Digital Transformation of Ukraine: Impact on the Economy, Quality of Life and Achievement of Sustainable Development Goals

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Abstract. The adoption of digital technologies and integration into the networked economy have become essential for the advancement of modern societies, with the aim of enhancing economic development, quality of life, and achieving sustainable development goals (SDGs). In the face of Russia's ongoing war against Ukraine, the country is making efforts to embrace digital transformation and apply it to improve various aspects of society and the economy. This research aims to evaluate Ukraine's preparedness for a networked economy through an examination of the digital transformation's influence on its economy, quality of life, and advancement towards achieving the SDGs. The evaluation is based on several international indices and metrics, which highlight the country's strengths and areas that require improvement. The findings indicate that Ukraine has shown significant progress in the economic dimension owing to digital transformation. In 2023, Ukraine ranked 35th in the economy meter, a substantial improvement from 75th in 2019. However, the country faces challenges in high-tech production and exports, which limit its potential for transitioning to a high-tech industry. The Quality of Life meter showed improvement, with Ukraine moving from 82nd place in 2019 to 59th place in 2023, despite the adverse effects of the ongoing war. Conversely, the SDG Contribution dimension revealed a deteriorating trend, with Ukraine dropping from 43rd place in 2019 to 86th place in 2023, indicating insufficient progress towards sustainable development. The study concludes that, while Ukraine has made strides in integrating into the networked economy, significant efforts are required to overcome existing barriers. These include enhancing high-tech production and exports, reducing income inequality, improving quality of life, and better addressing urban pollution and clean energy generation to achieve the SDGs. Ukraine can achieve full integration into the global networked economy and ensure sustainable economic growth and social development by concentrating on these areas and incorporating innovative digital technologies. The continuous digitalization will play a crucial role in this process, driving economic development, enhancing the quality of life, and supporting the attainment of sustainable development goals. Moreover, further research and practical implementation of digital technologies are critical for advancing these objectives and enhancing societal resilience and innovation.

Keywords: Digital transformation, Ukraine, Digital economy, Networked Economy, Sustainable development goals (SDGs), Quality of life, the Network Readiness Index, Bibliometric analysis.

***JEL Classification:** O10, O33, Q01*

1 Introduction

Digital transformation is characterized by the integration of digital technologies into all areas of business and society, which radically changes the ways of doing business, providing services, communicating, and managing. With the rapid development of information and communication technologies (ICT), digitalisation is becoming an integral part of the modern world, affecting all spheres of life: the economy, social sphere, education, health care, and other industries.

The economic impact of digital transformation is significant as it improves productivity, creates new business models, stimulates innovation, and opens up new markets. The introduction of digital technologies in production processes and management systems can reduce costs, increase production efficiency, and increase company profitability. Research shows

that countries with high levels of digitalisation have higher rates of gross domestic product (GDP) and economic growth.

Digital transformation also significantly affects citizens' quality of life. It contributes to improving access to education and health services, expanding employment opportunities, and increasing the level of social integration. Thanks to digital technologies, citizens have more opportunities for training and professional development, which contributes to the growth of human capital and increased competitiveness in the labour market.

In addition to economic and social impacts, digital transformation has significant potential to achieve the Sustainable Development Goals (SDGs) approved by the UN in 2015. The goals of sustainable development are 17 global goals aimed at solving the main problems of mankind, such as poverty, hunger, inequality, and climate change. The use of digital technologies can contribute to the achievement of many of these goals, for example, by increasing the efficiency of resource use, developing renewable energy sources, improving the waste management system, and promoting inclusive and quality training.

Despite the numerous advantages of digital transformation, its implementation is associated with certain challenges and risks. Among the main challenges are the digital divide between different social groups and regions, the threat of cybersecurity, the issue of data privacy, and the need to adapt legislation and regulatory mechanisms to the new conditions of the digital era. An important aspect is the provision of appropriate digital education and training, which is a key factor in successful digitalisation.

Thus, digital transformation is an important direction in the development of modern society, affecting all aspects of life. Its effective implementation can be key to economic growth, improving the quality of life of citizens, and achieving Sustainable Development Goals. However, this requires considering the challenges and risks associated with digitalisation and implementing comprehensive measures to overcome them.

The present research is based on analytical materials about the Network Readiness Index (NRI), created by a group of scientists from the Portulans Institute and Saïd Business School, University of Oxford. The NRI is presented as a key metric for assessing digital trends and understanding the evolution of online trust in this networked era (Network Readiness Index). The NRI is defined as the degree of readiness of countries to participate in a networked world (Kirkman S.G. et al., 2002), and consists of four sub-indices that collectively measure the impact of ICT on the development of countries in various aspects. The NRI ranking reflects the overall level of readiness in different countries. The main sub-indices of the NRI include technology, personnel, management, and impact, each of which has a few components.

This article aims to analyse the impact of digital transformation in Ukraine on its economy, the quality of life of the population, and achievement of sustainable development goals.

It is planned, based on the WoS scientometric database, using the bibliometric analysis method, to analyse the existing research results on the impact of digitalisation on the economy, quality of life, and achievement of sustainable development goals; build profiles of Ukraine on the Impact subindex of The Network Readiness Index (NRI) and its components, and conduct a comparative analysis of the profiles of Ukraine and the leading countries; and analyse the dynamics of the Impact subindex and its components for 2019–2023.

2 Bibliometric analysis of the impact of digitalization on the economy, quality of life and achievement of sustainable development goals

From the moment of computerisation and the introduction of Internet technologies into economic processes, interest in determining the consequences of digitalisation processes and their distribution has constantly increased, acquiring various aspects, which is confirmed by the results of bibliometric analysis. To prepare the presented bibliometric study, the term "digital transformation" was chosen with the following three clarifications: "impact on the economy" (IoE), "sustainable development goals" (SDG) and "quality of life" (QoL). Web of Science (WoS), one of the main online resources for bibliometric analyses, was selected as the dataset (Luo S. & Zou D., 2022). Excluded publications with Russian affiliation and publications for 2024.

