Knowledge Management and Economic Growth: 
The Assessment of Links and Determinants of Regulation

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Abstract

Purpose: In order to make an informed choice of the most effective tools for ensuring the development of a competitive economy, it is important to take into account the links between macroeconomic indicators of progress and the most important components of knowledge management. In this regard, the aim of our study is to assess the relationship between knowledge management factors and economic growth in order to select the factors that most determine the positive changes in Gross national income per capita.

Methodology/results: As a result of the systematization of the main international indices, which use knowledge management factors and the authors’ correlation analysis of their relationships with GNI per capita, conclusions are made about the greatest effectiveness at the present stage of action, which results in skills development (such as the ability to work with new technologies and with people, flexibility and cooperation), innovative capacity, access to information and means of communication.

Findings: The perception of these factors as determinants of economic development and the appropriate direction of the levers of economic policy will result in achieving the greatest economic efficiency on the basis of the development of the knowledge economy.

Keywords: knowledge economy, economic growth, GNI per capita, knowledge management.

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Introduction

In the light of current trends for the general strengthening of knowledge factors’ influence on economic development, the modern economy is increasingly being analyzed through the prism of such concepts as “knowledge economy,” “digital economy,” “creative economy.” Obtaining and using relevant knowledge today is a competitive advantage for organizations, industries, and economies in general. At present, knowledge acts both as a necessary factor of production and as an independent product. At the same time, effective knowledge management is a powerful factor in the high level of economic development of the world. In order to take full advantage of this opportunity, countries should focus on the following five main aspects (UNDP, 2019): education (focus on curriculum quality, orientation on new technologies); research, development, innovation, and science (skills/knowledge of researchers and organizations to stimulate the development of new technologies and the formation of necessary skills in the future); technologies (providing a high level of technological infrastructure and ICT needed to share knowledge, promoting the development of new technologies and teaching methods); economy (as a source of financial resources for the introduction of new technologies); favorable environment (organizational support for entrepreneurship development and innovation). These elements are an integral part of the concept of knowledge management, so knowledge growth is a crucial determinant of economic growth.

However, such assessments of knowledge’s impact at the macroeconomic level are complicated by dynamic changes in knowledge management, along with the emergence of new opportunities. Despite the steep development of efficient entrepreneurial knowledge management systems and employment practices, the support that aims at attracting highly skilled employees – described by Oliinyk et al. (2021) as the scientific justification of knowledge management factors – influences economic growth with some information inconsistencies. They are caused by too generalized information base on the macroeconomic level. Such a research is conducted mainly based on the use of composite indices, which to varying degrees consider factors of knowledge and innovation as a result of knowledge management in relation to the competitiveness of the economy (Poór et al., 2018). Incomplete information at the macroeconomic level is compensated by research on the level of knowledge’s impact on business efficiency and scaling of obtained dependencies so as to understand patterns of macroeconomic processes. Researchers have proven the strengthening of the influence of knowledge factors on economic growth due to the influence of information and communication.
technologies (Rymarczyk, 2020), the quality of knowledge management (Ulewicz and Blaskova, 2018; Atkociuniene, Mikalauskienė, 2019; Fitri et al., 2019; Limba et al., 2020; Novikova et al., 2020; Podra et al., 2020), including in Industry 4.0 (Ungerman et al., 2018; Písař, Tomášková, 2020; Portna et al., 2021; Rymarczyk, 2021), and as a component of economic development infrastructure (Dinh, 2020; Yousif et al., 2020; Bogdan, Lomakovych, 2021).

To consider components of knowledge management is currently part of the main indices that characterize economic progress: Global Competitiveness Index, Global Skills Index, or Global Knowledge Index. As a source of information in this study we used the results of international generalizations of dynamics and knowledge management results presented in analytical reports on the dynamics and components of these and other indices related to knowledge management. Thus, our work seeks to assess the relationship of knowledge management factors with the results of economic growth to select the factors that most determine the positive macroeconomic changes.

The paper is organized in four sections: the literature review substantiates current research perspectives on knowledge management in relation to economic growth; this is the basis for our choice of factors and substantiation of methodological bases for evaluating their connections in section two, with the presentation of results in the third section of the study. The fourth section concludes what can be used as a basis for developing recommendations for improving knowledge management to promote macroeconomic growth.

