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RESEARCH ARTICLE

Prospects and Challenges of the Impact of Artificial Intelligence and Machine Learning on Social and Economic Progress

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ABSTRACT

The relevance of researching the opportunities and potential threats posed by the spread of artificial intelligence (AI) and machine learning technologies is determined by their impact on economic processes and social structures in different countries worldwide. These technologies open new business opportunities at all levels, including optimising production processes, developing human resources, data analytics, and forecasting. However, with the growth of AI applications, corresponding risks also increase, which can affect economic resilience and social security. Considering these aspects within this research is critically important for understanding and effectively managing the impact of artificial intelligence on modern global challenges and opportunities. The research aims to analyse the impact of artificial intelligence and machine learning on modern society's economic development and social structures. It also aims to determine the impact of these technologies on the socio-economic aspects of various countries, including ethical aspects of data usage, cybersecurity, and sustainable development in the context of their implementation in modern society. During the research, general scientific methods of cognition were used, namely literature analysis, statistical data analysis, comparative analysis, systematisation, and generalisation methods. In addition, correlation analysis was applied to determine the relationship between GDP volume and Total Government AI Readiness. The results of the analysis, conducted in the JASP program using the "Correlation" tool, helped determine the strength and nature of the relationship between AI readiness and economic development indicators in different regions. The research found that Government AI Readiness statistically impacts economic development in different geographical regions. In particular, a moderate positive correlation was established between GDP and the overall readiness score, as well as for aspects such as government readiness, technology sector, and data infrastructure. The results highlight the importance of these relationships for understanding the impact of artificial intelligence on the modern global economic environment.

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INTRODUCTION

The rapid development and generative breakthroughs in the field of artificial intelligence, significant advancements in AI regulation, such as the European Union's AI Act, and the substantial increase in the number of AI-focused summits have drawn global attention to the prospects and potential challenges in this area (Hankins et al., 2023). Therefore, analysing the impact of artificial intelligence and machine learning on the development of the economy and society at the current stage is a crucial topic reflecting profound transformations in various fields of activity. AI accelerates innovation processes, changes business models, optimises managerial decisions, and improves citizens' quality of life. However, research into the impact of AI on the economy and society identifies both opportunities and threats associated with the rapid implementation of these technologies.

Regarding opportunities, it is worth noting that AI has the potential to create approximately 97 million new jobs, which will help alleviate future labour displacement issues (Ilzetzki & Jain, 2023). Additionally, implementing AI can significantly increase the productivity of various sectors, particularly manufacturing, leading to an expected profit increase of $3.8 trillion by 2035 (Ghorpade, 2020). However, several threats exist. For example, around 77% of respondents expressed concern about potential job reductions due to automation and AI implementation (Haan & Watts, 2023). It is forecasted that by 2030, AI-related technologies could undergo transformations affecting about 15% of the global workforce (George, 2024). Furthermore, there is a threat of increasing cybercrime associated with artificial intelligence, which may include phishing, cyberattacks, and the use of AI for financial crimes and other illegal activities (Shkodenko & Biehun, 2024; Kussainov et al., 2023). In this context, analysing the impact of AI on the economy and society is highly relevant and essential for the future development of technologies, requiring not only the promotion of opportunities but also the avoidance of potential challenges associated with these technologies.

This scientific article aims to analyse the impact of artificial intelligence and machine learning on modern society's economic development and social structures. The article seeks to assess the potential of information technologies in solving economic problems and identify opportunities for optimising production processes and increasing productivity in various sectors of the economy. It also examines the impact of artificial intelligence on jobs, income distribution, and social adaptation. The research includes identifying key challenges such as ethical data use issues, cybersecurity, and the need for the sustainable implementation of artificial intelligence technologies in modern society.

