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Review Paper

The Relationship between the Green and Digital Economy in the Concept of Sustainable Development

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ABSTRACT

The question of the relationship between the green and digital economies is extremely important in terms of preserving the planet and ensuring sustainable development. The purpose of the study is to establish the relationship between the green and digital economies by combining the general and specific characteristics that arise under the conditions of sustainable development. The presented research uses the following methods: analysis and synthesis to determine the main features of digital and green economies, induction and deduction to determine the directions of further development of economic processes within the framework of sustainable development; an expert method for determining the assessment of the degree of influence of groups of factors of the external environment on the relationship between the digital and green economy, a graphic method for visual display of research results. In order to build a relationship between the green and digital economies, the authors suggested establishing a balance between their features. When comparing the digital and green economies, their regularities were revealed, which made it possible to build a system of interconnection of the green and digital economies. This makes it possible to implement infrastructure projects, form a state order for the development of new and development of existing digital platforms, form the ability to implement elements of high-tech transport and communal infrastructure, develop the institute of green finance, green financial instruments, as well as green trends in tax and investment policy, promote formation of green economy clusters and others. Uncovering and studying the relationship between the green and digital economy becomes an effective way to overcome the crisis situation when the economy is growing.

HIGHLIGHTS

- The synergy between the green and digital economies offers a viable pathway towards sustainable development, albeit with the need to address challenges such as the environmental impact of digital infrastructure and ensuring equitable access to digitalization.
- Successful implementation of the interconnection between the digital and green economies requires collaborative efforts among stakeholders, including local administrations, entrepreneurs, and skilled professionals, along with comprehensive government support and international cooperation to leverage sustainable development experiences from other countries.

Keywords: Digitalization, globalization, green investments, "green" technologies, digital tools

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In recent times, the relevance of green and digital economies has grown significantly in the context of sustainable development. This is primarily because the current trend towards decarbonizing the economy and digitization aligns with the goals of sustainable development. The preservation and development of humanity depend on reducing environmental pollution and fostering a circular economy. Environmental economics has become one of the most rapidly growing trends globally over the past few years. The COVID-19 pandemic has created conditions for the development of the digital economy by digitizing all aspects of human society. Green economics has also gained more prominence due to the serious anthropogenic pressure on environmental pollution.

One of the main ways to "green" and digitize the economy is through the creation of innovative tools and the implementation of new technologies in various fields. In 2020, after a rapid transition of the economy and trade into the digital realm, a stage of fundamental economic restructuring began.

The global business community is directing its resources and finances towards the development of technologies aimed at preventing climate change and reducing environmental pollution. The development of alternative energy technologies is one of the most powerful drivers of innovation.

Based on this, the authors of the study concluded that the issue of the relationship between the green and digital economies is extremely important for the preservation of the planet and the development of the global economy.

The purpose of the current work is to establish the relationship between the green and digital economies by combining their common and specific characteristics in the context of sustainable development.

Literature Review

The current research presents the results achieved in pursuit of the research goal. The study explicitly employs various scientific research methods such as analysis, synthesis, deduction, induction, modeling, and other theoretical research techniques. As a methodological tool for re-evaluating the relationship between the green and digital economies, a reflexive analysis of strategy as a process and outcome of activities is proposed and utilized. The method of reflexive analysis allows for the formation of a reflexive image of this relationship, abstracting from its inherent practical connections.

The work of A. Pawłowski (2023) enabled the authors to choose a journal for publication. As part of the current study, the authors analyzed a sufficient volume of scientific literature. However, the most significant are the work of Daams M.N. and Veneri P. (2017), in which attention is paid to the importance of preserving natural resources in the conditions of electronic exploitation. In the work, a substantiated study of the social indicators of various city districts was carried out.

