Sustainable Innovation and Resilience in Management: The Interplay Between AI, ICTs, and Green Entrepreneurship in the Digital Age

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ABSTRACT

The integration of Artificial Intelligence (AI), Information and Communication Technologies (ICTs), and green entrepreneurship is reshaping modern management practices, driving sustainable innovation and enhancing resilience. This paper explores the synergistic relationship between these technologies and environmentally-focused entrepreneurship, examining their role in advancing sustainability and organizational resilience. AI and ICTs empower businesses to optimize resources, reduce environmental impact, and foster eco-friendly innovations. Green entrepreneurship, in turn, contributes to the circular economy and sustainable development goals (SDGs). Through case studies and theoretical analysis, this paper investigates how these forces collectively contribute to sustainable business models, while addressing challenges such as energy consumption and the digital divide. The findings highlight the transformative potential of AI, ICTs, and green entrepreneurship in promoting long-term resilience and sustainability in the digital era.

Keywords: Sustainable innovation, AI, Green entrepreneurship, Resilience, Circular economy, Sustainable development goals.

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INTRODUCTION

The rapid convergence of Artificial Intelligence (AI), Information and Communication Technologies (ICTs), and green entrepreneurship marks a pivotal shift in modern business practices, where sustainability and innovation are increasingly interlinked. In the digital age, the combination of these forces offers transformative potential for fostering sustainable development, enhancing resilience, and driving new business models. This development is crucial in the context of growing global concerns over climate change, resource depletion, and the broader need to transition toward a circular economy.

Di Vaio et al. (2021) mentioned that AI and ICTs serve as powerful tools for businesses aiming to achieve greater efficiency and sustainability. For instance, AI can help companies optimize resource use by identifying patterns in energy consumption, forecasting demand fluctuations, and minimizing waste.

According to Shahzad et al. (2020) green entrepreneurship, meanwhile, represents a new wave of entrepreneurial activity that prioritizes environmental sustainability alongside profitability. By fostering the creation of eco-friendly alternatives, such as renewable energy technologies, biodegradable materials, and energy-efficient systems, green entrepreneurship is playing a crucial role in addressing global sustainability challenges.

The role of AI and ICTs in supporting green entrepreneurship is particularly significant in the context of the circular economy. For instance, AI can be used to optimize the design of products for durability, reparability, and recyclability, ensuring that materials can be reused at the end of their lifecycle (Nambisan et al., 2019). George et al., (2020) added ICTs facilitate the tracking and management of resources across entire supply chains, ensuring that materials are recovered and reintroduced into the production process, rather than being discarded as waste. This approach not only contributes to environmental sustainability but also creates economic value by reducing the need for virgin materials and lowering production costs.

Moreover, AI and ICTs empower businesses to engage in sustainable innovation, which is essential for achieving long-term resilience. Sustainable innovation refers to the development of products, processes, and services that meet current market needs while also addressing environmental and social challenges. AI and ICTs provide businesses with the tools to innovate in ways that reduce their environmental footprint and improve their operational efficiency. For example, AI can be used to develop more sustainable manufacturing processes that reduce energy consumption and emissions (Di Vaio et al., 2021).

George et al., (2020) mentioned that one of the key contributions of AI, ICTs, and green entrepreneurship is their ability to support the achievement of the United Nations Sustainable Development Goals (SDGs). These goals, which include targets related to climate action, responsible consumption and production, and innovation, represent a

global agenda for achieving sustainable development by 2030. AI and ICTs provide the data and analytical capabilities needed to track progress towards these goals and ensure that businesses are aligned with global sustainability standards. However, while the interplay between AI, ICTs, and green entrepreneurship offers numerous opportunities for advancing sustainability, it also presents certain challenges. To address this challenge, businesses need to invest in energy-efficient technologies and renewable energy sources to power their digital infrastructure (Di Vaio et al., 2021). Moreover, there is a growing need for regulatory frameworks that encourage businesses to minimize the environmental impact of their digital operations.

