

EXPLORING THE SYNERGY OF GREEN INNOVATION AND DIGITAL TRANSFORMATION FOR ENHANCING SME PERFORMANCE: A SYSTEMATIC LITERATURE REVIEW

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Abstract

Green innovation and digital transformation are one of the crucial components in dealing with industrial development and environmental issues for SMEs. Each has an important and interrelated role in helping the performance of SMEs. This study aims to identify how the collaboration of green innovation and digital transformation in improving the performance of SMEs with a systematic literature review technique. This research uses a systematic search strategy to collect journal articles from the Scopus and Web of Science databases for the last 5 years. The results of the systematic review revealed that green innovation and digital transformation collaborate in improving the quality of information and resources that lead to effective SME operational processes with efficient costs so to create market competitiveness and improve SME performance both financial and non-financial. The results of this study can be taken into consideration for SMEs to implement green innovation and digital transformation in their operations.

Keywords: Green Innovation, Digital Transformation, SME Performance, Systematic Review

INTRODUCTION

Technological advances have maneuvered companies to operate and compete. Today, companies must understand that in order to compete, they must be able to accept change, which is necessary to monitor and understand their performance (Taticchi et al., 2010) so that companies not only satisfy stakeholders, but also manage the development of the company over time and to achieve optimal operating levels (Bhagwat & Sharma, 2007). This situation is not much different for SMEs (Small and Medium Enterprises), although there are some theoretical limitations with management practices compared to companies that are much larger in scale and complex.

Performance is the result of work achieved by a person or organization, in accordance with the authority and law, and in accordance with morals and ethics (Afandi & Bahri, 2020). SME performance measurement is a basic factor for managing and improving the performance of these SMEs. This performance improvement is important because SMEs have a significant contribution to manufacturing, sales and development (Hidayat et al., 2024)

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and are one of the economic drivers of society. Primadhita et al. (2021) stated that in terms of improving performance, SMEs need to have the ability to innovate, be able to utilize technological advances and have the ability to adapt quickly to social and environmental changes. Utilization of technological advances can be realized, one of which is digital transformation.

Digital transformation is accomplished through the integration of digital tools, processes and systems in SMEs' business processes, which will improve their operational efficiency and productivity (Mohammed & Trzcielinski, 2021). Furthermore, digital transformation is seen as a valuable tool for SMEs to collaborate on to increase competitiveness by facilitating management decisions such as the use of social media to increase customer engagement. This statement is in line with the results of research by (Saputri et al., 2022) which states that one of the elements of digital transformation, namely digital literacy, has a positive effect on marketing performance. SMEs that are digitally literate are able to improve their marketing performance through sales on online platforms.

Digital transformation in SMEs is certainly not free from various obstacles, even more than large-scale companies. The barriers that arise include limited human resources and inadequate educational backgrounds, large financial burdens and lack of readiness to accept new technologies (Queiroz et al., 2022). Rather than viewing digital transformation as a strategic investment, SME managers perceive it as a new cost burden. Appropriate and efficient steps are needed for SMEs to successfully implement digital transformation so as to minimize risks to the smooth running of business processes.

Additionally, in this era of globalization, SMEs need to ensure the sustainability of their business through cost savings while paying attention to the impact on the environment. As knowledge and technology develop, public awareness of environmental issues increases, leading to demands for environmentally friendly business processes. SMEs need environmentally friendly production methods, product quality improvisation, and environmentally friendly marketing practices as well. This can be realized by SMEs implementing green innovation, especially for SMEs that have greater potential to impact the environment such as pollution, pollution and energy consumption (Cheng et al., 2014). Green innovation is not only oriented towards financial performance, but also considers its impact on the environment and society (Wang et al., 2023).

Similar to digital transformation, green innovation also has its own challenges in its implementation by SMEs. Weng & Lin (2011) stated that large companies tend to find it

easier to implement green innovation, unlike SMEs that have limited resources and weaker infrastructure. Gupta and Barua identified green implementation challenges including human resource challenges, financial and economic challenges, lack of support from the government regarding green innovation, and lack of knowledge and information regarding green practices.