Eyraud L., Clements B. and Wane A. (2013), the issue of "green" investments is revealed. Recently, taking into account the direction of integration processes into the European Community, where such technologies are crucial and ensure national security, there is a need to adapt the legislation to the EU legal system. Of course, when making "green" investments, investors need state support and guarantees for the protection of such investments, since their payback period is quite long. Independent investment by commercial companies within the framework of natural processes of business operation at the expense of own funds or loan financing must be provided by the state with a favorable environment for business operation and the presence of long-term stable and transparent rules of operation in the market and economically justified prices for consumers that ensure the return of investments. .

The work of Hao X., Li Y., Ren S., Wu H. and Hao Y. (2023), is devoted to the role of digitization in green economic growth. Aspects of the need for an industrial structure and the importance of environmental innovations are revealed. Li S., Chang G. and Zunong R. (2023), in a study examine the impact of regional digital economy development on green investment. Ma D. and Zhu Q. (2022) conducted research on the digital economy that promotes high-quality environmental development. The authors suggest developing the digital economy through innovation, technology, thus ensuring sustainable development.

The current study considered the work of Naldi L., Nilsson P., Westlund H. and Wixeb S. (2015), which

accepts the smart development of agriculture, this enabled the authors of the current study to highlight the development trends and the relationship between the green and digital economy.

Olsson A.R. and Cars G. (2011), reveal polycentric spatial development through institutional challenges of inter-municipal cooperation, while Peng X-Y., Zou X-Y., Zhao X-X. and Chang C-P. (2023), pay attention to the uncertainty of economic policy and its impact on the environment innovations.

Rachinger M., Rauter R., Müller C., Vorraber W., and Schirgi E. (2019) noted the beginning of the impact of digitalization on innovative business models. Cognitive modeling of the concepts of sustainable development of society in the work of Shevchenko I., Boychenko E. and Martynovych N. (2021), deserves attention considering the current conditions for the development of the digital and green economy. Weizsaecker E. and Wijkman A. (2018) have a very well-founded study on the risks of destroying the planet, it is their study that serves as the basis for the current work.

The analyzed specialized literature allowed the authors to make sure that today there are works devoted separately to the green economy or the digital one, but there is no research that would reveal the relationship between these economies and emphasize the great significance of this interdependence.

METHODS

The connection between the green and digital economy in the concept of sustainable development is very important and is a powerful tool for achieving sustainability and preserving the environment. Digital technologies make it possible to monitor environmental pollution and control the level of pollution, which helps preserve nature and the health of the population. Taking this into account, a critical analysis of modern scientific and practical methods used in the assessment of socio-economic systems was carried out in order to identify the most suitable ones for solving research tasks (Table 1).

Table 1: Analysis of methods in the context of research tasks

The main research tasks that need to be solved	Theoretical methods					Methods of quantitative expert assessment			
	Analysis method	Synthesis method	Induction method	Deduction method	Graphical method	The method of rating assessments	Method of point evaluations	Pairwise comparison method	Method of serial comparison
Expert assessment of the importance of the components of the external environment on the relationship between the digital and green economies						+	+	+	+
Defining the features of the digital and green economy	+	+							
Determination of directions for the further development of economic processes within the framework of the formation of sustainable development			+	+					
Study of the cause-and-effect relationship and identification of the influence between the factors-signs and the resulting sign	+	+	+	+					
Visual display of research results					+				

Source: *Compiled by the authors.*

RESULTS

The term "green economy" was first used in 1989 when a group of ecological economists included it in a report on the principles of sustainable development. The definition of this term, which is found in the UN Environment Programme, states that the green economy aims to improve people's quality of life and ensure social justice by reducing negative environmental impacts and overcoming the deficit of ecological resources. However, this definition is limited to setting target objectives and pointing out the potential positive outcomes of the green economy without delving into specific mechanisms for achieving these results. So, in modern conditions, the digital economy plays a big role, the significance of which is revealed through its place and role in all spheres of social reproduction.