The R-package of the bibliometrix software was used to process the received data. Package R is an open-source software package that contains several tools for quantitative bibliometric research. These include the most important statistical and scientific mapping algorithms. The web interface application (Biblioshiny) has been added to the latest versions of the bibliometrix R-package to help users who are unable to encode in R develop source data for bibliometric analysis. The Biblioshiny interface allows users to import data from Scopus or Web of Science databases in BibTex, CSV or Plain Text formats. It is also possible to filter the data using Biblioshiny. The WoS dataset was imported from the R package using biblioshiny characteristics for bibliometrix.

After selecting different terms and applying the series of parameters, the following data were obtained (Table 1).

The present study conducted a bibliometric analysis of three areas of digital transformation: the economy, quality of life, and achievement of s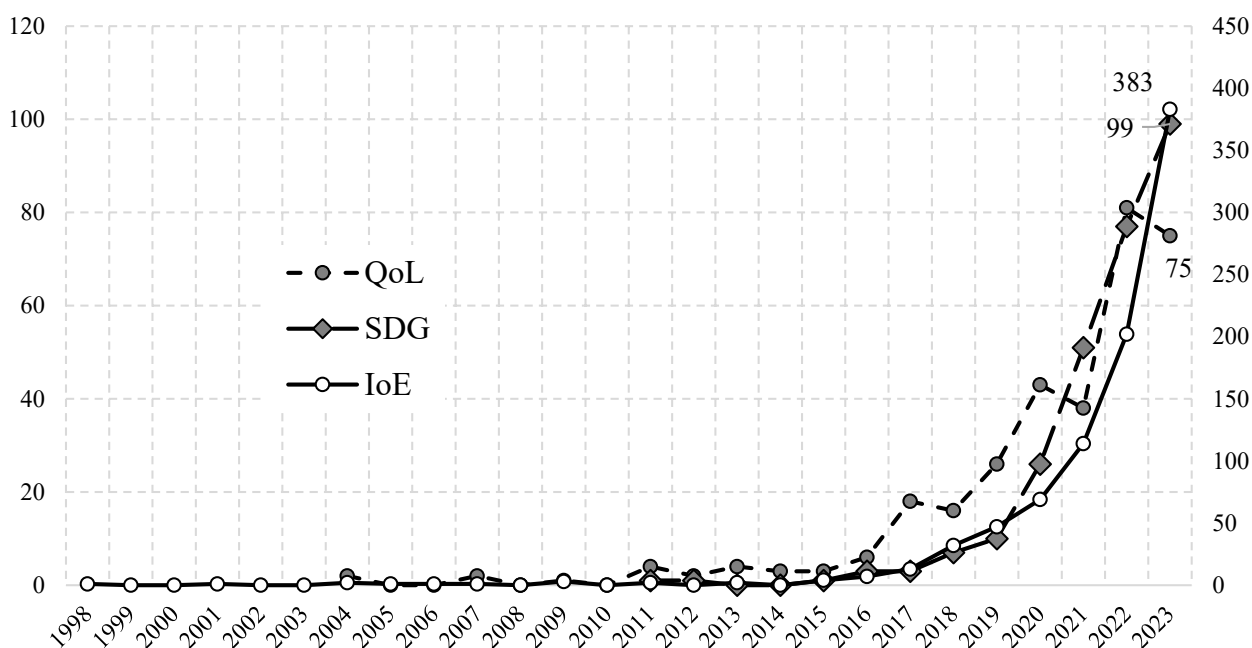ustainable development goals. For the period 1998–2023 885 scientific documents on the impact of digitalization on the economy have been published in the WoS scientometric database, the Annual Growth Rate is 26.86% (Figure 1).

During to 2004–2023, 324 scientific papers were published on the impact of digitalisation on quality of life (Annual Growth Rate is 21.02%).

Table 1 Characteristics of the bibliometric study database of the impact of digitalization on the economy, quality of life and achievement of sustainable development goals (WoS)

«Digital transformation»			
Description	«Impact on the Economy»	«Quality of Life»	«Sustainable Development Goals»
MAIN INFORMATION ABOUT DATA			
Timespan	1998-2023	2004-2023	2011-2023
Sources (Journals, Books, etc)	454	265	179
Documents	885	324	279
Annual Growth Rate %	26.86	21.02	46.66
Document Average Age	2.54	3.67	2.44
Average citations per doc	15.49	11.44	19.09
References	42084	15456	17617
AUTHORS			
Authors	2485	1590	1214
Authors of single-authored docs	111	47	31
AUTHORS COLLABORATION			
Single-authored docs	119	48	32
Co-Authors per Doc	3.44	5.38	4.52
International co-authorships %	23.05	28.7	33.69

Source: authors' development via Biblioshiny app (Aria M. & Cuccurullo C., 2017; R Core Team, 2014; RStudio Team, 2020)


Figure 1 Annual Scientific Production in the direction of «digital transformation» («impact on the economy» (IoE), «sustainable development goals» (SDG), «quality of life» (QoL)) in the scientometric database WoS (until 2023)

Source: authors' development via Biblioshiny app (Aria M. & Cuccurullo C., 2017; R Core Team, 2014; RStudio Team, 2020)

There is a growing scientific interest in the impact of digitalisation on the achievement of sustainable development goals, which is confirmed by the Annual Growth Rate of 46.66%. For the period 2011–2023 179 scientific documents on this direction were published in the WoS scientometric database, which also recorded the highest value of

international cooperation – 33.69% (International co-authorships).