**Literature Review**

Economic growth is a complex category influenced by such various factors as politics, social issues, and financial matters. Boldeanu and Constantinescu (2015) claim that economic growth is affected by direct factors such as human resources (increase in the active population, investment in human capital), natural resources (land, water, fossil fuel), increase in fixed capital, and technological progress. Moreover, there is the influence of indirect factors such as institutions, the magnitude of aggregate demand, interest on deposits, investment rates, the efficiency of the financial system, budgetary and fiscal policies, labor and capital migration, and government efficiency.

Simultaneously with the spread of intellectualization of the global economy and its active digitalization, knowledge is increasingly becoming important in achieving eco-
nomic stability. Although the role of knowledge management in economic development is obvious, many issues in this area remain unexplored. Scholars pay not enough attention to determining the impact of knowledge management on macroeconomic indicators, which currently are the main ones in the process of assessing economic growth. These issues are considered by researchers using cases of countries with different economic development and dynamics of progress (Bryl, 2018; Chlebisz, Mierzejewski, 2020; Kitrar, Lipkind, 2021). The existing scientific and methodological developments are more related to the study of the relationship between the individual components of knowledge management and economic growth. In this aspect, Kalashi et al. (2020) prove a significant positive impact of the application of information and communication technology skills on the process of knowledge management. To confirm this thesis, Adam (2020) considers four elements: ICT development, e-government development, institutional quality, and economic development. The development of ICT is measured by the ICT Development Index, which is based on ICT indicators grouped into three clusters: access, use, and skills. The obtained results allow us to state that country development in the field of ICT is positively related to its economic development and can lead to economic growth.

The impact of ICT on economic growth has been confirmed at various hierarchical levels (Takhtravanchi, Pathirage, 2018; Bilan et al., 2019; Suknunan, Maharaj, 2019; Polyakov et al., 2020). The authors use data of correlation analysis and modeling of the impact of ICT factors on the main financial results and prove that sustainable socioeconomic growth has acquired the features of constant digital development. Given the current trends in the development of ICT in business and their relationship with financial results, our study proposes the main measures that should be aimed primarily at expanding Internet access and the effective use of web technologies, especially in the field of e-commerce.

Moreover, we should emphasize the studies that confirm the significant relationship between knowledge management and other aspects and performance indicators. These include the significant positive impact of knowledge management on regional development (Klimuk, 2019; Kostiukevych et al., 2020), organizational performance (Majid and Mahmud, 2019; Soniewicki and Paliszkiewicz, 2019; Wijaya and Suasih, 2020), marketing effectiveness (Raeeszadeh et al., 2016), resource planning (Akimova et al., 2020), and the improvement in the quality of supply chains and creating competitive advantages (Azizi et al., 2016; Karpenko et al., 2017; Haseeb et al., 2019). Askarian and Abdollahi (2016) found in their study that there is a significant relationship between knowledge management and organizational behavior.
Quantitative analysis also demonstrates the relationship between knowledge management capabilities, processes, and organizational performance. The opportunities created by knowledge management have a significant positive impact on operational processes, but also on financial and non-financial indicators (André Luhn et al., 2017). At the same time, the shortage of skilled workers slows down business development and leads to additional costs for human capital development (Grishnova et al., 2019; Bilan et al., 2020; Oliinyk, 2020). In this regard, we must indicate the significant links between knowledge sharing and organizational culture, but also between organizational structure and knowledge management (Chión et al., 2019).

The above overview confirms the opinion that knowledge management is an important factor in economic development. At the same time, one of the most important tasks of the organization is the formation of employees’ relevant skills and competencies to achieve planned business goals. From this viewpoint, scholars find that knowledge management tools have a significant positive impact on the work activity of employees (Raeeszadeh et al., 2016). The study analyzes some aspects of knowledge management such as hires, employee work competencies, mentors’ roles, motivation, employee management, communication, favorable working environment, and human capital investments. Raeeszadeh et al. (2016) determine that each of these elements has a significant positive impact on employment and employee involvement.

