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# SUSTAINABLE FINANCE: VENTURE INVESTMENTS IN THE MANAGEMENT OF QUALITY 5.0 IN A GREEN ECONOMY

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A B S T R A C T

*This paper elaborates on the concept of Quality 5.0 as a modern paradigm of product quality management, which focuses on the role of human and sustainable development in the interaction with digital technologies in the conditions of environmental and social challenges. The paper characterises the relevance of environmental and social challenges in the modern conditions; characterises Industry 5.0 as a factor in solving social and environmental problems through technological innovations; discloses the essence and specifics of the green economy; considers the influence of quality management on the economic development of companies; describes the process of the shift of the goals of quality management in the conditions of the Quality 5.0 concept; dwells on the problems of financial support of investing in the green economy; studies venture investments as the tools for financial support and stimulation of the management of Quality 5.0 in the green economy; establishes their place in the system of sustainable finance; and substantiates the influence of venture investment on the implementation of the Quality 5.0 concept in the conditions of the green economy.*

*The methodological framework of this research is based on the combination of concepts related to sustainable development, quality management, and innovation financing within the context of the green economy. A system approach is used, which integrates technological, financial, socioeconomic, and environmental aspects, with emphasis on the Quality 5.0 concept as a new stage of the evolution of quality management systems, taking into account digital technologies and human factor. The methodological tools include an analytical overview and synthesis of scholarly sources, component and comparative analysis of quality management systems and financial tools for venture investment, as well as methods of observation, grouping, and generalisation, which ensures a comprehensive approach to the research.*

*The scientific value of this paper lies in the formation of the author's vision of the Quality 5.0 concept as a harmonious combination of product quality, innovations, and environmental responsibility. The paper emphasises the strategic role of venture investment as a flexible financial mechanism which can support breakthrough environmental technologies and innovative projects, ensuring effective integration of the principles of Quality 5.0 in sustainable development. This creates a new architecture of financial and technological transformation, which contributes to the formation of responsible, competitive, and sustainable production ecosystems in the digital age.*



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## 1. INTRODUCTION

Climate change has become increasingly relevant, which is manifested not only in ecology but also in public and economic processes. The limit of an increase in the global average temperature of 20C by 2030, set within international global policy, is considered a critical threshold after which irreversible climate change could take place (Sullivan, 2025). According to the analytical report by Swiss Re, achievement of this threshold could lead to the reduction of global GDP by 11 % until 2050 (Swiss Re Institute, 2021).

In these conditions, the importance of responsible business behaviour grows. It must go beyond the limits of formal ESG reporting and include actions aimed at the management of environmental risks and reduction of their consequences through readjustment of business projects, application of risk-oriented proper checking (due diligence), consideration of global Sustainable Development Goals during the preparation of plans, and application of human-oriented approach which takes into account social implications of climate change (OECD, n.d.). This approach to the organisation of business, as noted in a Deloitte report, takes into account the negative influence of climate and environmental changes, which affect around 70 % of economic sectors and form new spheres and opportunities. This stimulates business companies to voluntarily implement sustainable development strategies in their activities, which would contribute to an increase in competitiveness, growth of investment attractiveness, and receipt of reputational benefits (Sullivan et al., 2021).

Additional factors in using the Sustainable Development Goals as real economic business landmarks are receipt of access to cheaper financing, expansion of sales through entering green markets, upgrade and modernisation of equipment, etc. In total, these factors, which are based on the rational use of natural resources, reduction of anthropogenic and technological impact on the environment, support of economic and social justice, stimulation of environmental innovations, and priority of long-term stability over short-term profit, form preconditions for the transition to the green economy. In the conditions of a change in the economic paradigm, the issues of businesses' adaptation to new challenges become very relevant. These circumstances predetermine the necessity for improvement of the management of supply chains, an increase in energy- and resource efficiency, ensuring high product quality according to the Quality 5.0 concept, and diversification of financial sources for these transformations, in particular, with the use of the mechanism of venture investment in innovative sustainable solutions.

## 2. EXPERIMENTAL SECTION

Venture investments are an important flexible tool for financing promising, but risky, projects, many of which are implemented in the spheres of quality management and green economy. The study of venture investments in the context of sustainable finance forms a complex scientific problem, which requires solid theoretical and methodological support, given the current theories, concepts, and views. According to this, the methodological basis of the paper is determined by the concepts of sustainable development, quality management, and financing of innovations which take place in the conditions of the green economy. These concepts have a strong basis and stem from the theories of innovative development, evolutional economy, and a system approach to the management of socioeconomic phenomena. The theoretical integrity of the research is ensured by the concept of Quality 5.0, which is a new stage in the evolution of quality management systems due to the use of digital technologies and attention to human factor in cyber-physical production systems.