On the basis of the conducted research, the authors identify such dominant trends in the development of the digital economy in the world as the shift of the center of economic activity towards developing countries (in which the industrial revolution and the process of urbanization, occurring at the same time, gave impetus to the development of the global economy), as well as the accelerated spread and the economic impact of technology (technology has always been the engine of the world economy). In the developed markets of Europe, North America and Australia, improving ethical practices and environmental topics are expected to become increasingly important (Ma and Zhu, 2022; Jiang *et al.* 2019). Consumers have begun to evaluate the ethical performance of brands, supplier policies and sustainable development with increasing effectiveness and more tangible significance of the relevant groups of influence.

In addition, we cannot ignore another dominant trend, in particular food security, which, according to the author, is a key driver of the formation of social and political priorities at the global level, because global population growth, problems of sustainable development and uneven income growth create constant challenges, among which, first of all, it is worth highlighting the following: increasing the general availability of food, meeting the growing diversification of the consumer basket and meeting higher quality standards (safety, environment, welfare and ethics) (Fraga-Lamas *et al.* 2021).

It should be noted that the trends of the digital economy are closely related to the goals of the green economy. This is what makes the current research so necessary and timely. The digital economy represents an economic paradigm where information technology is the primary driver of development. It is based on the ability to collect, process, and analyze large volumes of data, enabling companies and governments to make more informed decisions. The digital economy encompasses components such as artificial intelligence, the Internet of Things, blockchain, and big data processing. This rapid development is transforming traditional sectors of the economy, including finance, healthcare, transportation, and education (Mondejar *et al.* 2021). It creates new opportunities for businesses, enhancing their competitiveness and market potential. However, it also raises questions about data security and demands new skills and knowledge from the workforce.

The digital economy is a key factor in the future, and its development requires active adaptation and collaboration across all sectors of society to fully leverage the advantages of this new economic landscape. Building a relationship between green and digital economies requires a balance between features. When comparing the digital and green economy, it is possible to identify their regularities, shown in the Table 2.

Therefore, the analysis of the characteristics of the digital and green economies has revealed a paradoxical regularity: the contraction of traditional industrial sectors and the reduction of anthropogenic impact on the environment, achieved in this way, open up opportunities for the development of the digital and green economies. The potential of the digital and green economies encompasses a combination of climate, forest, mineral, water, and other resources that can support global economic development (Mustafa *et al.* 2022; Rahman *et al.* 2022). Taking into account the limitations associated with ecology that require avoiding extensive production and unconscious environmental treatment, modern digital technologies become the primary driver of green economy development. These technologies simultaneously contribute to nature conservation and high levels of technological progress in production. The ecological orientation of production impacts all business sectors, with

Table 2: Comparative characteristics of the digital and green economy (author's vision)

Feature	Digital economy	Green economy
Ecological component	Reduction of man-made disasters Reducing the consequences of natural disasters	Preservation of natural capital Reconstruction of ecosystems
Economic result	Production customization Reducing losses by minimizing environmental impact through the use of digital tools The use of digital human potential platforms is controlled and directed by digital systems.	Rational use of natural resources High-tech productions, organically integrated into the natural environment. Rational use of human potential in compliance with the principles of the green economy A decrease in the turnover of the mining and processing industry, which entails a reduction in environmental pollution due to a reduction in industrial emissions
Spatial characteristic	Virtual environment	The reduction of the area of land involved in agricultural circulation causes the transition to organic farming
Sources	An alternative source is the creation of the Metaverse and Industry 5.0. the spread of the Internet of Things and artificial intelligence.	Alternative energy sources are renewable energy resources obtained through the utilization of hydroenergy, wind energy, solar energy, geothermal energy, biomass, and tidal energy. Unlike fossil fuels such as oil, natural gas, coal, and uranium ore, these energy sources do not deplete, which is why they are referred to as renewable.