Besides, knowledge management can increase the job satisfaction of individual employees. Kianto et al. (2016) propose a theoretical model that relates to the relationships between job satisfaction and five components of knowledge management (acquisition, exchange, creation, codification, and retention). The presence of knowledge management processes in the workplace significantly affects the growth of job satisfaction. The key process is the internal organizational exchange of knowledge.

Masa’deh et al. (2019) explore the role of technological, organizational, and cultural knowledge management infrastructure in increasing job satisfaction. The results show that the technological and cultural infrastructure of knowledge management has a significant positive impact on job satisfaction, as technology is one of the tools that contribute to the creation of new knowledge using information and communication systems in order to integrate fragmented information flows and technologies. This removes communication barriers between different structural units of the organization.

In the process of analysis, one cannot neglect scientific developments that allow assessing the impact of knowledge management on innovation, because innovation activity is one of the key factors that ensures sustainable competitiveness in modern conditions.
Therefore, increasing the efficiency of innovation is critical to creating a competitive advantage. The results obtained by Inkinen (2016) and Klopova et al. (2018) evidence that the implementation of knowledge management practices strongly drives innovation. Moreover, specific leadership characteristics and organizational arrangements support competitiveness through the better management of knowledge resources.

Therefore, the availability of information and knowledge can be identified as one of the best ways to increase the innovative capacity of organizations. In this regard, the role of leadership in knowledge management and organizational innovation development is growing (Bannay et al., 2020). Sadeghia and Rad (2018) investigate the relationship between knowledge-based leadership, knowledge management, and innovation efficiency. Data analysis and hypothesis testing prove a significant relationship between these three measures. In particular, there is a positive and meaningful relationship between knowledge management and innovation efficiency with a correlation coefficient of 0.73.

Obeidat et al. (2016) prove the impact not only of the whole system but also of individual processes of knowledge management (acquisition, exchange, and use) and approaches to knowledge management (social network, codification, and personalization) on innovation. The knowledge management studies within the results of knowledge sharing are typical not only for the national but also entrepreneurial level (Tvaronavičienė, Burinskas, 2021). Particularly, what develops steadily is the practice of ICT-based personnel selection tools in the framework of firms’ knowledge management systems (Balcerak, Woźniak, 2021).

Within the study of existing approaches to assessing the impact of knowledge management on economic growth, an important place is occupied by the category of “knowledge economy,” which acts as a new type of economy based on knowledge and ideas, while the most important factor of development and prosperity is knowledge capitalization. The Organization for Economic Cooperation and Development (OECD, 1996) has introduced the following definition into scientific circulation: a knowledge economy or a knowledge-based economy is an economy that is directly based on the creation, distribution, and use of knowledge and information. Thus, knowledge management emerged as a necessity in a post-industrial society and a new knowledge economy. Changes in the structure of the economy and its important assets led to a new type of economy, in which the scarcity of material resources was replaced by the sufficiency of intangible resources, while economic theories of resource optimization and profit maximization were brought in line with knowledge creation and business sustainability (Vovk et al., 2017; Bolisani and Bratianu, 2018).
Simplice et al. (2020) prove that developing countries can accelerate their development and catch up with advanced economies by identifying knowledge as a driver of development. It is based on this approach that they assess the potential of knowledge and its impact on economic progress. Given the close relationship between the individual elements of the knowledge economy, the results of the study demonstrate the positive impact of the interaction between them on economic growth. This agrees with the findings of Roszko-Wójtowicz and Grzelak (2020) about the positive impact of the components that characterize knowledge management in the Global Competitiveness Index and the EU Regional Competitiveness Index on macroeconomic stability. The significant macroeconomic effect of innovation in the system of factors of the knowledge economy is also confirmed in studies of competitiveness factors of the Visegrád Group countries (Ivanová and Čepel, 2018).

Van Dung et al. (2017) also consider the role of different components of the knowledge economy in economic growth. Using the Driscoll-Krai estimation method, regression analysis, and the three-stage least squares method, they argue that there is a positive relationship between economic growth and components of the knowledge economy such as ICT infrastructure, education, and innovation.