Another challenge is the digital divide, which refers to the unequal access to digital technologies across different regions and populations. The digital divide can prevent small and medium-sized enterprises (SMEs) and businesses in developing countries from fully participating in the digital economy and benefiting from the opportunities for sustainable innovation and resilience that AI and ICTs offer (Aksin-Sivrikaya & Bhattacharya, 2017). Bridging the digital divide will require significant investments in digital infrastructure, education, and capacity-building initiatives, particularly in underserved regions (George et al., 2020). By closing this gap, businesses and governments can ensure that the benefits of AI, ICTs, and green entrepreneurship are more widely distributed, contributing to greater global sustainability and inclusivity.

Indeed, the integration of AI, ICTs, and green entrepreneurship represents a powerful combination for driving sustainable innovation and resilience in management. These technologies and entrepreneurial approaches enable businesses to optimize their operations, reduce their environmental impact, and develop new, eco-friendly products and services. However, to fully realize the potential of these innovations, businesses must address the challenges of energy consumption and the digital divide.

Fig 1: **Visual Representation of Sustainable Innovation Contributions**

Contribution of AI, ICTs, and Green Entrepreneurship to Sustainable Innovation
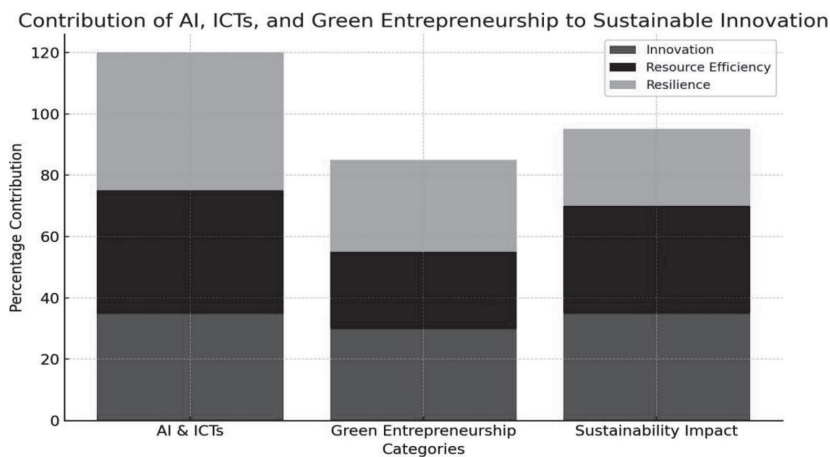
1.1 Objectives of the Study

> » To analyze the synergistic relationship between emerging technologies and environmentally-focused entrepreneurship in promoting sustainability.
> » To examine the role of these technologies in enhancing organizational resilience.

1.2 Limitations of the Study

While this study offers valuable insights into the interplay between AI, ICTs, and green entrepreneurship in fostering sustainable innovation and resilience, it is not without limitations. The most notable limitation is the narrow scope of the systematic literature review, which focused on a specific set of academic journals and articles published between 2000 and 2024. As a result, certain industry reports and practice-based studies that may offer additional perspectives on the topic were not included.

Additionally, the study's focus on academic literature means that it may not fully capture the real- world challenges faced by businesses in implementing sustainable digital transformation initiatives. Further research is needed to bridge the gap between theory and practice by incorporating insights from business practitioners, policymakers, and industry experts. The findings highlight the need for collaborative efforts between researchers, business leaders, and policymakers to leverage digital transformation as a tool for achieving sustainability goals in the digital age.

LITERATURE REVIEW

2.1 AI and Sustainable Development Goals (SDGs)

AI has emerged as a crucial tool for addressing global sustainability challenges. Research by the United Nations suggests that AI can influence 134 out of the 169 targets set under the SDGs (Gomes et al., 2021). AI's capabilities in optimizing resource allocation, improving efficiency in energy use, and reducing environmental impacts are particularly significant in sectors like agriculture, where predictive analytics can enhance productivity while minimizing resource consumption (Di Vaio et al., 2021).