The system approach allows establishing the interconnection between technological innovations, financial tools, and socioeconomic and environmental aspects of sustainable development. The focus is on the integration of approaches to quality management and principles of the green economy and venture investment. The latter is assigned a complex role as a source of financing and support for innovative eco-oriented projects. The methodological framework of the research is formed by an analytical overview and synthesis of scientific and export sources on the Quality 5.0 concept, green economy, venture investment, and sustainable development; the component analysis of quality management systems from the position of integration of digital technologies and ESG metrics; comparative analysis of institutional and venture tools of financing innovative projects based on green technologies, and methods of observation, grouping, and generalisation.

The modern economic paradigm combines complex processes connected with technological innovations, environmental challenges, and new approaches to quality management. This creates new conditions for the development of sustainable financial tools and venture investments in the green economy. Analysis of scientific and expert works within these topics allows distinguishing several main directions, which determine the theoretical foundations for understanding the interrelations between sustainable finance, venture investments, and quality management based on Industry 5.0 principles. Thus, within the evolution of the concept of quality management to the level of Quality 5.0, the principles and conditions of the paradigm shift from reactive control to proactive creation of values with the help of digital technologies and principles of sustainable development are considered (Arsovski, 2023; Bisho & Sam, 2022), with the combination of economic, environmental, and social aspects (Cardoso et al., 2022) and formation of the Quality 5.0 concept based on Society 5.0 (Maljugić et al., 2024). Within the characteristics of Industry 5.0 as a driver of sustainable

development, transition from the concept 4.0 to 5.0 is studied with a focus on the favourable economic and social influence of this evolution (El Jaouhari et al., 2021) and human-centredness as an essential feature of Industry 5.0 (Ghobakhloo et al., 2022) with the corresponding influence on the labour market and social sustainability (Gamberini & Pluchino, 2024).

From the position of green finance and mechanisms of financing the environmental transition, the specifics of the perspectives of transition of the green finance market in the context of transfer to the digital economy are studied (Kantor et al., 2023), attention is paid to the necessity for developing new financial tools that are relevant for the current challenges (Tyagi, 2023) and identification of the main obstacles and challenges in the sphere of transitional finance (Harnett et al., 2024; World Economic Forum, 2024). From the position of venture investments in green technologies, attention should be paid to views on the justification of the critical role of venture capital in start-ups' success (Bocken, 2015) and transition to a sustainable economy (Maiti, 2022; Yu et al., 2024), as well as agreement of the traditional tools of investing with ESG criteria (Lin, 2022). Within the problem of digital transformation of the green economy, the focus is made on its essence and potential (Lv et al., 2024), the role of green finance in stimulating the transition to Industry 5.0 (Dhayal et al., 2023), assessment of the challenges for digital transformation (Melkamu, 2025), and understanding the potential of the green economy at the local level (Huseynova et al., 2024). Equally important theoretical foundations are formed based on an understanding of a complex interaction between financial development, human capital, Industry 5.0 in the conditions of environmental dynamics (Muzaffar et al., 2024), the relevance of the problem of sustainable supply chains based on responsible innovations (Popkova et al., 2024), and development of the strategies of adaptation to climate change and rethinking of investment strategies (Sullivan et al., 2021; Sullivan, 2025).

The goal of this paper is complex research of the role of venture investment in the implementation of the Quality 5.0 concept in the green economy, which is manifested through solving the following tasks: analysis of modern challenges of sustainable development in the conditions of digital transformation from the position of their influence on the quality management system; the study of the conceptual foundations of quality management in the conditions of Industry 5.0, which combines digital technologies, the human factor, and environmental criteria; determination of the specific features and the role of venture capital in financing and supporting breakthrough eco-oriented technologies; the study of the mechanisms of financing and management of risks within venture investments, which contribute to sustainable development and implementation of environmentally-responsible approaches in business; identification of additional effects of venture investment as a tool of sustainable finance in the environment of the green economy and Quality 5.0.

## 3. RESULTS

The basis of economic development is defined by technological innovations. Several waves of technological revolutions allowed, due to the introduction of mass production, power thrust, and automatization of production, for a significant increase in labour efficiency, effectiveness, and manageability of business. At the same time, systemic transformations caused the accumulation of important global challenges, which are manifested through the aggravation of the climate crisis, an increase in social inequality, and a reduction of the level of resilience of supply chains. Against the background of the growth of reservations regarding further prospects of technological progress within Industry 4.0, these challenges became a reason for reconsideration of traditional views of the role of technologies in human civilisation's development.

