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THE ROLE OF TECHNOLOGY IN THE GREEN ECONOMY: A LITERATURE REVIEW ON INNOVATION AND SUSTAINABILITY

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Abstract

This research aims to review the role of technology in the green economy with a focus on innovation and sustainability. Through a literature review, this research explores various forms of green technologies such as renewable energy, energy efficiency, and waste management technologies, and their benefits in reducing environmental impacts and improving resource efficiency. The results show that technological innovation is a key pillar in driving a green economy, but its successful adoption is highly dependent on appropriate government policy support. In addition, public education and awareness on the importance of green technologies are also crucial factors in accelerating the transition to a more sustainable economy. By integrating technology, policy and education, this research emphasises the importance of a holistic approach to achieving global sustainability goals.

Keywords: Role, Technology, Green Economy, Innovation, Sustainability.

Introduction

Green economy has become one of the main topics in the global discussion on sustainable development. This concept places the principle of sustainability as the basis of economic growth, taking into account environmental and social impacts. This paradigm aims to reduce greenhouse gas emissions, use natural resources efficiently, and develop environmentally friendly technologies (Merino-Saum et al., 2020) .

A green economy is an economic model that aims to improve human well-being and social equity, while significantly reducing environmental risks. The concept emphasises multi-faceted sustainability, including the efficient use of natural resources, the reduction of carbon emissions, and the implementation of environmentally friendly practices in all sectors of the economy. The green economy encourages the integration of environmental principles in economic decision-making processes, with a focus on innovation and investment in green technologies, renewable energy, and development that does not damage ecosystems (Maltais & Nykvist, 2020) .

The importance of a green economy is not only limited to environmental conservation, but also has implications on social and economic aspects. By applying green economy principles, countries can reduce the negative impacts of climate change and environmental degradation, ultimately reducing the risk of natural disasters and maintaining ecosystem health (Affolderbach, 2022) . In addition, the green economy also opens up opportunities to create new jobs in sustainable industry sectors, increase economic resilience, and reduce social inequality through a fairer distribution of natural

resources. The implementation of a green economy can be interpreted as an investment in a more stable, healthy and inclusive future for all people (Sun et al., 2020) .

With growing awareness of climate change and environmental degradation, the role of technology in supporting the transition to a green economy is becoming increasingly important. Technological innovation has great potential to address various environmental challenges, reduce the negative impacts of human activities, and create new, more sustainable economic opportunities. Technology can help in areas such as renewable energy, waste management, sustainable agriculture, and green transport (Mohsin et al., 2022)

However, while the potential of technology in supporting a green economy is widely recognised, there are still various barriers to its implementation. These challenges include high costs, lack of supporting infrastructure, and resistance from traditional industries. In addition, there is still a gap in the deployment of green technologies between developed and developing countries (Hao et al., 2023) .

Through this literature review, we aim to identify the significant role of technology in the green economy and evaluate the innovations that have been made in support of sustainability. This research seeks to answer several key questions, such as how technology contributes to the development of a green economy and what are the recent innovations that promote sustainability. By doing so, it is hoped that this research can provide deep insights into the importance of technology and innovation in achieving green economy goals and provide recommendations for better policies and practices in the future.

Research Methods

The study in this research uses the literature method. The literature research method is an approach in research that utilises written materials or existing documents as the main data source to answer research questions or achieve specific research objectives. This research involves critical analysis and synthesis of information obtained from various literature sources, including books, journal articles, reports, and other publications (Sanusi, 2015) ; (Wekke, 2020) . This method is useful for identifying research trends, finding gaps in the existing literature, and bringing together different perspectives and tested findings. Literature research is often chosen because it allows researchers to build a solid theoretical foundation before proceeding to empirical studies, and can save time and resources compared to field research or experiments (Syafril & Erlina, 2018) .

Results and Discussion

The Role of Technology in a Green Economy

Technology plays a vital role in developing and implementing green economy approaches. One of the biggest contributions of technology is in reducing carbon

footprint and greenhouse gas emissions through innovations in renewable energy, such as solar, wind and biomass. These technologies allow us to shift from the use of environmentally damaging fossil fuels to cleaner and more sustainable energy sources (Ye et al., 2022) . In addition, developments in energy storage technologies, such as advanced lithium-ion batteries and energy storage grids, are also further strengthening our ability to efficiently manage and utilise renewable energy (Gilchrist et al., 2021) .

In addition to innovations in energy, technology also plays a role in improving resource efficiency in various sectors of the economy. The use of the Internet of Things (IoT) and big data, for example, enables more effective and careful management of natural resources, such as in precision agriculture and sustainable water management. These technologies help minimise waste, optimise the use of water, fertilisers and pesticides, and increase production yields without harming the environment. Thus, technology supports greener economic growth by promoting more efficient and environmentally friendly practices (Zhou et al., 2021) .

