DOI: https://doi.org/10.30525/2256-0742/2026-12-1-393-404

THE IMPACT OF TECHNICAL PROGRESS AND TECHNOLOGICAL IMPROVEMENT ON THE EFFECTIVENESS OF DIGITAL PRODUCTION, ENTREPRENEURSHIP AND THE ECONOMY*

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Abstract. The *purpose* of scientific research is to establish cause-and-effect relationships between technical progress and technological improvement, and the acceleration of the digitalisation of entrepreneurship. It also involves searching for reserves for the digitalisation of business projects that affect production efficiency and the effectiveness of the country's economy. The *object* of scientific research is the field of knowledge and technology, existing patents and utility models, and scientific and technical articles, analysed in the context of groups of countries by income level. This analysis includes an evaluation of rating indicators and the GII, as well as the expansion of digital opportunities for entrepreneurship, based on existing human capital. The implementation of inventions, utility models and ideas produced by this capital is one of the key drivers of innovative and digital economic development. *Methodology.* Using dialectical and systemic methods, the impact of technical and technological progress on the movement of the production function curve in digital enterprises was investigated. This revealed a promising reserve of existing innovation with positive dynamics, highlighting the need for a strategic approach to the digitalisation of entrepreneurship. The concretisation method was employed to develop the author's proposals for innovation and the digitalisation of the country's economy. *Results.* The factors that determine the quality and efficiency of a digital enterprise are presented, including harmonisation of costs associated with developing innovative products and digital services, network effects, the growing importance of big data and analytics, resource availability, digital infrastructure, consumption dynamics and working with clients. Analysed statistical data showed that, for post-industrial countries with an innovative approach and a digital strategy, "healthy" competition stimulates digital development as businesses strive to provide higher-quality innovative products and digital services. The findings of the research conducted allowed the assertion to be made that digital entrepreneurship is both the result and the source of continuous scientific and technical achievements, inventions and ideas. Furthermore, the digital changes taking place in its work are based on new technologies that are constantly produced by the scientific world. *Practical implications.* The dissemination of practical advice has been undertaken, with the objective of maintaining positive dynamics in terms of accelerating innovation and digitalisation of national economies at both the macro and micro levels. Measures to promote the digitisation of traditional entrepreneurship are outlined, including the establishment of scientific, production, research and experimental digital ecosystems based on the country's leading industry-focused universities, and the development and implementation of youth scientific support programmes lasting three, five and seven years, under the names "Youth in Research", "Innovations and Young Researchers", and "Youth. Inventions. Progress". Hold events in leading scientific and technical laboratories

* This article is published in terms of scientific research work "Development models of the wartime and postwar economy of Ukraine based on digital entrepreneurship and virtual business mobility" (State registration number 0124U000066).

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under the names "Week of Innovations and Inventions", "Week of Science and Technology" and "Week of the Researcher, Innovator and Inventor". Every science needs individual researchers, inventors and innovators. In the innovation-digital process, the innovator who produces the invention is therefore a valuable "player" and a key link. *Value/Originality.* After conducting a thorough analysis of the Global Innovation Index ratings by country group and income level, the authors found that China leads the group of countries with above-average incomes in terms of the number of patents and utility models. The leaders of the "Labour and Technology Results" index in terms of knowledge creation remain the three high-income countries of Sweden, Switzerland and the USA. Analysis of the available data revealed that the level of development of intangible assets can accelerate the formation and development of digital entrepreneurship and facilitate business mobility. Technical and technological progress is proposed to be understood through the prism of the formation of Industry 5.0, which is a consistent process of improving and perfecting production and industrial business processes with the aim of producing new products and services while focusing on the quality of existing goods and services. It has been determined that changes in technology and technologies are indicative of transformations occurring in terms of digitalisation in production business processes. Alternatively, enterprises have the capacity to develop and utilise new or improved innovative products and digital services. The overall socio-economic effect of digital entrepreneurship is predicated on the interrelation of technical and technological changes, capital utilisation, and enhanced productivity per employee. It is hypothesised that, in terms of the genesis of Industry 5.0, this will signify the evolution of digital business, enhanced remuneration for proficient workers who possess digital competencies, and an enhancement in the quality and standard of living of the population.

Keywords: digital entrepreneurship, e-production, economic efficiency, Industry 5.0, production function, resource use, knowledge, innovation development institutions, technology, patents, citations.

JEL Classification: D20, O30, O31, O40, P13

1. Introduction

In the 21st century, engineering and technological advances have been increasingly focused on enhancing the quality of goods and services, as well as the volume of output, of digital enterprises. Reflecting on the technological advancements that occurred during the 20th century, it is evident that these innovations precipitated a significant "breakthrough", giving rise to digital "explosions" that profoundly transformed the landscape of numerous industries and, in certain regions, the fabric of people's lives. For instance, the advent of ICT has had a profound impact on the quality of life and the performance of employees, both in office environments and in digitised production settings. Moreover, high-tech weaponry has been instrumental in altering the course of numerous conflicts in the 21st century.