Innovation and technology utilization are strategies to boost SME performance (Mauludin et al., 2023). Digitalization involves a series of financial and human resources to achieve efficiency. Undoubtedly, digitalization is a crucial element in accelerating SMEs' green innovation to achieve sustainable performance. The collaboration of green innovation and digitalization is an opportunity for SMEs to improve performance. Green innovation and digital transformation help improve competitiveness, access to new markets, develop new and sustainable products or services, and benefit from the rapidly rising demand for environmentally friendly products (Reza-Gharehbagh et al., 2022).

There have been many literature studies related to green innovation and its effect on improving SME performance. Naharuddin et al. (2024) presented a literature study related to the determinants of Triple Bottom Line Sustainability Performance in SMEs which emphasized the role of green innovation and sustainable practices as key determinants for sustainable performance. Passaro et al. (2023) proposes a systematic literature review of the determinants of eco-innovation in SMEs and explores the relationships among them. (Sikandar et al., 2024) conducted an SLR of the eco-innovation literature pertaining to small and medium businesses as well as the effect of the eco-innovation adoption on SME's performance.

There have also been many literature studies related to the effect of SME digitalization. Laziva & Atieq (2024) conducted a literature study of SME digitalization strategies and factors in the era of Society 5.0 to minimize the risk of failure and achieve success. Pfister & Lehmann (2023) compiled a literature study on the effect of digitalization on SME performance. Dimoso & Utonga (2024) conducted SLR digital technology adoption in SMEs and its implications for SME performance in developing countries. However, studies on the collaboration of green innovation and digital transformation in improving SME performance are still rare. The previous literature study by Dionisio & Paula (2024) discussed the interconnection of digital transformation with green innovation, but the implications for SME performance have not been discussed. This research will fill the gap. Based on the description above, this literature study will raise the following research questions:

1. How do green innovation and digital transformation collaborate in the context of SMEs?
2. How can the collaboration of green innovation and digital transformation improve the performance of SMEs?

The purpose of this paper is to identify through a systematic review how green innovation and digital transformation relate and practice collaboration in SMEs and how their collaboration catalyzes SME performance.

LITERATURE REVIEW

Green Innovation

Green innovation is defined as all actions that can be taken by any person or organization to promote the development and application of improved processes, products, techniques and management systems that contribute to reducing negative environmental impacts and achieving specific ecological goals. According to Chang (2011) green innovation is an important strategic catalyst for achieving sustainable development, including technological innovations involved in energy saving, pollution prevention and waste recycling. Green innovation is grouped into two categories (Chen et al., 2016), namely: green product innovation is creating or significantly improving products or services to reduce adverse impacts on the environment. The implementation of green product innovation is related to the selection of product materials that have the minimum possible pollution impact, the minimum possible energy use, the use of products to be recycled, reused or decomposed. Secondly, green process innovation, which is creating new production or delivery methods that are better than previous methods.

Digital Transformation

Digital transformation is defined as transformation related to changes in digital technology that result in company business models, products or organizational structures. Hinings et al. (2018) state that digital transformation is the combined effect of several digital innovations generated by the actors involved, structures, practices, values, and beliefs that change, replace, or complement existing rules in organizations, environments, industries, or other fields. At the core of this digital transformation is the integration of emerging technologies such as big data analytics, artificial intelligence, cloud computing, Internet of Thing, and blockchain into the structure of business operations (Tang et al., 2023). Digital transformation involves a fundamental change in the way a business or organization operates using digital technologies. It involves the integration of digital technologies into every aspect

of a business or organization, including changes in business models, operating processes, and customer experiences (Putra et al., 2023).

SME Performance

Mutegi et al. (2015) define SME performance as the results of work achieved by individuals and adjust to the role or duties of these individuals in a company in a certain period of time, which is associated with a certain measure of value or standard of the individual company. work. SME performance can be seen from its profitability and productivity (Mutoharoh & Buyong, 2020). The use of subjective measures of performance is a valid proxy (Bouwman et al., 2019). Many previous studies have used Return on Asset (ROA) and Return on Equity (ROE) as indicators of profitability. In terms of productivity, Sihombing (2018) defines productivity as a measure of the amount of output compared to the amount of input that the company has used in producing output. This can be shown by the use of labor costs or working capital which results in increased sales.

