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Impact Of Sustainability And Digitalization On Business Model Innovation In Organizations: A Research Agenda

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Abstract
Digitalization and sustainability are two significant megatrends reshaping industries and business models. The integration of these trends, often called "Digitainability," highlights the potential for digital technologies to drive sustainable business practices. The intersection of digitalization, sustainability, and business model innovation (BMI) has gained significant academic attention over the past two decades. This study explores the intersection of digitalization and sustainability, examining their collective impact on business model innovation. Through a systematic literature review and bibliometric analysis spanning two decades (2000-2024), this research identifies key trends, thematic areas, and gaps in existing studies. Findings reveal that digital transformation initiatives, including artificial intelligence, big data, and IoT, significantly influence sustainable practices by enhancing efficiency and reducing environmental impact. Conversely, sustainability imperatives drive digital adoption by encouraging innovations in resource efficiency and circular economy models. The study highlights the bidirectional relationship between digitalization and sustainability, impacting the business models of organizations. It underscores the need for integrated strategies that leverage digital tools to achieve sustainable business growth. The research concludes with a conceptual framework outlining future research avenues and managerial implications for fostering business model innovation at the intersection of these two transformative forces.

Keywords: *Sustainability, Digitalization, Business Model Innovation, Digitainability.*

INTRODUCTION

Digitalization and sustainability reshape industry innovation by prompting businesses to adopt new technologies and practices. As organizations navigate the complexities of modern business, understanding how these two domains interact is essential for fostering innovation and achieving long-term success. The relationship between digitalization and sustainability is increasingly recognized as a critical area of research and practice. This transformation offers opportunities as well as challenges. This research explores the relationship between these trends, emphasizing their impact on business models and strategies, and highlighting the need for organizations to adapt to remain competitive and address global issues.

Sustainability has become a key strategic priority for businesses globally, driven by environmental concerns and stakeholder expectations, supporting the creation of innovative, responsible products and services. Organizations are integrating sustainable practices into their operations, influenced by the United Nations' Sustainable Development Goals. A holistic focus integrates sustainability into all business processes for genuine transformation, linking sustainable practices with organizational performance. Companies are adopting technologies and circular economy principles to drive efficiency and meet the growing demand for eco-friendly products (https://www.deskbird.com/blog, 2024).

Digitalization is the integration of advanced technologies like AI, IoT, and big data into business operations, enhancing efficiency and customer engagement. Digitalization through abundant data and enhanced computational capabilities is speeding up this transformation, particularly in manufacturing through automation and smart processes and predictive analytics, and maintenance, and in services through personalized experiences and data-driven decisions. This revolution supports improved agility, efficiency, and productivity in firms. It fosters innovative business models by incorporating technologies such as IoT and AI, making them capable of responding to market changes and customer demands. The barriers to AI integration, such as data security, ethics, and sustainability concerns, need to be addressed for successful implementation. Enhanced data privacy and ethical standards will foster sustainability-focused AI initiatives (Gursoy, 2025).

The concept of Digitainability emphasizes the cross-fertilization between digitalization and sustainability. It suggests that while digital solutions can optimize operations and reduce costs, they also pose challenges such as increased carbon footprints. Therefore, businesses must balance these aspects to achieve a sustainable digital transformation (Lichtenthaler, 2021) (Shashi, 2022). Digitalization and sustainability have different starting points and objectives, but can synergistically intersect over time. Companies typically initiate separate digital and sustainable initiatives before attempting integration, requiring ongoing adaptation, resource allocation, and strategic planning. Digitalization promotes sustainability by optimizing resource use and introducing new revenue opportunities, despite requiring significant investment and adaptability (https://www.deskbird.com/blog, 2024).

Digitalization significantly enhances sustainability by improving resource management and operational efficiency. Conversely, sustainability initiatives often drive digital transformation, as organizations seek to comply with environmental regulations and meet stakeholder expectations (Ezzat, 2023). Digital transformation is linked to corporate green innovation, where businesses adopt environmentally friendly practices, enhancing both the quantity and quality of sustainable practices (Mohammadian & Vares, 2022). Strengthening stakeholder engagement and establishing effective business frameworks are also important. The adoption of Industry 4.0 technologies, such as automation and smart manufacturing systems, is a focal point for enhancing sustainable practices while maintaining profitability (Trolli, 2023). Organizations are increasingly using digital technologies to support sustainability goals, requiring transparency and accountability (Łabądź, 2023). This integration reduces waste, improves resource utilization, and fosters innovative solutions that benefit both businesses and the environment (Frick, 2025).

Business Model Innovation involves altering the value promised and delivered to customers, necessitating a focus on sustainability for all stakeholders. Full organizational support and a well-designed approach are crucial for success. This requires a deeper understanding of value creation, delivery, and capture within business model innovation (Ying Li, 2023).

The integration of sustainability and digitalization significantly impacts business model innovation by driving changes in how businesses create, deliver, and capture value. This transformation is essential for achieving both economic growth and sustainability goals. Digitalization supports sustainability by enabling more efficient resource use and reducing environmental impact. Business model innovation acts as a mediator, enhancing both economic and environmental performance through digital capabilities (Chiara Acciarini, 2021). A proposed framework suggests expanding business models to link sustainability with Digitalization to offer a competitive advantage while also considering wider impacts like economic and societal achievements (Vinit Parida, 2019). Digitalization reshapes business models by enabling new revenue streams through sustainable products and services, facilitating operational changes that align with circular economy principles, and encouraging innovation through enhanced collaboration across supply chains. Digitalization, through technologies like IoT, big data, and AI, enables businesses to adopt advanced service models and co-creation strategies that align with sustainability goals and create more value (Brenner, 2018) (Vinit Parida, 2019) (Yang, 2024).

Organizations leverage digitalization to develop transformative capabilities, such as agility and closed-loop processes, which are crucial for sustainable business models. These capabilities help adapt to external dynamics and create shared value. Digitalization fosters network capabilities, which are essential for business model innovation. These networks facilitate collaboration and sharing economy models, contributing to sustainability (Suying Gao, 2022).

LITERATURE REVIEW AND RESEARCH QUESTIONS

Specific management-oriented research connecting digital transformation and sustainability, and digitalization's role in business models, needs to be done to enhance insights and applicability in the field. Lack of management focus, inconsistent terminology usage, limited overarching studies, insufficient comparative research, and few organizational-level studies are the reasons for the limited focus on this area. (Guandalini, 2022).

Literature review papers play a crucial role in shaping academic discussions by assessing current knowledge and suggesting future research directions, encouraging critical assessments (Garrod, 2023). A good critical literature enables deeper insights, meeting the standards outlined by the National Council for Excellence in Critical Thinking (pages/the-national-council-for-excellence-in-critical-thinking/406, n.d.). A systematic literature review

aims to summarize existing evidence, pinpoint knowledge gaps, and highlight areas needing further research, thereby enhancing credibility and replication or building upon findings (Mahir Pradana, 2023).

The integration of digitalization and sustainability presents both challenges and opportunities for businesses. Digital technologies are seen as catalysts for sustainable development, though there are challenges regarding their application and interaction with sustainability (Leila Irajifar, 2023). Challenges include high implementation costs, technological complexities, skill gaps, and resistance to change. Companies must navigate the complexities of integrating digital technologies with sustainability initiatives, ensuring that digital transformation leads to both economic and environmental benefits (Peter M. Bican, 2020). Despite these hurdles, businesses can benefit from innovation, cost efficiencies, and improved brand reputation by successfully merging these practices. This transition is prompting companies to adapt their strategies and invest in workforce skills. This collaboration between digitalization and sustainability is reshaping business models, particularly in manufacturing and services, fostering long-term economic growth and development. Digital technologies are being used to develop software solutions and platforms that integrate sustainability into business operations, promoting ecological and economic sustainability (Timo Phillip Böttcher, 2023).