One of the most important aspects of the development of mankind is the issue of quality. It is viewed in the context of combining interests of different spheres of activities, covering consumer demands (products with high consumer qualities), business interests (competitive advantages), and government policy (regulation and overview). At present, an inseparable component of quality is social and environmental dimensions, which are viewed in the context of sustainable development, reduction of the negative anthropogenic influence on nature, preservation of resources and equal accessibility to quality products for all social groups.

The above factors lie in the basis of a new model of development of business, which is characterised by a harmonious combination of economic, environmental, and social goals, which are set on a digital basis. In these conditions, such digital tools as artificial intelligence, big data, cloud computing, blockchain, the Internet of Things, etc. acquire the status of the main drivers of progress, which covers different spheres of public and economic life.

The concept of Quality 5.0 is a result of extrapolation of the principles of the idea of Society 5.0, which formed in Japan, at the global scale. Quality in this context is a component of social standing. It takes into account five main topics, which are as follows:

- New values for future development of industry and transformation of society;
- Revision of economic and social risks and challenges;
- Support of the development of science;
- Active development of innovations and technologies;
- Integration of human resources, knowledge, and innovative potential into a unified system (Arsovski, 2023).

When studying the concept of Quality 5.0, S. Arsovski characterises it as a dynamic phenomenon, which covers the practical aspect of quality, its scientific basis, and concepts of Industry 4.0 and Society 5.0, which are set into scientific research and development of intelligent technologies based on knowledge and ethical norms. In total, these components form Quality 5.0, which is peculiar for sustainable development, social innovations, sustainable digital innovativeness, a high level of digital culture, and quality of life (Arsovski, 2023).

Quality management is one of the most effective tools for ensuring the competitiveness and success of a business. Building a rational system of quality management allows achieving significant economic results, which include a reduction of costs and losses of resources, an increase in the level of productivity and effectiveness of operational activities, growth of the market share, improvement of the level of manageability of production sub-system, etc. Apart from this, quality management is an important factor in the achievement of non-financial results, which is manifested through the formation of a positive image, growth of trust in manufacturers and products, and support of compliance with ethical and environmental norms.

Dissemination of the concept of Quality 5.0 actively influences the systems of quality management at companies, transforming them and supplementing them with relevant elements. The gradual evolution from quality management systems, which are oriented towards internal operational effectiveness, to active managerial models, which cover digital transformation, focus on the role of humans in cyber-physical production processes, and stimulate environmental responsibility and innovative sustainability, takes place (Fig. 1).