The innovative and digital development of economic relations and business interactions, influenced by the 4th Industrial Revolution, is characterised by the utilisation of virtual and augmented reality, necessitating in-depth research. The format of relations, the purpose of which is to accelerate the development of digital technologies and to form new forms of entrepreneurship as a result of the transformation of the business system and the formation of its innovative digital eco-form, has not yet been properly reflected in the available scientific literature.

The integration of conventional and digital methodologies has already precipitated the emergence of a novel virtual-real method of production, predicated on an intellectual-innovative and technical-technological structure. The digital transformation of the global economy, characterised by the rapid advancement of technology, exerts a significant influence on the pace of digital entrepreneurship. This fact determines the need to form a new generation of intellectual elite that could digitize business processes, production, and industry. This determines the continuity of innovative development in the virtual and real domains, which in turn dictates the necessity for its digital vector.

2. Literature Review

Researcher S. Calimanu (2023) conducted a study on the impact of influence technology on various industries, positing that such technologies have the capacity to transform work processes, engender novel consumption patterns, and enhance production methodologies. In their 2022 study, R. Zhang and Y. Fu examined the impact of technological progress on the energy efficiency of technological innovations and the introduction of technologies. Scientists A. Balcerzak, M. Zinecker, R. Skalicky, E. Rogalska and K. Doubravsky adopt a distinctive scientific perspective on the role of new technological enterprises. They regard these enterprises as making a disproportionately significant contribution to the creation of innovative products and as the driving force behind the transformation of entrepreneurship (Balcerzak (Ed.),

2023). In 1995, researchers R. Evenson and L. Westphal conducted a study on the relationship between the strategies that enterprises should choose as a result of active technological changes in the economy.

In their study, F. Meng and W. Wang (2023) used intelligent data analysis technology to measure the degree of digitalisation and discovered a relationship between enterprise productivity and the degree of digitalisation of its activities. Researchers I. Kolupaieva and L. Tiesheva consider the impact of technological digital divides on country competitiveness differently, depending on the level of digitalisation. They examine cluster groups of countries and propose ways to reduce the digital divide in EU countries, such as changing spending priorities to promote innovation and productivity growth and diversifying the digital technologies used (Kolupaieva & Tiesheva, 2023).

N. Ghazy, H. Ghoneim and G. Lang (2022) published the results of a study investigating the relationship between entrepreneurship and productivity in 27 EU Member States. They proved the leading role of digitisation in the functioning of the business ecosystem. In their 2021 study, researchers A. Malkowska, M. Urbaniec and M. Kosala demonstrate the impact of technological transformation on the economies and societies of EU countries. They emphasise grouping the countries studied by growth level to promote technological development cohesion within each group and assess the digitalisation gap between EU Member States.

In a presentation to the scientific community, researchers Z. Song, A. Mishra and S. Saeidi presented an empirical case study. This study evaluated the key technological opportunities in the digital economy for integrating the Internet of Things (IoT) and the CPS. The advantages of using digital doubles to create high-quality virtual models of physical objects in virtual space were explained, with the process enabling the simulation of their behaviour in real space and the provision of feedback. CPS and digital doubles have been identified as mechanisms that facilitate the achievement of cyber-physical integration, thereby establishing a foundation for intelligent production (Song (Ed.), 2023, p. 5).

An attempt was made to analyse the impact on the efficiency of the enterprise of the process of digital transformation through the prism of implementation of state policy and innovation scientists Y. Peng, Ch. Tao (2022). The findings of the study demonstrated that digital transformation has the capacity to enhance efficiency by stimulating innovation within the enterprise. The digital transformation currently underway is heavily reliant on technological advances and artificial intelligence. Researchers N. Suki, N. Suki, A. Sharif, S. Afshan, and K. Jermsittiparser (2022) have outlined a set of guidelines for policymakers and practitioners, with the aim of encouraging investors to allocate more funds to technological innovation in the economy.

The present study focuses on the research conducted by scientist J. Gu, who was engaged in the study of issues of qualitative application of technological innovations through the prism of the workings of the sharing economy. Gu (2022) advanced the hypothesis that "technological innovations exert a mild influence on economic growth" (p. 4) and empirically confirmed the connection between business development and personalised credit information and digital finance, which are related to the sharing economy (pp. 5–9).

B. Mumba presented the publication in which he expounded the necessity for constant changes in people's skills as a result of technological progress. B. Mumba arrived at the conclusion that "digital technologies have changed the world… computers, mobile phones, embedded digital devices and the Internet have entered the daily life of people, but the institution of education is the best tool invented by man, but it is not is a kind of partner for new inventions, but remains static and relies on traditional models" (Mumba, 2023, p. 9).

The findings of the scientific research conducted by K. Valaskova, M. Nagy, and G. Grecu (2024) are of practical significance, as they proffer recommendations on measures that could be adopted to enhance the level of digitalisation within the nation. These recommendations include the promotion of the acquisition of digital knowledge among business entities and the general populace through a variety of means, such as the reformulation of legislation, the augmentation of state support for entrepreneurs, and the modification of the education system.