Previous Research

Previous literature studies by Dionisio & Paula (2024) entitled “A systematic review on the interconnectedness of eco-innovations and digital transformation” discuss the interconnection of digital transformation with green innovation and its impact on business sustainability. Queiroz et al., 2022 entitled “Digitalization as an Enabler to SMEs Implementing Lean-Green? A Systematic Review through the Topic Modeling Approach” discusses digitalization as an enabler of Lean-Green implementation in SMEs which has a positive impact on environmental performance and business sustainability.

RESEARCH METHOD

This research type is a literature study research. The method used was systematic literature review. Systematic literature review tries to collect all empirical evidence that meets the inclusion criteria set previously, with the aim of answering specific research questions.

a. Literature Search Strategy

The literature used in the review is articles from the Scopus and Web of Science databases. The keywords used in the screening of articles include “sustainable innovation”, “green innovation”, “eco-innovation”, “digital transformation”, “digitalization”, “TTC”, “SMEs”, “performance”. The publication period is set in the range of 2020 to 2024.

b. Inclusion and Exclusion Criteria

Journal articles published between 2020 and 2024 were reviewed. This study only used articles from journals and eliminated other sources such as preprints and conference papers. These criteria were necessary for the initial identification of high-quality articles. The articles reviewed should focus on the collaboration of green innovation and digital transformation in the context of SME performance. This research did not limit the type of SME performance discussed. Only English language articles were included in the review. Table 1 summarizes the inclusion and exclusion criteria applied.

Table 1. Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusion
Topic	Focused on the integration of green innovation and digital transformation, implication on SME's performance	Not focused on the integration of green innovation and digital transformation, no implication on SME's performance
Period	2020-2024	Articles outside the period
Language	English	Not English
Source	Journal	Sources other than journal
Access	Open Access	Not open access

c. Data Extraction and Analysis

Data extraction is undertaken to obtain key information from the article. This extraction includes: bibliographic details (author, year of publication, name of journal, etc), research objectives and methodologies, key findings and insights related to green innovation, digital transformation and SME's performance. The extracted data is then analyzed to answer the research questions that have been determined previously.

RESULT AND DISCUSSION

The search for journal articles for this study using Publish or Perish 8 software by entering predetermined keywords in the Scopus and Web of Science databases resulted in a total of 580 articles. Title and accessibility analysis was conducted first to identify 3 criteria in the article. Relevant articles needed to contain green innovation and digital transformation and be fully accessible. This stage resulted in 53 articles that fit the criteria. Then, the article abstracts were analyzed to determine whether the articles discussed green innovation and digital transformation collaboration, as well as their influence on SME performance. Researchers did not limit the type of performance discussed. The results of this analysis

obtained 20 relevant articles. The extraction results of 20 articles reviewed in this study are shown in table 2 below.

Table 2. Extraction Result of Reviewed Articles

Title	Journal & Publication's year	Country	Research Method	Data Collection and Analysis Method
“Green Innovation And Sustainable Products In Small And Medium-Sized Enterprises In China: The Moderating And Mediating Roles Of Technology And Work Engagement”	Environmental Engineering and Management Journal (2023)	China	Quantitative	Survey, PLS-SEM
“Factors Influencing Green Innovation Adoption and Its Impact on the Sustainability Performance of Small- and Medium-Sized Enterprises in Saudi Arabia”	Sustainability (2022)	Saudi Arabia	Quantitative	Survey, PLS-SEM
“Green Innovation Driven by Digital Transformation: An Innovation Chain Perspective”	Systems (2024)	China	Quantitative	Secondary data, Baseline Regression
“Technological Innovation, Sustainable Green Practices and SMEs Sustainable Performance in Times of Crisis”	Information Systems Frontiers (2022)	Oman	Quantitative	Survey, PLS-SEM
“SME's Sustainability And Success Performance: The Role of Green Management Practices, Technology Innovation, Human Capital and Value Proposition”	International Journal of eBusiness and eGovernment Studies (2022)	Saudi Arabia	Quantitative	Survey, PLS-SEM
“Research on the Impact of Digital Inclusive Finance on Green Innovation of SMEs”	Sustainability (2024)	China	Quantitative	panel data, threshold