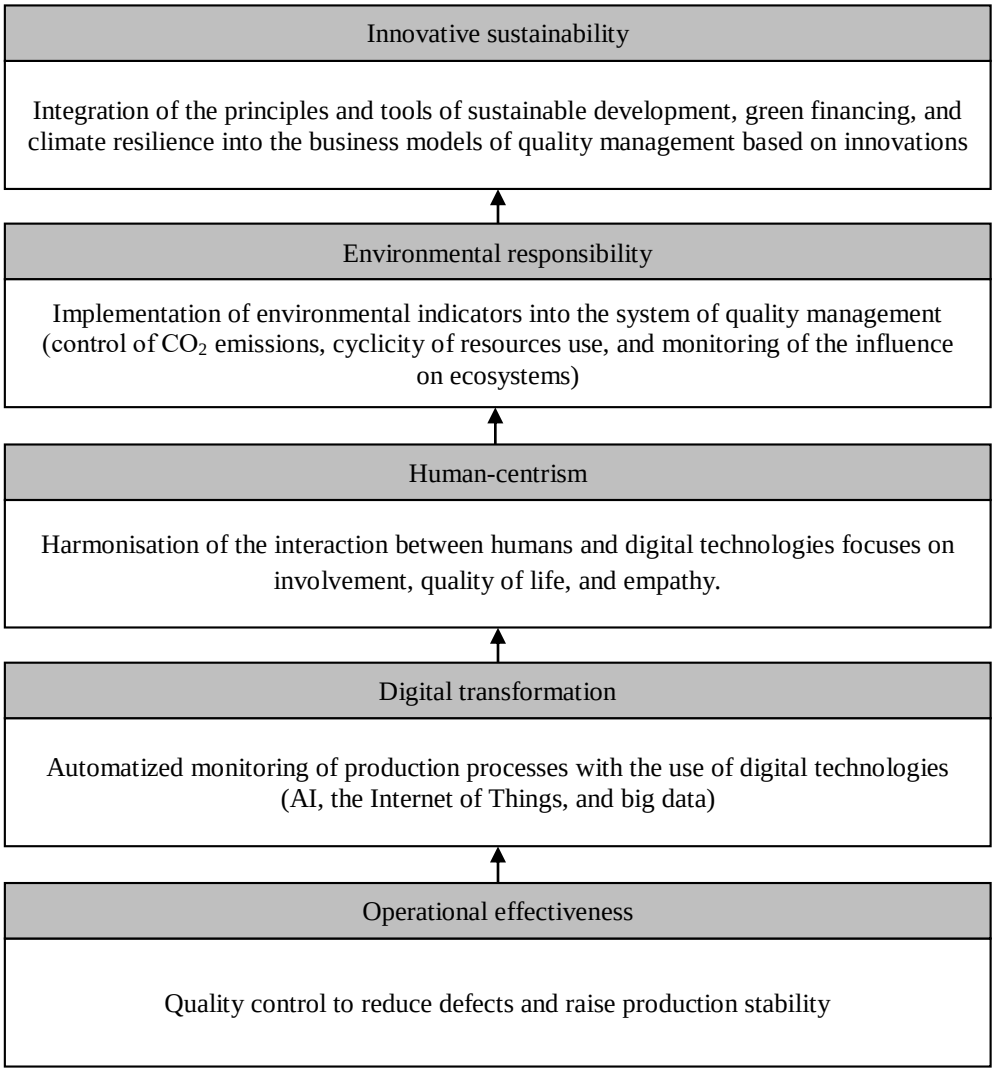


**Figure 1.** Evolution of quality management to the level of Quality 5.0
Source: Created by the authors based on (Gamberini & Pluchino, 2024; Ghobakhloo et al., 2022; Lv et al., 2024; Maljugić et al., 2024)

In these systems, the notion of quality is viewed together with digital tools, which ensure automatized monitoring of production, formation of large datasets, and analytics based on algorithms. This allows tracking the parameters of production in real-time but also offers mechanisms for preventing deviations and defects at early stages. Unlike

Industry 4.0, Quality 5.0 pays special attention to human factor in cyber-physical systems, which allows for the rational use of creative human potential, integrating it with the elements of computer vision, natural language processing, adaptive machine learning, etc. This approach demands special attention to human involvement in production and management processes and support of comfortable conditions of labour and quality of life for complete creative realisation.

The above specifics of quality management in the conditions of Industry 5.0 are supplemented by factors of environmental responsibility, which effect is aimed at inclusion of the corresponding criteria into the system of operational indicators of quality. This approach expands the influence of business beyond the limits of its stakeholders, assigning it a global scale, which is manifested in attention to tracking the carbon footprint, cyclicity of the use of resources, and monitoring of interaction with nature. Innovative sustainability, which completes the evolution of Quality 5.0, focuses on the integration of innovations with the principles of sustainable development, climate resilience, and green financing.

The development of the concept of Quality 5.0 is in harmony with the principles of the green economy, which is also oriented towards the systemic transformation of production and management processes, social responsibility, and saving resources. Their common values are environmental responsibility, innovative sustainability, social equality, and accessibility. The concept of the green economy was formed as a response to relevant environmental and social challenges. Its main features are low-carbon, resource-saving, and socially-oriented production. The innovative aspect of the green economy is aimed at the development of renewable energy, circular production, environmental design of products, value chain management, etc. A specific feature of a green economy is its ability to create an economic financial interest based on environmental and social factors, which allows creating new types of products, jobs, and entire sectors. Thus, the green economy is a complex model which harmoniously combines production and management processes with the Sustainable Development Goals, offering the basis for their financial support.

In the theory of classical political economy, the main priority of business is profit. Therefore, all sub-systems and mechanisms in business structures must aim their efforts towards the maximum profitability of the business. In the conditions of dissemination of the concepts of sustainable development and corporate social responsibility, the priority of profitability has reduced relevance, and non-profit goals connected with energy efficiency, environmental sustainability, climate resilience, etc, become landmarks for management, similar to financial results. Despite the fact that non-financial goals, in their majority, also indirectly influence the profitability and competitiveness of companies, their complete implementation into the strategic model of business management requires additional incentives.

