rating); the complexity of property registration (92nd place); inefficiency of the preparation, registration, and payment of corporate income tax, value-added tax, and income tax (77th place).

Ukraine occupies the highest positions in only one sub-indicator compared to the US, Azerbaijan, and Poland – in Dealing with construction permits (20th place). The main reasons for the most unfavorable business climate among the studied countries (64th place in the rank) are the lack of an effective insolvency resolution mechanism: costly, significant duration, and focus on the debtor's liquidation. In terms of Resolving insolvency for 2020, Ukraine ranked 146th in the world out of 168 countries represented in the rank.

In dynamics for 2016-2020, there was an increase in the Ease of doing business indicator in the countries, which improved legislative regulation and reduced the time of document circulation, expansion of information accessibility, and access to financial resources due to the development of industry 4.0. No common stimulants and no stimulators in business development have been identified for the studied countries.

The index of economic freedom for 2010-2020 for the US was at the level of 74.8-78, Azerbaijan - 58.8-69.3, Poland - 63.2-69.1 (Fig. 3b). For Ukraine, the indicator's value is ½ of the potential level: 46.18-54.9, which indicates the presence of significant restrictions on the free movement of labor, goods, capital, and the impossibility of efficient using the business development potential (Heritage Foundation, 2022). Against the background of low values, there are no stable positive dynamics in the economic freedom development: a decrease in

the index of financial independence was observed throughout 2011, 2015-2016. The absence of growth dynamics was recorded for the United States, for which the index of economic freedom for the study period decreased by 1.8%. Azerbaijan and Poland demonstrate stable growth dynamics of the index of financial independence as an impetus for business development.

The highest foreign direct investment inflows per capita are in the United States ($920.41 in 2020). The United States demonstrated stable economic growth, generating ¼ of the world's gross domestic product (World Bank, 2022a). That makes the US attractive to investors. For Poland, the value of foreign direct investment per capita inflow was $379.27 for 2020, for Azerbaijan - $150, and for Ukraine - S131.42. The lowest investment attractiveness in Ukraine was due to the instability of economic development, political instability, the complexity of doing business, and a relatively low level of financial freedom. It limits business development opportunities in the country. The indicator of gross domestic product per capita in Ukraine for 2020 is 1.13 times lower than in Azerbaijan, 4.22 in Poland, and 17.02 in the US.

In terms of the development of society, the situation is similar: a higher level of growth in the US and Poland. The United States is the most provided with labor resources (50.13% of the economically active population for 2020), Poland (47.97%), and Azerbaijan (48.28%). For Ukraine, the value of the indicator was 44.1%. In dynamics, the growth is observed only for Poland - an increase of 0.56 p.p. for 2010-2020. For other countries, the proportion of the economically active population declined, which indicates a decreasing labor potential. The quality of the labor potential for Azerbaijan, the US, and Poland has grown, as evidenced by the upward dynamics of the Human Capital Index. For Ukraine, this indicator decreased by 0.2% in 2020 compared to 2010. The lowest values were for Azerbaijan, which, along with a decrease in the economically active population, may pose a problem for businesses of a shortage of necessary personnel.

Higher economic performance in the US and Poland also led to higher Social Progress Index values (for 2020, 85.71 and 84.32, respectively). It is an additional opportunity for business development to create effective demand. It will also contribute to the growth of human capital quality.

The most favorable conditions for business development on the state and the political system have been created in the United States and, to a lesser extent, in Poland because of democracy, the rule of law, and effective public administration. Despite this, all indicators were far from the maximum level. For the US, this is especially true for the indicator political stability and absence of violence/terrorism (the value: "-0.02" for 2020 from a maximum of 2.5). Poland has issues in creating an effective political environment for business development is the low quality of public services (the value of the Government Effectiveness indicator for 2020 was 0.38). For Azerbaijan and Ukraine, the destructive influence of political factors on business development prevails. For Azerbaijan, the main problem was the inability to participate in government elections, the lack of expression freedom (Voice and Accountability "-1.55" in 2020); for Ukraine, a significant problem was political instability terrorism (Political Stability and Absence of Violence/Terrorism «-1.16»).

The public administration effectiveness, as a component of the five-fold spiral, does not allow realizing the potential for business development characterizing political instability (for Azerbaijan, the US, Ukraine), the lack of free political choice (for Azerbaijan), poor quality of public services, and inefficient regulatory policy, the presence of corruption, non-compliance with the rule of law (for Azerbaijan, Ukraine).

The highest spending and return on research and development is in the US and Poland (2.83% and 1.21% of GDP in 2020). Income of intellectual property in the US: $345.33 per person, in Poland - $29.01. Science is the least developed in Azerbaijan: public spending on research and development is 0.18% of GDP, intellectual property is not set. The level of digitalization was the highest in the US (the country today is the world leader in digital transformation: digital development level 81.44 with the maximum possible 100), for Poland: 66.61, Ukraine: 55.95, Azerbaijan - 54.78. Ukraine also has problems with innovation development due to the low level of state support and income using intellectual property legislative unregulated use of intellectual capital. The US and Poland provide more opportunities for developing innovative sectors of the economy, which is more relevant

in the context of industry 4.0.