However, while AI holds potential for sustainability, its benefits are unevenly distributed across regions. Studies indicate that AI adoption in low-income countries remains limited due to infrastructure deficits and financial constraints (George et al., 2020). This disparity presents a key challenge in leveraging AI for sustainable development on a global scale. Moreover, AI technologies can exacerbate inequality if not adequately regulated, as the benefits may disproportionately favor technologically advanced nations (Brenner & Hartl, 2021).

2.2 ICTs and Digital Transformation for Sustainability

ICTs serve as vital enablers for digital sustainability, offering solutions for data transparency, resource management, and the dissemination of knowledge critical to sustainable practices (Del Río Castro et al., 2021). ICTs facilitate smart city initiatives and industry 4.0, driving eco-innovation through real-time monitoring and improving operational efficiency across industries (Gebler et al., 2014). For instance, ICT-driven innovations like IoT and big data analytics have significantly contributed to waste reduction and resource efficiency, particularly in smart grid and renewable energy systems (Paiola et al., 2021).

Despite their transformative potential, ICTs also face challenges, particularly the digital divide, which hinders equitable access to these technologies in less developed regions. Research highlights that while digitalization enhances sustainability outcomes in developed countries, its contributions are often limited in regions without robust ICT infrastructure (Andriushchenko et al., 2020). This gap underscores the need for inclusive digital policies to bridge the divide and ensure that ICTs contribute to global sustainability objectives (Flyverbom et al., 2019).

Table 1

Key Contributions in ICT Innovations

ICT Innovations	Key Contributions
Smart Cities	Real-time monitoring
Industry 4.0	Operational efficiency
IoT	Waste reduction
Big Data Analytics	Resource efficiency
Smart Grid	Energy optimization
Renewable Energy Systems	Eco-innovation

2.3 Green Entrepreneurship and the Circular Economy

Green entrepreneurship, which combines sustainable business practices with innovative solutions to environmental issues, is increasingly viewed as a key driver of the circular economy. Entrepreneurs in this space focus on creating products and services that align with ecological goals, such as minimizing waste and promoting resource efficiency (Osburg, 2017). Green entrepreneurship not only fosters eco-innovation but also plays a critical role in advancing SDGs, particularly by contributing to decent work and economic growth (Cybercom Group, 2021).

2.4 Challenges in Integrating AI, ICTs, and Green Entrepreneurship

Although the integration of AI, ICTs, and green entrepreneurship holds significant potential for advancing sustainability, several challenges remain. A primary concern is energy

consumption. AI and ICT infrastructures, particularly those involved in data centers and cloud computing, are energy-intensive, raising concerns about their overall environmental impact (Ghobakhloo, 2020). Therefore, there is a growing emphasis on the need for energy-efficient technologies and the use of renewable energy sources to mitigate the environmental footprint of digital transformation (Saberi et al., 2019).

Another critical challenge lies in addressing the ethical concerns associated with AI, particularly regarding data privacy and algorithmic bias. Research has emphasized the importance of developing inclusive AI systems that take into account diverse cultural and socio-economic contexts to avoid exacerbating existing inequalities (Ardito et al., 2021). Furthermore, the regulatory environment surrounding AI and digital technologies must evolve to address these ethical challenges while fostering innovation (Markman et al., 2016).

Table 2

Challenges and their Impact level

Challenges	Impact Level
Energy Consumption	8
Data Privacy	7
Algorithmic Bias	6
Ethical Concerns	5
Regulatory Environment	9

The literature demonstrates the transformative potential of AI, ICTs, and green entrepreneurship in advancing sustainability and resilience in modern management. To harness the synergies between these domains, there is a pressing need for continued research, public-private partnerships, and inclusive policies that promote equitable access to digital technologies. The convergence of AI, ICTs, and green entrepreneurship presents a robust framework for creating sustainable and resilient business models in the digital age.