A. In the extant literature, Botti, Parente, Vesci (2021; 2022), Herold (2022) and Magliocca (2021) have dedicated their research to the study of issues of learning digital entrepreneurship in the conditions of systematic modernisation of business processes at enterprises. Researchers M. Civelek, V. Krajcik and A. Kljusnikov (2023) sought to establish a positive correlation between the dynamic capabilities of business entities and digital transformation. However, their research did not support this hypothesis.

In the present study, the positive impact of the implementation of ChatGPT on the effectiveness of digital entrepreneurship and the acquisition of digital entrepreneurial skills was presented by H. Bui and C. Duong (2024). The study considered AI technologies that shape entrepreneurial aspirations and provided valuable information for scientists and practitioners who are oriented in the transformational landscape of digital entrepreneurship. The research conducted by R. Ngantung, E. Masengi and W. Bogar is of significant

value, as it has demonstrated the existence of a positive functional influence between Information Technology (IT) and the productivity of employees. Furthermore, the research has also established a relationship between financial remuneration and labour productivity of workers, as well as between IT and financial reward and employee performance (Ngantung (Ed.), 2024, pp. 23, 27–35).

A review of the literature devoted to digital transformation through the prism of finance, marketing and innovation management was carried out by scientists J. Hausberg, K. Netheler, S. Packmohr, S. Pakura, K. Vogelsang (2019) and S. Anim-Yeboah, R. Boateng, E. Kolog, A. Owusu, I. Bedi (2020). The review also served to deepen the understanding of the economic categories "digital transformation" and "digital entrepreneurship".

In the past, the enterprise under discussion was engaged in the study of issues of digital transformation of business processes. The aim of this study was to accelerate the development of Industry 5.0 in the context of the development of the gig economy. During the course of the study, the work of the digital ecosystem was analysed, and the reserves of economic growth were indicated (Kraus (Ed.), 2021; Kraus (Ed.), 2023).

The *purpose of the article* is to ascertain the influence, interdependence and effectiveness of technical progress and technological improvement on the acceleration of digitisation and innovation of business processes in production and entrepreneurship. The objective is to present a series of measures to improve the innovative and digital development of the country's economy based on this knowledge.

The following tasks have been delineated in the article: firstly, to ascertain the relationship between the level of knowledge and technologies in countries and the innovative development and production of the latest digital products, patents and utility models; secondly, to analyse the regularities of the impact of technical and technological progress on the movement of the production function curve of a digital enterprise with the aid of graphic modelling; thirdly, to present trends in the ratio of country ratings by industrial designs and trademarks by origin, in order to identify factors that determine the quality and efficiency of digital entrepreneurship on the basis of this knowledge; fourthly, to ascertain the regularities of the functioning of the institutes of innovative and digital development through the prism of technical and technological changes in order to improve their work in the course of implementation in the non-monolithic institutional environment of countries; and finally, to develop proposals for accelerating innovation and digitisation of the economy in conditions of structural transformation and economic re-equipment.

3. Research Methods

The scientific research was carried out using a thorough and reliable database. The theoretical materials and research work contained in scientific articles of rating and highly cited journals indexed in the Scopus database play an important role. The database is distinguished by the calibre of its scientific publications, its openness, and the extensive coverage of scientific journals and countries. These aspects provide the research with representative and relevant data covering a wide range of scientific developments and the results of in-depth research from various fields of knowledge and disciplines. The data contains confirmed and substantiated concepts and hypotheses regarding the digitalisation of business, production and the economy in the context of technical and technological change.

The publications presented in the Scopus database for research are also valuable in that they contain an overview of digital transformations influenced by technological achievements and developments in countries of different continents, with different levels of national income and different results of STP and human capital. Scopus's user-friendly interface facilitates the search for scientific publications, as well as the swift downloading and citation of these publications, which is crucial for maintaining methodological accuracy.

The analytical data for the research was sourced from the reporting materials of the World Intellectual Property Organization (WIPO) of Geneva, entitled "Global Innovation Index 2023: Innovation in the face of uncertainty", which contains rating information by country of the world according to different indices and sub-indices that reflect innovation and scientific and technical activity. This enables a comparative analysis to be conducted by countries and regions with regard to their innovative and technological activity. In addition, it facilitates the identification of factors that contribute to leadership in the rating or lag, as well as the undertaking of a retrospective analysis and the formulation of a forecast for the future. The WIPO's analytical information provides a comprehensive overview of the current state of affairs in the domains of innovation and digitisation. This facilitates purposeful and methodically grounded research.

Various methods were employed during the research, particularly the graphic method, to determine the impact of technical and technological progress on the movement of the production function curve in a digital enterprise. Methods of comparison and scientific facts were employed when presenting the GII rating indicators by country group according to income level. The methods of analysis, synthesis, induction and deduction are employed to present the factors that affect the efficiency and effectiveness with which a digital

enterprise functions, as well as the characteristics of the work of institutes that promote the country's economic development through technical and technological innovation. The concretisation method was employed when developing the author's proposals for measures to innovate and digitalise the country's economy.

4. Technological Developments that Change Production

Digital entrepreneurship can be considered both the result of and the source for ongoing scientific and technical achievements, inventions and ideas. The digital changes taking place in this field are based on new technologies that are constantly being produced by the scientific community.