Furthermore, digital technologies, including artificial intelligence (AI) and blockchain, also play an important role in the transformation to a green economy. AI can be used to improve product design and production processes that are more efficient and low-emission. Meanwhile, blockchain technology can support transparency and sustainability in the supply chain, ensuring that every step in production and distribution meets strict environmental standards. By automating and integrating processes, digital technologies can reduce the cost, time, and environmental impact of various economic activities (Du et al., 2022) .

Not only that, technology also opens up new opportunities in green job creation and skills development. Technological innovation in the renewable energy sector, for example, requires a workforce with specialised skills in the installation, maintenance and management of advanced energy systems (Söderholm, 2020) . Technology-based education and training can equip the labour force with the necessary capabilities to participate in this green economy, while supporting the transition from conventional jobs that may be less environmentally friendly. Thus, technology supports not only environmental sustainability but also economic and social prosperity (Guo & Yu, 2022) .

Finally, the application of technology in the green economy also creates opportunities for global collaboration. Countries can share technologies and best practices through international partnerships and alliances, such as co-operation in renewable energy research and development or pilot projects for green smart cities. This collaboration enables more efficient and rapid transfer of knowledge and technology and financing of green innovations around the world. By utilising technology as a key enabler, the green economy can continue to grow and provide far-reaching benefits not only for the environment, but also for society and the global economy as a whole.

Technology Innovation for Sustainability

Technological innovation plays an important role in achieving environmental, social and economic sustainability. One of the key areas utilising innovative technologies for sustainability is renewable energy. Technologies such as solar panels, wind turbines, and biomass power plants enable cleaner and more environmentally friendly energy production compared to fossil fuels. In addition, innovations in the development of batteries and other energy storage technologies ensure that renewable energy can be utilised efficiently and made available whenever needed, strengthening the resilience and sustainability of the global energy system (Yumei et al., 2021) .

In addition to the energy sector, technological innovations are also emerging in the transport sector to support sustainability. Electric cars, electric buses, and hydrogen-based transport are becoming increasingly popular solutions to reduce carbon emissions from the transport sector. Autonomous technology and smart transport systems maximise travel efficiency and reduce congestion, thereby reducing the overall carbon footprint. These initiatives not only help preserve the environment but also create new opportunities in the mobility industry (Zhou et al., 2021) .

Technological innovation also plays a role in sustainable agriculture that empowers farmers with environmentally-friendly tools and techniques. Precision agriculture powered by the Internet of Things (IoT), drones, and real-time soil sensors allows farmers to optimise the use of water, fertiliser, and other resources. This not only increases crop yields but also reduces the environmental impact of conventional farming practices. With this approach, agriculture can better contribute to global food security while maintaining natural ecosystems (Mentes, 2023) .

In addition, urban development also benefits from technological innovations for sustainability. Green construction using eco-friendly building materials, energy-saving technologies, and sustainability-oriented architectural design can reduce the environmental impact of modern cities. The smart city concept with smart sensors and data management enables more efficient management of urban resources, including water, electricity and waste management. This helps to create urban environments that are healthier and more comfortable to live in (Eckert & Kovalevska ., 2021)

Finally, the role of technology in sustainability also includes improvements in waste management and recycling. New technologies in automated waste segregation, material recycling, and processing organic waste into fuel or compost can reduce the volume of waste that ends up in landfills. With more efficient and innovative waste management, we can reduce environmental pollution and support a sustainable circular economy, where materials are continuously reused and support longer product life cycles. This transformation contributes not only to ecological but also economic sustainability, by creating new industries and jobs in the recycling and waste management sectors.

Challenges and Opportunities for Green Technology Development

The development of green technologies faces various challenges, one of which is the high costs associated with research and development. Initial investments in green technologies, such as solar panels, wind turbines, or electric cars, can require substantial capital (Ruggerio, 2021) . In addition, green technologies usually require different or new infrastructure, which means there are additional costs to transition from conventional technologies. Limited financial resources are often a barrier for small and medium-sized enterprises, as well as developing countries, in widely adopting green technologies (Karjoko et al., 2020) .

However, despite the high initial cost, green technology offers great opportunities in the long run. Energy efficiency and operational cost savings are the main benefits of using green technology. For example, homes that utilise solar energy systems and other energy-efficient technologies can significantly reduce electricity bills. In addition, with the growing global awareness and pressure towards sustainability, there are great opportunities for innovation and business development in this sector. Industry players that can offer efficient and economical green solutions have broad market potential both nationally and internationally (Fang, 2020) .

One of the other key challenges is resistance to change and limited knowledge of green technologies. Many stakeholders, including governments, companies, and communities, may be reluctant to switch to new technologies due to lack of information, old habits, or uncertainty about their benefits. Education and awareness campaigns are essential to overcome these barriers. Training programmes and incentives for green technology adoption can also help accelerate the acceptance and implementation of these technologies in different sectors (Shan et al., 2021) .