LITERATURE REVIEW

The digitalisation of modern society is marked by a radical transformation of the economic landscape due to the intensive implementation of artificial intelligence (AI), which opens new horizons for automation, optimisation of production processes, and managerial decisions, reprogramming the fundamental principles of modern economic systems (Shevchenko et al., 2023; Khatniuk et al., 2023). It expands opportunities and revolutionises business processes, modern marketing, human resources, public administration, financial services, education, etc., by automating complex tasks, improving analytics based on large data volumes, increasing decision-making accuracy, optimising resource use, supporting strategic decision-making through forecasting, and enhancing user interaction through personalisation and process automation (Klochan et al., 2021; Bielialov et al., 2023).

However, today, the main problem in many countries, according to Kornieieva (2021), is the gap between the rapid development of artificial intelligence technologies and their implementation in society. According to Baranov (2023), artificial intelligence represents a strategic initiative to create technological conditions achieved by automating decision-making processes, allowing AI systems to operate with quality and optimal choices independent of potential human factor influences. Therefore, AI plays a crucial role in ensuring sustainable development, increasing productivity, and improving the quality of life by implementing advanced technologies in management and production processes. It should be noted that the areas of practical application of artificial intelligence in modern conditions, according to Pohorelenko (2018), include not only machine learning but also neural networks, cognitive computing, computer vision, theorem proving, image recognition, machine translation, understanding human language, gaming programs, machine creativity, and expert systems. These areas are critical to developing the economy and society, ensuring process

automation, increased labour productivity, improved management systems, and creating new opportunities in fields where innovation plays a critical role.

According to the theoretical foundations presented by Acemoglu and Restrepo (2018), the impact of new technologies on society, particularly on the labour market, can be divided into three main effects: **the displacement effect,** which concerns the replacement of human labour by automated systems and robots, potentially leading to job reductions in specific sectors; **the productivity effect,** which involves increased labour efficiency through the implementation of new technologies, allowing work to be done faster and with fewer costs; **and the recovery effect,** when new technologies create platforms for new tasks and jobs in many service sectors where human labour has a comparative advantage over machines, thus increasing the demand for labour (Acemoglu & Restrepo, 2018). These effects generally define AI's complex and multifaceted impact on the labour market, necessitating further research and policy adaptation to ensure balanced economic development and job retention. With the development of AI technologies, more and more enterprises are incorporating it into their production processes, leading to expectations of significant changes in employment structure. Frey and Osborne (2013) estimated that 47% of all jobs in the US are at risk of automation within the next decade, so a significant share of employment in service sectors, where job growth has been highest in the US over the past decades, is susceptible to the development of artificial intelligence, machine learning, and other innovations.

RESEARCH METHODS

In the course of our work, we applied the following methods: literature analysis, utilised to identify the potential and possible threats of implementing artificial intelligence and machine learning technologies in various spheres of the global socio-economic environment; statistical data analysis, used to assess the growth rate of the global AI market; comparative analysis, applied to measure the level of AI development in different countries within geographical regions; systematisation method, employed to structure the collected data and research results, allowing us to highlight the main trends, challenges, and opportunities associated with the implementation of AI and ML in the modern socio-economic environment; and the generalisation method, used to form an overall understanding of the impact of AI and ML on various sectors of the economy and society by analysing data from different sources and the results of previous studies.

To study the impact of government readiness for AI usage on the overall economic development of geographical regions, we chose a correlation analysis based on determining the relationship between Gross Domestic Product (GDP) and Total Government AI Readiness, as well as its components: Government Pillar, Technology Sector Pillar, and Data & Infrastructure Pillar. We created a table of Pearson correlation coefficients in the JASP program during the study using the “Correlation” tool. The results of the analyses were obtained in the form of calculated linear connection indicators, significance levels, confidence interval boundaries, effect size and errors, which allowed us to conclude the strength and nature of the relationship between AI readiness and economic development indicators in different regions.