Thus, in recent decades, the topic of the knowledge economy has become increasingly popular in academia and business, as it is viewed as a major source of economic growth and sustainable competitiveness in all economic activities. As a result, the main drivers of economic growth are the following main elements (pillars) of the knowledge economy: incentives for economic and institutional development; educated and skilled workers who can contribute to the creation and dissemination of knowledge; an adequate system of innovations able to cover the globalized stock of knowledge, understand it, and adapt to specific regional/local conditions; modern information infrastructure that allows people to communicate, transmit, and process information and knowledge (Hadad, 2017).

**Data and Methodology**

To study the links between knowledge management and economic growth, we formed and tested the following hypotheses:

**H1:** The high level of knowledge management factors development leads to GNI per capita growth.
**H2:** The factors that characterize the possession of current skills have a significant impact on changes in GNI per capita.

Basing on the above hypotheses, we assessed the impact of knowledge management factors by indicating the most significant factors that should be used in state policy aimed at economic development by appropriate knowledge management.

In both research hypotheses, we selected the GNI per capita (gross national income per capita, US dollars; WBG, 2020) as the dependent variable $Y$, which is currently the basic indicator in international statistics that characterizes macroeconomic growth.

In order to select knowledge management indicators to assess their impact on economic growth, we analyzed the composition of international indices in this area (Table 1).

The choice of international indices is justified by a generally accepted approach (Mishchuk et al., 2016; Lestari and Hamka, 2018; Torres et al., 2018), according to which the main components of knowledge management are people, technologies, and processes. Therefore, we selected and analyzed international indices whose calculation methodology is based on indicators that correspond to the concept of knowledge management. Such indices include in particular the Global Knowledge Index, whose main purpose is to establish a comprehensive link between knowledge and sustainable development (UNDP, 2021). This approach seeks to help politicians, researchers, civil society, and business to jointly work to promote “knowledge-based development.” At the same time, it seeks to provide people from an early age with the necessary skills for sustainable competitiveness in the labor market in the future.

However, our study used indices that aim to assess individual elements of knowledge management (e.g. ICT, innovation, skills, education, intellectual property). The use of such indices and sub-indices will detail the role of each of the components of knowledge management in economic growth.

The values of the independent and dependent variables were selected for the group of 20 EU countries for which such data were the most complete, i.e. the relevant factors were monitored according to the selected indices.

The obtained results were further used as a basis for substantiation of management decisions at different hierarchical levels, in particular on the feasibility of investing in different areas of knowledge management.
Table 1. International indices and sub-indices containing components of knowledge management

<table>
<thead>
<tr>
<th>Title</th>
<th>Coverage of countries</th>
<th>Components</th>
<th>Indicator</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Global Competitiveness Index. ‘Skills’ Sub-Index (WEF, 2020)</td>
<td>141</td>
<td>Current workforce: mean years of schooling. Skills of current workforce: extent of staff training; quality of vocational training; skillset of graduates; digital skills among active population; ease of finding skilled employees. Future workforce: school life expectancy. Skills of future workforce: critical thinking in teaching; pupil-to-teacher ratio in primary education.</td>
<td>score</td>
<td>X₁</td>
</tr>
<tr>
<td>The Global Competitiveness Index. ‘Innovation Capability’ Sub-Index (WEF, 2020)</td>
<td>141</td>
<td>Interaction and diversity: diversity of workforce; state of cluster development; international co-inventions; multi-stakeholder collaboration. Research and development: scientific publications; patent applications; R&amp;D expenditures; research institutions prominence. Commercialization: buyer sophistication; trademark applications.</td>
<td>score</td>
<td>X₂</td>
</tr>
<tr>
<td>The Digital Economy and Society Index (EC, 2020)</td>
<td>29</td>
<td>Connectivity; capital; use of internet services; integration of digital technologies; digital public services.</td>
<td>score</td>
<td>X₃</td>
</tr>
<tr>
<td>Global knowledge index (UNDP, 2019)</td>
<td>134</td>
<td>Pre-university education; technical, vocational education and training; higher education; research, development, and innovation; information and communication technologies; economy; general enabling environment.</td>
<td>value</td>
<td>X₄</td>
</tr>
<tr>
<td>Prosperity index. ‘Education’ sub-index (Legatum Institute, 2020)</td>
<td>167</td>
<td>Pre-primary education; primary education; secondary education; tertiary education.</td>
<td>score</td>
<td>X₅</td>
</tr>
<tr>
<td>The Social Progress Index. ‘Foundations of Wellbeing’ sub-index (The Social Progress Imperative, 2020)</td>
<td>149</td>
<td>Access to basic knowledge; access to info and comms; health and wellness; environmental quality.</td>
<td>score</td>
<td>X₆</td>
</tr>
<tr>
<td>Global Entrepreneurship Index. ‘Entrepreneurial Abilities’ Sub-Index (GEDI, 2020)</td>
<td>137</td>
<td>Opportunity startup; technology absorption; human capital; competition.</td>
<td>score</td>
<td>X₇</td>
</tr>
<tr>
<td>The Global Innovation Index (Cornell, INSEAD &amp; WIPO, 2020)</td>
<td>129</td>
<td>Institutes; human capital and research; infrastructure; market sophistication; business sophistication; knowledge and technology outputs; creative outputs.</td>
<td>score</td>
<td>X₈</td>
</tr>
</tbody>
</table>
### The Global Social Mobility Index. ‘Lifelong Learning’ Sub-Index (WEF, 2020)
- Score: X₉
- Extent of staff training; active labor market policies; impact of ICTs on access to basic services; percentage of firms offering formal training; digital skills among active population.