Government regulations and policies also play a crucial role in the development of green technologies. Stringent environmental policies and financial incentives such as subsidies, tax credits, or feed-in tariffs for renewable energy can encourage the adoption of green technologies. On the other hand, complicated or inconsistent regulatory barriers can slow down the development and application of these technologies (Raihan & Tuspekova, 2022) . Therefore, cooperation between the public and private sectors and harmonisation of international policies are essential to create an enabling environment for green innovation.

Finally, opportunities for global collaboration and technology exchange should not be overlooked. With environmental challenges of a global nature such as climate change, pollution and resource scarcity, international co-operation is crucial. Countries can share knowledge, technologies and best practices in the development and implementation of green technologies. Initiatives such as the Global Energy Partnership and the UN Climate Change Conference (COP) are examples of platforms where countries can share and collaborate. Through global collaboration and agreement,

green technologies can be developed and implemented more effectively, bringing us closer to a sustainable future (Wang, 2021) .

Thus, green technology development is a strategic and essential step towards achieving environmental sustainability. While they face challenges such as high initial costs, resistance to change, and regulatory and policy complexity, the opportunities are immense. In the long run, green technologies not only deliver significant energy efficiency, but also open up a wide range of business and innovation opportunities.

The importance of public education and awareness, government support through appropriate policies, and global collaboration are critical to the success of green technologies. With synergy between various sectors and countries, barriers to green technology development and adoption can be minimised, accelerating the transition to a cleaner and more sustainable environment.

In conclusion, although challenging, the development of green technologies has great potential to have a broad and profound positive impact, especially in dealing with global environmental issues. With the right commitment and support, we can achieve a more sustainable and healthy future for the earth and future generations.

Conclusion

Results The conclusions of this study; First, technology plays an important role in the development of a green economy by facilitating innovations that support sustainability. Various literatures show that the application of green technologies-from renewable energy, energy efficiency, to waste management technologies-can significantly reduce negative impacts on the environment. These innovations not only help reduce greenhouse gas emissions but also support the efficient production and consumption of natural resources, which in turn increases overall economic productivity.

Second, the literature review shows that there is a link between technological innovation and government policies in creating an enabling environment for a green economy. Appropriate policy support, such as fiscal incentives, stringent environmental regulations, and investments in research and development, go a long way in promoting the adoption of green technologies. Without policy support, technological innovations tend to be difficult to develop and widely adopted, which hinders progress towards a more sustainable economy.

Third, in addition to technological and policy aspects, the importance of public education and awareness cannot be ignored. To achieve a sustainable green economy, there needs to be a thorough understanding at all levels of society of the importance of green technology. This awareness will drive the adoption of green behaviours and support innovative initiatives. Increased green literacy can accelerate the transition to a green economy and ensure its sustainability in the future.

References

Affolderbach, J. (2022). Translating green economy concepts into practice: Ideas pitches as learning tools for sustainability education. *Journal of Geography in Higher Education*, *Query date: 2024-12-27 09:07:44.* https://doi.org/10.1080/03098265.2020.1849063

Du, L., Razzaq, A., & Waqas, M. (2022). The impact of COVID-19 on small-and medium-sized enterprises (SMEs): Empirical evidence for green economic implications. *Environmental Science and ...*, *Query date: 2024-12-27 09:07:44.* https://pmc.ncbi.nlm.nih.gov/articles/PMC9344445/

Eckert, E., & Kovalevska, O. (2021). Sustainability in the European Union: Analysing the discourse of the European green deal. *Journal of Risk and Financial Management*, *Query date: 2024-12-27 09:07:44.* https://www.mdpi.com/1911-8074/14/2/80

Fang, H. (2020). A study of methods and strategies for the penetration of patriotic awareness in higher education based on big data systems. *2020 International Conference on Big Data and Informatization Education (ICBDIE)*, *Query date: 2024-12-27 08:37:54*, 15-20. https://doi.org/10.1109/icbdie50010.2020.00011

Gilchrist, D., Yu, J., & Zhong, R. (2021). The limits of green finance: A survey of literature in the context of green bonds and green loans. *Sustainability*, *Query date: 2024-12-27 09:07:44.* https://www.mdpi.com/2071-1050/13/2/478

Guo, H., & Yu, X. (2022). A survey on blockchain technology and its security. *Blockchain: Research and Applications*, *Query date: 2024-12-25 10:55:15.* https://www.sciencedirect.com/science/article/pii/S2096720922000070

Hao, X., Li, Y., Ren, S., Wu, H., & Hao, Y. (2023). The role of digitalisation on green economic growth: Does industrial structure optimisation and green innovation matter? *Journal of Environmental Management*, *Query date: 2024-12-27 09:07:44.* https://www.sciencedirect.com/science/article/pii/S0301479722020771