RESEARCH RESULTS

Artificial Intelligence (AI) and Machine Learning (ML) are central to the modern discourse on technological progress and its impact on the economy and society. These technological innovations not only transform the technical aspects of various sectors of the economy but also change the economic structure and social relationships among all their participants. Additionally, they serve as catalysts for innovative activity, solving complex problems, and implementing new opportunities in all areas of economic activity. The current stage of AI and ML development is characterised by rapid growth, as confirmed by forecast data from Statistica on the volume and expected expansion of the global AI market (Figure 1).

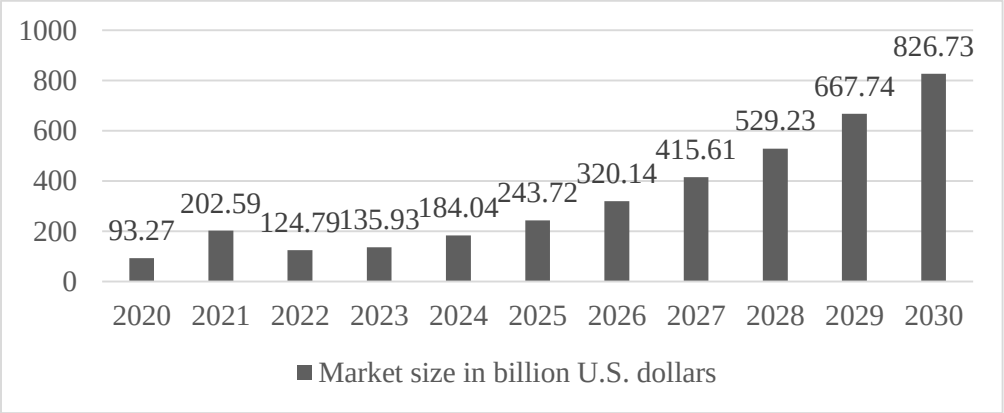

Figure 1: Global artificial intelligence (AI) market in 2020–2030

Source: compiled by the author based on Thormundsson (2024)

In 2024, the artificial intelligence market reached an impressive volume of over 184 billion USD, marking a significant economic leap compared to the previous year when it was about 134 billion USD. This shows an increase of nearly 50 billion dollars or approximately 37%. Additionally, a Statistica report forecasts that this trend will continue and that by 2030, the AI market could exceed 826 billion USD, indicating the extremely rapid development of this industry and its significant impact on the global economy.

Based on statistical justification and analysis of thematic studies, AI and ML demonstrate significant potential in various areas of the global socio-economic environment. They are used for automating production processes, optimising supply chains, improving the quality of medical diagnoses and treatments, analysing large volumes of data to forecast market trends, and improving managerial decisions (Table 1). However, along with the prospects and opportunities opened up by these technologies, problems arise that will be resolved in the long term to ensure the sustainable and responsible implementation of AI and ML technologies in modern society.

Table 1: Opportunities and challenges related to the proliferation of ai in the global socio-economic environment

Direction	Features	Opportunities	Challenges
Economic growth	The impact of AI on the economy by increasing productivity and creating new markets and opportunities	Growth of economic indicators, increased competitiveness and creation of new markets	Risks of economic dependence on AI and the possibility of rising unemployment in some sectors
Global challenges	The impact of AI on global challenges such as poverty, climate change and global security	Potential solution to global problems through improved data analysis of the political, economic or social situation in the country and risk forecasting	Risks of a digital divide and the inability of some regions to adapt to new technologies
Social adaptation	The impact of AI on social relationships and the cultural landscape, including access to technology and ethical issues	Increased access to technology and improved welfare of the population	Risks of bias in AI systems and inequality of access to technology
Human resource development	The impact of AI on human resource management, including learning, career development and talent management	Improved training and development of employees, personalised career management	Risks of job losses due to automation and the need to retrain workers
Regulatory policy	The impact of AI on legal and regulatory policies,	Improving the legislative	Problems with the balance between innovation and