Technological development is the condition for the emergence of new technologies, and it is determined by technological capabilities and the available "inventive capabilities – investment capabilities – investment capabilities" (Evenson & Westphal, 1995, p. 2238). According to S. Calimanu (2023), progress in robotics and artificial intelligence means that routine, habitual and repetitive tasks can be automated, thereby increasing the productivity and efficiency of production and industrial processes due to their digitisation.

The concept of technical and technological progress for the formation of Industry 5.0 is understood as a consistent process of improvement and enhancement of business processes in production and industry. The objective of this process is twofold: firstly, to produce new products and services, and secondly, to focus on the quality of existing goods and services. In order to corroborate this opinion, the following hypothesis was formulated: H1.

The hypothesis suggests that technical progress exerts an influence on the acceleration of innovative development in the country's economy.

The evolution of techniques and technologies is indicative of the ongoing transformation within the domain of digitisation in production business processes. Alternatively, enterprises have the capacity to develop and utilise the latest or improved innovative products and digital services.

Among the inventions that have had a profound impact on the nature of industrial work and the very philosophy of production are textile machines, steam engines, electric motors, internal combustion engines, microelectronics, nanotechnologies, helium and nuclear energy. The most impressive technological developments are demonstrated by nanoelectronics. The subjects under discussion include scanning microchips, nanofactories, nanosystem engineering, nanometrology, nanophotonics, nanomaterials, nanopowders, genetic engineering and cellular technologies. However, the technological changes in the production process that are currently being traced are essentially a constant process of small, medium and large improvements.

It is imperative to acknowledge that the proliferation of developments, inventions and innovations is contingent upon the generation of relevant knowledge by individuals who are creative and intelligent. Figures 1 and 2 present the ranking of countries according to produced intangible assets, created useful models, existing patents and scientific and technical publications. These demonstrate scientific research and development carried out by teams of scientists in some countries of the world.

According to the GII 2023 ranking, three high-income countries – Sweden, Switzerland and the USA – remain the leaders in terms of knowledge creation, as measured by the "Outcomes of Science and Technology" index. Among countries with above-average incomes, China leads in terms of the number of patents and utility models. Indicators of the quality of science in China have shown an upward trend, as have the number of scientific publications with a high impact factor. Until 2013, the USA was a leader in the publication of high-quality scientific articles, which attracted the attention of companies operating in the field of high technology. Since 2022, China has consistently dominated the field in terms of the number of publications and their citations. However, a notable aspect of this research landscape is the prevalence of self-citations among Chinese scientists, a phenomenon that has been observed in the published articles.

It is evident that Chinese scientists are at the forefront of research in a wide range of disciplines, including earth science, physics, chemistry, biology, food crops, robotics, engineering, environmental science, and military technology. The quality and quantity of their publications in these areas is noteworthy, setting a high standard for research and innovation. In the Chinese context, the protection of innovations and inventions is primarily achieved through the utilisation of patents. As Zhang and Fu (2022, p. 428) assert, the acceleration of the innovation process can be facilitated by the development and implementation of technologies. Research in the field of agriculture is a priority for the support of the country's government. However, in China, there has been a paucity of truly revolutionary innovations; the majority of such innovations have been aimed at improving a product or service, and thus are only partial in nature. European researchers have been shown to excel in the field of medicine. In the context of the submission of a publication to a prestigious publication, the quality, novelty, and impact potential of the presented research are of particular significance to publishers and reviewers.