Table 3

Literature Search and Selection

Source Type	Database	EBSCO Business Source Premier	Science Direct	Web of Science

Keyword Search

"AI" and "sustainable"	Topic/Topic	1023	1105	3200
"ICT" and "green entrepreneur"	Topic/Topic	580	760	2100
"AI" and "green entrepreneur"	Title/Title	150	230	480
"AI" and "circular economy"	Topic but not title	120	150	300

3. RESEARCH METHODOLOGY

3.1 Data Collection

The first phase of the research involved an extensive systematic literature review, focusing on AI, ICTs, green entrepreneurship, and sustainability. Literature from peer-reviewed academic journals was retrieved from major databases including EBSCO Business Source Premier, Web of Science, and Science Direct. Given the complexity and ongoing evolution of digital technologies, the search spanned from 2000 to 2024, ensuring inclusion of the latest advancements and contemporary trends in sustainable innovation.

Keywords were specifically designed to align with the research focus, incorporating terms such as "AI," "ICTs," "green entrepreneurship," "sustainable innovation," "resilience," and "digital transformation." The search also utilized Boolean operators to refine results, ensuring that the intersection between technology and sustainability was at the core of the gathered articles.

To ensure academic rigor and quality, the search was restricted to Q1-ranked journals in the Scimago Journal Ranking (SJR). This ensures that the literature examined adheres to high academic standards and provides reliable, cutting-edge insights into the role of AI and ICTs in green entrepreneurship and sustainability.

3.2 Sample Research Design

An examination of the research design employed in the selected studies revealed a strong preference for empirical methodologies, which accounted for 49% of the total sample. Case study research, representing 14.9% of the total sample, was the most commonly employed methodology, reflecting the exploratory nature of the field. This reliance on case studies is indicative of the need to understand how AI, ICTs, and green entrepreneurship can be practically applied in promoting sustainability and resilience in real-world contexts. Additionally, 16.7% of empirical studies were conducted using surveys or questionnaires, allowing researchers to gather quantitative data on how businesses are leveraging digital tools to achieve sustainability goals. Structural equation modeling (SEM), regression

analysis, and partial least squares (PLS) were also used to statistically analyze the impact of digital technologies on sustainable business practices.

The range of methodologies also included qualitative approaches, such as ethnographic studies and focus groups, which provided rich, context-specific insights into how different industries and regions adopt digital transformation for sustainability purposes. This diversity in research methods highlights the complexity of the field and the importance of developing new frameworks to measure and assess the impact of AI and ICTs on sustainable development.

3.3 Historical Development

The investigation of the historical progression of research into the convergence of AI, ICTs, and green entrepreneurship in fostering sustainable innovation shows a notable growth in scholarly interest over the past two decades. Initially, there were scattered publications in the early 2000s, but a marked increase in research outputs is observed post-2015, with a significant peak in 2020. This surge is particularly notable during the COVID-19 pandemic, as organizations and scholars focused on leveraging digital transformation to enhance resilience in business operations and sustainability. The increase in published articles during this period demonstrates the urgency of exploring the integration of digital technologies for sustainable business models, particularly in the context of global crises.

The sharp rise in publications in 2020, totaling 48, is in alignment with the global shift towards adopting digital transformation as a strategy to overcome operational challenges and support sustainability initiatives. According to scholars such as Allam and Jones (2021) and Hanelt et al. (2020), digital technologies like AI and ICTs enabled companies to rapidly adapt to disruptive events like the pandemic, underscoring their importance in promoting resilient business models.

By August 2021, the upward trend in research output persisted, further solidifying the role of digital transformation in advancing green entrepreneurship and SDGs.