	including data protection, transparency and ethical standards	environment for consumer protection and ethical use of AI	consumer and privacy protection
Automation	AI automates routine tasks, which can reduce the need for simple operations	Increased production efficiency and reduced costs	The need to retrain employees and socially adapt to new technologies
Data analytics and forecasting	Use of AI to analyse large amounts of data and predict market trends and consumer behaviour	Improved decision-making in both government and private business and the ability to predict risks	Data privacy issues and the need to protect users' personal information
Financial services	Application of AI in the financial sector to automate trading, risk, credit scoring and portfolio analysis	Improved efficiency of financial transactions and settlements	Potential cybersecurity threats and financial manipulation through the use of AI
Innovations and start-ups	Development of AI technology start-ups for the development of new products and services	Increased innovation activity of countries or individual enterprises and their competitive advantages	High research and development costs that may be inefficient
Environmental sphere	Using AI to solve environmental problems, including energy efficiency and waste management	Reduced environmental impact, increased resource efficiency	Risks of increasing electricity consumption and the need for high-tech resources

Source: compiled by the author based on Androschuk (2021), Bihun et al. (2024), Das & Sandhane (2021), Horowitz et al. (2022), Kussainov et al. (2023), Lysyi (2024), Radanliev (2024), Skrypnyk & Shpatakova (2023)

Thus, in the modern world, AI is becoming increasingly critical in technological and economic development. Government readiness for the effective use of this technology becomes a critical condition for ensuring the competitiveness of countries and regions in the global economic environment. Analysing the impact of government readiness for AI implementation on the overall economic development of countries and geographical regions is essential in understanding how technological innovations affect socio-economic processes and can contribute to sustainable development goals.

Therefore, critical indicators for analysis have been identified, including the Government AI Readiness Index (Table 2), to measure the level of AI development in various countries within geographical regions. Countries were selected using a random sampling method to ensure the objectivity of the analysis results. An additional indicator for analysis is the Gross Domestic Product (The World Bank Group, 2024) as a variable demonstrating countries' economic achievements. Thus, the analysis of these variables will allow us to determine how effectively countries use the potential of AI to stimulate economic growth, ensure innovative activity, and adapt to changing global market conditions.

Table 2: Index of states' readiness for the implementation of artificial intelligence within geographical regions in 2023

Global Ranking	Country	Total score	Government Pillar	Technology Sector Pillar	Data & Infrastructure Pillar
North America					
1	United States of America	84,8	86,04	81,02	87,32
5	Canada	77,07	85,3	64,73	81,17
Latin America and the Caribbean					
32	Brazil	63,7	72,44	45,08	73,57
54	Argentina	57,72	70,31	35,27	67,59

Western Europe					
3	United Kingdom	78,57	82,5	68,8	84,42
4	Finland	77,37	88,34	60,36	83,39
Eastern Europe					
17	Estonia	70,86	80,54	52,52	79,54
31	Czech Republic	65,17	72,25	47,72	75,55
60	Ukraine	53,29	68,93	36,18	54,75
Middle East and North Africa					
18	United Arab Emirates (UAE)	70,42	78,32	56,67	76,28
94	Iran	42,07	31,56	38,77	55,88
Sub-Saharan Africa					
151	Zimbabwe	30,71	24,08	23,41	44,63
178	Congo	24,19	22,50	19,68	30,4
South and Central Asia					
40	India	62,58	75,18	49,39	63,17
47	Turkey	60,51	75,08	42,32	64,13
East Asia					
2	Singapore	81,97	90,4	66,19	89,32
7	The Republic of Korea	75,65	87,55	54,36	85,02
193	The Democratic People's Republic of Korea (DPRK)	9,2	8,03	14,27	5,29
Pacific					
12	Australia	73,89	83,34	52,57	85,75
49	New Zealand	60,18	51,85	47,05	81,66

Source: compiled by the author based on Hankins et al. (2023)