The strategic management of digital-sustainable business models involves balancing value propositions, creation and delivery processes, and value capture mechanisms. This balance is crucial for achieving the triple-bottom-line outcomes of economic, social, and environmental sustainability. The intersection of sustainability and digitalization reshapes business model innovation by enhancing value creation, improving sustainability performance, and fostering transformative capabilities. This integration is vital for businesses to remain competitive and responsible in the digital economy (Peter M. Bican, 2020) (Maximilian Palmié, 2024).

Digitalization contributes to sustainable business models by providing tools for real-time monitoring of environmental impacts, supporting data-driven strategies that prioritize sustainability, and enhancing stakeholder engagement through transparent communication channels, resulting in societal and environmental benefits. Economically, it improves process efficiency, reduces costs, and enhances collaboration within supply chains across various industries. Digitalization aligned with sustainability goals impacts SBM components, emphasizing the necessity of capturing value. Investments in digitalization can catalyze significant shifts toward sustainable practices if strategically managed (Laura Broccardo, 2023).

Drawing on systems theory and the dynamic capabilities framework, we argue that digitalization, sustainability, and business model innovation represent an interconnected triad where:

1. Digitalization provides the technological infrastructure and data capabilities necessary for implementing and monitoring sustainable practices
2. Sustainability imperatives create market pressures that drive both technological adoption and business model reconfiguration
3. Business model innovation serves as the strategic mechanism through which organizations integrate digital capabilities with sustainability goals

This integration is not merely additive but synergistic - the combined effect exceeds what each element could achieve independently.

This systematic literature review (SLR) examines this intersection of **Sustainability, Digitalization, Business Model Innovation, and Digitainability**. The study aims to understand key trends, major research contributions, emerging challenges, and future directions in this evolving domain.

The key Research Questions are

RQ 1 - How does the interaction between digitalization and sustainability drive business model innovation?

RQ 2- What are the key challenges and opportunities in implementing integrated digital-sustainable business models?

RQ 3- What mechanisms enable organizations to leverage digitalization for sustainable business model innovation?

METHODOLOGY

Now that the key Research questions have been identified, the next step is to identify the search criteria. The keywords were identified and then combined for a Boolean search logic on the Scopus Database. The Keywords used were "Sustainability," "Digitalization," "Business Model Innovation," "Sustainability and Digitalization,"

"Sustainability and Business Model Innovation," " Digitalization and Business Model Innovation," and "Digitainability" in the Title, Abstract, or Keywords. The articles published between 2000-2024 with the keywords in Scopus were looked at. The Inclusion Criteria were Peer-reviewed journal articles, conference papers, and review articles that provide empirical or theoretical insights, while the Exclusion Criteria were non-English articles, non-peer-reviewed sources, opinion pieces, and redundant studies. The initial list based on the above criteria was 3716 articles. These were then further shortened by further limiting to the subject areas of Business and Economics. This gave a list of 2795 articles. These articles were then further refined manually by looking at the title closely and a quick look at the abstract to get a feel of which of the articles focused more on the core aspects of Digitalization, Sustainability, and Business Model Innovation with conceptual or empirical studies or literature reviews. This gave a final shortlist of 563 articles. These articles were then reviewed for various aspects to answer the research questions.

Fig 1 – SLR Framework

Further, a critical review of the 10 most influential papers by Citation, as well as 7 articles that are of high impact as per the author, has been done to bring clarity to the relationship between these three aspects and the themes for the future. A conceptual model has been proposed based on the analysis. The research is important for both researchers as well as practitioners to help them understand the synergies between these aspects and strategize to grow sustainably.

KEY BIBLIOMETRIC INSIGHTS

The number of publications on **Sustainability, Digitalization, Innovation, Business Model Innovation, and Digitainability** has increased significantly over the past two decades. The synergy between digitalization and sustainability reflects a growing academic interest and practical relevance in **Digitalization, Sustainability, and Business Model Innovation**. A sharp rise in publications is observed post-2015, aligning with the global push for Sustainable Development Goals (SDGs) and digital transformation. The Peak Publication Years have been 2020-2024, showing increased academic and industry interest.

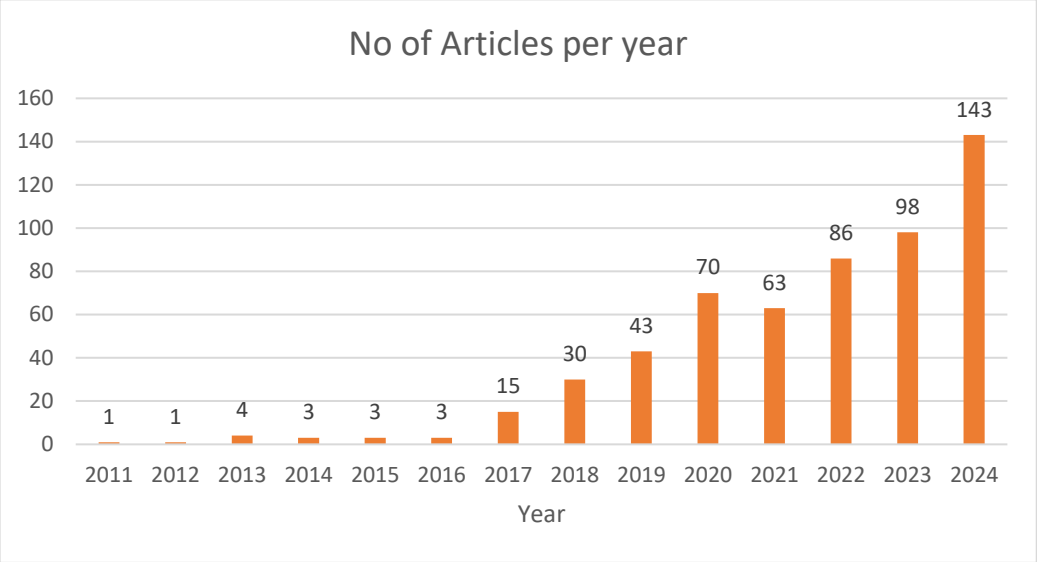

Fig 2 – Articles Per Year Published

TOP CONTRIBUTING AUTHORS AND JOURNALS

The top contributing authors with at least 3 articles during the defined period and with a minimum of 25 citations, with weights as per no of citations as shown below. The top 10 Contributing Journals, along with the total number of citations of the articles published, are shown below. These publications contributed 242 articles out of the selected 563 articles.

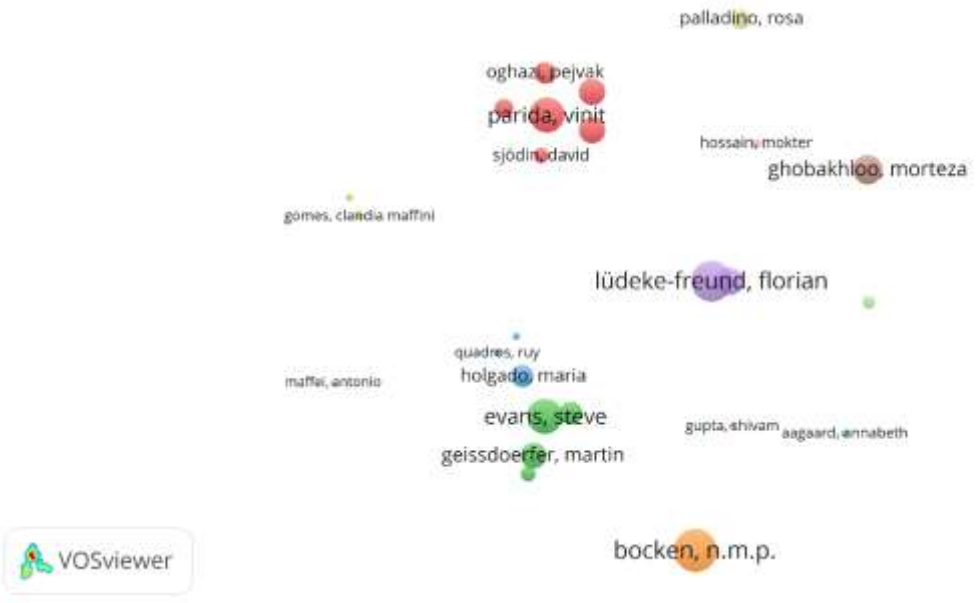

Fig 3 – Top Authors contributing at least 3 articles

Source Title	Nos of Articles	Citations
Sustainability (Switzerland)	104	3048
Journal of Cleaner Production	47	10745
Business Strategy and the Environment	30	2077
Journal of Business Research	17	5572
Technological Forecasting and Social Change	12	1550
Sustainability	9	1289

IEEE Transactions on Engineering Management	6	129
International Journal of Innovation Management	6	102
Journal of Open Innovation: Technology, Market, and Complexity	6	122
European Journal of Innovation Management	5	124

Table 1 – Top Research Publications

- **Sustainability (Switzerland)** – Focuses on digital transformation and sustainability actions with their impact on business models.
- **Journal of Cleaner Production** – Focuses on digital sustainability and circular economy.
- **Business Strategy and the Environment** – Covers corporate sustainability and innovation.
- **Journal of Business Research** – Showcases the impact of digitalization on sustainable business models.
- **Technological Forecasting and Social Change** – Highlights the future impact of digitalization on sustainability.
- **Sustainability (MDPI)** – Features interdisciplinary studies on sustainability and digital transformation.