The largest share of renewable energy sources in electricity generation is in the US (19.8% in 2020) and Poland (16.7%). These countries are also characterized by the lowest energy intensity of the economy (0.107 koe/$ in the US and 0.083 koe/$ in Poland). In industry 4.0, developing this five-fold spiral component is possible by introducing new technologies, for example, a digital twin helping to optimize production processes, increase energy efficiency, and reduce CO_2 emissions by 40% (Siemens, 2021).

The survey results helped determine how effectively companies use the existing potential for business development in the conditions of Industry 4.0 (Table 2).

Table 2: Assessing the Potential for Business under using the Five Helix Model in Industry 4.0

Component of Five Helix Model	Business type	Efficiency by country			
		Azerbaijan	Poland	Ukraine	US
Business	Small and medium	3.0	3.9	2.5	4.5
	Large	3.5	4.2	3.1	4.7
Society	Small and medium	3.2	3.8	3.0	4.1
	Large	3.3	4.2	3.2	4.5
State	Small and medium	2.8	3.8	1.6	3.9
	Large	3.0	3.8	2.2	4.0
Science/Education	Small and medium	3.1	4.3	3.8	4.8
	Large	2.6	4.0	3.4	4.5
Environment	Small and medium	1.2	1.7	1.5	2.4
	Large	1.3	2.0	1.6	2.9

Source: Authors' finding

Prospects for small and medium-sized business development lie in maximizing profits by simplifying the conditions for doing business (registering a business, providing tax incentives and streamlining the procedure for administering taxes, giving access to loans) ("3.2" - "4.6" points). For large businesses, the positive effect of these measures was less significant - "2.9"-"4.2" points. The revealed pattern influence of the development of the components "business," "society," "state" on the profitability was confirmed in all the countries. To a greater extent, the positive effect from development of the spiral components is reflected in more developed countries (US, Poland), which is explained by an extensive range of business development opportunities (large investment volumes, a large number of business support programs, and more significant assistance, etc.). The lowest efficiency of business interaction with the components of the spiral was for companies in Ukraine ("1.6" - "3.0" points for small and medium-sized businesses, "2.2" - "3.2" for large companies). The "state" component has the most negligible positive impact on business development in Ukraine.

The scientific environment development has a more significant positive impact on small and medium-sized businesses, which are the drivers of innovation and the sources of digitalization. Small and medium-sized enterprises register 13 times more patents annually than large ones. Most IT companies are small and medium-sized businesses (Feinstein & Partners, 2022). For Azerbaijan, this efficiency was "2.6" points for large businesses "3.1" points for small and medium. For Poland: "4.3" points for small and medium, "4.0" for large; for Ukraine - "3.8" and "3.4" points, respectively; for the US - "4.8" and "4.5" points.

The environmental component development has practically no positive or negative impact on business development in these countries ("1.2" -
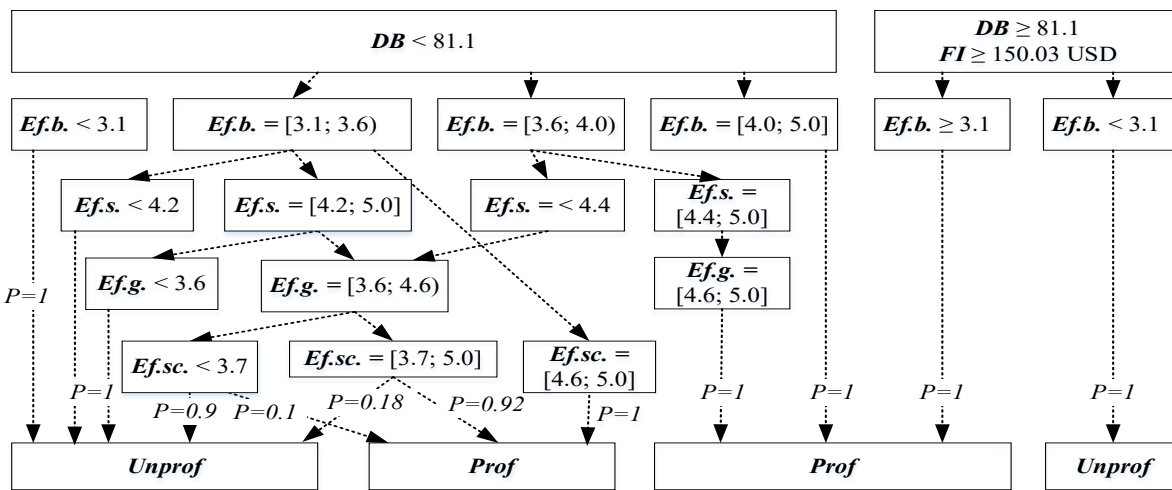
"2.9" points).

The application of the t-criterion made it possible to determine three levels of company efficiency:

1. inefficient, unprofitable functioning. The return values on assets for companies that have formed this level do not exceed "-0.03";
2. effective functioning, for which the return the value on assets indicator is "0.04" and higher;

3. unstable functioning. The return values on assets for companies of this level were in the range (-0.03; 0.04), which does not allow an unambiguous conclusion about the company's efficiency.