### The Global Connectivity Index (Huawei, 2020)
- Score: X₁₀
- Four pillars in ICT: supply, demand, experience, potential.

### International Intellectual Property Index (GIPC, 2020)
- Score: X₁₁
- Patents, related rights, and limitations; copyrights, related rights, and limitations; trademarks, related rights, and limitations; design rights, related rights, and limitations; trade secrets and the protection of confidential information; commercialization of IP assets; enforcement; systemic efficiency.

### The International Property Rights Index. ‘Intellectual Property Rights’ Sub-Index (Property Rights Alliance, 2020)
- Score: X₁₂
- Protection of intellectual property rights; patent protection; copyright piracy.

### The Global Skills Index (Coursera, 2020)
- Percent: X₁₃
- Business; technology; data science.

### The Hays Global Skills Index (Hays plc., 2020)
- Score: X₁₄
- Education flexibility; labor market participation; labor market flexibility; talent mismatch; overall wage pressure; wage pressure in high-skill industries, wage pressure in high-skill occupations.

### The Global Talent Competitiveness Index (INSEAD, 2020)
- Score: X₁₅

### The Global AI Index (Tortoise, 2020)
- Score: X₁₆

Source: own elaboration.

We conducted the further identification of connections in accordance with the research hypotheses by the method of correlation analysis using the MS Excel software. In particular, we determined Pearson’s correlations with a significance level of p-values of 0.95. The statistical significance of correlation coefficients was verified by standard rules: by comparing the critical and calculated values of t-statistics.

To use the assessed links in the practice of knowledge management, we also modeled the impact of factors on the GNI based on the use of the most significant links.
Results

The obtained results of the correlation-regression analysis proved the existence of a close relationship between the components of knowledge management and GNI per capita (WBG, 2020) (Table 2).

The results of the correlation analysis confirm the high importance of knowledge management in ensuring the economic growth of European countries, as the correlation coefficients exceed 0.7. Their statistical significance was checked using the Student’s criterion (Table 2). The only exception is the Global AI Index, as its correlation coefficient is 0.461, and the calculated value of the Student’s criterion is below critical. Let us note that this index contains components that are within the concept of knowledge management. In particular, the Global AI Index includes the Talent sub-index, which assesses the availability of qualified practitioners to provide artificial intelligence solutions, and the Research sub-index, which focuses on specialized research in artificial intelligence, the number of publications and citations in credible scientific journals. However, its main object of research is artificial intelligence, investment in its development, and its implementation (Tortoise, 2020). Therefore, from the calculations we can conclude that the introduction of artificial intelligence today cannot be perceived as a determinant of economic growth; its role is more pronounced in certain activities and in combination with the influence of other factors, such as the Global Connectivity Index. However, artificial intelligence as a separate factor has not yet played a decisive role in the formation of general macroeconomic results.