KEYWORD CO-OCCURRENCE ANALYSIS

- **Frequent Keywords:** "Digital Transformation," "Sustainability," "Business Model Innovation," "Digitalization," "Circular Economy", "SMEs."
- **Emerging Themes:** "Digitainability", "Industry 4.0.", "Environmental Sustainability", "AI", "Dynamic Capabilities".

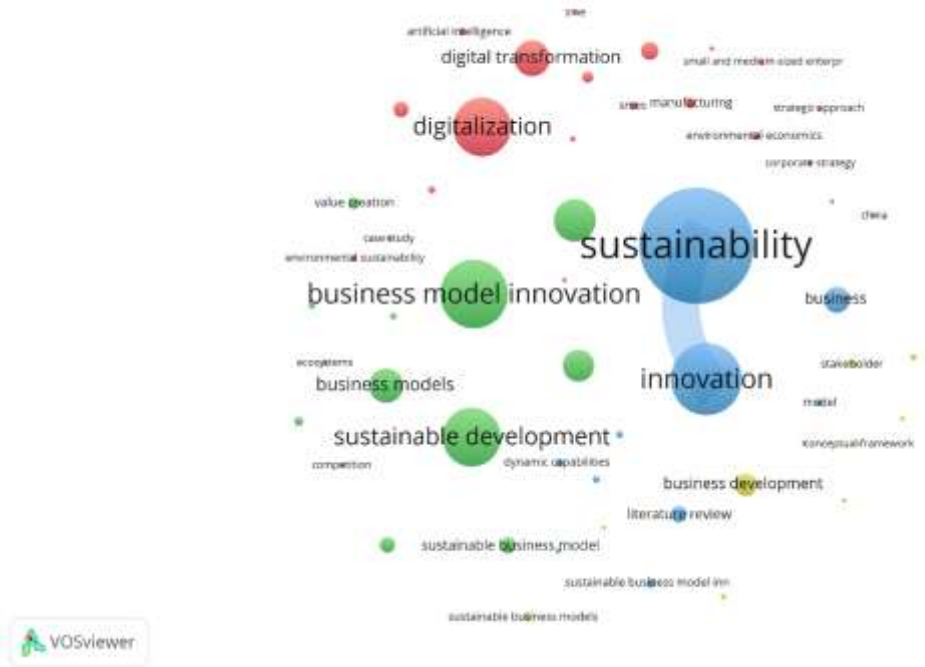

Fig 4- Top Keyword Analysis (at least 10 repeats)

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Fig 5: Word Cloud

THEMATIC CLUSTERS IDENTIFIED

Research on the intersection of sustainability and digitalization primarily focuses on the effectiveness of digital tools in enhancing sustainable practices, the role of ESG criteria in guiding digital transformations, and the challenges organizations face in integrating these two domains effectively. Using abstracts and keywords, the papers have been grouped into five major themes:

1. **Sustainability-Driven Business Model Innovation** (152 papers) – The papers examine eco-friendly business practices and modifications via sustainability principles.
2. **Digital Transformation & Industry 4.0** (135 papers) – The papers look into the role of digital technologies (like AI, IoT, blockchain) in promoting sustainable operations.
3. **Innovation Strategies for Sustainability** (112 papers) – The papers focus on collaborative innovation and co-creation for developing sustainable solutions.
4. **SMEs and Sustainability Challenges** (89 papers) – The papers evaluate barriers faced by small and medium enterprises in adopting sustainable digital solutions.
5. **Policy, Regulations, and Governance** (76 papers) – The papers analyze the impact of governmental regulations and frameworks on business sustainability and transformations

Each theme comprises various insights, challenges, and models for fostering sustainable practices across fields and organizations. The key themes in sustainability-driven business models explore how firms integrate eco-friendly practices, digital technologies, and innovation to ensure long-term value creation. Models addressing circular economy principles, digital transformation impacts, and collaboration in innovation are discussed in several papers with significant insights. Challenges for SMEs in adopting sustainability measures and the role of regulatory frameworks in shaping these transitions are discussed in several papers.

Theme	Key Focus	Insights from Selected Papers	Concepts Highlighted	Key Topics	Example	Reference Papers
Sustainability-Driven Business Model Innovation	How firms integrate sustainability into their business models by adopting eco-friendly processes, circular economy principles, and sustainable supply chains.	1. Value proposition redesign for sustainability (e.g., Philips' lighting-as-a-service). 2. Business model transitions toward net-zero carbon emissions, leveraging green financing. 3. Case studies on regenerative business models shifting from linear to circular value chains. 4. Stakeholder-oriented business models focusing on long-term ESG value creation.	Sustainability-oriented business models should explicitly link to value creation, cost structure, and stakeholder engagement.	Circular economy, sustainable business models, value creation	Adoption of circular economy principles in product design	Bocken et al. (2014) - 'A literature and practice review to develop sustainable business model archetypes'; Lüdeke-Freund et al. (2016) - 'Business Models for Sustainability: A Co-Evolutionary Analysis of Sustainable Entrepreneurship, Innovation, and Transformation'
Digital Transformation & Industry 4.0	How digital technologies (AI, IoT, blockchain) impact and enable sustainable operations and optimize ESG compliance.	1. Blockchain's role in supply chain transparency, preventing greenwashing. 2. AI-driven predictive analytics help firms optimize resource allocation, reducing carbon footprints. 3. IoT-enabled real-time monitoring systems track emissions in energy-intensive industries. 4. Digital twins create virtual simulations to enhance resource efficiency.	Digital enablers should be mapped to tangible sustainability outcomes (e.g., AI → Energy Efficiency, IoT → Waste Reduction).	AI, IoT, blockchain, smart manufacturing	Smart manufacturing for energy efficiency	Idris Sadaf Khan et al. (2021) - 'Industry 4.0 and sustainable development: A systematic mapping of the triple bottom line, Circular Economy and Sustainable Business Models perspectives'; Tiscini et al. (2020) - 'The blockchain as a sustainable business model innovation'
Innovation Strategies for Sustainability	The role of open innovation frameworks, ecosystem collaboration, and value co-creation in sustainability-driven innovations.	1. Collaborative innovation networks as drivers of sustainable solutions. 2. Circular economy integration through digital twins. 3. Innovation ecosystems co-creating sustainability solutions in renewable energy. 4. Open-source platforms and digital sustainability hubs enabling best practice sharing.	Emphasize the interaction between digitalization and innovation ecosystems in enabling scalable sustainability solutions.	Open innovation, dynamic capabilities, sustainable product design	Open Innovation models adopting Green Technologies	Bocken et al. (2020) - 'Barriers and drivers to sustainable business model innovation: Organization design and dynamic capabilities'; Cressler et al. (2020) - 'Towards a conceptual framework of sustainable business model innovation in the agri-food sector: A systematic literature review'
SMEs and Sustainability Challenges	The barriers SMEs face in adopting digital sustainability solutions, including financial and technological constraints.	1. Funding limitations as a primary obstacle for SMEs in implementing ESG frameworks. 2. Affordable IoT-based sustainability solutions for SMEs. 3. Lack of digital literacy among SMEs, hindering digital sustainability transitions. 4. Comparative studies on how regulatory incentives drive SME adoption of green technologies.	Introduce scalability and accessibility as critical components for SME-oriented sustainability solutions.	Adoption barriers, policy implications, financial constraints	Green Financing mechanism for SMEs	Bouwman et al. (2019) - 'Digitalization, business models, and SMEs: How do business model innovation practices improve performance of digitalizing SMEs?'; Denicolai et al. (2021) - 'Internationalization, digitalization, and sustainability: Are SMEs ready? A survey on synergies and substituting effects among growth paths'
Policy, Regulations, and Governance	How regulatory and reporting frameworks shape digital sustainability transitions and business model transformations.	1. ESG Reporting 2. Mandatory carbon accounting policies and their influence on firm-level digital sustainability strategies. 3. Carbon pricing mechanisms influencing corporate sustainability strategies. 4. Board-level ESG commitments in digital transformation initiatives.	Align regulatory enablers with market-driven digitalization trends to highlight their combined impact on sustainable business models.	CSR, sustainability reporting, regulatory frameworks	Comparative Analysis of Sustainability across regions	Yixuan Peng et al. (2023) - 'Impact of Digitalization on Process Optimization and Decision-Making towards Sustainability: The Moderating Role of Environmental Regulation'; Mesquita et al. (2023) - 'The role of ESG reporting, artificial intelligence, stakeholders and innovation performance in fostering sustainability culture and climate resilience'