The most developed countries in the context of technological progress are North America and Western Europe, which are global leaders in the Government AI Readiness index (Figure 2). An average level of AI readiness is observed in Eastern Europe, the Middle East, and North Africa, indicating the growing potential of these geographical regions, whose countries often face additional political and economic challenges. Among the difficulties that can be highlighted are prolonged Russian aggression against Ukraine, occupation of parts of Moldova and the Autonomous Republic of Crimea; civil conflicts in Syria and Yemen, political instability in Iraq, Libya, and Sudan as well as the high vulnerability of the Middle East & North Africa to climate change. However, a much worse situation is observed in Sub-Saharan Africa and some East Asian countries, such as North Korea, which occupies the last place in the ranking. This trend indicates a lack of positive trends and unpreparedness for AI development, highlighting the need for international support, changes in political and economic systems (particularly in North Korea, Turkmenistan, and Cuba), and investments in these regions to activate and increase readiness for the use of artificial intelligence.

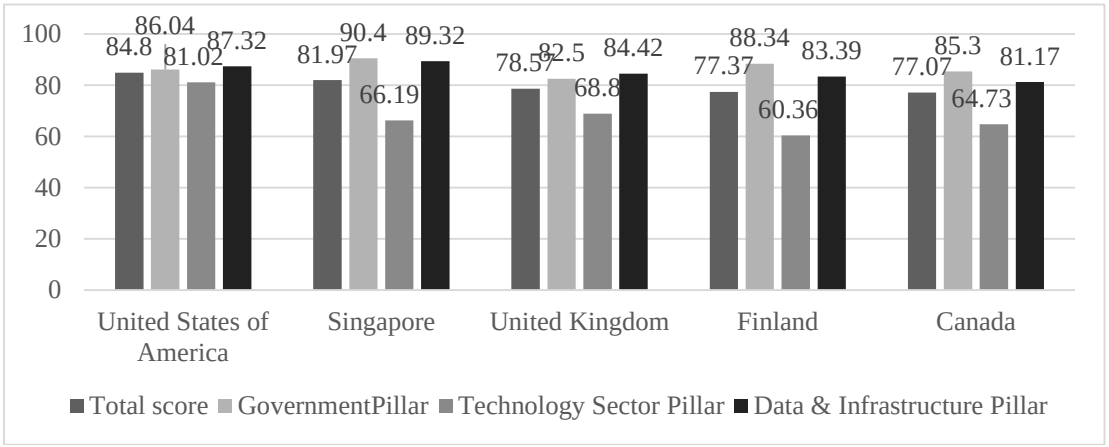

Figure 2: Countries with the highest government AI readiness index

Source: compiled by the author based on Hankins et al. (2023)

Based on the Oxford Insights study, countries with the highest Government AI Readiness index and their potential opportunities and challenges in the global technological landscape were analysed. In this context, the United States, with an overall rating of 84.8, is a leader due to high scores in all aspects: government readiness (86.04), technology development (81.02), and data infrastructure (87.32). These indices indicate the ability of these countries to effectively utilise and integrate artificial intelligence into various spheres of the economy and administration. In turn, Singapore is noted for exceptionally high government readiness (90.4) and data infrastructure (89.32) scores but has potential for improvement in the technology sector (66.19). Meanwhile, the United Kingdom, with a score of 78.57, demonstrates strong government readiness (82.5) and data infrastructure (84.42) scores, although it lags in technology development (68.8). Additionally, Finland and Canada, with overall scores of 77.37 and 77.07, respectively, also show high government readiness and data infrastructure but fall behind other countries on this list regarding technology development.

Thus, government readiness for AI usage is essential to their economic competitiveness and innovation potential. Therefore, within this study, an analysis was conducted on the impact of government AI readiness on overall economic development in geographical regions using a correlation analysis of the following variables:

Gross Domestic Product (GDP): An overall indicator reflecting the economic level of countries in monetary terms.

Total Government AI Readiness: An overall indicator of AI readiness.

Government Pillar: An auxiliary indicator reflecting government readiness for AI implementation, including Vision, Governance and Ethics, Digital Capacity, and Adaptability.