The most important factors at the present stage of world development for economic growth are the indicators considered as components of the Global Talent Competitiveness Index and the Global Connectivity Index with correlation coefficients of 0.939 and 0.935, respectively. The Global Talent Competitiveness Index examines the impact of technological change on talent competitiveness and confirms that – despite the trend of displacing jobs at all levels by machines – technology also creates new opportunities. The skills that are key to success are the ability to work with new technologies and with people, along with flexibility and collaboration (INSEAD, 2020). The Global Communications Index assesses the transformation of the digital economy as it constantly expands and updates its own methodology as innovation is implemented and promoted around the world. Currently, this index includes technologies such as broadband, cloud computing, AI, and the internet of things (IoT; Huawei, 2020). Therefore, the penetration of IT into all areas of activity will facilitate the creation and exchange of knowledge, as time and space barriers slowly disappear. Innovative technologies such as big data, machine learning, and cloud computing allow organizations to collect
Table 2. Results of correlation analysis of knowledge management relationship with the GNI per capita

<table>
<thead>
<tr>
<th>Country</th>
<th>Y</th>
<th>X_1</th>
<th>X_2</th>
<th>X_3</th>
<th>X_4</th>
<th>X_5</th>
<th>X_6</th>
<th>X_7</th>
<th>X_8</th>
<th>X_9</th>
<th>X_10</th>
<th>X_11</th>
<th>X_12</th>
<th>X_13</th>
<th>X_14</th>
<th>X_15</th>
<th>X_16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>51300</td>
<td>79.4</td>
<td>74.5</td>
<td>54.3</td>
<td>64.7</td>
<td>83.01</td>
<td>87.41</td>
<td>65.1</td>
<td>50.9</td>
<td>73.2</td>
<td>65</td>
<td>*</td>
<td>8.434</td>
<td>97</td>
<td>5.9</td>
<td>68.87</td>
<td>23.6</td>
</tr>
<tr>
<td>Belgium</td>
<td>47350</td>
<td>79.3</td>
<td>71.4</td>
<td>58.7</td>
<td>64.8</td>
<td>83.57</td>
<td>87.29</td>
<td>67.4</td>
<td>50.2</td>
<td>68.0</td>
<td>65</td>
<td>*</td>
<td>8.195</td>
<td>93</td>
<td>3.9</td>
<td>68.87</td>
<td>17.6</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>9410</td>
<td>67.9</td>
<td>45.0</td>
<td>36.4</td>
<td>48.8</td>
<td>74.78</td>
<td>75.3</td>
<td>26.5</td>
<td>40.3</td>
<td>52.9</td>
<td>51</td>
<td>*</td>
<td>5.687</td>
<td>*</td>
<td>*</td>
<td>45.76</td>
<td>*</td>
</tr>
<tr>
<td>Croatia</td>
<td>14910</td>
<td>63.5</td>
<td>37.8</td>
<td>47.6</td>
<td>50.6</td>
<td>73.64</td>
<td>80.88</td>
<td>31.8</td>
<td>37.8</td>
<td>48.4</td>
<td>50</td>
<td>*</td>
<td>4.791</td>
<td>*</td>
<td>*</td>
<td>43.53</td>
<td>*</td>
</tr>
<tr>
<td>Cyprus</td>
<td>27710</td>
<td>72.2</td>
<td>46.3</td>
<td>44.0</td>
<td>53.9</td>
<td>78.41</td>
<td>86.84</td>
<td>49.3</td>
<td>48.3</td>
<td>56.0</td>
<td>*</td>
<td>*</td>
<td>6.226</td>
<td>*</td>
<td>*</td>
<td>57.47</td>
<td>*</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>22000</td>
<td>72.9</td>
<td>56.9</td>
<td>50.8</td>
<td>57.5</td>
<td>81.78</td>
<td>82.52</td>
<td>42.6</td>
<td>49.4</td>
<td>65.5</td>
<td>58</td>
<td>*</td>
<td>7.401</td>
<td>64</td>
<td>4.2</td>
<td>60.91</td>
<td>17.3</td>
</tr>
<tr>
<td>Denmark</td>
<td>63240</td>
<td>85.7</td>
<td>76.2</td>
<td>69.1</td>
<td>67.6</td>
<td>87.84</td>
<td>90.18</td>
<td>90.14</td>
<td>58.4</td>
<td>75.1</td>
<td>78</td>
<td>*</td>
<td>8.245</td>
<td>81</td>
<td>6.5</td>
<td>75.18</td>
<td>24.9</td>
</tr>
<tr>
<td>Finland</td>
<td>49580</td>
<td>85.7</td>
<td>75.8</td>
<td>72.3</td>
<td>69.7</td>
<td>86.58</td>
<td>89.25</td>
<td>64.6</td>
<td>59.8</td>
<td>78.0</td>
<td>75</td>
<td>*</td>
<td>8.903</td>
<td>100</td>
<td>*</td>
<td>74.47</td>
<td>26.6</td>
</tr>
<tr>
<td>France</td>
<td>42400</td>
<td>71.9</td>
<td>77.2</td>
<td>52.2</td>
<td>62.5</td>
<td>81.23</td>
<td>90.72</td>
<td>66.8</td>
<td>54.2</td>
<td>64.4</td>
<td>68</td>
<td>91.50</td>
<td>7.929</td>
<td>73</td>
<td>6.0</td>
<td>64.83</td>
<td>34.1</td>
</tr>
<tr>
<td>Germany</td>
<td>48520</td>
<td>84.2</td>
<td>86.8</td>
<td>56.1</td>
<td>64.6</td>
<td>83.24</td>
<td>87.70</td>
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Correlation coefficient: 0.905 0.920 0.831 0.928 0.894 0.864 0.916 0.889 0.820 0.935 0.842 0.881 0.869 0.742 0.939 0.461

