

DIGITALIZATION – THE ‘BOARDING PASS’ TO SUSTAINABILITY

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Abstract

The current research paper explores the intersection between digitalization and sustainability, while providing a brief overview of the most cited scientific papers from the literature. At the same time, the main goal of the authors is to identify and expose, in a summary, the general trends, opportunities and challenges associated with the adoption and implementation of the emerging digital technologies into the business environment. Considering that digitalization plays a crucial role in transforming business models, facilitating their competitiveness, efficiency, and productivity, the selected studies provide a consistent overlook of how organizations that have adopted and implemented digital technologies into their processes and operations are better prepared to respond to market changes and unpredictable challenges. At the same time, the paper highlights the interconnectivity between digitalization and sustainability, exposing how the use of digital technologies can contribute to sustainable development by improving organizations’ resource management and operational efficiency. Hence, the role of the current research paper is to provide a short explanation, based on the existing scientific literature, of why digitalization is not only a tool for economic growth, but it is also playing an essential role in achieving the sustainability goals. Businesses and organizations adopting and implementing the digital technologies present a higher flexibility that can be used in becoming more innovative and environmentally responsible, facilitating businesses’ contribution towards sustainable development of the society in general. Hence, by exploring the theoretical framework and recommendations provided by the most cited scientific papers relevant to the purpose of the paper, a compact guide highlighting the good practices summarized by the authors can be consulted. The need for ethically and sustainably produced goods is an on-going trend alongside both individuals and businesses, but the implementation of good practices is only possible if all the decision and policymakers are involved in strong and long-term collaboration.

Keywords

digitalization, sustainability, technical innovation, environmental impact, sustainable development

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Introduction

In the recent years, the global urgency for sustainable development intensified, driven by climate change and resource depletion. As a response to this matter, businesses, industries, and governments are turning to the digital transformation as a potential solution. Digitalization – the integration of technologies such as: the Internet of Things (IoT), Artificial Intelligence (AI), and blockchain – possess the power to revolutionize processes, to improve efficiency, and to reduce waste, positioning it as a critical tool in addressing environmental challenges (Samoilenko et al., 2023). When we bring into discussion topics such as energy management, smart cities, and sustainable agriculture, there is no doubt that digital technologies optimize resource usage and minimize the environmental impact, constituting a strategic instrument in overcoming the contemporary challenges. At the same time, businesses are also interested in implementing the latest digital technologies, as the sustainable future of the energy system -which represent an important resource for every businesses' activities- is on a leading path to a low-carbon or zero-carbon economy, determined by the present European directives (Borowski, 2021).

Beyond environmental benefits, we can also highlight the fact that digitalization has profound social implications, promoting inclusivity by improving access to education, healthcare, and employment through digital platforms (Andrushchenko et al., 2022). However, challenges remain, including the environmental footprint of digital devices and data centres, as well as concerns about the digital divide that could deepen social inequalities. This aspect is determined by digitalization's capabilities to further development, as the present social opportunities provided by digital tools, that are reshaping human nature, such as custom manufacturing, custom services, public surveillance, remote schooling and working, medical consulting, and health care are still under constant improvements, while the discrepancy of the digital infrastructure could make digital equity and equality difficult (Xu et al., 2022).

This article aims to explore whether digitalization can indeed serve as a '*boarding pass*' to a sustainable development, examining its potential to address both environmental and social dimensions of sustainability, while considering the risks associated with its widespread adoption and implementation into the business environment. The key question remains whether digitalization is a net enabler of sustainability or if it introduces new challenges that must be carefully considered, but also managed and overcome.

Hence, as the authors developed the structure of the current paper, the necessity for a compact theoretical guide - based on the open-access scientific literature - regarding the impact of digitalization over the business environment as a facilitator for sustainability has been identified. The present paper focuses on presenting the current context, reviewing the scientific literature, summarizing and highlighting the most relevant papers for the topic, providing valuable insights from a theoretical approach, and formulating recommendations for good practices in implementing digital technologies into business activities.

