APPLICATION OF DIGITAL TECHNOLOGIES FOR SUSTAINABLE BUSINESS DEVELOPMENT

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Abstract. The last century's economic progress, technology and digitalization have led to efficient use of time resources and shortened distances. Due to technological progress, changes, and the variety of communication tools, part of the business processes transferred to the digital space became faster and easier; there were opportunities to contact or chat with people in all corners of the world, regardless of the distance. Digital technologies raise living standards and improve the service sector. At the beginning of the twenty-first century, the field of digital technologies has provided a variety of predictions to determine the state of the fundamental concepts in the field, as well as to stimulate debate, help allocate and implement resources, initiatives, and initiate research to improve the understanding of many revolutionary topics related to the digitalization transition. Since 2000, publications focused even more on automation and digital technologies. The authors describe the impact of digital technologies on sustainable business development. At the end, the authors present the results of the bibliometric analysis, during which 8 different thematic clusters were formed; the main keywords are "digitalization", "business", "management", and "sustainability". Each cluster includes contemporary criteria published in the last two years, specifically 2022–2023. To fill the thematic gaps, the authors presented studies by topic.

Keywords: digitalisation, business, management, sustainability, information, big data.

JEL Classification: M21.

1. Introduction

Digital technologies occupy an increasingly significant place in today's world, and they are undoubtedly a strong societal trend that is inevitably connected to the need to create a sustainable future.

Nowadays, digital technologies are driving important changes for individuals, organisations, and society at large. The vast amount of digital data opening up to businesses can become a new source of value creation. However, the mechanisms by which companies can use digital technologies to improve performance are not sufficiently defined. In the post COVID-19 era, the application of digital technologies for business suggested three outcomes: to increase competitiveness for companies that had already scaled digital technologies, to make revisions of the application of digital technologies for companies that were still scaling up them in business, and to

wake-up for companies which were not started to apply digital technologies. Firms have already adopted and are applying many ground-breaking digital technologies to transform their business into more sustainable ones. There is growing global demand for a new direction of economic development and progress compatible with the Sustainable Development Goals (SDGs), i.e., people- and earth-centered economic models. For industrialization, trade, and sustained growth to occur within a green economy, countries need to intensify the use of digital technologies and circular production principles. Applying digital technologies can unlock business growth, sustainable manufacturing, resource efficiency, and other possibilities if accompanied by the right policies and bolstered by collaborative national and international efforts.

In this paper, the authors analyse theoretical links from the impact of digital technologies for sustainable development. The paper is divided into several parts.

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First of all, the authors stress the importance of sustainability in business processes. Secondly, the authors describe aspects of implementing digital technologies in business enterprises. Thirdly, the authors carry out and describe a bibliographic study on the digitisation of sustainable business processes. Fourth, they carry out a bibliometric cumulative analysis. Fifth, they describe the main themes identified in the study and the resulting clusters. Finally, the authors provide concluding remarks.

The aim is to describe the impact of digital technologies on sustainable business development.

The main objectives are:

1. To provide a theoretical justification of the impact of digital technologies on sustainable business development.
2. To conduct a biometric analysis of articles focusing on digitisation, business, management, and sustainability and identify main clusters of keywords.

2. Literature review

In Web of Science (2024) publications database yielded 3,301,613 related publications, which can be broken down into different sections, e.g., by year for over a 10-year period. We could see a clear upward trend from 2014 up to these days presented in Table 1.

Table 1. Number of publications, units (source: Web of Science (2024) publications database using the keywords "digitalisation", "business", "management", and "sustainability")