Implementation of the Quality 5.0 principles, which involves providing quality management systems with not only operational effectiveness but also digital integration, eco-friendliness, and social focus, requires large-scale transformations and investments. Unlike investments in an operational system, in which the connection between modernisation and effectiveness of quality management is easily tracked, investing in a complex digital, environmentally focused, and socially oriented system of Quality 5.0 has a much lower level of connection with concrete expected effects. Given this, financial support for this transition is characterised by serious challenges and reservations. The problems of this nature include the following:

- The financial gap between the need and support for financing of environmental and climate initiatives. Achievement of the climate goals until 2025 required $125 trillion, while the real volume of investment is much lower (World Economic Forum, 2024);
- Green premiums – large initial investments, necessary for the implementation of green technologies which significantly exceed the current solutions based on fossil fuels (World Economic Forum, 2024);
- Instability of the government policy and insufficient level of government and institutional support of green initiatives;
- Financial aspects of the development of financial sectors of developing countries (low credit rankings, economy's dependence on foreign investment, currency risks, etc.) (Tyagi, 2023);
- Insufficient transparency and absence of experience in most green innovative projects (absence of a credit history in most environmental projects, ambiguous metrics of projects' effectiveness, poor access to financial tools) (Harnett et al., 2024);
- Risks of transitional finance for financing companies that work on the implementation of the environmental transition (image challenges and greenwashing);
- Structural and financial risks, which are connected with the possible depreciation of traditional financial tools connected with fossil fuels (Harnett et al., 2024).

Thus, large-scale implementation of the Quality 5.0 concept in the conditions of transition to the green economy is a rather complex task in the institutional and financial aspects. Its resolution requires the application of flexible approaches. A limited interest of traditional investors in financing innovative eco-oriented projects is connected with restricted possibilities to forecast their short-term investment effectiveness. In these conditions,

venture investment is an effective alternative for the mobilisation of financial resources, which could be aimed at supporting potentially disruptive technologies in the sphere of ecology. Due to the adoption of risks and uncertainty, as well as the focus on long-term effects, venture funds can compensate for such systemic risks and green premiums, absence of credit history, regulatory limitations, and insufficient maturity of financial markets. Apart from this, venture investments are not only a source of financing but also a tool for support and development of projects at early stages. In these conditions, venture financing of the management of Quality 5.0 allows implementing a new architecture of sustainable development, which is based on technologies and principles of sustainable development and a system approach to quality.

The above features of venture investment are imposed on the concept of sustainable finance, which characterises the direction of financial activities, which is aimed not only at financial return but also at consideration of ESG metrics. They cover the spheres of preservation of ecosystems, the fight against climate change, social development, and the liquidation of poverty. The main tools of sustainable finance are green bonds, green loans, ESG funds, and mixed financing.

In the system of sustainable finance, venture investments play a special role, contributing to the capitalization of high-risk innovative projects aimed at ensuring breakthroughs in three key dimensions of sustainable development: environmental, economic, and social. Unlike traditional tools of sustainable financing, venture capital is used to support projects and start-ups in the early stages (Lin, 2022). Venture funds provide long-term support for the period of research, testing, and scaling of novel solutions, which is not limited to investing but includes also expert support, formation of an ecosystem, and optimisation of business processes (Bocken, 2015). To reduce uncertainty in forecasting the return on innovative projects in the management of venture funds, their stage-by-stage financing is conducted, with a strict audit of the project and monitoring of compliance with ESG metrics. This allows managing the project and reducing investment risks (Lin, 2022).

From the position of the potential of venture capital in effective management and stimulation of project development in the sphere of the green economy, its application in the context of the Quality 5.0 paradigm is important as a tool of diversification of financial sources and the mechanism of comprehensive stimulation of innovative transformations. Depending on the type of investment tools, the character of their influence on the implementation of Quality 5.0 principles and the nature of expected results will vary significantly (Table 1).

**Table 1.** The influence of venture investments on the management of Quality 5.0 in the conditions of the green economy