Most often, within the framework of the topic of research on digital transformations, such words and phrases as "digital", "innovation", "sustainability", "circular economy", "artificial intelligence", "digital health", "smart cities" were used (Figure 2).
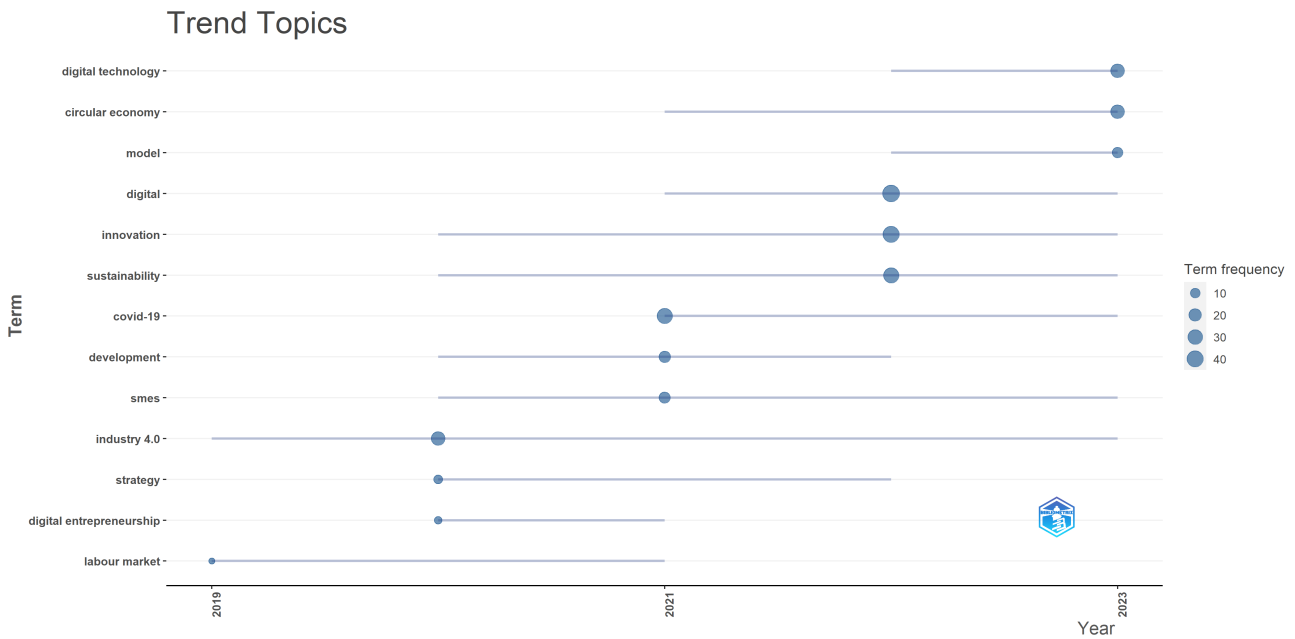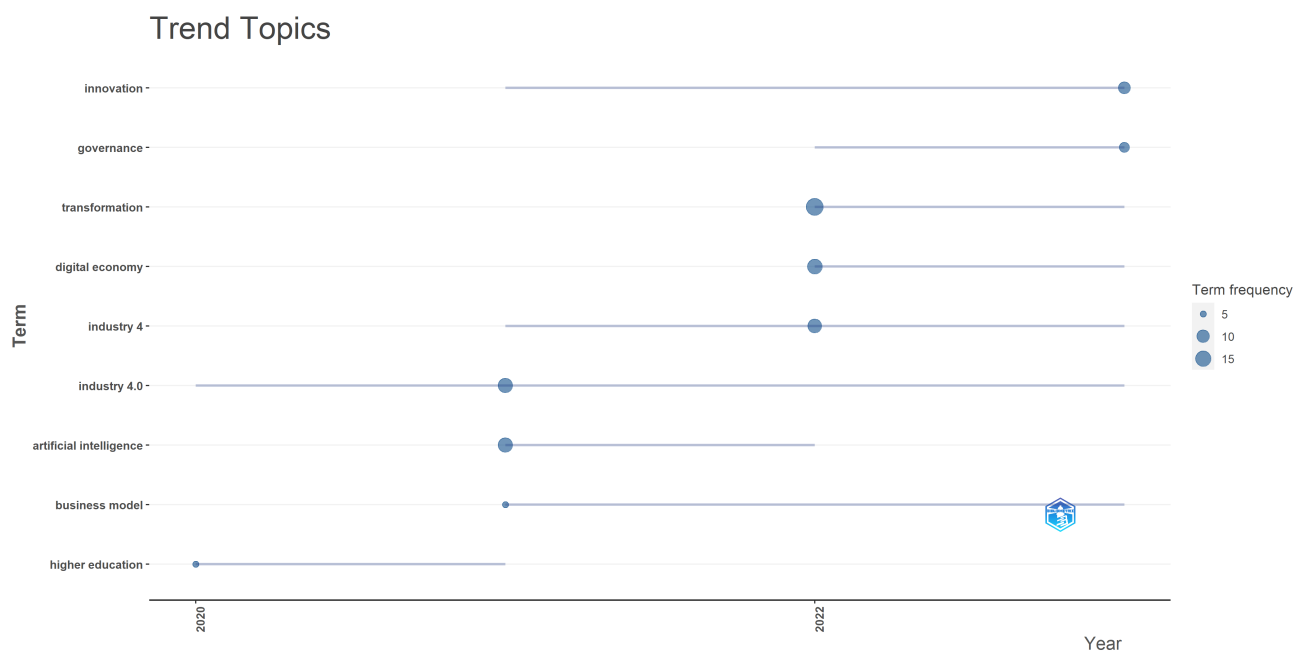