Year	No of publications
2014	132,141
2015	142,500
2016	154,226
2017	163,121
2018	173,515
2019	229,313
2020	255,541
2021	273,047
2022	270,131
2023	236,578
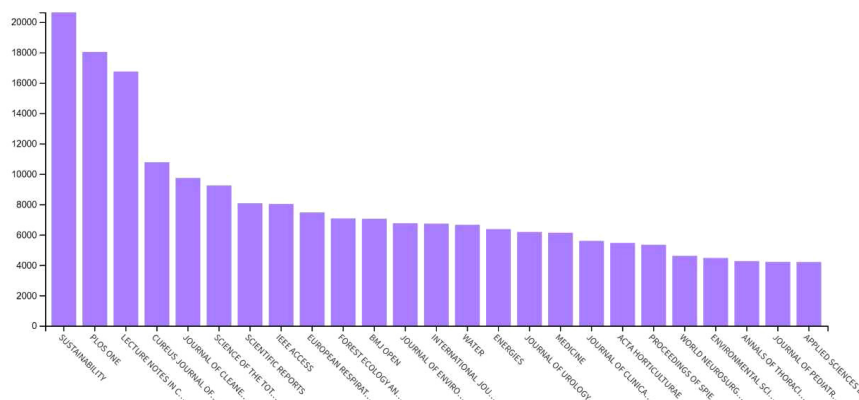
As we see in Table 1, the number of publications was steadily growing from 2014 till 2021. After 2021, the attention of researches to the topic started to decline. The highest number of publications, 273,047 units, was in 2021. In 2022 an insignificant decrease in publications is noticeable – 270,131 units, and a significant decrease of 236,578 units, which is higher than in 2019 but lower than in 2020.

The Figure 1 shows the names of the 25 journals with the highest number of publications found from the four keywords searched.

The main journals publishing papers in research field are these: *Sustainability* is the leading journal, with 20,638 publications found, which is 0.625 % of the 3,301,613 publications found, *Plos One* in second place with 18,033 publications (0.546 %), the *Lecture Notes in Computer Science* in third place with 16,741 publications (0.507 %), and the *Journal of Cleaner production* in fifth place with 9,735 publications (0.295 %). In twenty-fifth place, at the end of this list, is the journal *Applied Science Basel*, which has 4,201 publications (0.127 %).

2.1. Importance of sustainability in business

Sustainability is a contemporary topic that needs to be mainstreamed in all areas of organisational life. However, sustainability is a complex concept with no single definition, constantly evolving and changing its meaning, making it difficult for organisations to understand and apply all its aspects accurately. Often, managers of organisations only consider the aspects of sustainability that are directly relevant to their organisation, which results in a rather narrow concept of sustainability, but business models must incorporate and balance the ecological, social, economic, and cultural value creation aspects (Erokhin et al., 2020; Mercuri et al., 2021).

When assessing and identifying sustainability aspects in companies, Bateh et al. (2014) suggested considering three elements of the definition of sustainability, longevity, maintenance of guiding principles or goals, and responsibility for external needs. When examining sustainability aspects in corporate strategy, Hristov et al. (2019) observe that managers do not sufficiently consider quality analysis and that environmental and sustainability

Figure 1. The number of publications by the title of journals

aspects are not always linked to economic success. They suggest analysing the conditions to see whether a system of sustainability-balanced scorecards is an appropriate tool to create sustainability value. Using independent variables, Caesaria & Basuki (2017) reveal the economic, environmental, and social dimensions of sustainability to calculate the dependent variable market performance, found that all three unaddressed variables have a positive impact on companies' market performance, and presented the results of the study in a sustainability report. By examining sustainability assessment methods, Fritz et al. (2017), proposed 36 sustainability dimensions to modify the sustainability aspects of the supply chain; based on these dimensions, data can be exchanged to support the sustainability assessment of supply chains. Rossi et al. (2020) directly link the circular economy to sustainability and argue that the circular economy makes sustainability through circularity indicators, particularly at the micro level, possible in companies. The circularity indicators will help implement the principles of the circular economy, considering the specificities and needs of each circular business model.

Şahin & Çankaya (2020) describes the concepts of corporate social responsibility, which have been transformed into concepts of sustainability. Sustainability of business enterprises, which deals with economic, environmental, social, and governance issues, provides a competitive advantage for various companies.

Cantele & Zardini (2018) using structural equation modelling based on a survey of small and medium-sized Italian manufacturing firms, described a model in which sustainability practices influence a firm's financial performance through strategic factors or the antecedents of the firm's success by incorporating indicators that show the relationship between sustainability and financial performance (Miroshnychenko & De Massis, 2022).