Table 2: Themes, Focus Areas, and Concepts discussed (Author's work)

Top 10 Influential / Most Cited Articles:

The most cited papers focus on Sustainable business models and value creation, Digital transformation strategies for sustainability, circular economy, and green finance. The top 10 most cited papers focus on the intersection of digitalization and sustainability, highlighting frameworks for integrating AI, blockchain, and IoT with sustainable business models.

1) A literature and practice review to develop sustainable business model archetypes

by N.M.P. Bocken, S.W. Short, P. Rana, S. Evans , Journal of Cleaner Production 2014 (2537 Citations)

The article describes business model archetypes for sustainability, categorized into Technology, Social, and Organizational types. Each type focuses on different areas of innovation and provides examples that encourage businesses to explore combinations for transformative change. Key strategies include eco-innovations and postulations regarding efficiency, waste reduction, renewable resources, and collaborative approaches with stakeholders, emphasizing the need for continuous evolution in sustainable practices and educational resources. (N.M.P. Bocken, 2014).

2) **Digital transformation: A multidisciplinary reflection and research agenda**
By Peter C. Verhoefa, Thijs Broekhuizena, Yakov Bartb, Abhi Bhattacharyaa, John Qi Donga, Nicolai Fabiana, Michael Haenlein, Journal of Business Research 2021 (2263 Citations)

This paper analyzes digital transformation from a multidisciplinary viewpoint, highlighting its necessity due to technological and customer behavior shifts. It describes three stages—digitization, digitalization, and digital transformation—each needing distinct organizational resources and strategies. The paper emphasizes the development of digital capabilities, success metrics, and potential research areas, including phase sequencing, resource roles, organizational structure, platform growth strategies, and suitable metrics. (Peter C. Verhoefa, 2021).

3) **Business models for sustainable innovation: State-of-the-art and steps towards a research agenda**
By Frank Boons, Florian Ludeke-Freund, Journal of Cleaner Production 2013 (1584 Citations)
The article discusses the relationship between sustainable innovation and business models, noting that current research often overlooks how value propositions, supply chains, customer interfaces, and financial models are connected. It argues that business models can promote sustainable innovation and balance performance with environmental considerations. The authors call for more empirical research to assess how companies implement these principles and recommend that future studies work on creating standards for sustainable business models. (Boons, 2103).

4) **Industry 4.0, digitization, and opportunities for sustainability**
By Morteza Ghobakhloo, Journal of Cleaner Production 2020 (1272 Citations)
The study investigates how Industry 4.0 can promote sustainability by highlighting important design principles and technologies. It shows that economic gains often come before social and environmental improvements. The research provides advice for leaders and stakeholders in both public and private sectors to work together in leveraging the digital revolution for enhanced sustainability. (Ghobakhloo, 2020).
5) **Sustainable business model innovation: A review**
By Martin Geissdoerfer, Doroteya Vladimirova, Steve Evans, Journal of Cleaner Production 2018 (885 Citations)
The paper reviews literature on sustainable business model innovation, identifies key concepts and research gaps, and proposes related questions. It explores how organizations shift to sustainable models, highlighting their potential advantages over non-sustainable ones. The author aims to create a framework to help organizations innovate sustainably, which could enhance societal and economic outcomes. (Martin Geissdoerfer, 2018).
6) **Business Model Innovation for Sustainability: Towards a Unified Perspective for Creation of Sustainable Business Models**
By Steve Evans, Doroteya Vladimirova, Maria Holgado, Kirsten Van Fossen, Miying Yang, Elisabete A. Silva, and Claire Y. Barlow , Business Strategy and the Environment 2017 (832 Citations)
Business model innovation presents challenges due to uncertainty and resource demands, leading many companies to be hesitant in experimenting. Effective approaches include trial and error and simulations to lower costs. There is a need for better assessment systems for sustainable business models (SBMs), as current frameworks hinder measuring sustainability outcomes. Limited understanding of SBM adoption necessitates future exploration, and stakeholders should acknowledge the complexities of evaluating new models. Policymakers are also urged to grasp the key factors that promote sustainability in business models. (S. Evans, 2017).
7) **Business cases for sustainability: The role of business model innovation for corporate sustainability**
By Stefan Schaltegger, Florian Lüdeke-Freund and Erik G. Hansen, International Journal of Innovation and Sustainable Development 2012 (807 Citations)
A business case for sustainability promotes economic success through the effective management of social and environmental initiatives. Companies need to innovate strategically in areas like costs and reputation, rather than relying on one-time solutions. Various management approaches—defensive, accommodative, and proactive—can help, but hurdles such as managerial resistance and conflicts with existing business practices exist. Addressing these challenges requires new strategies and leadership to prioritize sustainability alongside economic benefits. (Stefan Schaltegger, 2012).

8) **Business model innovation for circular economy and sustainability: A review of approaches**
By Pieroni, Marina P.P., McAloone, Tim C., Pigosso, Daniela C.A, Journal of Cleaner Production 2019 (712 Citations)
This research analyzes 92 frameworks and tools related to sustainability and circular economy business model innovation (BMI). Findings indicate growing diversity in methods but highlight gaps in linking design and implementation of these innovations, along with a need for further integration of circular economy and sustainability principles. The study emphasizes the need for a collaborative approach to BMI and suggests future efforts will focus on developing collaborative integration strategies using case studies to evaluate sustainability outcomes. (Marina P. Pieronia, 2019).

9) **Digitalization and its influence on business model innovation**
By Michael Rachinger, Romana Rauter, Christiana Müller, Wolfgang Vorraber, Eva Schirgi, Journal of Manufacturing Technology Management 2019 (659 Citations)
The article highlights how digitalization affects value creation in the automotive and media sectors, impacting processes and collaboration. It creates new employee skill demands while enhancing value propositions and revenue, driven largely by customer demand. Digitalization prompts quicker innovation cycles, potentially transforming value propositions as companies integrate services with products, like predictive maintenance. The automotive sector sees significant influence from digitalization, especially in optimizing production processes. (Michael Rachinger, 2019).

10)**Digital servitization business models in ecosystems: A theory of the firm**
By Marko Kohtamäki, Vinit Parida, Pejvak Oghazi, Heiko Gebauer, Tim Baines, Journal of Business Research 2019 (662 Citations)
The study examines digital servitization, exploring business models shaped by digitalization. It identifies five specific digital servitization models and employs four business theories to analyze them. Key findings emphasize the need to integrate digital and servitization strategies to create value, while also highlighting the importance of choosing suitable business models and being adaptable in a competitive environment. (Marko Kohtamäkia, 2019).