2a)
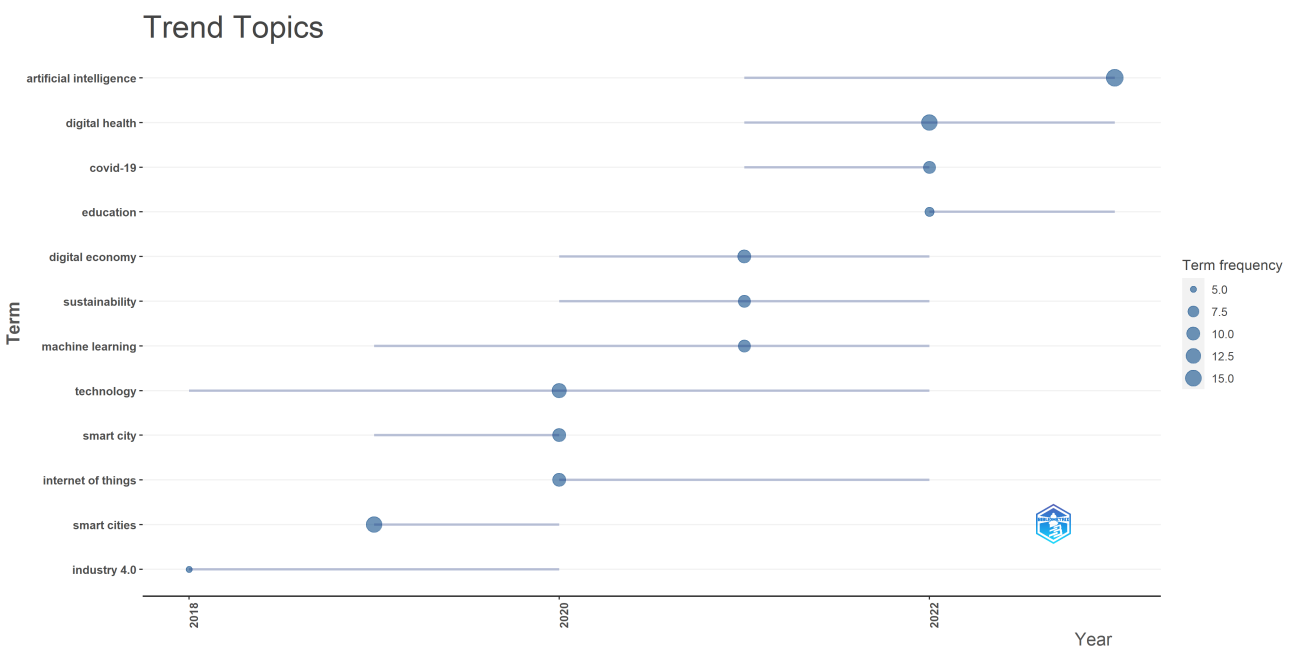
2b)

Figure 2 Keywords trend topics in the direction of «digital transformation»:
(2a) IoE, (2b) QoL, (2c) SDG

Source: authors' development via Biblioshiny app (Aria M. & Cuccurullo C., 2017; R Core Team, 2014; RStudio Team, 2020)

2c)
Figure 2 (Continuation)

Figure 2 illustrates the development of research articles using keywords. The main emphasis in the trending hashtags in the field of digital transformation and its impact on the economy is focused on the technological provision of the digital economy, in the search for new effective models of doing business in a networked economy and sustainable development, and on the role and opportunities of medium and small businesses. In the field of digital transformation and its impact on the quality of life, scientific interest focuses on key aspects, such as artificial intelligence and digital health, in parallel with education. Studies of the impact on the achievement of sustainable development goals are focused on areas such as innovation, governance, the digital economy, the triad of digitalisation, business models, and sustainable development.

Of the greatest interest were the following scientific research results:

– A study of the fourth industrial revolution and digital transformation (known as Industry 4.0) and sustainable development opportunities, the results of which help stakeholders understand the opportunities that the digital revolution can offer for sustainable development and collaborate more closely to ensure that the planned functions of sustainable development are fulfilled (Ghobakhloo M., 2020);

– Industry 5.0 Impact Study (Nahavandi S., 2019), in which the authors present the concept of Industry 5.0, where robots are connected to the human brain and work as co-authors rather than

competitors, resulting in Industry 5.0 creating more jobs than it takes away;

– study the impact of the readiness of small- and medium-sized businesses for artificial intelligence on international efficiency for AI. Scientists have found that digitalisation and sustainability are positively linked, but they become competing growth paths when a company goes international (Denicolai S. et al., 2021);

– exploring the possibility of incorporating the concepts of "Society 5.0" and "Industry 5.0" into the practice and policy of universities, which will allow both universities and society to fully benefit from digital transformation. As a result of this study, a set of recommendations has been proposed for universities aimed at developing new forms and channels of dissemination of education, research, and innovation in the context of society 5.0 – socially and digitally involved models (Carayannis E.G. & Morawska-Jancelewicz J., 2022);

– exploring the metaverse through an understanding of the benefits and challenges associated with widespread adoption of this technology from several different perspectives and the impact on areas of business and society (Dwivedi Y. K. et al., 2022).

Consequently, digitalisation significantly affects various aspects of social life, including the economy, quality of life, and the achievement of sustainable development goals. A bibliometric study based on Web of Science data confirmed the growing interest in these topics in the scientific

community. The analysis showed a high level of scientific productivity and international cooperation in research on the impact of digital transformation. The main areas of research were the technological support of the digital economy, the impact of digital technologies on quality of life, and achievement of sustainable development goals.

3 Assessment of Ukraine's readiness for a networked economy through the prism of researching the impact of digital transformation on the economy, quality of life and achievement of sustainable development goals

A country's readiness for a networked economy implies holistic growth and improvement of society in the context of digital transformation. The NRI contains a component (subindex) "Impact", the purpose of which is to assess the various consequences of participation in a networked economy (in economics, quality of life, and the achievement of sustainable development goals), and on the basis of which the presented study is based.

According to the results of 2023, Ukraine ranks 54th among 134 countries in terms of the impact of digitalisation, while GDP per capita is $14,326. USA (Figure 3).

Singapore ranks first in the Impact subindex, with an annual GDP per capita of $1,31425.71. USA (the highest value, Luxembourg, $ 141587). USA, 17th place in terms of the impact of digitalisation).