Karjoko, L., Winarno, D., Rosidah, Z., & ... (2020). Spatial planning dysfunction in East Kalimantan to support green economy. *International Journal of ...*, *Query date: 2024-12-27 09:07:44.* https://www.ijicc.net/images/vol11iss8/11819_Karjoko_2020_E_R.pdf

Maltais, A., & Nykvist, B. (2020). Understanding the role of green bonds in advancing sustainability. *Journal of Sustainable Finance &Investment*, *Query date: 2024-12-27 09:07:44.* https://doi.org/10.1080/20430795.2020.1724864

Mentes, M. (2023). Sustainable development economy and the development of green economy in the European Union. *Energy, Sustainability & Society*, *Query date: 2024-12-27 09:07:44.* https://doi.org/10.1186/s13705-023-00410-7

Merino-Saum, A., Clement, J., Wyss, R., & ... (2020). Unpacking the Green Economy concept: A quantitative analysis of 140 definitions. *Journal of Cleaner ...*, *Query date: 2024-12-27 09:07:44.* https://www.sciencedirect.com/science/article/pii/S0959652619332093

Mohsin, M., Taghizadeh-Hesary, F., Iqbal, N., & ... (2022). The role of technological progress and renewable energy deployment in green economic growth. *Renewable Energy*, *Query date: 2024-12-27 09:07:44.* https://www.sciencedirect.com/science/article/pii/S0960148122003603

Raihan, A., & Tuspekova, A. (2022). Role of economic growth, renewable energy, and technological innovation to achieve environmental sustainability in Kazakhstan. *Current Research in Environmental Sustainability*, *Query date: 2024-12-27 09:07:44.* https://www.sciencedirect.com/science/article/pii/S2666049022000433

Ruggerio, C. (2021). Sustainability and sustainable development: A review of principles and definitions. *Science of the Total Environment*, *Query date: 2024-12-27 09:07:44.* https://www.sciencedirect.com/science/article/pii/S0048969721025523

Sanusi, I. (2015). Bridging Qualitative and Quantitative Research. *Journal of Da'wah Science*,*4* (13), 409-409. https://doi.org/10.15575/jid.v4i13.400

Shan, S., Genç, S., Kamran, H., & Dinca, G. (2021). Role of green technology innovation and renewable energy in carbon neutrality: A sustainable investigation from Turkey. *Journal of Environmental ...*, *Query date: 2024-12-27 09:07:44.* https://www.sciencedirect.com/science/article/pii/S0301479721010665

Söderholm, P. (2020). The green economy transition: The challenges of technological change for sustainability. *Sustainable Earth*, *Query date: 2024-12-27 09:07:44.* https://doi.org/10.1186/s42055-020-00029-y

Sun, J., Wang, T., & Luo, M. (2020). Research on the Construction and Innovation of Lifelong Education System Under the Background of Big Data. *2020 International Conference on Big Data and Informatization Education (ICBDIE)*, *Query date: 2024-12-27 08:37:54*, 30-33. https://doi.org/10.1109/icbdie50010.2020.00014

Syafril, S., & Erlina, N. (2018). *Preparing Interview Protocols, Selecting Informants and Probing in Qualitative Research*. *Query date: 2024-05-25 20:59:55.* https://doi.org/10.31219/osf.io/pvsh3

Wang, M. (2021). Research on Strategies of Applying Artificial Intelligence to Psychology Teaching in Colleges and Universities. *2021 International Conference on Artificial Intelligence and Electromechanical Automation (AIEA)*, *Query date: 2024-12-27 08:22:21*, 205-209. https://doi.org/10.1109/aiea53260.2021.00051

Wekke, I. S. (2020). *Qualitative Research Design*. *Query date: 2024-05-25 20:59:55.* https://doi.org/10.31219/osf.io/4q8pz

Ye, J., Al-Fadly, A., Huy, P. Q., Ngo, T. Q., & ... (2022). The nexus between green financial development and renewable energy: Investment in the wake of the Covid19 pandemic. *Economic Research ...*, *Query date: 2024-12-27 09:07:44.* https://hrcak.srce.hr/file/436731

Yumei, H., Iqbal, W., Irfan, M., & Fatima, A. (2021). The dynamics of public spending on sustainable green economy: Role of technological innovation and industrial structure effects. *Environmental Science and Pollution ...*, *Query date: 2024-12-27 09:07:44.* https://doi.org/10.1007/s11356-021-17407-4

Zhou, S., Greenspan, H., Davatzikos, C., & ... (2021). A review of deep learning in medical imaging: Imaging traits, technology trends, case studies with progress highlights, and future promises. *Proceedings of the ...*, *Query date: 2024-12-25 13:43:50.* https://ieeexplore.ieee.org/abstract/document/9363915/