| Venture financial tools | Description of the tool | Influence on the management of Quality 5.0 | Expected result in the green economy |
|---|---|---|---|
| Specialised green venture funds | Involvement of private capital in eco-oriented start-ups, diversification of financing sources | Support of start-ups that implement digital technologies in quality management systems | Development, certification, and scaling of solutions with low carbon footprint and large environmental effects |
| Hybrid financing (combination of angel and venture capital) | Integration of the resources of investment angels and venture funds to ensure the sustainability of start-ups at early stages | Accelerate the development, testing, and improvement of prototypes in the sphere of Quality 5.0 | Creation of adaptive production chains, energy-saving processes, and optimisation of quality |
| Impact investing | Venture financing of projects with a high level of compliance with ESG criteria | Integrate ESG metrics into quality management strategies, including the assessment of the carbon footprint, inclusion, and openness. | Growth of social responsibility of business, stimulation of the circular economy, decarbonisation, etc. |
| Combination of government grants and coinvestment | Tool of mixed investment, which reduces investment risks due to the attraction of public funds together with private venture capital | Support of comprehensive financing at all stages of R&D for complete integration of the components of Quality 5.0 (man-machine interaction, environmental focus, digitalisation) | Development of environmentally-oriented innovations, support of eco-certification procedures, scaling of sustainable solutions |

Source: Created by the authors based on (Dhayal et al., 2023; El Jaouhari et al., 2021; Maiti, 2022; Muzaffar et al., 2024; Yu et al., 2024)

Venture financing, which is realised in the system of sustainable finance, significantly expands the tools of quality management in the conditions of Industry 5.0. According to this, specialised green funds ensure targeted financing of eco-oriented projects, contributing to environmental modernisation, digital transformation, and integration of these solutions into the quality management model. Hybrid mechanisms of financing ensure financial flexibility and accelerate the processes of development and implementation of innovations that are necessary for adaptive quality management. Impact investing is based on ESG metrics and raises the social and environmental value of innovations, including through the influence on Quality 5.0 tools. The

mechanisms of venture co-investing with the use of government grants contribute to the reduction of investment risks and ensure a stable financial basis for realising the full innovative cycle from the idea to solution scaling.

Venture capital is viewed as one of the most important components of the financial architecture, which affects systemic new innovations, supporting and directing their development. Apart from the function of involvement of additional financial resources it contributes to the formation of clusters of technological cooperation and creation of innovative systems, which conform to the provisions of the green economy and Quality 5.0. Integration capabilities of venture capital have a special value, given the necessity for inter-sectorial interaction of science, business, and government in the sphere of disruptive eco-oriented technologies. Executing an integration function, venture investments support dynamic innovative development in the spheres in which the capabilities of traditional financial tools are limited (Bocken, 2015).

Successful completion of green start-ups, which are implemented with support from venture funds, perform an important mission, demonstrating to institutional investors not only the environmental but also economic attractiveness of these projects. As a result, there appears a multiplication effect, which positively influences the entire sector of sustainable finance, including green bonds, ESG funds, etc. In this context, venture capital ensures, apart from the function of direct financing of risky but attractive projects, the demonstration of successful financial experience, which, in the aggregate, stimulates the sustainable transformation of the economy.

A special role of the above financial tools is assigned to management of Quality 5.0, which offers a clear focus on the integration of green innovative initiatives into the system of quality management with a focus on human factor. The directions for technological progress offer innovative solutions for automatized monitoring and analysis of product parameters in real-time, control of product quality at all stages of the value chain, early detection of defects, and their elimination. These capabilities allow for a transition from a reactive to a proactive system of quality control, which, in aggregate, stimulates the formation of stable production ecosystems, which conform to the demands of the green economy and provide new opportunities to strengthen the company's competitiveness in the conditions of a dynamic and competitive environment.

## 4. DISCUSSION

The problem of sustainable finance, in particular, venture investments in the management of Quality 5.0, has a complex nature and cannot be fully resolved in one study. These reservations are supplemented by the high level of dynamics of the considered topics, which is manifested due to the innovative component of the Industry 5.0 concept, which is the basis for Quality 5.0. Apart from this, certain aspects of the targeted sphere require additional discussion and justification.

Given the specifics of the green economy and its indicators, there are certain reservations regarding the possibility of establishing direct connections between investing in innovative projects and indicators of their effectiveness. In this context, attention should be paid to the assessment of venture investments' ability to ensure a long-term financial effect from the implementation of green start-ups in the sphere of Quality 5.0, in view of their riskiness and uncertainty of the environment's conditions. Apart from this, a separate direction is formed by the problem of the search for balance between financial expedience and socio-environmental expectations from the implementation of sustainable innovative projects.

A widely discussed issue is the adoption and standardisation of the parameters of investments' sustainability, including the ones based on venture capital. This problem lies in the institutional dimension and is characterised by the absence of unified metrics of sustainable investing in the global context. The current approaches to standardisation of the criteria of assigning financial flows to environmentally- or socially favourable require additional development and agreement.