Title	Journal & Publication's year	Country	Research Method	Data Collection and Analysis Method
				regression analysis
“Achieving green tourism through environmental perspectives of green digital technologies, green innovation, and green HR practices”	Environmental Science and Pollution Research, (2023)	China	Qualitative	interview, HFL-AHP analysis
“Digitalisation driving sustainable corporate performance: The mediation of green innovation and green supply chain management”	Journal of Cleaner Production (2024)	China	Quantitative	Survey, PLS-SEM
“Implementing Eco-Innovation by Utilizing the Internet to Enhance Firm’s Marketing Performance: Study of Green Batik Small and Medium Enterprises in Indonesia”	International Journal of E-Business Research (2020)	Indonesia	Quantitative	Survey, PLS-SEM
“Navigating Competitive Intensity: The Role of Digital Orientation in SMEs’ Green Innovations”	Journal of the Knowledge Economy (2024)	China	Quantitative	Survey, PLS-SEM
“The role of digital transformation in boosting CSR-driven green innovation among Yemeni manufacturing SMEs”	Discover Sustainability (2024)	Yemen	Quantitative	Survey, PLS-SEM

Title	Journal & Publication's year	Country	Research Method	Data Collection and Analysis Method
“Digitization, perception of policy uncertainty, and corporate green innovation: A study from China”	Economic Analysis and Policy (2023)	China	Quantitative	Secondary data, Fixed Effect Regression Analysis
“Greening the future: analyzing green entrepreneurial orientation, green knowledge management and digital transformation for sustainable innovation and circular economy”	European Journal of Innovation Management (2024)	Saudi Arabia	Quantitative	Survey, PLS-SEM
“Sustainable Innovation in Small and Medium-Sized Enterprises: Environmental Regulations and Digitalization as Catalyst”	The Journal of Environment & Development (2023)	China	Quantitative	panel data, fixed effect regression analysis
How Industry 4.0 technologies and open innovation can improve green innovation performance?”	Open Innovation (2021)	Malaysia	Quantitative	Survey, PLS-SEM
“Exploring the relationship between digital transformation and green innovation: The mediating role of financing modes”	Journal of Environmental Management (2024)	China	Quantitative	Secondary data, regression analysis
“Effect of digital transformation on enterprises' green innovation: Empirical evidence from listed companies in China”	Energy Economics (2023)	China	Quantitative	Secondary data, benchmark regression analysis

Title	Journal & Publication's year	Country	Research Method	Data Collection and Analysis Method
“Unraveling the transformation: the three-wave time-lagged study on big data analytics, green innovation and their impact on economic and environmental performance in manufacturing SMEs”	European Journal of Innovation Management (2023)	India	Quantitative	time-lagged method, CFA
“Research on the impact of digital inclusive finance on regional carbon emissions: Based on the sustainable green innovation of small and medium-sized enterprises”	Journal of Cleaner Production (2023)	China	Quantitative	panel data, Baseline regression analysis
“Network embeddedness and manufacturing SMEs’ green innovation performance: the moderating role of resource orchestration capability”	Business Process Management Journal (2023)	China	Quantitative	Survey, hierarchical regression analysis
“Study on the impact of digital transformation on green competitive advantage: The role of green innovation and government regulation”	PLoS ONE (2024)	China	Quantitative	Survey, PLS-SEM
“Green innovation and enterprise digital transformation: Escape from the “dilemma” of development and governance choices”	PLoS ONE (2024)	China	Quantitative	Secondary data, Mesomeric effect test

From table 2 above, it can be observed that articles were published in various international journals from different regions of the world, indicating that the topic of green innovation and digital transformation is a topic that is often examined by researchers from

various countries and disciplines. China is the country that contributes the most papers of all. 14 out of 20 articles (70%) examined the effect of green innovation and digital transformation on SME performance in China. The type of study that is mostly used is quantitative with primary data sourced from survey questionnaires. The analysis method often used is PLS-SEM with the help of SmartPLS or AMOS software. PLS-SEM is often used because of its robustness, especially when the sample size is relatively small and the research objective is to analyze the effect (Al-Hakimi et al., 2021). Compared to CB-SEM, PLS-SEM provides superior statistical power to handle complex models with limited samples (Al-Swidi et al., 2024).