Student's criterion: 9.05 9.96 6.33 10.56 8.46 7.28 9.41 8.24 6.08 10.54 3.82 7.90 6.33 3.67 11.58 1.79

The critical value: 2.101 2.101 2.101 2.101 2.101 2.101 2.101 2.101 2.120 2.447 2.101 2.160 2.201 2.101 2.179

Significance α = 0.05 + + + + + + + + + + + + + + + +

* data unavailable. Source: own elaboration.
and process vast amounts of data. Today, the key to success for many organizations is the speed with which they can integrate such knowledge into their existing business models/processes or share it with a wide range of stakeholders (UNDP, 2019). Thus, the obtained results confirm the decisive role of modern information technologies as the most important catalyst for long-term economic growth.

For a more detailed study of the impact of knowledge management on economic growth, testing hypothesis H1, we developed an appropriate economic and mathematical model using the built-in “Regression” function in the MS Excel software. This feature allows one to identify the mathematical relationship between the parameters of the model and then assess its statistical significance, adequacy, and suitability for practical use.

As a result of a step-by-step assessment of the impact of the parameters listed in Table 2 on GNI per capita based on a multifactor regression model, we identified the below three-factor model (1):

\[ y = -137,793 + 0.85x_1 + 0.37x_2 + 1.003x_6 \]  

(1),

in which \( y \) is GNI per capita in USD; \( x_1 \) is the value of the ‘Skills’ sub-index in the Global Competitiveness Index (score); \( x_2 \) is the value of the ‘Innovation Capacity’ sub-index within the Global Competitiveness Index (score); \( x_6 \) is the value of the ‘Fundamentals of Welfare’ sub-index in the Index of Social Progress (score).

The main statistical indicators that confirm the statistical significance and adequacy of this model are shown in Table 3.

**Table 3. Results of checking the adequacy of the economic-mathematical model on the main statistical indicators**

<table>
<thead>
<tr>
<th>No.</th>
<th>Indicators</th>
<th>Estimated value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Multiple correlation coefficient</td>
<td>0.959</td>
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<tr>
<td>2.</td>
<td>Coefficient of determination</td>
<td>0.919</td>
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<tr>
<td>3.</td>
<td>F-statistics</td>
<td>60.67</td>
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<tr>
<td>3.1</td>
<td>The critical value for this model, F</td>
<td>3.24</td>
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<tr>
<td>4.</td>
<td>t-statistics</td>
<td></td>
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<td>4.1</td>
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<td>2.51</td>
</tr>
<tr>
<td>4.2</td>
<td></td>
<td>2.15</td>
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</table>
The obtained results of checking the adequacy of the model allow us to state that the constructed three-factor model is characterized by high theoretical capacity and is suitable for practical use.