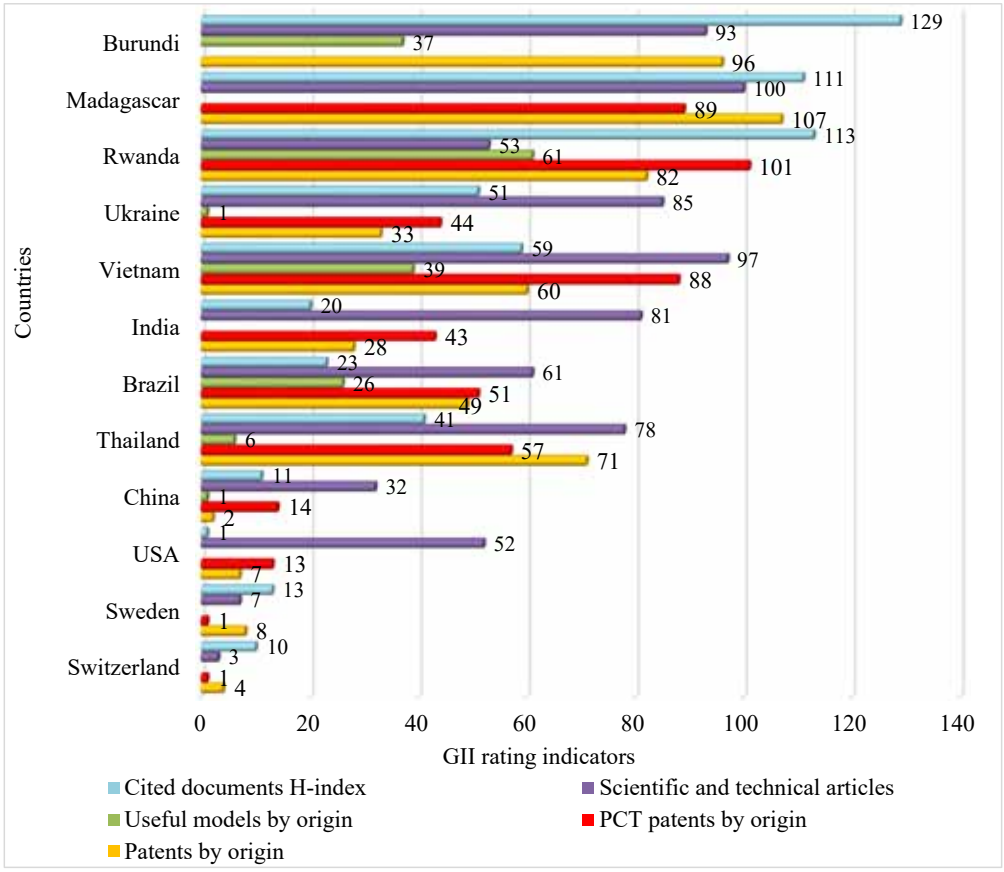


Figure 1. GII 2023 country rating according to the index "Results of knowledge and technologies" in the section of the subindex "Creation of knowledge" in the section of groups of countries by income level

Source: constructed based on (Dutta (Ed.), 2023, pp. 96, 100, 106, 132, 150, 183, 193, 194, 196, 202, 206, 209

Within the group of countries exhibiting incomes below the average level, India, Vietnam and Ukraine have been identified as the leading performers. With regard to the group of low-income countries, the GII indicates that the most favourable positions are occupied by Rwanda, Madagascar and Burundi. However, it is imperative to emphasise that, in the general rating scale, the positions of these countries are among the worst in the world.

5. Leadership of Countries in Intangible Assets

An analysis of the data presented in Figure 2 reveals China's prominent ranking in key indicators, including its attainment of the first position in terms of trademarks of origin and the second position in industrial designs by origin. The USA has been ranked 86th and 69th, respectively. In the context of examining the policy of supporting industrial designs and trademarks, it is advisable to direct scientific attention towards such countries as Madagascar, Ukraine and Switzerland. This phenomenon can be attributed to the fact that the rating indicators for 2023 are sufficiently elevated in comparison with those of countries such as Sweden, Thailand, Vietnam and Rwanda. It is evident that the advancement of intangible assets has the capacity to expedite the emergence and evolution of digital entrepreneurship, thereby rendering business processes more mobile.

The prevailing scientific world order of the 20th century, spearheaded by the USA, Japan and European countries, is being superseded by a new scientific order in the 21st century, which is constituted by researchers from China. The People's Republic of China is distinguished by its substantial industrial infrastructure, affordable labour force and low energy costs. This enables digital enterprises to function at full capacity and facilitates the effective digital production of Industry 4.0.

In the context of post-industrial, innovatively developed countries, the concept of 'healthy' competition has been identified as a catalyst for digital development. This is due to the motivation of businesses to provide superior, innovative products and digital services. In the context of nations that do not lead the field in terms of innovation, the advent of economic entities that are financed by foreign capital has been shown to facilitate the adoption and integration of advanced equipment and technologies by enterprises.

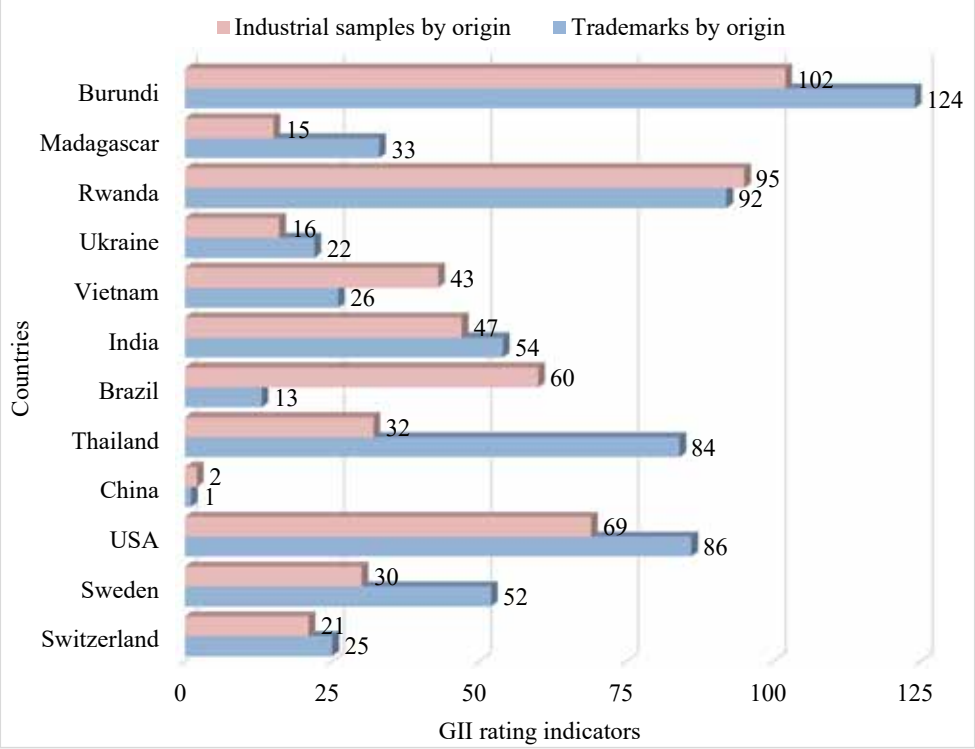


Figure 2. GII 2023 country rating by sub-index "Intangible assets" by country groups by income level