Technology Sector Pillar: An auxiliary indicator reflecting the development of the technology sector in the context of AI, including Maturity, Innovation Capacity, and Human Capital.

Data & Infrastructure Pillar: An auxiliary indicator reflecting the development of data and infrastructure for AI. It includes Data Representativeness, Data Availability, and Infrastructure, considering that AI tools require large amounts of high-quality data.

The Pearson correlation coefficients table (Table 3 and Appendix A) formed in the JASP program (Correlation tool) was used for the analysis. Confidence intervals and effect size (Fisher's z) were determined to assess the results' accuracy and reliability depending on the statistical significance level. Additionally, effect size (Fisher's z) was calculated for each variable to determine the importance of the found connections between AI readiness and economic development, and the obtained effect size error allowed for objective conclusions regarding the stability and significance of the correlation.

Table 3: Correlation analysis of the impact of government ai readiness on the overall economic development of geographic regions

Pearson's Correlations					
Variable		**Total score**	**Government Pillar**	**Technology Sector Pillar**	**Data & Infrastructure Pillar**
GDP (current LCU)	n	20			
	Pearson's r	0.265	0.278	0.310	0.183
	p-value	0.258*	0.236*	0.183*	0.439*
	Upper 95% CI	0.634	0.641	0.662	0.579
	Lower 95% CI	-0.201	-0.188	-0.154	-0.282
	Effect size (Fisher's z)	0.272	0.285	0.321	0.186
	SE Effect size	0.243	0.243	0.243	0.243
* p < .05, ** p < .01, *** p < .001					

Source: compiled by the author

The correlation analysis results aimed at identifying the impact of Government AI Readiness on overall economic development in different geographical regions showed high p-value indicators for each variable studied, indicating a high level of significance and statistical reliability of the

correlation. Therefore, the analysis showed statistically significant correlations between AI readiness and economic development in various aspects. In particular, there is a moderate positive correlation between the Total Score of AI readiness and GDP (current LCU), which for different aspects (government readiness, technology sector, data infrastructure) ranges from 0.265 to 0.310. However, it is worth noting that for the Data & Infrastructure Pillar indicator, the correlation is less significant ($r = 0.183$), indicating that AI readiness in the aspect of data infrastructure has a less pronounced impact on economic development compared to other aspects such as government readiness and technology development.

DISCUSSION

Many scientists in various research institutes and universities are conducting a deep analysis of the impact of artificial intelligence. For instance, Bowles (2014) used the Frey and Osborne (2013) system to estimate that 54% of jobs in the EU are at risk of computerisation. Acemoglu and Restrepo (2020) provided a historical example of excessive automation, which negatively affects the labour market due to low productivity and the rebound effect, finding that the areas in the USA most exposed to industrial automation in the 1990s and 2000s experienced significant negative impacts on employment and wages. In this context, Morikawa (2017) conducted a detailed study based on original survey data collected from over 3000 Japanese companies operating in the manufacturing and service sectors. His research aimed to examine these companies' views on the impact of AI on their business and employment levels in the future. The results showed that most companies expect a positive impact from introducing AI, particularly regarding production efficiency and competitiveness. In turn, Berg et al. (2018) conducted an in-depth analysis of labour market models with different elasticity of substitution between robots and human labour. They created several models to analyse how automation, mainly through the introduction of AI, could transform the labour market under different conditions. Thus, automation has the potential to significantly change the demand for labour, depending on the specific industry and level of technological integration. In particular, Lu's conclusions showed that in conditions of high elasticity of substitution, robots could completely replace some categories of workers.