Another 7 Influential Articles on the Topic as per the Author:

A) A value mapping tool for sustainable business modelling
By Bocken, Nancy ; Short, Samuel ; Rana, Padmakshi ; Evans, Steve, Corporate Governance (Bingley) 2013 (474 Citations)
The value mapping tool assists companies in incorporating sustainability into their business models by identifying opportunities for value creation with input from various stakeholders. Available in two versions—one for in-depth analysis and another for quicker use—it can be utilized independently or with other analytical tools. It supports workshops, educational sessions, and industry analysis, and also helps in recognizing environmental and social impacts. Effective facilitation is necessary to maximize its benefits, and future testing will assess its applicability across different organizations and contexts. (Bocken, 2013).

B) The impact of digitalization on business models
by Bouwman, Harry; Nikou, Shahrokh; Molina-Castillo, Francisco J.; de Reuver, Mark , Digital Policy, Regulation and Governance 2018 (239 Citations)
Research shows that internal factors related to innovation and technology heavily impact Business Model Innovation (BMI), particularly through the use of big data and social media. Case studies suggest big data has a more significant effect on company operations than social media. Effective resource allocation is crucial for enhancing innovation and performance. There's an identified gap in understanding innovative pathways and a need for more research into technology's roles in influencing BMI, especially for small and medium-sized enterprises. The study recommends policy support for SMEs to focus on BMI along with traditional practices, and calls for further investigation into experimental strategies and organizational influences on BMI effectiveness. (Harry Bouwman, 2018).

C) The digitalization sustainability matrix: A participatory research tool for investigating digitainability
by Gupta, Shivam; Motlagh, Mahsa; Rhyner, Jakob, Sustainability (Switzerland) 2020 (62 Citations)
The paper emphasizes the role of Digitalization and Artificial Intelligence (D&AI) in promoting Sustainable Development Goals (SDGs) while cautioning against potential societal and environmental risks. It describes a

workshop using the Digitalization-Sustainability Matrix (DSM) to discuss ethical implications and collaborate on collective action plans for D&AI and SDG indicators. The DSM encourages stakeholder cooperation to enhance understanding of D&AI's benefits for sustainable change, though it acknowledges some operational challenges. Future versions of the DSM will be needed to seek to improve its effectiveness and address shortcomings. (Shivam Gupta M. M., 2020).

D) Digitainability: The combined effects of the megatrends digitalization and sustainability

by Lichtenthaler, Ulrich, Journal of Innovation Management 2021 (81 Citations)

The article presents a framework called 'digitainability' that connects digitalization with sustainability, pointing out that many digital initiatives often contradict sustainability goals by increasing carbon emissions and energy usage. It calls for organizations to embed sustainability in their digital strategies to reduce negative effects while benefiting from innovations. It emphasizes the importance of both digitalization and sustainability as critical trends that require strategic focus, particularly in the aftermath of COVID-19, and encourages further stakeholder discussions and empirical research on these interactions. (Lichtenthaler, 2021).

E) Business model innovation for sustainability: A new Framework

by Ferlito, Rosaria ; Faraci, Rosario, Innovation and Management Review 2021 (55 Citations)

The article introduces the concept of 'digitainability,' highlighting the conflict between digital initiatives and sustainability goals, especially in terms of carbon emissions and energy use. It urges organizations to incorporate sustainability into their digital strategies to mitigate negative impacts and harness the benefits of innovation. The piece emphasizes the need for attention to both digitalization and sustainability and calls for ongoing discussions and research on their relationship, particularly in the context of post-COVID-19 development. (Rosaria Ferlito, 2021).

F) Mindful Application of Digitalization for Sustainable Development: The Digitainability Assessment Framework

by Gupta, Shivam ; Rhyner, Jakob Sustainability (Switzerland) 2022 (23 Citations)

The study presents the Digitalization Assessment Framework (DAF), which evaluates the effects of digital interventions on sustainable development goals. It uses the Theory of Change to analyze contexts, actors, and impacts on specific indicators while promoting a systematic evidence-gathering approach. DAF helps identify trade-offs and synergies, thereby aiding in sustainable development collaboration, though it faces challenges due to complex interdependencies. Future enhancements may incorporate machine learning for improved analysis. (Shivam Gupta J. R., 2022).

G) Role of Digital Transformation for Achieving Sustainability: Mediated Role of Stakeholders, Key Capabilities, and Technology

by Rafael Martínez-Peláez, Alberto Ochoa-Brust, Solange Rivera, Vanessa G. Félix, Rodolfo Ostos, Héctor Brito, Ramón A. Félix, and Luis J.Mena , Sustainability 2023 (288 Citations)

The study analyzes how owners and senior managers of small and medium-sized enterprises (MSMEs) can efficiently launch a sustainable digital transformation. It highlights the importance of building a supportive organizational culture, involving stakeholders in innovation, and utilizing technologies like big data and e-commerce. The research suggests that aligning digital practices with sustainability goals and engaging stakeholders are essential for improving efficiency and competitiveness in MSMEs. (Rafael Martínez-Peláez, 2023).

Based on the analysis of these 17 papers, we have classified them on the basis of the integration level of Sustainability, Digitalization, and Business Model Innovation, along with the dependent and independent variables to better understand the impact of these factors on each other as well as the outcomes.

S No	Citation	Digitalization	Sustainability	BMI	Integration Level	Independent Variable(s)	Dependent Variable(s)
1	Rachinger et al. (2019)	✓	✕	✓	Digital + BMI	Digitalization Dimensions	Business Model Innovation
2	Bouwman et al. (2018)	✓	✕	✓	Digital + BMI	Digital Tech Adoption	Innovation Pathways and Performance
3	Gupta et al. (2020)	✓	✓	✕	Digital + Sustainability	Digital-Sustainability Matrix Factors	Collaborative Action for SDGs
4	Boons & Lüdeke-Freund (201	✕	✓	✓	Sustainability + BMI	Sustainable Innovation Constructs	Sustainable Business Model Adoption
5	Schaltegger et al. (2012)	✕	✓	✓	Sustainability + BMI	Corporate Sustainability Practices	Business Case Effectiveness for Sustainability
6	Bocken et al. (2013)	✕	✓	✓	Sustainability + BMI	Value Mapping Framework	Identification of Sustainability Opportunities
7	Ferlito & Faraci (2021)	✕	✓	✓	Sustainability + BMI	Governance, Value Propositions	Sustainable Business Model Transitions
8	Bocken et al. (2014)	✓	✓	✓	Sustainability + Digital + BMI	Business Models, Sustainability Archetypes	Sustainable Business Model Archetypes
9	Verhoef et al. (2021)	✓	✓	✓	Sustainability + Digital + BMI	Digital Transformation Stages	Strategic Digital Transformation Outcomes
10	Ghobakhloo (2020)	✓	✓	✓	Sustainability + Digital + BMI	Industry 4.0 Technologies	Sustainability Outcomes
11	Geissdoerfer et al. (2018)	✓	✓	✓	Sustainability + Digital + BMI	Sustainability Strategies, Capabilities	Sustainable Business Model Transition
12	Evans et al. (2017)	✓	✓	✓	Sustainability + Digital + BMI	Organizational Processes, Business Models	Sustainable Innovation Metrics
13	Pieroni et al. (2019)	✓	✓	✓	Sustainability + Digital + BMI	Sustainable CE Innovation Methods	Implementation Effectiveness of CE BMs
14	Kohtamäki et al. (2019)	✓	✓	✓	Sustainability + Digital + BMI	Servitization Strategy, Digital Tools	Value Creation through Servitization
15	Lichtenthaler (2021)	✓	✓	✓	Sustainability + Digital + BMI	Digitainability Constructs	Strategic Growth & Innovation Alignment
16	Gupta & Rhyner (2022)	✓	✓	✓	Sustainability + Digital + BMI	Digital Assessment Framework (DAF)	Impact on SDGs, Trade-offs
17	Martínez-Peláez et al. (2023)	✓	✓	✓	Sustainability + Digital + BMI	Stakeholder Roles, Digital Tech Capabilities	Sustainable Digital Transformation Readiness

Table 3: Integration Levels with Variables (Author's work)

DISCUSSION AND ANALYSIS

The analysis of the published papers along thematic lines and the more detailed analysis of the 17 papers provide answers to the Research questions. The findings of this study reveal a strong interconnection between digitalization and sustainability, both acting as catalysts for business model innovation. Digital transformation technologies, such as AI, blockchain, and IoT, enable companies to optimize resource utilization, enhance transparency, and improve operational efficiency. These advancements contribute to sustainability efforts by reducing energy consumption, minimizing waste, and promoting circular economy principles. Conversely, the growing emphasis on sustainability has accelerated the adoption of digital solutions, as organizations seek to comply with environmental regulations, enhance stakeholder engagement, and achieve competitive differentiation.