RQ1. How do green innovation and digital transformation collaborate in the context of SMEs?

The collaboration of green innovation and digital transformation in SMEs is manifested in several ways. This section will describe how green innovation interacts with digital transformation based on the research findings collected previously.

Green Innovation and Digital Transformation Collaboration in Enhancing Information Sharing

Research by Le et al. (2024) state that digital transformation facilitates SMEs quick access to internal and external data, allowing SMEs to make informed decisions related to green innovation. Based on research by Al-Swidi et al. (2024), Aryanto et al. (2018), Zhang et al. (2024), increased information sharing facilitates SMEs communication and more optimal data integration and synchronization, leading to an effective green innovation process. Digital transformation also improves SMEs' understanding of market demand and environmental changes, enabling SMEs to make informed decisions regarding green technology (Geng et al., 2023). Minimizing misinformation allows SMEs to make more informed decisions regarding business sustainability. This information transparency is also crucial for proper resource allocation in the green innovation process.

Collaboration of Green Innovation and Digital Transformation in Improving Decision-Making

The adoption of information technologies such as data analytics and AI is driving improvements in the decision-making process. Such technologies enable SMEs to collect and analyze large amounts of data quickly, along with more accurate measurement of environmental impacts for an efficient green innovation process (X. Zhang et al., 2024). This data-driven approach supports better decision-making, enabling SMEs to cope responsively

with changing market and consumer needs, which in turn improves SME competitiveness (Al Halbusi et al., 2024). Utilizing digital technology, SMEs can gain the latest green insights to be applied in environmentally friendly decision-making.

Collaboration of Green Innovation and Digital Transformation in Resource Optimization

SMEs have various resources, such as human, financial, technical and technological resources. These technological resources, which include infrastructure, competencies, and technology integration, are SME resources to increase green innovation (Rasool et al., 2023). In the research of Geng et al. (2023) and (Xie et al., 2024), digital transformation facilitates SMEs to access and integrate efficient internal and external resources, enabling SMEs to apply green innovation in each of their production, sales and Research and Development processes. SMEs that have expert technological human resources will produce environmentally friendly product innovations (Dong et al., 2024). Research by Al Halbusi et al. (2024) explained that digital transformation improves resource management by developing supply chain visibility and integrating circular economy principles into organizational practices and optimizing the use of materials and energy. These efficiencies not only reduce costs but also align with green innovation processes and contribute to improved performance.

Green Innovation and Digital Transformation Collaboration in Cost Saving

In its operations, SMEs cannot be separated from costs. The relatively small scale of the business requires SMEs to be smart in allocating costs for operational efficiency and achieving maximum profit. Digital finance, one of the components of digital transformation, can help deal with financial barriers that SMEs may experience. The results of research by Du et al. (2024) prove that digital inclusive finance has a non-linear and significant positive effect on green innovation. The higher the level of digitalization of inclusive finance, the greater the positive impact on the green innovation process of SMEs. Du et al. (2024) also added that the integration of digital inclusive finance and green innovation can provide SMEs access to green financing options, such as green loans or green bonds, and even government incentives and subsidies. Tang et al. (2023) claim that digital transformation can help SMEs obtain and absorb external knowledge efficiently and at lower cost, so that SMEs are encouraged to increase knowledge and information about green product and green process innovation. Wu et al. (2024) state that by increasing access to financing and reducing the cost of capital, SMEs can invest more in green innovation to maintain business sustainability. The

collaboration of digital transformation and green innovation optimizes the use of technological resources while minimizing environmental impacts, leading to significant cost savings.