1. Review of the scientific literature

In the recent years, the global urgency for sustainable development intensified, driven by climate change and resource depletion. As a response to this matter, businesses, industries and governments are turning to the digital transformation as a potential solution. Digitalization – the integration of technologies such as: the Internet of Things (IoT), Artificial Intelligence (AI), and blockchain – possess the power to revolutionize processes, to improve efficiency, and to reduce waste, positioning it as a critical tool in addressing environmental challenges (Samoilenko et al., 2023). When we bring into discussion topics such as energy management, smart cities, and sustainable agriculture, there is no doubt that digital technologies optimize resource use and minimize environmental impact, constituting a strategic instrument in overcoming the contemporary challenges.

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The aim of this article is to explore whether digitalization can indeed serve as a ‘boarding pass’ to a sustainable future, examining its potential to address both environmental and social dimensions of sustainability, while considering the risks associated with its widespread adoption and implementation into the business environment. The key question remains whether digitalization is a net enabler of sustainability or if it introduces new challenges that must be carefully considered, but also managed and overcome.

2. Research methodology

The main objective of this article is to investigate the extent to which digitalization can contribute to achieving sustainability goals. Particularly, it seeks to answer the following research question: ‘*To what extent can digitalization contribute to achieving sustainability goals?*’. Given the complicatedness of sustainability challenges and the diverse applications of digital technologies, this research aims to explore not only the positive impacts of digitalization but also the potential risks and limitations associated with it, generated by the scientific literature.

Hence, the authors have selected the seven most cited scientific papers, relevant to the topic of the current study, to explore the theoretical background. For selecting the scientific papers, the impact of the literature has been considered by a citation threshold of 100 citations, between 2019 and 2024. At the same time, the authors have been considering the previous studies that have been already conducted to provide a rich and recognized knowledgebase in the field of adopting and implementing the digital technologies into the business environment for enhancing the sustainable development. The scientific papers cited in the current study have been selected after querying the Google Scholar platform, keeping in mind the necessity of open-access literature, using the keywords ‘*digitalization*’ and ‘*sustainability*’, considering at the same time how

impactful the studies conducted were for the development of the scientific literature, their contribution to the theoretical framework, and the real-world examples provided.

3. Results and discussions

Conducting an overview of the current state of the scientific literature is always essential for any academic study, as it can provide a solid basis for a better understanding of the research context, or a breaking point for new research opportunities that might be carried out by scholars contributing to the academic community. The analysis and the synopsis of the most relevant scientific papers connected to the research topic and with similar research questions allow an easier identification of the current paradigm, trends, main theories, methods, and the latest result in the chosen research field. At the same time, the process of providing an overview leads to identifying and highlighting the research gaps and needs, therefore guiding and encouraging scholars to approach the research field with innovative approaches.

The research question, well-suited for a theoretical framework approach, as the complexities of digitalization’s impact on sustainability, and vice-versa, can be effectively explored through a review of existing scientific literature and case studies. By summarizing in *Table no. 1*, the latest work and the scientific research papers that have been the most cited, this article provides a concise overview of the current state of knowledge regarding the role of digital technologies in driving sustainability. The scientific papers are listed based on their number of citations, starting from the highest number of citations and continuing to the citation threshold.