Diversification of venture investment tools within the Quality 5.0 concept requires a detailed analysis to reveal advantages, disadvantages, and specific features. According to this, it is required to determine the level of suitability of different tools for solving a range of relevant problems in the sphere of quality management in the conditions of Industry 5.0. Inter-sectorial interaction, peculiar to certain financial tools, also requires additional substantiation in order to establish the mechanism of this interaction, stimulate parties, etc. In this context, the multiplication effect of venture investments, which they make in the sphere of sustainable finance, requires in-depth elaboration and substantiation based on mathematical models.

## 5. CONCLUSION

The influence of technologies within Industry 4.0 allowed for a significant increase in the level of the effectiveness of production and management processes. However, it also led to the aggravation of global problems and challenges connected with environmental and social problems. The concept of Quality 5.0 is a response to these challenges. It is based on human-centrism, the use of digital technologies and a harmonious combination of economic, social, and environmental interests. Within this approach, traditional systems of quality management expand their influence

from the focus on internal effectiveness to the complex integration into the ecosystem of sustainable and responsible business. The use of such digital technologies as AI, big data analytics, the Internet of Things, etc. leads to the formation of new advantages of quality management, which are aimed at early detection of defects and the possibility of monitoring and forecasting of deviations. In the conditions of the green economy, apart from economic parameters of quality, large attention is paid to the principles of sustainable development, social equality, environmental responsibility, and innovative sustainability. These criteria are integrated into the system of Quality 5.0 and supplement its influence, which goes beyond the limits of local interaction with stakeholders.

Development and implementation of the complex models of Quality 5.0 require large-scale institutional transformations and substantial financial resources. The main problems of involving investments in the sphere of green innovations are large initial investments, the absence of transparent metrics of sustainable financing, risks of financial transition, etc. In these conditions, traditional financial tools have a limited effect due to the high level of riskiness and uncertainty in the sphere of green start-ups. Venture investment is an effective alternative, which can compensate for current risks and support the development of disruptive innovative solutions in the sphere of Quality 5.0 and the green economy. A specific feature of venture capital is the focus on the early stages of development of green projects and long-term expert support, which allows executing promising start-ups and scaling them. Diversification of venture financial tools allows for effective implementation of Quality 5.0 principles in the conditions of the green economy.

## References:


Arsovski, S. (2023). Quality 5.0: From challenges to reality. *Journal of Innovative Business and Innovation*, *1*(1), 13–22. https://doi.org/10.61552/JIBI.2023.01.002

Bisho, A. H. A. I., & Sam, M. F. B. M. (2022). Total quality management integrated strategy: Its implication to organizational success. *Proceedings on Engineering Sciences*, *4*(3), 371–378. https://doi.org/10.24874/PES04.03.014

Bocken, N. M. P. (2015). Sustainable venture capital – Catalyst for sustainable start-up success? *Journal of Cleaner Production*, *108*(Part A), 647–658. https://doi.org/10.1016/j.jclepro.2015.05.079

Cardoso, R. P., Reis, J. S. da M., Sampaio, N. A. de S., Barros, J. G. M. de, Barbosa, L. C. F. M., & Santos, G. (2022). Sustainable quality management: Unfoldings, trends and perspectives from the triple bottom line. *Proceedings on Engineering Sciences*, *4*(3), 359–370. https://doi.org/10.24874/PES04.03.013

Dhayal, K., Giri, A., Kumar, A., Samadhiya, A., Agrawal, S., & Agrawal, R. (2023). Can green finance facilitate the Industry 5.0 transition to achieve sustainability? A systematic review with future research directions. *Environmental Science and Pollution Research*, *30*, Article 29539. https://doi.org/10.1007/s11356-023-29539-w

El Jaouhari, A., Arif, J., Samadhiya, A., Dhayal, K. S., Luthra, S., & Singh, S. (2025). From automation to augmentation: Exploring the role of industry 5.0 advanced technologies for developing countries. *Engineering Management Journal*, *37*(3), 306-323. https://doi.org/10.1080/10429247.2024.2407254

Gamberini, L., & Pluchino, P. (2024). Industry 5.0: A comprehensive insight into the future of work, social sustainability, sustainable development, and career. *The Journal of Industrial Relations*, *33*(1). https://doi.org/10.1177/10384162241231118

Ghobakhloo, M., Iranmanesh, M., Mubarak, M. F., Mubarik, M., Rejeb, A., & Nilashi, M. (2022). Identifying Industry 5.0 contributions to sustainable development: A strategy roadmap for delivering sustainability values. *Sustainable Production and Consumption*, *33*, 775–793. https://doi.org/10.1016/j.spc.2022.08.003

Harnett, E., Holland, T., & Crouch-Hess, K. (2024). Unpacking five key barriers to transition finance. RMI. https://rmi.org/five-barriers-transition-finance/ (Accessed: 05.06.2025).