Based on data from NRI studies (Network Readiness Index) for the period 2019–2023. The Ukrainian aspect of the economic consequences of integration into the network economy (Economy), the nature of the social consequences of participation in the network economy (Quality of Life), and the impact of the involvement of the network economy on the achievement of Sustainable Development Goals (SDG Contribution) were analysed.

The impact sub-index, which is an integral part of the NRI, is an indicator that comprehensively describes the consequences of participation in the network economy is the Impact subindex, which is an integral part of the NRI (Network Readiness Index). The goals of the Impact subindex are achieved using three components: Economy, Quality of Life, and SDG Contribution (Table 2 and Figure 4).

Figure 4 presents the results of the calculation of the subindex "Impact" of Ukraine according to the assessment of 2023 (NRI: Country Profile. Ukraine, 2023) in the context of its components. According to the results for 2023, Ukraine ranked 54th (55.7) among 134 countries. At the same time, according to the level of economic consequences of integration into the network economy (Economy), Ukraine occupies the 35th position (38.3 points), according to the level of social consequences caused by participation in the network economy (Quality of Life) – 59th place (69.8 points), in terms of the impact of attracting a networked economy on the achievement of Sustainable Development Goals (SDG Contribution) – 86th place (59 points).

Thus, we can conclude that Ukraine has the best positions in terms of the economic consequences of participation in the network economy, and the worst in terms of involvement of the network economy in achieving sustainable development goals. This indicates the inefficiency of using existing digital solutions and their potential, as shown in Fig. 5.

In terms of Economy, the leader is Singapore (Fig. 5b), which has higher values according to the criteria: High-tech and medium-high-tech manufacturing (100 points against 22.13 points of Ukraine), High-tech exports (100 points against 7.93 points of Ukraine), Preference of gig economy (81.4 points against 57.85 points of Ukraine), PCC T patent applications (54.87 points against 8.53 points of Ukraine). However, the strength of Ukraine is the export of telecommunications, computers, and information services as a percentage of total trade in accordance with EBOPS 2010 (ICT services exports – 71.57 points) (World Bank).

Thus, the extremely weak points for Ukraine are:

Low level of high-tech exports (as a percentage of total trade)–products with high intensity of research and development, such as aerospace, computers, pharmaceuticals, scientific instruments, and electrical machines (World Bank);

– low number of applications under the Patent Cooperation Agreement;

– low levels of high-tech and medium-high-tech production (as a percentage of the total production of the processing industry), which indicates inefficient use of digital solutions, particularly for the transition from resource-based and low-tech activities to medium- and high-tech industries (United Nations Industrial Development Organization, 2023).

The digital environment and the networked economy offer better opportunities for skill development and technological innovation. However, Ukraine, which provides a high level of exports of telecommunications, computers, and information services, does not sufficiently provide its own medium and high-tech industry.
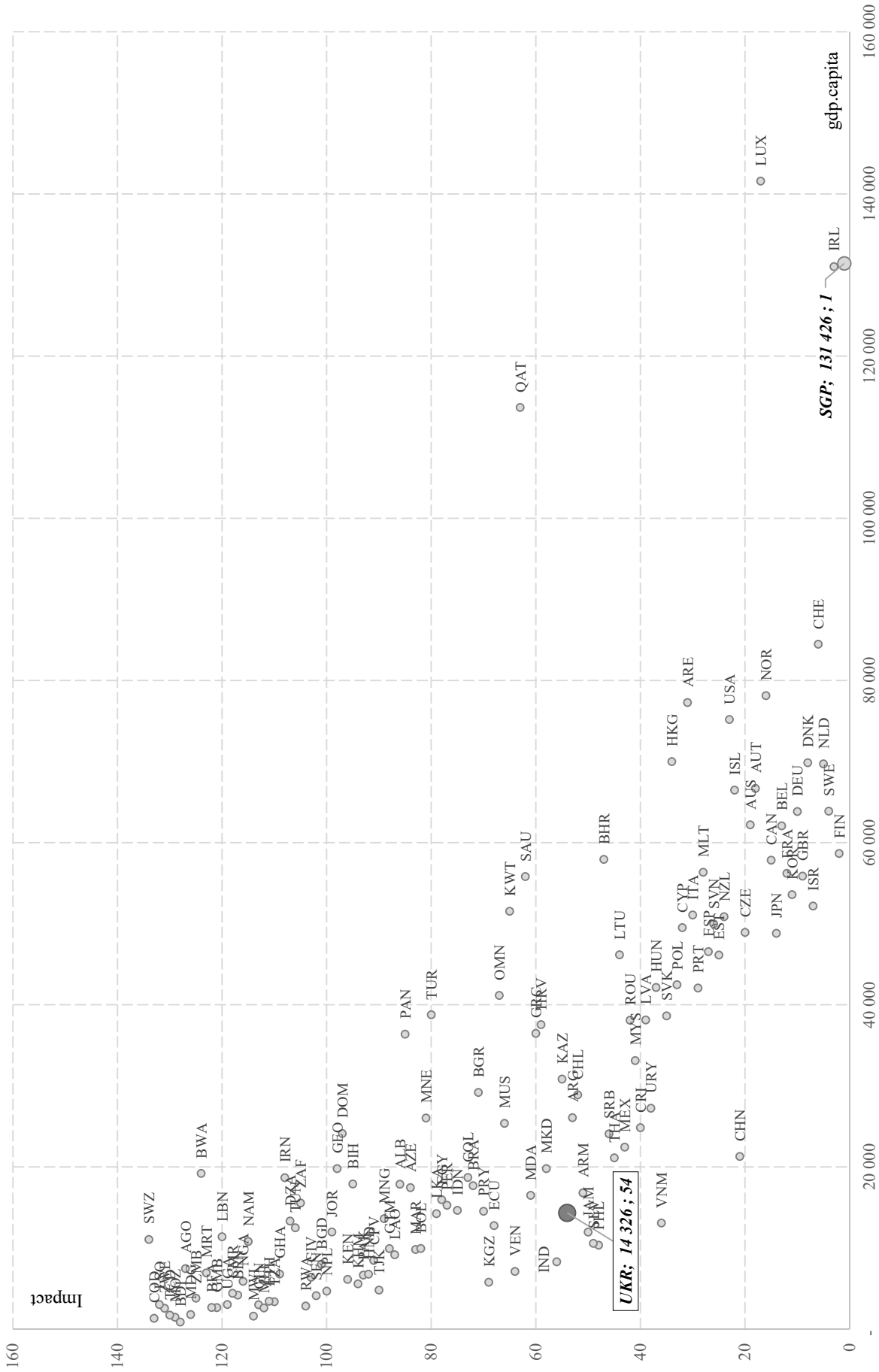
Figure 3 Ratio of the level of the Impact pillar to the level of GDP per capita, 2023 (134 economies)