RQ 1 – How does the interaction between digitalization and sustainability drive business model innovation?

Over the past decade, digitalization, sustainability, and business model innovation (BMI) have emerged as distinct yet increasingly intertwined strategic imperatives. While digitalization enables technological transformation and data-driven efficiency, sustainability demands environmental stewardship and long-term value orientation. BMI acts as a mediating mechanism that allows firms to operationalize digital and sustainable capabilities into concrete value creation strategies.

There is a progressive relationship between sustainability and digitalization in companies, showing that social sustainability is often prioritized before environmental sustainability and digital efforts. Initially, firms focus their resources on achieving sustainability, followed by advancements in digitalization. Growth strategies and workforce experience notably facilitate the convergence of these strategic challenges. Industries like fashion are adopting circular economy principles, focusing on maximizing material and energy efficiency, and creating value from waste. Digital transformation supports these efforts by enabling more sustainable production and consumption patterns (C. Colombi, 2023) (Lidiane Cássia Comin, 2019). The network economy, driven by digital technologies, is fostering new business models that emphasize collaboration, asset sharing, and co-creation.

These models aim to achieve sustainability by balancing economic, social, and environmental goals (Marek Jablonski, 2020).

Digital technologies influence environmental sustainability by transforming waste management, production practices, and urban development. These technologies enable businesses to create new models centered on sustainability, leading to overall improvements in environmental practices that could not have been achieved a decade ago. While some companies incorporate sustainable tactics, there is a lack of literature on the required capabilities for effective digital transformation in sustainability. So, the capabilities necessary for the digital transformation toward sustainability, the impact on organizational performance through these practices, and strategies for integrating sustainability into digital business decisions need to be better understood (Abdul Karim Feroz, 2021).

However, digitalization alone is not sufficient for achieving a sustainable future; careful implementation, understanding of its broader impacts, and further empirical research are needed (Edi-Cristian Dumitra, 2025). The integration of sustainability actions and digital transformation is driving the creation of new business models across various industries. These models aim to balance ecological, economic, and technological sustainability, leveraging digital technologies to innovate and transform traditional business practices. Organizations are undergoing dual transformations to integrate ecological sustainability into their core operations without compromising economic success. This involves adopting digital sustainable business models that utilize digital technologies to create sustainable value propositions (Timo Phillip Böttcher, 2023).

There is a strong connection between digitalization and sustainability, and the relationship is reciprocal; while digitalization enhances sustainability efforts, the need for sustainable practices can catalyze further digital transformation. Digitalization is a key enabler of sustainability, improving carbon footprint monitoring, energy efficiency, resource optimization, and supply chain transparency. Technologies such as AI, IoT, and Blockchain support smart grids, predictive maintenance, and circular economy practices. Studies indicate that data-driven decision-making leads to a 30-40% reduction in resource waste in smart manufacturing sectors. Successful integration of digital technologies like robotics and artificial intelligence enhances operational efficiency, contributes to sustainability initiatives like the Green Platform and Circular Economy, and helps companies meet both market demands and environmental goals. Manufacturing firms that adopt a holistic approach that fuses technological advancement with sustainability strategies balance profitability and social responsibility (Rashid Shabir Abbasi, 2024). Overall, leveraging digitalization can address inefficiencies and align the industry more effectively with sustainable objectives, benefiting both economic growth and environmental priorities (Manlio Del Giudice, 2022).

RQ2 – What are the key challenges and opportunities in implementing integrated digital-sustainable business models?

Companies that perceive a positive external environment are also more likely to engage in this dual focus (Jesús Valero-Gil, 2024). By using social representations and framing theories and a multi-method approach, the following framing perspectives were identified: viewing digitalization and sustainability as separate challenges, as having harmful impacts, or as having potential for positive transformation. Findings indicate that diverse perceptions among structured stakeholders highlight gaps in social sustainability discussions, necessitating attention for policymakers, as decisions will rely on how they interpret this complex intersection (Barbara Brenner B. H., 2021).

Companies prioritizing sustainability while meeting ESG expectations find a competitive edge, and effective governance and family ownership positively impact ESG performance. Crafting an overall ESG strategy requires thorough evaluation, integration of sustainability at all response levels, and fostering transparency for better future sustainable success. This focus is fostering innovation, reducing environmental footprints, and enhancing brand reputation across sectors like manufacturing and services. Effective leadership is essential in this transition, including understanding the significance of sustainability from definition creation to operational inclusion. The integration of digitalization and sustainability is crucial for modern businesses aiming to innovate and remain competitive. By adopting digital-sustainable business models, companies can achieve a balance between economic growth and environmental responsibility, ultimately contributing to broader sustainable development goals.

Future research should continue to explore the synergies and conflicts between digitalization and sustainability to refine strategies and frameworks for effective implementation (Claudia Ogrean, 2024) (Yang, 2024).
The increasing complexity of ESG regulations necessitates robust digital solutions for compliance and reporting, creating a feedback loop where regulatory demands drive technological advancements. Effective communication and transparency facilitated by digital tools enhance stakeholder trust and engagement in sustainability initiatives. Organizations must cultivate a culture of innovation and adapt their knowledge management strategies to navigate the evolving technological landscape successfully. As digital technologies evolve, it is crucial to ensure they do not exacerbate environmental challenges, such as increased energy consumption, thereby amplifying the need for a balanced growth approach (Ghosal, 2024). The integration of digital solutions in sustainability efforts raises concerns about cybersecurity risks that need addressing to protect sensitive information (Frick, 2025). Organizations must invest in training employees to effectively use new technologies while promoting sustainable practices (Shehadeh, 2024).
Small and medium-sized enterprises (SMEs) need to leverage technology to pursue sustainable development goals. SME's need to integrate sustainability into operations while emphasizing innovation and effective knowledge management. There is an influence of external pressures, leadership commitment, and organisational culture on adopting sustainability. Technologies such as cloud computing, fintech, and automation improve competitiveness but face challenges like cost and expertise limitations. Responsible technology adoption leads to benefits such as cost savings and enhanced reputation, although financial constraints can pose obstacles (Kannan & Gambetta, 2025).
In a review of empirical studies (Lanouar Charfeddine, 2023) identified various proxies categorized by researchers were used to measure environmental sustainability and the ICT/digitization nexus, showing a prevalent focus on traditional indicators such as carbon emissions and internet subscriptions. The studies primarily yielded negative relationships, suggesting a connection where increased ICT-related activity might lead to greater environmental degradation, although some positive and nonlinear associations were noted. Furthermore, the meta-analysis highlighted gaps in advancing research due to an insufficient examination of more integrated sustainability metrics across countries and research contexts. On the ICT/digitization front, dominant proxies included metrics for internet and mobile subscriptions, while global indices and less common measures were underutilized. Among published relationships between ICT/digitization and environmental sustainability, most gained insights into both negative and positive associations fall into traditional measurement, making up a low proportion.