In contrast, in cases of low elasticity, only partial substitution occurs, preserving specific jobs and creating new opportunities for workers who adapt to new technologies (Lu, 2021). In addition to changes in the human resources market, among the main problems and challenges for the economy and sustainable development of society in the context of expanding the use of artificial intelligence and machine learning are phishing, system breaches, fake news, hacker bots, AI evasion, local cyberattacks, and the overall increase in cybercrime (Androschuk, 2021; Shkodenko & Biehun, 2024), financial crimes, corruption schemes, and the use of AI robots for committing crimes or terrorist acts (Kussainov et al., 2023). To address the risks posed by these problems, comprehensive strategies must be implemented, particularly in cybersecurity, including protection against cyberattacks, development of cyber threat detection algorithms, enhancing cyber literacy, international cooperation in cybersecurity, and regulation of AI use (Horowitz et al., 2022; Das & Sandhane, 2021; Radanliev, 2024).

CONCLUSION

Today, artificial intelligence (AI) and machine learning (ML) have become integral components of technological progress, transforming the economic and social aspects of the global environment. These technological innovations modernise technical processes in all sectors of the economy but also significantly change how society interacts with technological resources. According to the results of thematic research analysis, AI and ML show significant potential in solving complex tasks and implementing new opportunities in areas ranging from production-process automation to forecasting market trends. However, rapid progress is accompanied by several challenges that require immediate resolution, such as ethical issues regarding the use of personal data, the impact on employment and social structures, and the need to ensure cybersecurity and transparency in the use of technologies.

The study determined the impact of Government AI Readiness on economic development in different geographical regions. The analysis revealed statistically significant correlations between AI readiness indicators and economic indicators such as gross domestic product (GDP). In particular, a

moderate positive correlation was found between GDP and the Total score (r = 0.265), as well as for aspects such as government readiness (r = 0.278), the technology sector (r = 0.310), and data infrastructure (r = 0.183). These indicators confirm the high significance and statistical reliability of the links between AI readiness and economic development, which are crucial to understanding the impact of AI technologies on the modern global economic environment.

Author contributions

V. G.: Conceptualization, Methodology, Resources, Formal analysis, Writing – Original draft, Writing – Review & Editing.

N. P.: Conceptualization, Methodology, Data Curation, Writing – Original draft, Writing – Review & Editing.

M. K.: Conceptualization, Methodology, Formal analysis, Project administration, Writing – Original draft, Writing – Review & Editing.

K. M.: Conceptualization, Methodology, Data Curation, Writing – Original draft, Writing – Review & Editing.

S. H.: Conceptualization, Methodology, Formal analysis, Project administration, Writing – Original draft, Writing – Review & Editing.

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Appendix A

Initial data for correlation analysis

Country	Total score	Government Pillar	Technology Sector Pillar	Data & Infrastructure Pillar	GDP (current LCU), trillion
United States of America	84,8	86,04	81,02	87,32	27,36
Canada	77,07	85,3	64,73	81,17	2,89
Brazil	63,7	72,44	45,08	73,57	10,86
Argentina	57,72	70,31	35,27	67,59	0,64
United Kingdom	78,57	82,5	68,8	84,42	2,69
Finland	77,37	88,34	60,36	83,39	0,28
Estonia	70,86	80,54	52,52	79,54	0,038
Czech Republic	65,17	72,25	47,72	75,55	7,34
Ukraine	53,29	68,93	36,18	54,75	6,54
United Arab Emirates (UAE)	70,42	78,32	56,67	76,28	1,85
Iran	42,07	31,56	38,77	55,88	0,4
Zimbabwe	30,71	24,08	23,41	44,63	0,12
Congo	24,19	22,50	19,68	30,4	0,01
India	62,58	75,18	49,39	63,17	0,29
Turkey	60,51	75,08	42,32	64,13	26,28
Singapore	81,97	90,4	66,19	89,32	0,67
The Republic of Korea (ROK)	75,65	87,55	54,36	85,02	2,24
The Democratic People's Republic of Korea (DPRK)	9,2	8,03	14,27	5,29	0,025
Australia	73,89	83,34	52,57	85,75	2,56
New Zealand	60,18	51,85	47,05	81,66	0,41