Source: compiled by the author according to (Network Readiness Index)

Table 2 Triad of Impact Subindex Constituents

| Dimensions	Description	Components (criteria)	Estimated indicator
1. Economy	Describes the economic implications of integration into the networked economy, including aspects such as the size of the domestic market	1) High-tech and medium-high-tech manufacturing 2) High-tech exports 3) PCT patent applications 4) Domestic market size 5) Prevalence of gig economy 6) ICT services exports	1) High-tech and medium-high-tech manufacturing (% of total manufacturing output) (2021) 2) High technology exports (% of total trade) (2021) 3) Number of Patent Cooperation Treaty (PCT) applications (per billion PPP$ GDP) (2022) 4) Domestic Market Size (2022) 5) Average answer to the question: In your country, to what extent is the online gig economy prevalent? [1 = Not at all; 7 = To a great extent] (2020) 6) Telecommunications, computers, and information services exports (% of total trade) (2021)
2. Quality of Life	Chronicles the societal implications derived from participation in the networked economy	1) Happiness 2) Freedom to make life choices 3) Income inequality 4) Healthy life expectancy at birth	1) Happiness score (life ladder) (2022) 2) Freedom to make life choices score (2022) 3) Gini index (2022) 4) Healthy life expectancy at birth (years) (2019)
3. SDG Contribution	Analyzes the influence of networked economy engagement in the purview of the Sustainable Development Goals (SDGs). In this context, ICT emerges as pivotal, with specific indicators weaving through health, education, gender parity, and environmental concerns	1) SDG 3: Good Health and Well-Being 2) SDG 4: Quality Education 3) SDG 5: Women's economic opportunity 4) SDG 7: Affordable and Clean Energy 5) SDG 11: Sustainable Cities and Communities	1) Universal health coverage (2021) 2) PISA average scores in reading, mathematics, and science (2018) 3) Women Business and the Law Index Score (scale 1-100) (2023) 4) Energy intensity (2021) 5) Urban safety and sustainability (2021)

Source: compiled by the author according to (Network Readiness Index; Dutta S. & Lanvin B., 2023)

In terms of Quality of Life, the leader is Finland (Fig. 5c), which has the highest values according to the relevant criteria: Happiness (100 points against 42.5 Â points in Ukraine), Freedom to make life choices (97.2 points against 75.64 points in Ukraine), and Healthy life expectation at birth (89.62 points against 67.21 points in Ukraine). The low level of happiness score (life ladder) for Ukraine is mainly explained by the active phase of Russia's war against Ukraine and not by the insufficient level of expansion of the network economy for the society of the country. The same is true for the Freedom to make life choices score, because war minimises the possibility and level of freedom to make life choices.

According to the SDG Contribution measurement, the leader is Ireland (Figure 5d), which has the highest values according to the set of relevant criteria: Women's Economic Opportunity (SDG 5) – 100 points against 78.76 points in Ukraine, Sustainable Cities and Communities (SDG 11) – 97.34 points against 44.97 points in Ukraine, Affordable and Clean Energy (SDG 7) – 89.81 points vs. 45.74 points in Ukraine, Good Health and Well-Being (SDG 3) – 89.29 points against 73.18 points in Ukraine, Quality Education (SDG 4) – 69.61 points against 52.5 points in Ukraine.