We used data on companies that formed inefficient and adequate functioning levels to build a decision tree.

Based on the results of building a decision tree (Fig. 4), quantitative criteria determine the choice of an effective business development scenario using the five-helix model.

DB – Ease of doing business; FI –Foreign direct investment, net inflows per capita ($); The efficiency of using the development potential for component «business» (Ef.b); «society» (Ef.s); «state» (Ef.g); «science/education» (Ef.sc); P – potential profitability (Prof) / unprofitability (Unprof) of companies

Figure 4: Decision Tree for Selecting an Effective Business Development Scenario using the Five Helix Model

Source: Authors' finding

The adequacy of the constructed decision tree was confirmed by % of correct classification of the training (92.35%) and test (89.64%) classifications.

If the value of the Ease of doing business indicator is below 81.1, then companies can be profitable according to the following scenarios:

- the efficiency of using the development potential of the "business" should be at the level of [4.0; 5.0];
- the efficiency of using the development cumulative potential of the "business" should be at the level of [3.6; 4.0), "society" - [4.4; 5.0], "state"- [4.6; 5.0];
- the efficiency of using the development cumulative potential of the "business" should be at the level of [3.1; 3.6), "society" -component [4.2; 5.0], "state" - [3.6; 5.0], "science/education" - [3.7; 5.0];
- the efficiency of using the development potential of the "business" should be at the level of [3.1; 3.6), "science/education" - [4.6; 5.0].

DISCUSSION AND CONCLUSION

The results of this study led to several important conclusions. For all the countries under investigation, the development potential for the components "business," "society," "state" are more effectively used by large businesses, which is natural and has been substantiated in many scientific resources (Vasiljeva et al., 2020; Megits, Neskorodieva & Schuster, 2020). Large business is more subject to the stimulating influence of economic, social, political development in the country and less dependent on the destructive power of the five-helix model. Large enterprises have more opportunities to attract foreign direct investment. They are more resistant to the adverse effects of external factors due to the availability of self-financing sources, reserve funds, product diversification, suppliers, markets, and financing sources. Small and medium-sized businesses are more sensitive to the destabilizing influence of external factors, which indicates a lower efficiency in using the development potential of these five-helix model components.

For all components of the five-helix model, the United States and Poland demonstrate higher development rates. That confirms the point of view of scientists, that the higher the development of the economy, the more developed the relationship between the participants of the innovation system within the framework of the five-helix model (Kitsios, Kamariotou & Grigoroudis, 2021). But on the other hand, considering such countries as Ukraine and Azerbaijan, we concluded that Azerbaijan, even though a higher level of economic development characterizes it, today, has less significant potential for introducing the five-helix model and entering Industry 4.0 in comparison with Ukraine. For Azerbaijan, science/education is underdeveloped, limiting the use of innovative digital technologies for business development, hindering the growth of knowledge-intensive sectors of the economy, and consequently, slowing down digital transformation. It can lead the country to a substantial lag from developed countries and countries inferior to Azerbaijan today in economic development.

Ukraine is characterized by the set of indicators of the five-helix model with minor prospects, mainly due to political instability. The main destructive factors are the complexity of doing business, the insufficient level of human capital development, the inefficiency of state regulation, and non-compliance with the principles of sustainable development (low level of economic and personal freedom, environmental issues, etc.). But because the country is characterized by a significant rate of potential growth in education and science, one can argue that Ukraine has a higher level of potential for developing the five-helix model compared to Azerbaijan.

We determined that business efficiency is more significantly influenced not by the development of the five-helix components, as indicated in studies (De la Vega, Puente & Sanchez, 2019; Kitsios, Kamariotou & Grigoroudis, 2021), but by the efficiency of using the components' potential.

The profitability ensuring of companies in these countries is possible through effective interaction with the components "business," "society," "state," that is, the implementation of the triple helix model, or effective interaction with the components "business," "society," "state," "scientific sphere," that is, the implementation of the quadruple helix model. A possible option is also through an innovative development scenario. The efficiency of using the development potential of the "scientific sphere" component should not be lower than "4.6" points.

Since the "environment" component does not significantly impact the profitability of companies, the implementation of the five-helix model is not to be used at the proper level in any of the countries studied. Due to the insufficiently widespread practice of business orientation towards the implementation of sustainable development goals, particularly the environmental component, the introduction of energy-saving technologies, the use of alternative energy sources for companies is of lower priority than the implementation of measures at maximizing profits.

Thus, today, businesses in the United States and Poland use the quadruple helix model. The less economically developed countries Azerbaijan and Ukraine have problems implementing the fourth helix due to the ineffectiveness of state regulation, political destruction, the complexity of doing business, and the insufficient level of development of science and education. All the countries studied

today do not use the potential of the five-helix model due to the focus of business only on making a profit and not on achieving sustainable development goals. The current situation may reduce the efficiency of the economy's transition to Industry 4.0, which necessitates the development of a strategy for achieving effective interaction between the five-helix model components to increase productivity in the economy and digital transformation.

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