Huseynova, A., Guliyev, R., Suleymanov, A., & Ostrovskaia, O. (2024). Assessment of regional innovation activity. *Journal of Trends and Challenges in Artificial Intelligence*, *1*(3), 97–112. https://doi.org/10.61552/JAI.2024.03.004

Kantor, O.G., Rudneva, Y.R., Dunov, D.Y., Ergasheva, S.T., Leybert, B.M. Green Finance: Analysis of Prospects of the Russian Market (2023). Food Security in the Economy of the Future: Transition from Digital Agriculture to Agriculture 4.0 Based on Deep Learning, pp. 45-56. https://doi.org/10.1007/978-3-031-23511-5_6

Lin, L. (2022). Venture capital in the rise of sustainable investment. *European Business Organization Law Review*, *23*(1), 187–216. https://doi.org/10.1007/s40804-021-00238-8

Lv, X., Wang, Y., Liu, L., & Yin, S. (2024). Digital green innovation economy for Industry 5.0. *Sustainable Economies*, *2*(1), Article 8. https://doi.org/10.62617/se.v2i1.8

Maiti, M. (2022). Does development in venture capital investments influence green growth? *Technological Forecasting and Social Change*, *182*, 121878. https://doi.org/10.1016/j.techfore.2022.121878

Maljugić, B., Ćoćkalo, D., Bakator, M., & Stanisavljev, S. (2024). The Role of the Quality Management Process within Society 5.0. *Societies*, *14*(7), 111. https://doi.org/10.3390/soc14070111

Melkamu, M. (2025). Artificial intelligence implementation challenges in industries: Developing countries prospective. *Journal of Trends and Challenges in Artificial Intelligence*, *2*(1), 175–180. https://doi.org/10.61552/JAI.2025.01.004

Muzaffar, M., Ghouse, G., & Alahmad, F. A. (2024). Assessing the interplay of financial development, human capital, democracy, and Industry 5.0 in environmental dynamics. *Sustainability*, *16*(16), 6846. Retrieved from https://doi.org/10.3390/su16166846

OECD. (n.d.). Responsible business conduct: Environment and climate change. Organisation for Economic Co-operation and Development. https://www.oecd.org/en/topics/sub-issues/due-diligence-guidance-for-responsible-business-conduct/responsible-business-conduct-environment-and-climate-change.html

Popkova, E.G., Kaurova, O.V., Maloletko, A.N. (2024). Introduction. Popkova, E.G., Kaurova, O.V., Maloletko, A.N. (Ed.) Sustainable Cooperation for the Creation of Green Supply Chains Based on Environmental Technologies and Responsible Innovations (Sustainable Civil Infrastructures , Part F3650), Springer Nature Switzerland. pp. V-VIII. https://doi.org/10.1007/978-3-031-70962-3

Sullivan, J. (2025). How soon should companies prepare for a 2°C world? TIME. Retrieved from https://time.com/7290141/wmo-climate-report-2c-business-impact/

Sullivan, K., Tanger, K., & Bachir, M. (2021). Climate change 101 for business leaders: Key questions and essential knowledge. *Deloitte Insights*. Retrieved from https://www.deloitte.com/au/en/issues/climate/climate-change-101-business-leaders.html

Swiss Re Institute. (2021). The economics of climate change: No action not an option. Retrieved from https://www.swissre.com/dam/jcr:e73ee7c3-7f83-4c17-a2b8-8ef23a8d3312/swiss-re-institute-expertise-publication-economics-of-climate-change.pdf

Tyagi, A. (2023). Green transition: Financing challenges and financial stability risks. *Observer Research Foundation*. Retrieved from https://www.orfonline.org/expert-speak/green-transition-financing-challenges-and-financial-stability-risks

World Economic Forum. (2024). The 3 key challenges to financing the climate transition – and what to do about them. *Climate Action*. Retrieved from https://www.weforum.org/stories/2024/06/net-zero-climate-finance-transition-challenges

Yu, P., Dai, H., Zhu, J., Hamori, S., Dong, R. K., & Yue, X. (2024). How does venture capital play a role in corporate green innovation? Evidence from China. *International Review of Economics & Finance*, 96(Part B), 103654. https://doi.org/10.1016/j.iref.2024.103654

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