Therefore, to increase the impact of attracting a networked economy on achieving the Sustainable
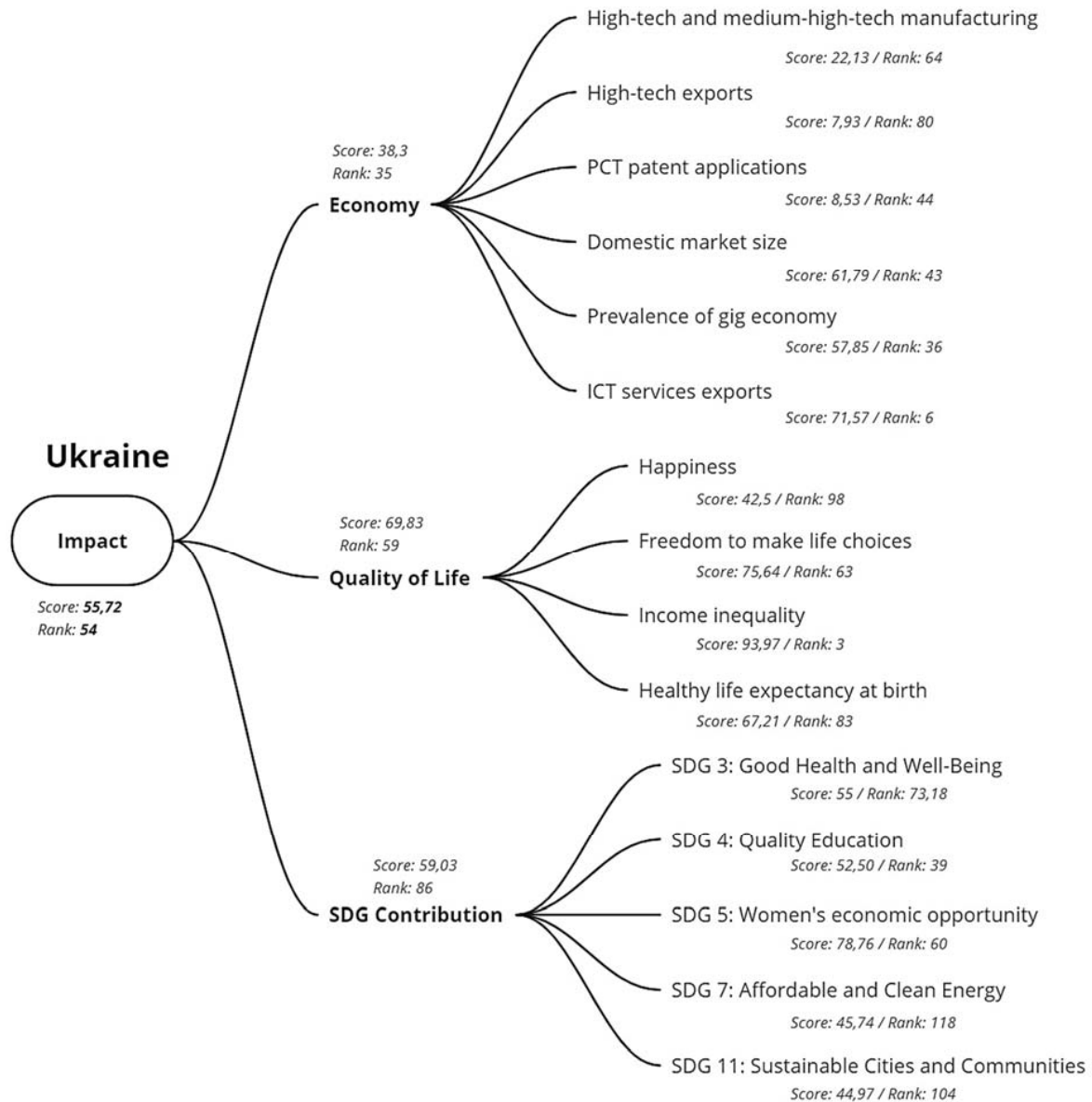
Figure 4 The Impact subindex of Ukraine according to the 2023 assessment

Source: constructed by the author based on data from (Dutta S. & Lanvin B., 2023; NRI: Country Profile. Ukraine, 2023)

Development Goals, Ukraine needs to solve the problems associated with the pollution of cities and households. Urban pollution is officially attributed to SDG 11: Make cities and human settlements inclusive, safe, resilient, and sustainable. It is important to implement modern digital technologies and innovative approaches to create sustainable and environmentally friendly urban environments.

Additionally, there is a need to increase the generation of affordable and clean energy. This is due to SDG 7: Ensure access to affordable, reliable, sustainable, and modern energy for all. Ukraine should work on developing infrastructure for the production and distribution of clean energy, which will help reduce its dependence on traditional energy resources and reduce greenhouse gas emissions.

Ensuring these measures will help Ukraine not only improve its performance in the field of sustainable development but also contribute to the overall improvement of the quality of life and economic opportunities for citizens.

During 2019–2023 Ukraine is gradually strengthening its integrated network, ensuring the economic and social consequences of digital transformations and the achievement of sustainable development goals (Table 3).

Consequently, the data in Table 3 allow us to conclude that the highest level of return on the implementation of the network economy was

5a)

5b)

5c)

5d)
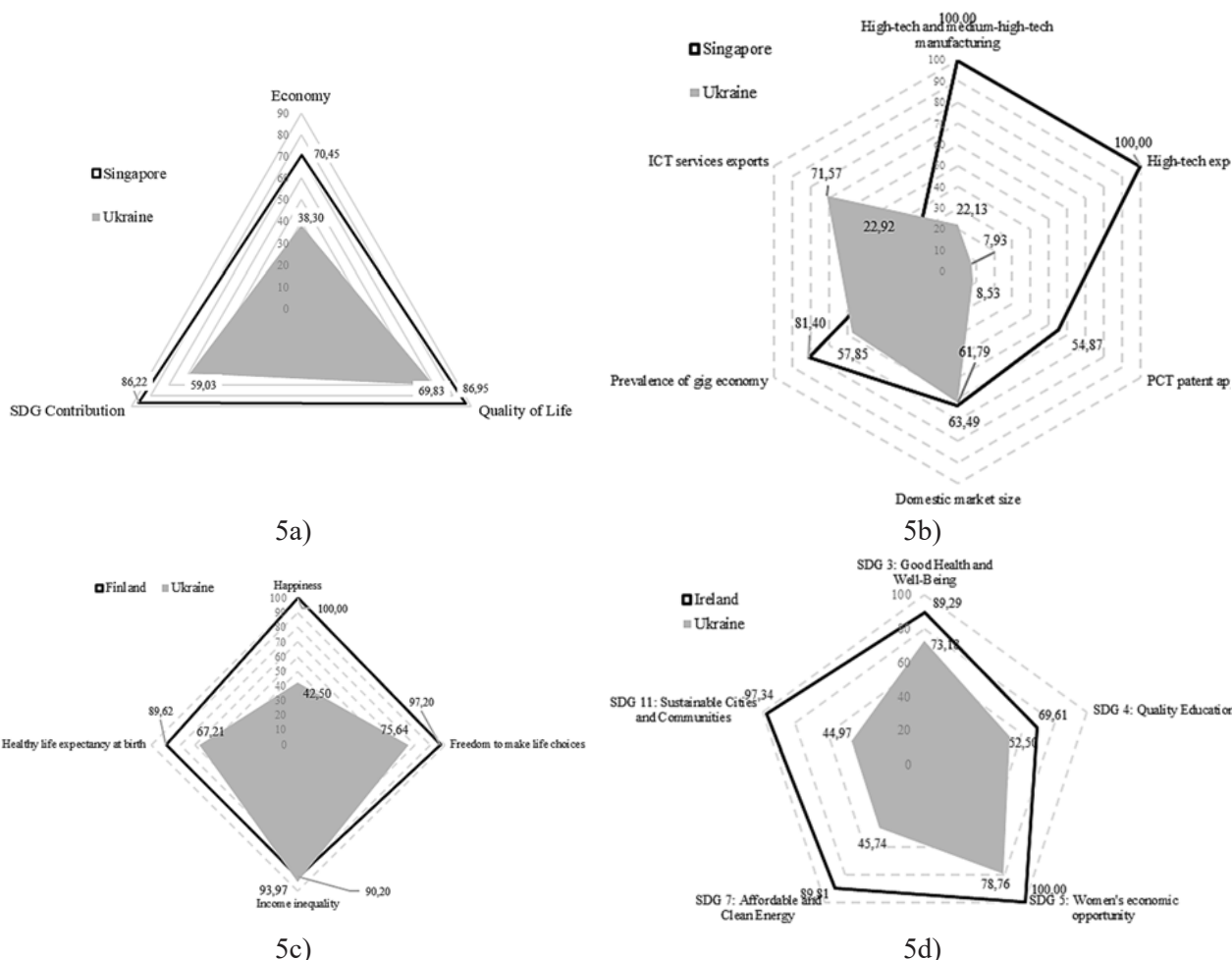
Figure 5 Profiles of Ukraine and leading countries in the Impact subindex and its dimensions: (5a) the Impact subindex; (5b) Economy; (5c) Quality of Life; (5d) SDG Contribution, 2023