Source: *Compiled by the authors.*

companies adhering to ecological responsibility principles gaining a competitive advantage over their competitors. Assessing companies based on ecological criteria helps investors understand a company's readiness to transition to a low-carbon economy (Belmonte-Urena *et al.* 2021; Chen *et al.* 2020). Today, it is considered that the green and digital economies are interconnected and "can constitute a single technological landscape." In fact, the green economy cannot exist without digital technologies, just as the digital economy must be ecologically oriented, considering the importance of ethical aspects. Digital technologies can contribute to achieving environmental goals, ultimately leading to the conservation of physical resources and ensuring economic benefits (Fig. 1).

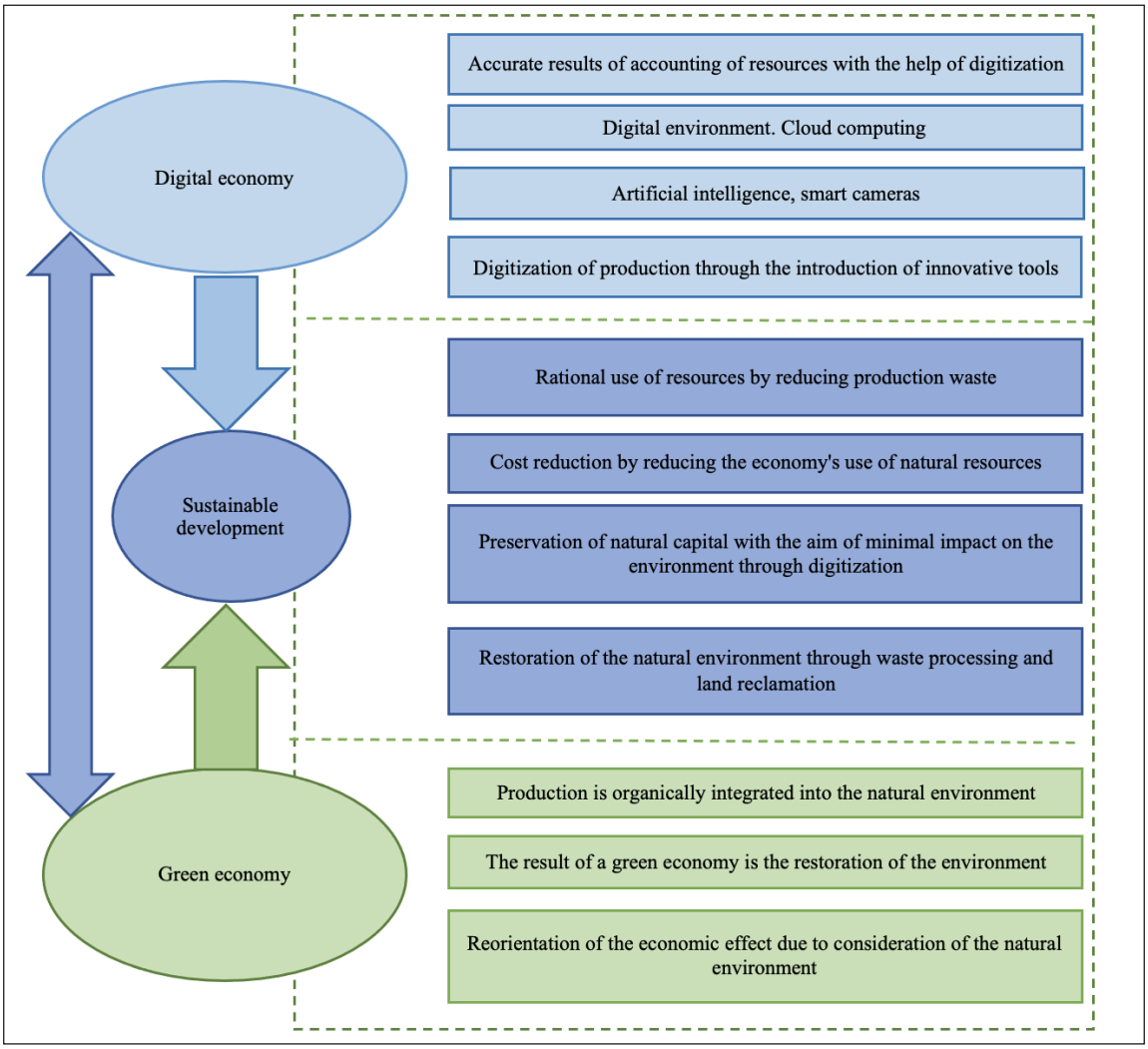
Fig. 1 clearly demonstrates the interconnection between the digital and green economies through the prism of the environmental effect. According to the authors of the study, this visual representation highlights the interdependence of the outcomes of these economies. The foundation of both the green and digital economies is natural capital. The introduction of the digitization process has made it possible to quantitatively assess natural capital and track its turnover in real time.