Table no. 1. Summaries of the frequently cited scientific papers

Most cited scientific papers		
Authors, Publication year	Number of citations	Summary of the findings/ Contributions to the scientific literature
Isensee et al., 2020	528	<p>This study is offering an integrative perspective on the relationship between SMEs’ (Small and Medium-sized Enterprises) organizational culture, environmental sustainability, and digitalization through a systemic literature review. Main contributions include:</p> <ul style="list-style-type: none"> • A standardized research framework to address the fragmented nature of existing research; • Insights into current research trends, gaps, and challenges, including publication data and a network analysis of concepts;

Most cited scientific papers		
Authors, Publication year	Number of citations	Summary of the findings/ Contributions to the scientific literature
		<ul style="list-style-type: none"> • Introduction of a novel analytical framework that improves on previous models; <p>Six propositions to encourage SMEs to advance sustainability and digitalization through organizational culture development.</p>
Miceli et al., 2021	276	<p>The model proposed by the authors of this study explores the complexities and the interactions encountered by businesses and organizations in managing resilience and sustainability. The framework provides an understanding of the dynamic that are taking place between the concepts, while highlighting the potential interdependencies and synergies, facilitating prioritization and evaluation. Hence, the authors propose an option for building strategic resilience through agile business processes that have been impacted by the adoption and the implementation of the latest digital technologies into the business environment, while effectively managing changes. The framework emphasizes on addressing the dilemma of efficiency versus effectiveness, particularly into decision-making processes, resource management, and operational activities. At the same time, the study exposed how the organizational adoption and implementation of the latest digital technologies into its processes and operations must be based on businesses' resources and capabilities, including the ones used for research and innovation, which are promising areas for developing strategic resilience focused on digitalization and sustainability.</p>
Chen et al., 2020	187	<p>This study explores the role of digitalization in enhancing environmental sustainability within manufacturing. They address the challenge of finding balanced research on</p>

Most cited scientific papers		
Authors, Publication year	Number of citations	Summary of the findings/ Contributions to the scientific literature
		<p>both the positive and negative impacts, as many studies focus on specific technologies or provide overly board generalizations. To overcome this, the authors conducted a comprehensive literature review and offered the following key contributions:</p> <ul style="list-style-type: none"> • A holistic assessment of digitalization’s environmental; • A lifecycle perspective considering both the environmental benefits and costs; • Practical guidelines for implementing digital technologies; • An analysis of the interconnectedness between economic, environmental, and social sustainability.
Grybauskas et al., 2022	164	<p>In this study it has been exposed how <i>Industry 4.0</i> and the digital transformation are reshaping the business environment and redefining the value creation mechanism, by exposing the impact of digitalization on business processes and business operations, while still highlighting that the literature on <i>Industry 4.0</i> is relatively young and it is composed preponderantly by scientific papers revealing the opportunities for businesses to increase the sustainability of their industrial operations by integrating the digital tools. At the same time, the study compared the positive and the negative social impacts of implementing the digital technologies in business processes and operations, considering sustainability’s role to improve the social wellbeing of the society.</p>
Brenner and Hartl, 2021	144	<p>This study explores the important and multidisciplinary relationship between digitalization and sustainability, using</p>

Most cited scientific papers		
Authors, Publication year	Number of citations	Summary of the findings/ Contributions to the scientific literature
		framing theory and social representations theory. It provides a multi-method analysis of how various actors perceive the connection between digitalization and sustainability across three dimensions. The paper emphasizes the need for further exploration and discussion of the interrelationship between organizational culture, sustainability, and digitalization. It also highlights the potential impact on policymakers, suggesting they can influence public opinion by participating in media discussions.
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Demartini et al., 2019	124	Digital technologies offer the potential to transform industrial processes, making them more resource-efficient, cost-effective, flexible, and sustainable. While these benefits are not automatic, the conceptual framework demonstrates how digitalization can enhance efficiency, resilience, and sustainability. Case studies illustrate the practice applications of key technologies in creating a more sustainable industrial future. The findings suggest that, when fully implemented digitalization could significantly contribute to a sustainable manufacturing landscape.

Source: Authors` contribution from the scientific literature.

Hence, briefly, after summarizing several of the most cited scientific papers regarding digitalization and its impact over the business environment and the ecosystem, it can be stated that it is one of the first steps and a strong requirement towards sustainable development. Digital technologies, such as the tools developed by the on-going *Industry 4.0* – once integrated into the business activities, provide significant potential for enhancing sustainable practices, particularly in manufacturing industries, by improving efficiency, reducing resource waste and lowering production costs. However, the current state of the scientific literature often exposes a fragmented perspective that is not necessarily defended by a comprehensive analysis of both positive and negative environmental impacts.