Source: built based on (Dutta (Ed.), 2023, pp. 96, 100, 106, 132, 150, 183, 193, 194, 196, 202, 206, 209)

This, in turn, enables enterprises to acquire the skills necessary to utilise modern digital technologies and state-of-the-art equipment during the process of digital transformation and modernisation of business processes in the context of digitised production. This, in turn, serves to ensure the emergence of innovative goods and digital services of a new standard. A number of factors have been identified as affecting the efficiency and effectiveness of the work of a digital enterprise. A selection of these is presented in Figure 3.

"For traditional and electronic enterprises, the development of high digital technologies, financial support for research and development, and the purchase of the latest digital equipment are important" (Meng & Wang, 2023, p. 8). It is "the development of digital technologies that allows enterprises to analyze the needs of users in real time" (Peng & Tao, 2022, p. 2). Electronic enterprises have developed digital equipment and employ highly qualified staff. For such enterprises, the highly professional talent currently invaluable for the digitisation of business processes –namely, those skilled in artificial intelligence, big data and cloud computing – is a decisive factor in the digitisation process, determining the level of production productivity (Meng & Wang, 2023, p. 8).

An effectively functioning digital enterprise, having data on its total income, can calculate the marginal revenue from the digital products/services it produces (MRP) without any particular obstacles (McConnell (Ed.), 2009, p. 255) according to the following formula:

$$MRP = \frac{\Delta \text{Total income}}{\Delta Q\text{uantities of used resources per 1 unit}} \quad (1)$$

The value by which each additional unit of the resource gives an increase in resource costs is called the marginal cost of the used resource (MRC) (McConnell (Ed.), 2009, p. 255). The mathematical form of the calculation is represented by the following formula:

$$MRC = \frac{\Delta \text{Total costs per resource}}{\Delta \text{The amount of resources used per unit of production}} \quad (2)$$

Another important hypothesis of the research is:

H2 Technological improvement has a direct impact on the operation of the digital enterprise in terms of the emergence of a large number of digital development tools.

A digital enterprise will consider the use of additional units of a resource to be profitable until the MRP of this resource is equal to the MRC. Technical progress and technological improvement are accompanied by an increased use of capital. The higher the quality of the capital, the higher the productivity (McConnell, 2009, p. 258). In fact, technological progress is often inseparable from new capital. For instance, buying a new generation of computers suggests not only an increase in their number, but also the rapid spread of computer technology (McConnell, 2009, p. 509).

Figure 4 shows how technical and technological changes shift the curve upwards from state 1 (APF_1)

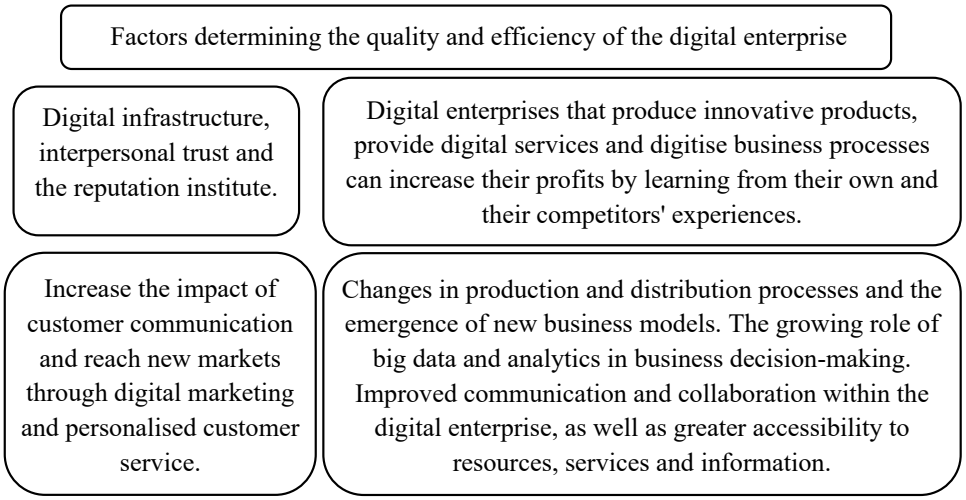
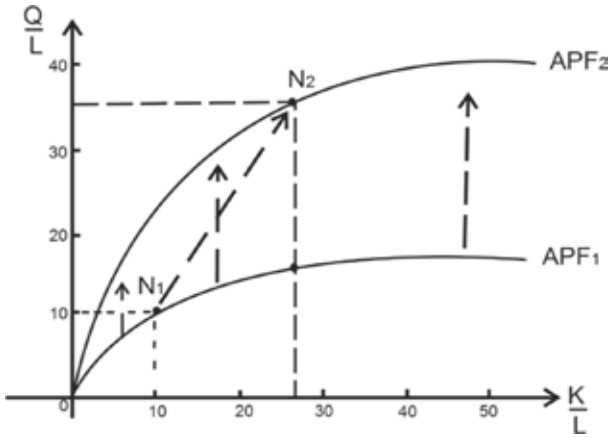