Collaboration of Green Innovation and Digital Transformation in Achieving Operational Efficiency

Mubarak et al. (2021) state that the use of modern IT infrastructure and the integration of green innovation can streamline operational processes, reduce costs and increase productivity while minimizing environmental risks. In the research of Xie et al. (2024) mentioned that the synergy of green innovation and digital transformation helps SMEs in directing innovation efforts with market needs and technological developments, so that SME operations can run efficiently. Green innovation plays a role in developing environmentally friendly products and processes, while digital transformation develops the infrastructure to realize green innovation. This collaboration will produce environmentally friendly products that meet consumer targets.

Collaboration of Green Innovation and Digital Transformation in Market Competitiveness

Research by Mubarak et al. (2021) found that the integration of green innovation and industry 4.0 technology positions SMEs to be competitive in the market in the long term. By adopting green innovation and industry 4.0 technology, SMEs can maintain market reputation and be able to meet the increasing demand for environmentally friendly products. This collaboration is also able to improve the market position of SMEs by differentiating their products and services (Wasiq et al., 2023). In the research of Tobing et al. (2024) presented that SMEs that have environmental awareness and technological literacy are able to access a wider market and environmentally conscious consumers through online platforms and e-commerce, which leads to an increase in market share and market competitiveness of SMEs.

RQ2. How does the collaboration of green innovation and digital transformation improve SME performance?

The collaboration of green innovation and digital transformation studied in this paper is assumed to improve SME performance. SME performance is classified into two types, namely financial performance and non-financial performance. Financial performance focuses on SME finances, while non-financial performance is more directed at aspects other than finance such as sustainability, customer satisfaction and effectiveness (Zehir et al., 2016).

The research results of Le et al. (2024) and Tang et al. (2023) confirm that digital transformation positively affects green innovation, which in turn will improve the sustainability performance of SMEs. Green innovation is also proven to mediate the relationship between digital transformation and SME sustainability performance. SMEs need to integrate digital transformation in their sustainable development goals and in their decision-making process, so that SMEs have a unique advantage over their competitors, strengthen their social position and maintain brand reputation. This will ultimately lead to improved financial performance.

In line with previous research, Dong et al. (2024) and Mubarak et al. (2021) prove that digital transformation has a positive effect on the green innovation process by facilitating human resource development, increasing the allocation of innovation resources and improving green innovation performance. Mubarak et al. (2021) also highlighted the important role of policymakers in promoting inclusion between open innovation and the utilization of industry 4.0 technologies that can help SMEs improve the green innovation process, which in turn will improve the performance and competitiveness of SMEs. Wu et al. (2024) proved that the collaboration of digital transformation and green innovation can improve the competitiveness of SMEs. SME performance will increase influenced by SME competitiveness through increased profits, sales and a large number of consumers (Yaskun et al., 2023).

On the other hand, research by She & Zhang (2024) proves that green innovation has a positive effect on digital transformation by overcoming financing constraints and increasing operational capacity and optimal resource distribution thereby improving financial performance. This result is supported by research by Wu et al. (2024) which states that SMEs are able to increase competitiveness through digital transformation by implementing green product and green process innovation. Increasing the competitiveness of SMEs will strengthen performance and long-term sustainability. The research results of (Xiumei et al., 2023) added that the application of sustainable practices can improve the reputation of SMEs and attract the attention of socially conscious consumers so as to encourage business success.

The research results of Hu et al. (2024) one of which focuses on the influence of green human resources management (GHRM) practices. It is proven that GHRM practices lead SME owners to encourage their employees to take green innovation training. This training will equip them with knowledge and skills related to green innovation, consumer preferences and market conditions so as to ensure the sustainability performance of SMEs. The above

findings are in line with the research of Dong et al. (2024) which states that digital transformation promotes green innovation through optimization of human capital structure. Through digital transformation, the employee recruitment system will be more systematic and as needed. Reliable employees are the key to success in implementing green innovation that encourages improved sustainability performance of SMEs.

CONCLUSION

The collaboration of green innovation and digital transformation in SMEs is realized in various ways. Their collaboration encourages improving the quality of internal and external information and efficient resource allocation so that operational costs are effective and operational processes continue to run efficiently while still paying attention to the impact on the environment. This will increase the competitiveness of SMEs in a wider market and reach consumers from various countries through online platforms. Increased competitiveness will lead to improved SME financial performance and ensure long-term business sustainability.

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