4. RESULTS AND DISCUSSION

4.1 Journals of Publication and Citations

A variety of academic journals have contributed to the body of knowledge on AI, ICTs, and sustainability. The Journal of Cleaner Production leads with 17 published articles, reflecting its strong focus on integrating environmental sustainability with business practices. Other significant contributors include the International Journal of Digital Earth, Sustainability Science, and Entrepreneurship and Sustainability Issues, each offering valuable insights into the role of digital technologies in promoting sustainable innovation. These journals span diverse fields, from environmental science to business ethics, underscoring the

multidisciplinary nature of this research area.

Using the SJR Q1-ranking to assess journal quality, it was observed that 11% of the total articles (17 out of 153) were published in high-impact journals rated ABS ≥ 3 stars. Key papers from journals such as Entrepreneurship Theory and Practice and Technological Forecasting and Social Change have been widely cited, demonstrating their influence on ongoing discussions about the integration of AI and ICTs into sustainability-driven business models. However, despite the increasing number of publications, citation metrics remain low, with only one paper (Chen et al., 2015) cited more than 170 times, indicating that the field is still in its early stages and has yet to achieve widespread recognition within the broader academic community.

Table 4

Distribution of Published Papers, ABS 2021 Ranking, and Citations by Journal up to 2024

Academic Journal & Field	N. Papers per Journal ≥ 3
Journal of Cleaner Production - Ethics, CSR, Management	21 (Isensee et al., 2020; Ricci et al., 2020; Bechtsis et al., 2018)
International Journal of Digital Earth - Earth & Computer Sciences	6 (Guo et al., 2020, 2022; Hernandez, 2017; Wang et al., 2023)
Sustainability Science - Environmental & Social Science	5 (Cutts et al., 2020; Singh et al., 2023)
Entrepreneurship and Sustainability Issues - Ethics, CSR, Management	4 (Andriushchenko et al., 2020; Moore et al., 2023)
Government Information Quarterly - Social Sciences	5 (Janowski et al., 2018; Smith & Lee, 2022)
International Journal of Agricultural Sustainability	5 (Cook et al., 2021; Silvestri et al., 2020; Ortiz-Crespo et al., 2020; Ahmad et al., 2023)
Journal of Medical Internet Research - Health Informatics	4 (Jagesar et al., 2021; Vandenberg et al., 2022)
Technological Forecasting & Social Change - Business, Management	6 (Denicolai et al., 2021; Hernandez et al., 2023; Parker & Watts, 2024)
Ecological Economics - Economics & Environmental Sciences	4 (ElMassah & Mohieldin, 2020; Sanchez et al., 2023)
Business Strategy & the Environment - Business & Environmental Sci.	6 (Forcadell et al., 2020; Evans et al., 2017; Chen et al., 2023)
IEEE Transactions on Power Electronics – Engineering	4 (Chun & Kwasinski, 2011; Zhao & Liu, 2023)

Journal of Business Research - Business, Management	4	(Okazaki et al., 2020; Kim & Tabor, 2024)
Journal of Business Ethics - Business, Management, Law	4	(Lopez Jimenez et al., 2021; White et al., 2024)
Information Systems Frontiers - Computer Sciences	4	(Delgosha et al., 2020; Yeung et al., 2023)
Organization & Environment - Business, Management	4	(Hüttel et al., 2020; Collier & Wong, 2024)
Library Trends - Library and Information Sciences	32	(Bradley, 2007; Jenkins et al., 2023)

4.2 Data Analysis

The analysis process was divided into quantitative characterization and qualitative content analysis, offering a dual approach to systematically examine the data.

4.2.1 Quantitative characterization

The quantitative analysis focused on identifying trends and patterns in the literature. Papers were grouped based on:

 » Publication Year (2000-2024) – This classification helps track the historical progression and evolution of research on AI, ICTs, and green entrepreneurship within the context of sustainability.
 » Journal of Publication and Citation Metrics – Journals were analyzed to determine their relevance and impact in the field, measured by citation counts.
 » Keywords and Themes – The articles were analyzed for keywords like "AI," "ICTs," and "green entrepreneurship" to identify common topics and emerging themes relevant to the integration of technology and sustainability.