Studies by different researchers confirm that sustainable business practices are essential for success in a competitive environment and identify sustainable competitive advantage and sustainable business performance by examining the role of social and technological challenges (Haseeb et al., 2019; Meidute-Kavaliauskiene et al., 2022).

Ukko et al. (2022), examining the impact of supplier collaboration on small e-businesses developing e-business sustainability and achieving better market performance, found that collaboration with suppliers influences market performance through e-business sustainability while maintaining high market performance.

2.2. Digitalisation in business

There are research papers highlighting the importance of digitalisation in business. Jones and Wynn (2021), in their article, described the experience of leading companies in digital transformation markets in creating sustainable development processes, using the inductive, qualitative approach, examining published company reports, and

identified six actively promoted and supported main sustainability topics (Benkhati et al., 2023; Wirtz et al., 2023).

Tohănean et al. (2020) highlight the importance of embracing new digital technologies and innovations to build sustainable and profitable businesses, gain competitive advantage, and maintain a high market share. The authors surveyed 92 technology companies to find out how they generate economic growth through sustainable innovation while avoiding predictable risks and competition, described a comparative approach to innovation, sustainability, and risk management, and identified principles to help companies become more competitive (Kwak et al., 2023).

Gregori and Holzmann (2020) explore the potential of incorporating digital technologies into sustainable business models, contributing to the creation of social and environmental value, and demonstrating new configurations of the components of a sustainable business model based on digital technologies: the blended value proposition, the integrated creation of value and the capturing of multiple values (Monda et al., 2023).

Ciulli and Kolk (2023) examined the environmental and social impacts of digital globalisation in the context of international business. The authors proposed a new approach to address specific sustainability issues through the use of individual new technologies.

Fuerst et al. (2023) argue that adopting and using digital technologies are considered one of the most promising developments in sustainability and highlight that sustainable entrepreneurship contributes to addressing social and environmental challenges. The authors examined the role of digital technologies in creating, delivering, and capturing value in sustainable entrepreneurship business models.

Fiorentino et al. (2020) sought to uncover and address the smart technology challenges associated with building and maintaining an organization's sustainable business model.

Rusch et al. (2023) argued that the tools for a sustainable circular economy are digital technologies (DT) such as the Internet of Things (IoT), big data, artificial intelligence (AI), or blockchain. The authors described the transition of digital technologies towards a sustainable circular economy, their potential for applications across the product life cycle, and their role in the circular economy.

The scientific literature mainly focuses on the integration of digital technologies into sustainable business processes and a sustainable circular economy. However, the scientific publications lack concrete proposals on the differentiation of strategic directions according to management principles and organisational activities, on the digitisation of painful transitions, on the analysis of innovations and big data, and to fill the gap we propose (Murphy & Hume, 2023; Rauniar et al., 2023; Yin et al., 2023).

Baig et al. (2022) examined the opportunities, barriers, and success factors of digital entrepreneurship and

identified six strands of digital entrepreneurship, such as digital enterprise models, entrepreneurial procedure, strategic platform, ecosystem, entrepreneurial training, and social digital entrepreneurship, and identified avenues for research on digital entrepreneurship using a multidisciplinary framework and the application of artificial intelligence (AI), machine learning, deep learning, and blockchain in the energy sector to assist energy regulators to help energy regulators allocate their support to new business models.

Neligan et al. (2023) noted that digitalisation is accelerating the economic transition towards more resource-efficient and circular production systems by developing new circular business models, innovation, and new ways of collaboration at all stages of the product life cycle. The authors examine the role of digitisation in driving circular business models and find that companies in the manufacturing sector strongly emphasize digitisation as a driver for the adoption of circular business models.

3. Bibliographical research of digitalisation of sustainable business processes

Bibliometric analysis is a quantitative analysis of scientific publications and their citations, which helps to compare the publications of individual researchers and institutions, assess the performance of publications, and improve the visibility and impact of scientific results. Bibliometric analysis is carried out through the choice of research methods, data management, and interpretation of results.