Figure 3. Factors affecting the efficiency and effectiveness of the operation of a digital enterprise

Source: grouped based on (McConnell (Ed.), 2009, pp. 637–638; Calimanu, 2023; the authors' own observations)

to state 2 (APF_2), which shows increased productivity and increased production volumes in digital enterprises. This is achieved through the introduction of new technology and improvements to business processes, making them more digitised.

"Technological influences, such as digitalization, automation, have revolutionized business processes, changed the content of work in traditional industries... technologies are changing the business landscape, influencing decision-making" (Calimanu, 2023). "There is a long lag between technological innovations and the transformation of innovative technologies into production" (Zhang & Fu, 2022, p. 428). "Technology plays an important role in the digitization of industry and the market" (Song (Ed.)., 2023, p. 13). The path that the technology takes from its appearance to its "work" in a digital enterprise is as follows: "information – science research and experimental design work – technical services (for example, engineering) – implementation activities – training services (activities for the transfer of skills, abilities; acquisition of competences by workers) – managerial services (for example, management of production facilities) – marketing services (for example, the study of hidden market needs)" (Evenson & Westphal, 1995, p. 2239). The use of digital technologies allows enterprises to organise their activities, both organisational and production-related, in accordance



where, APF – aggregate production function; Q – volume of digitised production; L – human capital involved in digitized production; K – the capital used in the digitised production process.

Figure 4. Graphical interpretation of the impact of technical and technological progress on the movement of the production function curve at a digital enterprise

Source: built based on (Samuelson & Nordhaus, 1998, pp. 527–528; McConnell (Ed.), 2009; the authors' own observations)

with users' differentiated and fragmented needs (Peng & Tao, 2022, p. 2).

It is also worth noting that "the key technological assets are human and organisational capital. Organisational capital is the know-how used to combine human skills and physical capital within an economic system in order to produce and deliver products that meet needs" (Evenson & Westphal, 1995, p. 2237). The general effect is the coordinated use of capital and technical and technological changes to increase productivity per employee. The graph illustrates this by shifting the APF_1 curve to the APF_2 curve and the N_1 point to the N_2 point. From the perspective of Industry 5.0's development, this indicates increased productivity, the growth of digital businesses, higher wages for digitally competent employees, and improved quality of life for the population.

6. Institutes of Innovative and Digital Development

The systematic quantitative and qualitative growth of enterprises and their digital activities require the work of existing innovation and digital development institutes to be defined and clarified. These new institutes contribute to accelerating the innovation and digitisation processes at all levels of economic aggregation, thereby ensuring economic growth. The new institutes of innovation and digital development increase savings and investments, which are essential for financing the development of the "soft" and "hard" digital infrastructure of the economy.

There are a number of modern institutes of innovation and digital development whose activities are focused on producing high technologies, innovations, techniques and digital tools for economic activity. It is worth mentioning the following: clearly formulated and prescribed property rights; the institutionalisation of the patent and copyright institute; effectively functioning financial and economic development institutes; financial literacy and access to education; a "healthy" competitive market system; the moral and material encouragement of the innovator's institute for its progressive development; and the qualitative institutionalisation of free trade.

H3 Institutes of innovation and digital development have a direct impact on the speed of innovation and digitalisation of the economy.

In the face of global challenges, governments should stimulate the acceleration of technological progress by encouraging the production of new ideas in order to rapidly rebuild economies on an innovative and digital basis. At the same time, the strategy of effectively applying existing equipment and technologies should continue to be followed (Samuelson & Nordhaus, 1998, pp. 531–532). Table 1 presents an overview of the work of various innovation and digital development institutes that influence the speed at which countries' economies are digitalised.

Government development institutions usually support the drive for technical and technological change by introducing informal economic and legal rules and regulations that nevertheless enforce intellectual property rights and give digital enterprises economic freedom. It is worth emphasising the indisputable fact that every field of science needs individual researchers, inventors and innovators. In the innovation-digital process, therefore, the innovator who produces the invention is a valuable "player" and a key link.

7. Conclusions

The objective of the present study was to ascertain the impact, interdependence and effectiveness of

Table 1

Institutes of innovative and digital development that influence the speed of innovation and digitalisation of the economies of countries

Institute of Innovation and Digital Development	The content of the work of this institute through the prism of technical and technological development
Patents, copy	With the constant influx of innovative digital technologies and modern new ideas, the government must take care in advance to ensure the high-quality institutionalisation of patenting and copyright. If legislation is weak on patenting issues, inventors and authors of ideas usually face theft and are unable to use them for financial gain. When the author of an idea has the exclusive right to promote and sell their developments, patents and copyrights, they have a powerful financial incentive that motivates them to engage in creative activities and inventions.
Transparent, clearly formulated property rights	This affects the speed and stability of economic growth. Inventors lose the desire to produce ideas and invest in their startup projects because they understand that a lack of transparency and ambiguity in legal norms can result in them being robbed of their expected income or their innovative digital business being "squeezed out" by unwritten laws imposed by shadow owners.
Financial literacy, innovative culture, access to education	It is only through education and creativity that individuals have the opportunity to become inventors and researchers. Without innovators, new equipment and technologies would never be developed. Without a sufficiently educated workforce, it is impossible to implement new technologies and use equipment effectively.