Therefore, based on the research results, it has been determined that the interrelation between the digital and green economies can be shaped as the result of implementing a series of entrepreneurial activities (Khan *et al.* 2021; Shahbaz *et al.* 2022), including:

1. Restructuring of the extractive and processing industries.
2. Infrastructure support for the economy, such as the construction of distributed energy facilities.
3. Diversification of the local economy by attracting investments in high-tech processing of non-timber forest resources and forest waste; eco-friendly construction and elite furniture production; construction of enterprises for processing organic agriculture products.
4. Development of ecological and health tourism due to the opportunities for selling a portion of the produced organic products.

The development of the digital and green economies depends on considering the social potential, which can be achieved through the following means:

1. Primarily, local entrepreneurs, especially in the tourism sector, show significant interest



Source: Compiled by the authors.

Fig. 1: Interrelationship of digital and green economy through the prism of sustainable development

in preserving the natural environment. They understand that this contributes to increasing the attractiveness of their region to tourists and leads to income growth. Additionally, these entrepreneurs share ideas about the harmonious coexistence of humans with nature.

2. A second important factor is "downshifters" - residents of large cities who choose rural areas for permanent residence. They make this choice in search of an ecologically clean natural environment and the opportunity for self-realization.

These two social phenomena play a crucial role in creating and supporting green and digital initiatives, thereby promoting sustainable development and environmental preservation. The source of social growth is the young generation, which is knowledgeable about digital technologies and raised with a mindset of environmental conservation (Khan *et al.* 2021; Tymoshenko *et al.* 2022). The implementation of an economy based on modern digital technologies and the principles of conserving natural capital is intended to radically change not only the nature of production. The focus on harmony with nature is undoubtedly important, but it's also essential to ensure accessibility, high-speed internet, and digital services to meet a broad range of needs. One form of human settlement and an adequate economic model that shapes its spatial framework is eco-cities. These cities embody the idea of an organic combination of the advantages of urban and rural lifestyles based on the use of nature-friendly technologies, digital services, and

resource-efficient architectural solutions (Govindan *et al.* 2020; Agrawal *et al.* 2022; Dvigun *et al.* 2022).

Despite the advantages of the digital and green economies, it's important to understand that the market mechanism of self-regulation alone is not sufficient for the successful implementation of these economic concepts. Resource constraints and mandates require active involvement of government bodies, which can:

1. Implement infrastructure projects for the establishment of high-speed communication networks in remote urban and rural areas.
2. Place government orders for the development of new digital platforms and support the development of existing ones aimed at promoting the green economy.
3. Place orders for the implementation of high-tech solutions for "smart cities" and the development of transportation and municipal infrastructure.
4. Develop the green financial sector and financial instruments aimed at supporting green initiatives.
5. Incorporate green and digital approaches into tax and investment policies, including improving mechanisms for charging fees for negative environmental impact.
6. Form digital and green economy clusters, providing financial support and participating in their management to protect the interests of the public, particularly in matters of environmental compliance.
7. Actively promote the formation of environmental policies and initiatives to create environmentally friendly cities.