The steps of a bibliometric analysis most often include the following general steps:
  – *Identifying the topic or field:* selecting a topic in the specific scientific field you want to investigate and identifying its keywords. You can study a broad topic or a very specific one.
  – *Data collection:* Identify and collect data on articles, books, conference papers, or other scientific publications related to your chosen topic. This can be done using scholarly databases such as Scopus, Web of Science, or Google Schoolar.
  – *Data management and analysis:* Choose appropriate analytical methods and tools to process the data collected. This may include citation counts, author network analysis, journal evaluation, etc. Analyse the data to gain insights into its dissemination and impact on the scientific community.
  – *Visualisation:* Create graphs, charts, or other visualisations to help understand trends and relationships in the data. Visualisations can include the distribution of citations over time, author grids, distribution of topics or fields, etc.
  – *Interpretation of results:* Interpret the results and provide insights into their meaning and relevance in the context of your study. Explain how your data can contribute to the development of scientific knowledge or practical benefits.

  – *Presentation of results:* Finally, present the results of your analysis in a scientific publication, paper, report, or other appropriate format. Ensure that your presentation is clear, consistent, and supported by data.
  Critical reviews: Review the methodology and results of your analysis, considering any weaknesses or limitations. This will help ensure that your study results are robust and objective.

The authors of this study established 8 Clusters after bibliometric analysis. Due to huge number of publications records, the recent publications were included into bibliometric analysis.

The bibliometric analysis follows such steps:
  – VOSviewer was used to analyse the articles published between 2022 and 2023;
  – A cluster analysis table followed the bibliographic cumulative analysis;
  – Based on the co-occurrences of keywords mentioned in the titles of the articles, new criteria relevant to articles on digitisation in sustainable business processes were identified.

After researching the keywords "digitalisation", "business", "management" and "sustainability", the authors were able to create bibliographic maps and form groups with VOSviewer. Bibliographic maps were created using documents from open-source databases whose titles mention related keywords. Bibliographic maps have certain features, which are different colored circles on the map that mark certain individual groups and identify associations of closely related keywords. A line on the map indicates the strength of the relationship between keywords. A line on the map indicates the strength of the relationship between keywords and links. The distance between keywords depends on the strength of the connection.

3.1. Results of bibliometric analysis

Below are the results of the bibliometric analysis. The constructed groups of 8 keywords can be seen in Figure 1 and Tables 1 and 2, which summarize the results of keyword clustering.
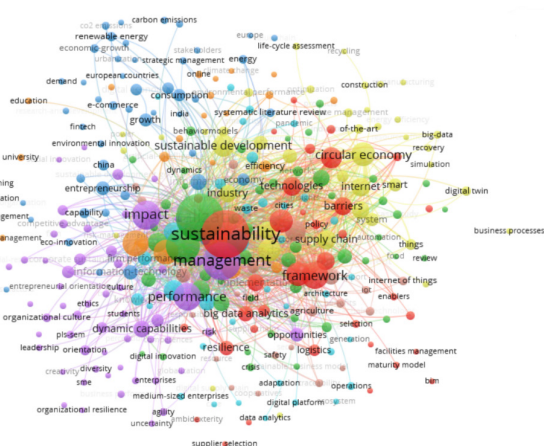

Figure 2. Eight clusters

A bibliometric analysis was collected from 755 articles, and 316 keywords, which were divided into 8 clusters, were obtained and presented in Figure 2. Articles were selected from Web of Science (2024) publications database whose keywords are "digitalization", "business", "management", and "sustainability". The lines indicate the links among keywords. The strength of links specifies the number of publications in which two keywords occured together; thicker lines indicate the stronger links. The sizes of circle show the importance of keywords. The same colors of circles show that keywords belong to the same cluster.