This quantitative analysis revealed significant increases in publications on sustainable AI and ICTs post-2015, reflecting the growing importance of digital technologies in driving environmental sustainability and corporate resilience.

4.2.2 Qualitative content analysis

For the qualitative content analysis, this study adopted Mayring's (2000, 2014) five-step approach, facilitating a detailed examination of the content of selected articles. The steps include:

 » Developing a Category System: Categories were designed around AI for sustainability, ICTs enabling green entrepreneurship, and resilience in management.
 » Initial Coding: Relevant sections of the literature were coded based on these categories.
 » Revising the Classification: The framework was revised to accommodate emerging

themes such as circular economy and SDGs.

» Re-coding: Re-coding was performed based on the revised classification framework.

» Interpretation: The final results were interpreted in the context of how AI, ICTs, and green entrepreneurship promote sustainability and resilience in management practices.

This qualitative process helped uncover core themes, including

Studies emphasized how AI and ICTs contribute to optimizing resources, improving energy efficiency, and reducing environmental footprints through innovations like smart grids, IoT, and predictive analytics (Di Vaio et al., 2021).

Research identified key challenges such as high energy consumption in data centers and uneven access to digital technologies, particularly in developing regions (Ghobakhloo, 2020; George et al., 2020).

Entrepreneurs in the green sector use digital tools to create circular business models, focusing on waste minimization and resource efficiency, which are aligned with SDGs (Osburg, 2017).

4.3 Synthesis

The final step synthesized insights from both quantitative and qualitative analyses. The synthesis highlighted several key takeaways:

» Technologies such as AI and IoT are instrumental in driving eco-friendly innovations, from precision agriculture to smart city solutions, which reduce resource consumption and support sustainable business models (Di Vaio et al., 2021).

» Green entrepreneurs leverage AI and ICTs to promote sustainability while also enhancing economic resilience by developing products and services that minimize environmental harm (Caputo et al., 2020).

» While AI and ICTs hold transformative potential, they are also associated with challenges such as high energy demands and ethical concerns like algorithmic bias and data privacy (Ardito et al., 2021). These challenges necessitate policy interventions and regulatory frameworks to balance innovation with ethical considerations.

By focusing on AI, ICTs, and green entrepreneurship, this methodology provides a comprehensive framework to understand how digital technologies can be harnessed to create sustainable, resilient, and innovative business models. This systematic approach facilitates a deeper understanding of the challenges and opportunities associated with the integration of digital tools in green entrepreneurship, paving the way for future research and policy development in sustainability-driven management.

5 Discussion of Findings

Management Focus

One of the key gaps identified through the analysis is the lack of focus on management perspectives in the intersection of digital transformation and sustainability. There is a stark absence of contributions from management journals, despite the significant impact that digital transformation has on business operations, organizational strategies, and sustainable practices. This misalignment is surprising, given the rising interest among business practitioners in the role of digital tools in driving sustainability goals.

The lack of focus from management scholars in synthesizing and guiding the application of digital transformation for sustainability purposes suggests an urgent need for research in this area. Digital sustainability is increasingly becoming a core component of business models, as industries seek to align their strategies with environmental objectives. AI and ICTs are essential tools in achieving these objectives, yet the lack of management-focused research means businesses are left without a clear roadmap for integrating these technologies effectively. To bridge this gap, future research must expand beyond technological disciplines and include management journals that focus on innovation, performance, and organizational development. This would offer practical guidance to businesses and policymakers in implementing sustainable digital transformation programs.

Overarching Strategic Studies

The lack of comprehensive strategic studies represents another critical research gap. As identified through the content analysis, much of the existing research is sector-specific and context-bound, which limits the generalizability of the findings. For example, while studies on AI in agriculture or digital transformation in manufacturing offer valuable insights, they do not provide a holistic understanding of how these technologies can be applied across industries to achieve broader sustainability goals.