To test hypothesis H2, we reduced the sample of countries to 13, according to the available data illustrating the development of skills (Table 2). As a result of assessing the impact of factors – namely international indices in the field of measuring modern skills – the below two-factor model emerged as the most statistically significant one (2):

\[
y = -49.07 + 0.709x_{13} + 6.502x_{14}
\]  

(2),

in which \( y \) is GNI per capita in USD; \( x_{13} \) is the Global Skills Index (percent); \( x_{14} \) is the Hays Global Skills Index (score).

The developed model is statistically significant and adequate, which is confirmed by the main statistical indicators (Table 4).

**Table 4. Results of checking the adequacy of the economic-mathematical model on the main statistical indicators**

<table>
<thead>
<tr>
<th>№ 3/н</th>
<th><strong>Indicators</strong></th>
<th><strong>Estimated value</strong></th>
</tr>
</thead>
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<tr>
<td>1.</td>
<td>Multiple correlation coefficient</td>
<td>0.937</td>
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<tr>
<td>2.</td>
<td>Coefficient of determination</td>
<td>0.879</td>
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<td>3.</td>
<td>F-statistics</td>
<td>36.34</td>
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<td>3.1.</td>
<td>The critical value for this model, ( F )</td>
<td>4.1</td>
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<tr>
<td>4.</td>
<td>( t )-statistics</td>
<td></td>
</tr>
<tr>
<td>4.1.</td>
<td>( x_1 )</td>
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<td>4.2.</td>
<td>( x_2 )</td>
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</tr>
<tr>
<td>4.3.</td>
<td>The critical value for this model, ( t )</td>
<td>2.228</td>
</tr>
</tbody>
</table>

Source: own elaboration.
Thus, the calculated value of Fisher's criterion (36.34) is more than critical (4.1). The increase in GNI per capita by 87.9% stems from the influence of available skills in the population and only by 12.1% from the influence of other factors not accounted for in the model, as the coefficient of determination $R^2 = 0.879$. The dependence of economic growth on current knowledge, skills, and abilities of the population is close and direct, as the coefficient of pair correlation is 0.937, i.e. with increasing value of international indices that assess the necessary skills in today's globalized world – GNI per capita increases. Therefore, skills are of paramount importance for economic growth in modern conditions.

## Conclusion

Based on the analysis of data from the European Union, we can confirm the existence of a positive relationship between GNI per capita and knowledge management. At the same time, what is the most effective at the present stage are management actions aimed at developing skills (e.g. the ability to work with new technologies and with people, along with flexibility and cooperation), innovation capacity, access to information, and means of communication. Further development of such components of the knowledge management system will result in achieving the greatest economic efficiency based on the development of the knowledge economy.

The results of modeling these links suggest that to strengthen the competitiveness of countries, governments should support the development of information technology at a high level. It will also position the IT sector as a driver of innovation. However, investing in information technology alone is not enough to strengthen competitiveness and resilience in the digital economy. Without the skills and talents needed to use these technologies and stimulate innovation, countries risk losing their competitiveness, reducing investment attractiveness, and slowing economic growth. This approach is useful for the periodic assessment of changes in relationships and selection of these factors whose impact is the most significant at a certain stage of economic development.

A certain limitation of this and similar studies is the incomparability of some statistical information on the composition of individual indices, as the methodology for determining them is constantly improving. As a consequence, this study was conducted with the limitation of data available for analysis in the context of all dimensions of knowledge management. In particular, some comparable data were unavailable to test hypothesis H2 and develop an appropriate economic and mathematical model due to the fact that not all countries conduct appropriate monitoring, which narrows
the analytical base of the study. Nevertheless, provided that at least the most significant links are taken into account and aligned with national economic development priorities, regulatory action to improve knowledge management will be aimed at developing mechanisms that will best enhance the implementation of knowledge management systems at various levels of economic relations.

References


Kalashi, M., Bakhshalipour, V., Azizi, B. and Sareshkeh, S.Kh. (2020). The Effect of the Application of ICT Skills on the Process of Knowledge Management Components and the Effectiveness of Creativity Indicators for the Improvement of Employees’ Performance System in the Ministry