Source: constructed by the author based on data from (Dutta S. & Lanvin B., 2023; NRI: Country Profile. Ukraine, 2023)

recorded in 2021, when Ukraine took 47th place with a score of 60.4 points. Ukraine's Economy meter displays positive trends: in 2019, it ranked 75th, and in 2023, it ranked 35th with a score of 38.3 points. As already noted, the dynamics of the Quality of Life meter do not fully reflect the real social consequences of Ukraine's transition to a networked economy, since the components of the meter are determined by the conditions of the active phase of Russia's war against Ukraine. Nevertheless, even in such extremely difficult conditions, a positive trend was observed: in 2019, Ukraine took 82nd place in the Quality of Life meter, and in 2023–59th place, although during the war, the value worsened by two positions. The situation deteriorates according to the SDG Contribution meter, as evidenced by the trend of its value; according to the results of 2019, Ukraine took 43rd place, and according to the results of 2023–86th place.

4 Conclusion

Digitalisation significantly affects various aspects of social life, including the economy, quality of life, and the achievement of sustainable development goals. The results of the bibliometric study based on Web of Science data confirmed the growing interest in these topics in the scientific community. The analysis showed a high level of scientific productivity and international cooperation in research on the impact of digital transformation. In particular, this study demonstrated that the introduction of digital technologies contributes to sustainable development and opens up new opportunities for businesses and society. Industry 4.0 and Industry 5.0 have the potential to not only increase efficiency, but also create new jobs and improve the quality of life.

The results of the analytical study demonstrate the importance of assessing the impact of digital transformation on the economy, quality of life, and

Table 3 Dynamics of the Impact subindex and its dimensions
(positive trend: increase in score; decrease in rank) in Ukraine for 2019–2023

Dimensions	Metric	2019	2020	2021	2022	2023	Dynamics
Impact	score	52,31	49,16	60,4	57,08	55,72	
	rank	65	79	47	57	54	
Economy	score	15,76	26,17	46,73	40,99	38,30	
	rank	75	62	42	43	35	
Quality of Life	score	54,97	62,86	69,01	70,98	69,83	
	rank	82	77	57	57	59	
SDG Contribution	score	86,22	58,46	65,45	59,28	59,03	
	rank	43	91	53	83	86	

Source: compiled by the author according to (Dutta S. & Lanvin B., 2023; Dutta S. & Lanvin B., 2022; Dutta S. & Lanvin B., 2021; Dutta S. & Lanvin B., 2020; Dutta S. & Lanvin B., 2019)

achievement of sustainable development goals in Ukraine.

The introduction of a networked economy in Ukraine has contributed to significant economic development. Ukraine achieved its highest level of return on network economy implementation in 2021, when it ranked 47th with a score of 60.4 points. Positive dynamics are also observed in the "Economy" meter, where Ukraine's rating improved from 75th place in 2019 to 35th place in 2023, indicating an increase in economic activity and an improvement in economic infrastructure. However, there are significant problems with high technology production and exports. Ukraine demonstrates a low level of high-tech exports, which indicates an inefficient use of existing digital solutions for the development of medium- and high-tech industries. This limits Ukraine's potential for transition from resource-based activities for the high-tech industry.

The results of the Quality of Life dimension analysis show that despite the improvement of Ukraine's position in 2023 to 59th place compared to 82nd place in 2019, the war minimized opportunities for improving living conditions and freedom of choice.

A deteriorating trend in the SDG Contribution dimension was observed. In 2019, Ukraine was ranked 43rd, and by 2023, it was already 86th. This indicates insufficient attention to the implementation of Sustainable Development Goals and the need to address the problems associated with urban pollution and the generation of affordable and clean energy. To increase the impact of the network economy of achieving the Sustainable Development Goals, it is necessary to introduce modern digital technologies and innovative approaches.

Overall, the study shows that Ukraine has significant potential for the development of the network economy but requires significant efforts to overcome existing barriers. It is necessary to increase the level of high-tech production and exports, reduce income inequality, improve the quality of life of the population, and contribute to the achievement of sustainable development goals through the introduction of innovative

digital technologies. This will allow Ukraine to integrate fully into the global network economy and ensure sustainable economic growth and social development.

Based on the results obtained, we can conclude that digitalization will continue to play a crucial role in economic development, improving quality of life, and achieving sustainable development goals. Further research and the practical implementation of digital technologies can contribute to greater progress in these areas, increasing the resilience and innovation of society.

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