RQ3 – What mechanisms enable organizations to leverage digitalization for sustainable business model innovation?
Several frameworks have been proposed to guide the integration of digitalization and sustainability in business models. These frameworks focus on strategic management, emphasizing the need for businesses to align their digital and sustainability strategies to create value propositions that are economically viable and environmentally responsible. This includes adopting practices like co-creation, usage-based pricing, and collaborative ecosystems (Brenner, 2018) (Maximilian Palmié, 2024).
(Sabrina Schork, 2025) discusses the positive impact of the integration of Digitalization, Innovation, and Sustainability (DIS) on organizations, emphasizing the need for standardized definitions and clear measurement methods in research to enable accurate comparison and understanding of DIS concepts. Furthermore, a cautious, case-by-case approach for organizations to apply DIS practices is needed, and the potential competitive benefits of developing Sustainable Digital Innovation (SDI) need to be clarified. The interconnectedness of these concepts advocates for a holistic framework to improve organizational sustainability and leadership practices. (Alshdaifat, Aziz, Alhasnawi, Alharasis, & Amosh, 2024) identifies trends in social entrepreneurship research, influential authors and institutions, and significant technologies such as AI, blockchain, and big data in promoting sustainability. The study highlights collaboration for innovation and provides guidelines for practitioners and policymakers to enhance efficiency and strategies for sustainable practices.
Digitalization is leading to new business models that focus on sustainability, emphasizing collaboration among policymakers, businesses, and society. Effective regulations, corporate strategies for environmental responsibility, and heightened consumer awareness are essential for ensuring that digital advancements promote both environmental and social wellness. Businesses are shifting from selling products to offering services, which

encourages resource efficiency and reduces waste. This model is supported by digital tools that facilitate service delivery and customer engagement (S. Evans, 2017). Companies are leveraging data analytics and digital tools to enhance their sustainability performance, using insights to optimize operations and reduce environmental impact (Ying Li, 2023).

Digitalization enables new business models, including

- Product-as-a-Service (PaaS): Companies shifting from selling products to offering subscription-based models (e.g., Philips' Pay-per-Lux lighting model).
- Green Supply Chains: AI-powered route optimization reducing logistics emissions by up to 25%.
- Sustainable E-Commerce: Leveraging blockchain for transparent carbon offsetting in digital transactions.

In a study (Patrizia Gazzola, 2024) explored the concept of "digitainability" in the fashion industry, highlighting the global collaboration in digitalization and sustainability efforts. Research indicates that digitalization enhances innovation in products, processes, and business models by integrating advanced technologies with eco-friendly practices. It enables sustainable design and improves communication between consumers and businesses, fostering collaboration through channels such as social media. However, successful implementation manifests challenges due to growing formulation and learning within the industry to leverage digital advancements. Overall, the findings indicate that combining digitalization and sustainability can create innovative solutions supporting the transition to a more sustainable fashion production model within a "digitainability" framework.

Various types of innovation, like digital technological innovation, user-driven social innovation, and organizational innovation, facilitate the transition to sustainable business models (SBMs) and bioeconomic innovation, eco-innovation, collaborative innovation, open/closed innovation, and product/service systems innovation for circular business models (CBMs). These innovations enhance competitiveness while addressing environmental and societal challenges, while creating more sustainable business practices, notably enhancing value creation, delivery, and capture across different business model dimensions (Barbara Brenner D. D., 2023). (Cricelli & Strazzullo, 2021) identified metrics measuring the economic sustainability benefits of Industry 4.0 technologies, emphasizing a significant economic opportunity through enhanced interconnection and cooperation in production. This transition will increase competitiveness, efficiency, and create innovative business models, fully transforming the industrial sector. Digitalization is crucial for achieving sustainable production by optimizing communication and resources. While certain low-skilled jobs may decline, new opportunities in IT and technical fields are expected to emerge.

Organizations achieve superior performance outcomes when they integrate digitalization and sustainability through systematic business model innovation, rather than pursuing these initiatives independently. A key insight from the analysis is the bidirectional influence between these two domains. Digital tools facilitate the tracking and reporting of sustainability metrics, enabling organizations to meet regulatory requirements and align with international frameworks such as ESG and SDG goals. Meanwhile, sustainability-driven business models encourage innovation in digital infrastructure, such as smart manufacturing and predictive maintenance, which contribute to long-term cost reductions and operational resilience.

We see an evolving relationship between the three aspects, with the early phase treating them as separate, with digitalization being efficiency-driven, sustainability being compliance-driven, and BMI being market-driven. Now we argue that Digital technologies are deployed to enable sustainability goals, driving new sustainable business models, and see the future as Holistic "Digitainability" – where digital transformation and sustainability co-evolve and catalyze dynamic business model shifts. Digitainability can be defined as: "The organizational capability to create, deliver, and capture value through the seamless integration of digital technologies and sustainable practices, enabled by innovative business models that generate positive outcomes for multiple stakeholders across economic, environmental, and social dimensions."

Organizations achieve superior performance outcomes when they integrate digitalization and sustainability through systematic business model innovation, rather than pursuing these initiatives independently. However, challenges persist in fully realizing the potential of digitalization for sustainability. Many organizations face difficulties in integrating emerging technologies due to high initial costs, a lack of skilled workforce, and regulatory uncertainties. Additionally, concerns over data privacy and cybersecurity remain significant barriers to widespread digital adoption.

The study also highlights the need for cross-industry collaboration and policy support to create a conducive ecosystem where digitalization and sustainability efforts can reinforce each other. Overall, the analysis underscores that while digitalization and sustainability are distinct concepts, their convergence presents new opportunities for organizations to create long-term value. Based on these factors and analysis, we propose a conceptual framework to explore cause and effect relationships of digital-sustainability BMI integration.

CONCEPTUAL MODEL

Digitalization and sustainability are deeply interconnected, with emerging technologies crucial in transforming business models toward more sustainable practices. The above systematic examination of the triadic relationship between digitalization, sustainability, and business model innovation reveals how their integration creates synergistic effects that drive organizational transformation. The study helps develop and understand this relationship further to develop a new conceptual model through five key elements that shape sustainability-driven business model innovation:

1. **Organizational Capabilities:** Companies that adopt dynamic capabilities, cross-industry collaboration, and value co-creation strategies gain a competitive edge in the sustainability transition. These capabilities allow firms to adapt to changing sustainability requirements while fostering long-term innovation. Better capabilities enhance business adaptability to digital and sustainability shifts and promote cross-industry collaboration for sustainability solutions. It also strengthens innovation ecosystems, supporting green technology adoption as also empowers SMEs and large firms to scale digital sustainability initiatives.
2. **Technology as an Enabler:** Digital technologies such as Artificial Intelligence (AI), the Internet of Things (IoT), Digital Twins, and Blockchain enhance Environmental, Social, and Governance (ESG) compliance while improving operational efficiency. These technologies facilitate data-driven decision-making, automate compliance, and optimize resource use, contributing to sustainability goals. They enhance ESG compliance through automated tracking and reporting as well as optimize operational efficiency by reducing resource wastage. By enabling real-time monitoring of emissions, energy consumption, and waste and strengthening supply chain transparency, digitalization prevents greenwashing. Also Digitalization facilitates predictive analytics for sustainability-driven decision-making.
3. **Regulatory and Market Forces:** Government regulations, industry standards, and financial instruments such as Green Finance and ESG compliance requirements push businesses toward sustainability. Companies must align with these policies to ensure long-term viability, stakeholder trust, and competitive advantage. These policies drive the adoption of mandatory ESG disclosures. They also influence corporate strategies through carbon pricing mechanisms, provide green financing incentives for sustainable business transformation, and align digital transformation with sustainability reporting frameworks.
4. **Sustainability Practices and Circular Economy Integration:** The integration of digital tools allows businesses to implement waste reduction strategies, energy-efficient operations, and sustainable resource utilization. This supports circular economy models, enabling recycling, reusability, and responsible consumption. Encourages resource efficiency, recycling, and sustainable consumption. Enables circular business models, shifting from linear supply chains. Supports carbon footprint reduction through smart manufacturing. Helps businesses transition toward net-zero emissions goals.
5. **Sustainable Business Model Innovation:** Digitalization fosters new and innovative business models, including carbon credit trading platforms, product-as-a-service models, and decentralized green supply chains. These innovations create sustainable revenue streams and enable businesses to offer eco-friendly products and services. Digitalization enables new revenue streams through digital sustainability solutions. It facilitates business model transitions toward sustainability-oriented designs. It supports product-as-a-service and regenerative business strategies. It encourages value co-creation between businesses and stakeholders.