For example, taking into consideration the scientific research conducted by Isensee et al. (2020) and the theoretical framework proposed by Lichtenhaler (2021). The research conducted by Isensee et al. (2020) is offering a detailed integrative perspective on the strong relation between the inside of an organization (SMEs' organizational culture), its environmental impact, and digitalization, while formulating six recommendations to encourage SMEs to continue their advancement towards sustainability through digitalization and organizational culture development. At the same time, the theoretical framework proposed by Lichtenhaler (2021) explores the meaning of 'digitability' which highlights the cross-fertilization between digitalization and sustainability which is often neglected by the scientific literature, even if there is a stable interrelated relevance between them. Considering that the future development of the business environment will lead to the interaction between digitalization and sustainability to increase more and more, it is important to observe how the scientific literature will shift from concrete study cases explored on businesses to theoretical strategic frameworks, as the discrepancy in the number of citations will tend to decrease.

Simultaneously, taking into account the approaches of the scientific literature regarding products' lifecycle, it is revealed that the digital technologies, once adopted and implemented into business procedures and operations, can enhance material efficiency while also optimizing energy consumption. At the same time, to fully enhance the opportunities and benefits provided by digitalization, organizations must build efficient internal infrastructure, that in the long run will minimize their environmental footprint, while optimizing their resource consumption.

Meanwhile, for consistent good practices, real life examples must be included as well. A relevant example is being highlighted by platforms like Airbnb and Uber, that facilitate shared access to resources, reducing the need for additional production and consumption, while digital tools help companies track and manage their environmental footprints in real time (Aloulou et al., 2024).

On the other hand, the increased use of blockchain technology, which is increasingly used to enhance transparency in supply chains, allows companies to verify even faster and more efficiently the sustainability of their sourcing practices and to be ensured that consumers have access to sustainably produced goods, as the social need for businesses' ethical behaviour towards the environment is stronger than ever (Hallstedt et al., 2020).

Conclusions

Digitalization fosters the creation of entirely new business models that prioritize sustainability. The rise of the sharing economy, circular economy platforms, and digital enabled supply chains allows businesses to rethink how they produce, distribute, and consume resources (Cuomo and Foroudi, 2023).

To sum up with, the current challenges require strong collaboration between policymakers, businesses, and society. Clear regulations promoting sustainable practices, corporate strategies that prioritize environmental responsibility, and consumer awareness are crucial to ensuring that digitalization drives both environmental and social sustainability, therefore contributing to social wellness. Hence, digitalization and its broaden definition provided by the scientific literature might be with ease considered 'the boarding pass' to a sustainable development. Nevertheless, digitalization by itself is

not the only requirement that should be taken into consideration for a completely sustainable future society, but it represents a first step that must be implemented. At the same time, while studies presented by the scientific literature demonstrate and expose promising outcomes, achieving long-term sustainability will require more than a careful implementation and management of digital technologies into the business environment, if the impact of digitalization driven by its social, economic, and environmental characteristics, it is not fully understood by the policymakers.

Meanwhile, it should be considered that despite the promising outlook over the possible future scenarios, further empirical research is much needed for exploring the direct impact of implementing the digital technologies in business processes and operations, especially due to their primarily contribution to sustainable manufacturing and their ability to reduce operational costs and resource consumption.

Hence, including the limitations of the current study to cover the widely spread field of digitalization and its impact over the sustainability of the business environment, the current study emphasis on the strong relation between the two of them and the impetuous collaboration between all the actors involved in the society, starting from individuals, businesses, and governmental institutions. At the same time, further research might be conducted in order to explore the direct implication in operational fields and in socio-economic national environment, from a macroeconomic perspective.

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