Source: grouped based on (McConnell (Ed.), 2009, pp. 504–505); the authors' own observations)

technical progress and technological improvement on the acceleration of digitisation and innovation of business processes in production and entrepreneurship. The study was conducted with a view to providing a number of practical measures to improve the innovative and digital development of the country's economy in the future. The findings of the conducted scientific research provide insight into the relationships between the level of knowledge and technology in countries and the innovative development and production of the latest digital products. The utilisation of graphic modelling will facilitate the exposition of the regularities inherent in the impact of technical and technological progress on the movement of the production function curve of a contemporary digital enterprise. The work presents the trends of 2023 of the GII rating of the countries of the world in terms of industrial samples and trademarks by origin. On the basis of data analysis, the factors that determine the quality and efficiency of digital entrepreneurship are characterised. The regularities of the functioning of the institutes of innovative and digital development have been clarified, taking into account the current technical and technological changes, in order to improve them and introduce them into the institutional environment of the countries.

It is imperative to emphasise the close relationship between technical progress and technological improvement on the one hand, and financial capital, namely available investments that could be "infused" into the innovation process at digital enterprises, on the other. The findings of the present study corroborate the postulated hypotheses H1 and H2, insofar as they demonstrate that technological progress and technological enhancement do indeed engender an augmentation in productivity and an escalation in the volume of production within the context of digital enterprises. This is achieved due to the introduction of new technology and the enhancement of business process technology, their digitisation and innovation. In order to have the latest equipment, innovative production technologies, robotics, and new machines at one's disposal, large financial investments are needed in the implementation of ideas and startups. Researchers and inventors need to be financially motivated.

It is imperative to establish novel legislation and to ensure its congruence with extant intellectual property rights legislation. There is a necessity for specific written rules that would transparently, honestly, fully and objectively regulate the procedure for the application of patents, copyrights, trade secrets and electronic storage and carrying of such information.

Among the proposals that should be adopted by the governments of the countries in order to accelerate the innovation and digitalisation of their national economies at the macro- and micro-level, the following are:

– Financing of pilot research and innovative projects on the territory of one's country in terms of strategy, currently, spheres of the country.
– Make a "bet" on "cheap" money and "cheap" loans and institutional, financial support of the country's intellectual capital.
– Provide grants for the purchase of high-quality, modern laboratory equipment, because researchers cannot produce inventions and be competitive on the global scientific market. Unfortunately, in underdeveloped countries, scientific and technical research equipment is outdated, underpowered and does not allow to fully set up experiments and test samples.
– To include in the country's strategic and current plans, innovative and digital projects for the development and reconstruction of post-war economies based on artificial intelligence, genetic engineering, and quantum technologies.
– To create scientific-production and research-experimental industrial digital ecosystems on the basis of the country's leading universities with a branch orientation and border scientific-production digital hubs with the aim of attracting researchers to implement joint progressive experimental-research innovative projects.
– To develop and implement youth scientific support programs lasting 3, 5 and 7 years (following the example of the duration of projects in the innovative EU countries). The following titles are offered: "Youth in research", "Innovations and young researchers", "Youth. Inventions. Progress". The organisation hosts a series of events under the titles "Week of Innovations and Inventions", "Week of Science and Technology", and "Week of Researcher, Innovator, Inventor". These events take place in prominent scientific and technical laboratories. The purpose of such events is to familiarise attendees with the available inventions and techniques, encourage them to search for like-minded scientists for future research and experiments, and motivate them to stay in their native country to study and conduct promising research.

The possibility of owning patents for their inventions protects the intellectual property rights of inventors and researchers, increasing their material interest. Inventors and innovators are becoming increasingly motivated by creating new, useful models and the latest software to digitise business processes in industry and manufacturing. It is hypothesised that the innovative, digital business organisation and entrepreneurial model proposed in H3 will enable a wider range of innovators and researchers to participate in the progressive development of e-production and the formation of Industry 5.0.

Future research should focus on identifying sources of funding for fundamental research and proper capital investment in innovative activities and the digital development of the economy. In the context of prospective scientific development, and with the aim of fostering an innovative economy, it would be worthwhile to conduct in-depth research into the potential applications of AI across various sectors and branches of the economy, with the ultimate goal of accelerating the development of digital entrepreneurship and smart production. It is advisable to conduct further research into the recruitment and retention of personnel involved in developing and implementing promising innovative and digital projects, with a particular focus on attracting and retaining ambitious and creative young people.

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Received on: 05th of December, 2025
Accepted on: 04th of February, 2026
Published on: 13th of March, 2026