Digital technologies are driving changes aimed at promoting the sustainable development of the world. An example of effective measures for implementing sustainable practices is the integration of innovative technologies into activities, allowing for a significant increase in resource efficiency through intensive methods. In the face of economic instability, the economy was able to reduce a significant portion of waste by considering import substitution and implementing digital solutions.

Another significant direction is efficient energy policy and a focus on human resources, utilizing the competencies that contribute to increased intellectual output not only in energy but also in other sectors through the intensive utilization of existing resources.

Discussion. In the face of economic volatility triggered by the coronavirus pandemic, it is more important than ever to foster flexibility and adaptability to promote sustainable development. Digital and green technologies have the potential to enhance the efficiency and reliability of both the green and digital sectors of the economy while also conserving energy and human resources (Dantas *et al.* 2021). The development of the digital and green sectors together undoubtedly contributes to the effectiveness of achieving sustainable development goals. To remain competitive in the current market, companies need to develop both in terms of innovation and environmental sustainability (Li *et al.* 2020; Centobelli *et al.* 2020; Zhou *et al.* 2020).

However, there is a debate about the potential consequences of the use and development of digital and green technologies. Digitization may lead to more significant future impacts on labor demand, increased income inequality, higher unemployment, and decreased job satisfaction for workers (Pan *et al.* 2022). Concerning the development of the green economy, there are discussions about the underestimation of the environmental factor in macroeconomic policy, the need for a nature-based economic restructuring, and the reduced demand for heavy industrial structures like black and non-ferrous metallurgy (Jabbour *et al.* 2020). The assessment of the degree of influence of groups of factors of the external environment on the relationship between the digital and green economies is given in Table 3.

Based on the analysis, using the data obtained in the table 1. The importance of the influence of external factors on the relationship between the digital and green economies and the possibilities of their strengthening, we will build an environment profile for enterprises, which is a matrix with two axes of coordinates: one reflects the possibility of strengthening the influence, the other - the estimated overall level of influence, given in Fig. 2.

The following conclusions can be drawn on the basis of the constructed profile of the environment. The most influential and most dynamic are the group of

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Table 3: Assessment of the degree of influence of groups of factors of the external environment on the relationship between the digital and green economies

№	Groups of factors	Experts																			$\sum_{j=1}^{m} R_j$	$\overline{d}$	d_j	d_j^2
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19				
1	Demographic	3	5	5	3	5	3	5	3	3	3	3	3	4	4	4	4	4	3	3	70	86,8	-16,8	280,6
2	Economical	8	8	7	8	7	6	7	8	8	7	6	8	7	8	7	8	7	8	7	140	86,8	53,3	2835,6
3	Social and cultural	4	4	3	3	3	3	3	5	5	5	4	5	5	5	5	5	5	4	4	80	86,8	-6,8	45,6
4	Ecological	2	3	4	3	3	3	3	3	3	5	4	5	3	5	4	5	5	5	5	73	86,8	-13,8	189,1
5	Political and legal	7	6	6	6	6	6	6	7	6	8	8	7	5	7	5	6	8	7	8	125	86,8	38,3	1463,1
6	Marketing and innovation	7	7	6	7	8	8	7	6	7	6	7	6	8	6	6	6	6	6	7	127	86,8	40,3	1620,1
The number of identical rank values (t_e)		$(2^3-2)+(2^3-2)$	–	(2^3-2)	$(3^3-3)+(2^3-2)$	(2^3-2)	$(2^3-2)+(2^3-2)$	$(2^3-2)+(2^3-2)$	(2^3-2)	(2^3-2)	$(2^3-2)+(2^3-2)$	$(3^3-3)+(2^3-2)$	(2^3-2)	$(2^3-2)+(2^3-2)$	(2^3-2)	(2^3-2)	$(2^3-2)+(2^3-2)$	(2^3-2)	–	$(2^3-2)+(2^3-2)$	615	I	Amount	6433,8