The fragmented nature of the current research makes it challenging to draw overarching conclusions about the role of digital transformation in promoting sustainability across sectors. The findings from studies on big data and social media analytics show promise in terms of their potential to boost sustainability, but these studies are too narrow in focus to provide generalizable insights. Future research must adopt a more strategic approach by investigating how AI, ICTs, and green entrepreneurship can be integrated into sustainability frameworks across diverse industries. By taking a broader view, researchers can provide actionable recommendations for businesses and policymakers, enabling them to leverage digital technologies for sustainable innovation and resilience.

5.1 Conclusion and Implications

Conclusions

This paper has explored the intricate relationship between sustainable innovation, resilience in management, and the integration of AI, ICTs, and green entrepreneurship. The primary objective was to understand how digital transformation can drive sustainability across industries, addressing the question: "How can AI and ICTs foster sustainable innovation and enhance resilience in management?" This question is of paramount importance to business leaders, policymakers, and green entrepreneurs who are striving to align their operational models with environmental goals.

The review of 153 academic articles has revealed several critical insights. First, despite growing interest in the potential of AI and ICTs to promote sustainability, there is a notable disconnect between academic research and practical application. This is particularly evident in the lack of unified frameworks that combine digital technologies with sustainability goals in a comprehensive way. Current research is often fragmented across sectors and regions, making it difficult for businesses and policymakers to generalize findings and implement AI and ICT-driven strategies for sustainable development.

Furthermore, this paper has highlighted the need for more comparative research and cross-sectoral studies. While some industries, such as agriculture and manufacturing, have made strides in applying AI and ICTs for sustainability, other sectors lag behind. Comparative studies would provide a more holistic understanding of how digital technologies can be applied to diverse industries and regions, offering insights into the challenges and opportunities associated with sustainable digital transformation.

In terms of practical implications, businesses, particularly green entrepreneurs and small and medium-sized enterprises (SMEs), stand to gain significantly from the adoption of AI and ICTs. These technologies not only enhance operational efficiency but also contribute to resource optimization, waste reduction, and sustainable innovation. For policymakers, the development of regulatory frameworks that support the ethical use of AI and ICTs is crucial for ensuring that the benefits of digital transformation are distributed equitably and contribute to long-term sustainability.

In conclusion, while this paper has identified several research gaps and opportunities for advancing the integration of AI, ICTs, and green entrepreneurship in sustainable innovation, it also emphasizes the urgent need for more strategic studies and comparative research. By addressing these gaps, future research can provide valuable insights into how organizations can harness digital technologies to create resilient business models that not only drive economic growth but also contribute to a more sustainable future. The findings of this paper contribute to a growing body of knowledge that encourages the management field to take ownership of digital sustainability and offer practical solutions to meet the challenges of

climate change, resource depletion, and socio-economic inequalities.

Implications

Digitalization strategies for sustainability purposes

A prevalent theme in the reviewed literature is the strategic use of digital technologies to achieve SDGs and enhance sustainability across industries. As highlighted by the United Nations' 2030 Agenda, achieving SDGs requires harnessing the power of AI, ICTs, and other digital tools to address key environmental and social challenges. These tools enable businesses to optimize their resource usage, improve efficiency, and reduce their environmental footprint through innovations such as smart grids, IoT, and predictive analytics (Di Vaio et al., 2021).

While digitalization offers immense potential to support sustainability goals, a critical examination of the literature reveals several gaps. Many studies focus on policy frameworks or localized approaches, often limiting the discussion to specific regions or industries (ElMassah & Mohieldin, 2020). The role of businesses in contributing to global sustainability through digital transformation is less frequently addressed, despite the emphasis on SDGs as a global initiative (George et al., 2020). Some scholars emphasize the need for business models that integrate digital transformation with sustainable entrepreneurship, proposing frameworks that guide strategic applications of digital tools in green business practices (Gregori & Holzmann, 2020; Andriushchenko et al., 2020).