By leveraging these five key elements, organizations can achieve the following outcomes:

- **Competitive Advantage**: Early adoption of digital sustainability solutions enhances market positioning.
- **Financial Performance**: Sustainable and digital-driven models improve profitability and resilience.
- **Environmental & Social Impact Reduction**: Measurable reductions in emissions, waste, and resource depletion.

- **Enhanced Brand Reputation**: Stronger stakeholder trust through transparent ESG commitments.

A conceptual framework is proposed below linking digitalization, sustainability, and business model innovation to illustrate how Digitalization acts as a key driver of Sustainability and Business Model Innovation. The framework reflects a dynamic interaction in which digital technologies serve as enablers, sustainability functions as the normative driver, and BMI acts as the transformation mechanism. Temporally, the integration evolves from early-stage digital adoption toward maturity characterized by circular, platform-based, or servitized business models.

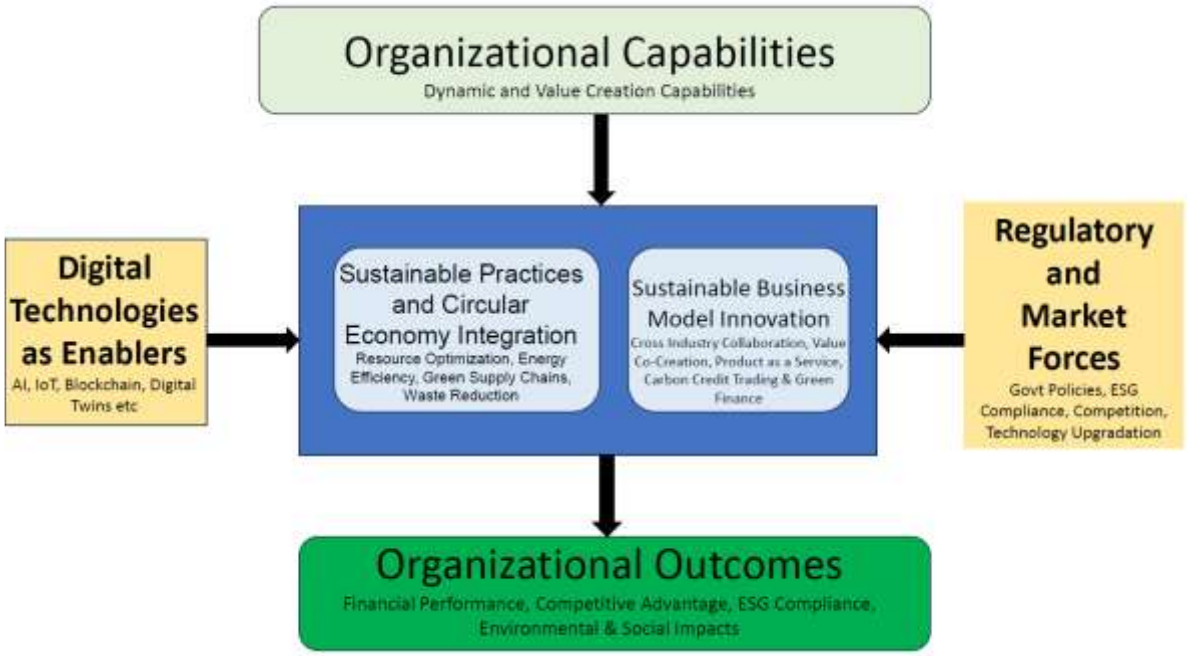

Fig 6: Conceptual Model (Author's work)

RESEARCH GAPS AND FUTURE DIRECTIONS

As the methodology of this research led to the thematic clustering of the articles, below are the identified key gaps as well as Opportunities in the literature across the five defined themes:

SUSTAINABILITY-DRIVEN BUSINESS MODEL INNOVATION

- **Gap:** Limited research on how firms measure the long-term financial impact of sustainability-driven business models. Further, there is a lack of models that can help measure the integration and maturity of Digitalization and Sustainability in the business models of organizations.
- **Opportunity:** Studies could focus on quantifying ROI from sustainable business model innovations. As businesses increasingly adopt circular economy practices, research should investigate the effectiveness of these models in various sectors. Future studies could also explore barriers to scaling these initiatives and strategies to overcome them, and measurement of the parameters.

DIGITAL TRANSFORMATION & INDUSTRY 4.0

- **Gap:** While digitalization is well-studied, few papers explore how AI and machine learning optimize sustainable operations.
- **Opportunity:** More research is needed on AI-driven sustainability metrics and decision-making. Longitudinal Studies to investigate the long-term impacts of digital transformation on sustainability outcomes across various industries to better understand temporal dynamics are also needed. Further comparative Analyses are needed to explore differences in digitalization's impacts on sustainability between developed and developing regions or sectors.

INNOVATION STRATEGIES FOR SUSTAINABILITY

- **Gap:** Most research focuses on large firms; SMEs lack clear innovation roadmaps**.**
- **Opportunity:** Case studies on SME-specific sustainability innovation can bridge this gap. There is a growing need to explore how artificial intelligence can be leveraged for sustainability initiatives. Research can focus on developing AI applications that optimize resource usage, enhance energy efficiency, and predict environmental impacts.

SMES AND SUSTAINABILITY CHALLENGES

- **Gap:** There's little research on how SMEs overcome financial constraints when adopting sustainable practices.
- **Opportunity:** Studies on alternative financing models (green bonds, impact investing) for SMEs would add value. SME Adoption Barriers like Lack of resources, regulatory complexity, and technological integration challenges. Empirical Studies to reveal Limited real-world data on the financial viability of sustainable digital transformation in SMEs.

POLICY, REGULATIONS, AND GOVERNANCE

- **Gap:** Lack of alignment between regulatory requirements across different regions.
- **Opportunity:** Comparative studies on global sustainability regulations would be useful. Researchers can also look at the integration of Behavioral Aspects to understand how organizational culture and employee behavior influence the adoption of digital tools for sustainability. Other areas of research could be Policy Impacts to assess how different regulatory environments affect the relationship between digitalization and sustainability practices.

CONCLUSION

The convergence of sustainability actions and digital transformation is leading to innovative business models that prioritize ecological, economic, and technological sustainability. These models are characterized by their focus on resource efficiency, circular economy principles, and collaborative ecosystems, supported by digital technologies that enable new ways of creating and delivering value. This study identifies key trends and research gaps in digitalization-driven sustainability initiatives. A conceptual model has been proposed to understand the various factors impacting the use of the various aspects of the megatrends of Sustainability and digitalization by organizations to grow sustainably. The study's findings provide insights for both academia and practicing managers to prioritize investments and enhance environmental sustainability strategies through digital transformation. It emphasizes the potential for organizations to adopt new business models or improve existing ones using digital technologies, facilitating better strategic discussions. Future research should focus on empirical validations, AI-based sustainability analytics, and SME-focused innovation models. The review highlights that digitalization is crucial for advancing sustainability goals and business model innovation, but challenges remain. Key recommendations include:

- Investing in AI and Blockchain for ESG compliance automation.
- Developing hybrid financial models for sustainable digital investments.
- Expanding regulatory support for SMEs in digital sustainability.
- Future research should focus on longitudinal studies and industry-specific case analyses, as well as the use of AI for digital transformation, as well as sustainability initiatives.
- Another area of research could be mechanisms to measure integration and maturity of the models.

Our study addresses multiple integration gaps identified in the literature and contributes a Conceptual model and integration pathway for the Digitainability model. This study provides a comprehensive analysis of how digitalization and sustainability intersect to drive business model innovation. The findings underscore a symbiotic relationship where digital advancements bolster sustainability efforts, and sustainability imperatives accelerate digital adoption. Despite these advancements, challenges remain, including regulatory uncertainties, technological integration complexities, and the need for cross-sectoral collaboration. By aligning digital transformation with sustainability goals, businesses can unlock new opportunities for resilience, efficiency, and long-term value creation.

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