$W = 12 \times 6433,8 / \left(\left[19^2 \times (8^3 - 8) - 19 \times 192 \right] \right) = 0,7134$

$\chi^2 = 19 \times (8-1) \times 0,7134 = 99,987$ – *the consistency of experts' opinions is not accidental.*

Source: *Compiled by the authors.*

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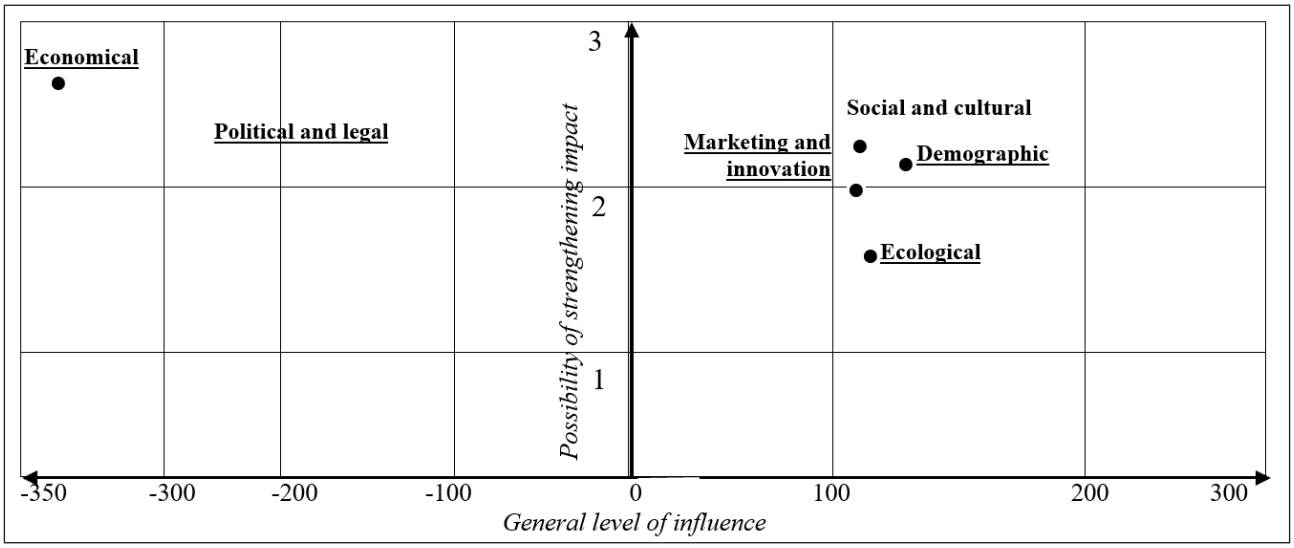

Source: *Compiled by the authors.*

Fig. 2: Environmental profile of groups of factors of external influence on the relationship between the digital and green economies

economic factors of the external environment, which is quite expected, since in most cases the relationship between the digital and green economies depends on the functioning of enterprises as a whole.

CONCLUSION

The synergy between the green and digital economies offers a pathway toward achieving sustainable development. It is important to consider the potential challenges, such as the environmental impact of digital infrastructure and the need to ensure that digitalization benefits all segments of society. Balancing economic growth, social equity, and environmental protection remains a complex task but is essential for a sustainable future.

The implementation of the interconnection between the digital and green economies with a strong digital component can be a viable way to overcome the current crisis. The decline of traditional industries based on an extensive approach can be seen as a source of growth for the green economy.

However, the development of the digital and green economies in conjunction can only occur under certain conditions, including community cohesion, collaboration among local administrations, entrepreneurs, and highly skilled professionals. It also involves prioritizing the development of high-tech companies with minimal environmental impact, the establishment of eco-cities, comprehensive government support, and collaboration with other countries to expand cooperation and incorporate their sustainable development experiences.

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