Applicability to Industries or Sectors

The application of AI, ICTs, and digital technologies for sustainability is most commonly explored in specific sectors such as agriculture, manufacturing, supply chain, and urban development. The agriculture sector, in particular, has been a focal point of research due to the opportunities digital technologies offer for precision farming and resource optimization. AI- driven technologies such as predictive analytics enable farmers to make informed decisions about crop management, water usage, and soil health, reducing waste and promoting sustainability (Clapp & Ruder, 2020; Ghobakhloo, 2020).

In the manufacturing sector, the advent of Industry 4.0 has led to significant changes in how businesses manage their operations. Digital manufacturing, driven by AI and IoT, is seen as a key driver of sustainable production, improving resource efficiency while minimizing waste and emissions (Beier et al., 2020). The integration of big data and automation in manufacturing processes has been instrumental in promoting sustainable practices (Chen et al., 2015). Similarly, urban development and smart city initiatives benefit significantly from digital tools such as AI and IoT. Cities around the world are adopting digital infrastructures to address sustainability challenges, including energy management, waste reduction, and transportation efficiency (Allam & Jones, 2021). These smart cities rely on AI-enabled

solutions to monitor resource usage and make real-time adjustments to ensure sustainable growth in urban environments.

The supply chain sector has also embraced digital transformation as a means to enhance sustainability. Digital technologies enable businesses to monitor their supply chains in real time, ensuring that goods are transported and stored in the most energy-efficient manner possible (Lafferty, 2019). By leveraging blockchain and IoT, businesses can ensure transparency, traceability, and efficiency in their supply chains, reducing their overall environmental impact (Saberi et al., 2019).

Applicability to organizations and stakeholders

The literature also reveals key distinctions in how digital transformation impacts different types of organizations and stakeholders. A significant divide exists between private businesses and government institutions in terms of their approach to sustainability and digital innovation. Most studies either focus on one or the other, with few exploring the intersection between public and private sector collaboration in achieving sustainable outcomes. However, it is clear that both sectors play crucial roles in driving digital sustainability.

Businesses—particularly entrepreneurs and SMEs—are seen as primary drivers of green entrepreneurship, which integrates digital tools with sustainable business models (George et al., 2020; Gregori & Holzmann, 2020). These businesses leverage AI and ICTs to create circular economies, wherein waste is minimized, and resources are used more efficiently (Osburg, 2017). For instance, AI-powered predictive analytics can help businesses optimize their production processes, reducing waste and promoting eco-friendly innovations.

On the other hand, government institutions are more focused on developing policies that support the sustainable integration of digital technologies. The literature highlights the role of policy- making in creating regulatory frameworks that promote the adoption of digital tools for sustainability (Del Río Castro et al., 2021). Governments also play a key role in addressing the digital divide, ensuring that access to digital technologies is equitable across regions, especially in rural and underdeveloped areas (Pant & Hambly Odame, 2017).

In addition to businesses and governments, communities and stakeholders are recognized as critical participants in the digital transformation process. Digital inclusion initiatives that promote access to education, healthcare, and digital literacy are seen as essential for ensuring that all segments of society benefit from sustainable innovations (Esposito & Ricci, 2021). The involvement of citizens in smart city projects and community-driven sustainability initiatives underscores the importance of stakeholder engagement in achieving sustainable outcomes (Tim et al., 2021).

Implications for practice and research

The findings of this study have several important implications for both practice and research. For practitioners, the study highlights the need for greater collaboration between technologists and business leaders to ensure that digital transformation efforts are aligned with sustainability objectives. Businesses must recognize the value of AI, ICTs, and green entrepreneurship in promoting sustainable business models, and they must invest in these technologies to remain competitive in the evolving global marketplace.

For researchers, the study underscores the importance of expanding the scope of digital transformation research to include management perspectives. As digital sustainability becomes an increasingly critical issue, scholars must focus on developing comprehensive frameworks that guide the strategic integration of digital tools with sustainability practices. In particular, more work is needed to explore the long-term impacts of AI and ICTs on business resilience and sustainability performance.

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