Table 2. The summary of prioritised criteria in scientific publications published during 2022–2023

No of cluster	Keywords	Number of Links	Occur-rence	Strength of links
1	Management	269	173	1310
	Impact	221	96	701
	Performance	205	90	682
	Dynamic capabilities	127	33	285
2	Digitalization	288	264	1695
	Innovation	239	133	920
	Transformation	146	45	336
	Business models	128	33	291
3	Information	128	30	239
	Information technology	105	26	203
	Entrepre-neurship	85	22	143
	Economy	85	16	135
4	Big data	166	61	478
	Circular economy	161	68	574
	Sustainable development	148	56	368
	Internet	141	42	375
5	Sustainability	297	276	1937
	Framework	195	84	652
	Challenges	180	68	537
	Industry 4.0	172	62	519
6	Model	158	55	369
	Business	151	47	223
	Artificial intelligence	117	29	248
	Covid-19	115	44	169
7	Digital transformation	175	80	521
	Technology	175	70	510
	Digitalization	128	41	286
	Efficiency	76	17	114
8	Future	159	53	417
	Blockchain	115	30	241
	Adoption	114	24	201
	Drivers	75	14	103

The keyword "management" has the highest overall link strength, indicating its importance in the content under consideration. The term "impact" ranks second in terms of the overall strength of the connection. Next in the top five are: "execution", "dynamic abilities" and "opportunities". Other cluster terms "corporate social responsibility", "resource-based approach," and "quality" contribute to the comprehensive coverage of organizational aspects in the cluster, while certain keywords such as "sustainable development goals", "decision-making", "orientation", "risk", and "competition" have extraordinary associative power and mean special attention in a wider context. The spatial arrangement of keywords reflects their interrelationship and strength of connections and shows the proximity of topics and their frequent overlap in the literature under review.

3.2. Revision of main keywords

After analyzing the most important keywords in the cluster, it is seen that each area of the topic is divided into different clusters. Each cluster has unique areas of topics and connections with other clusters, which are reflected in the number of leverage (links). This analysis allows you to better understand which topics of modern business are more widely studied and discussed. For example, a cluster related to "digitalization" is clearly related to the second cluster, the topics of which are innovation, business transformation, and technology. At the same time, "sustainability" is an extremely broad research topic related to the fifth cluster, reflecting the great interest of researchers in this issue. Each cluster has its important place in the analysis, and the links allows you to determine which topics are especially important in today's business environment or require deep research.
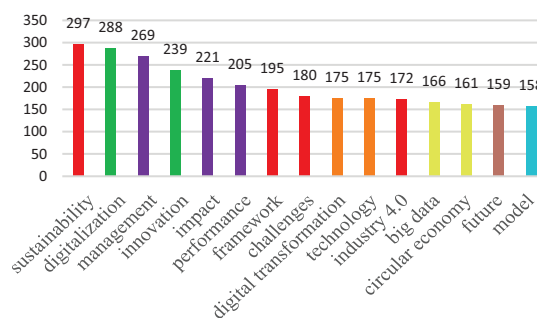
Figure 3. Keywords with the highest number of links

Figure 3 shows the keywords with the highest number of links.

Of the three hundred and sixteen keywords, the chart shows fifteen the most improtant ones, which are named below and reflects the numbers specified in Table 2.

Sustainability: links 297. The theme demonstrates long-term sustainability for business and society. Research covers sustainable development, social responsibility, and environmental protection issues.

Digitalization: links 288. Research in this cluster may include the use of digital technologies, digital marketing

strategies, and increasing the efficiency of business processes.

Management: links 269. This keyword focuses on organization management principles, impact analysis, and operational efficiency. Topics include strategic management, leadership styles, and organizational structures.

Innovation: links 239. Studies are related with innovation processes, innovations in the business model, and the ability of the organization to adapt to new conditions contribute to increasing competitiveness.

Impact: links 221. Topic is related to the impact of the organization on society and the environment. Studies of this cluster may include social reactions, the impact of business on the region, etc.

Performance: links 205. This group includes studies of the company's financial performance, operational efficiency, and evaluation of the organization's performance.

Framework: links 195. Topic focuses on conceptual systems, including theoretical models, methods, or systems applied to business processes.

Challenges: links 180. It presents the challenges of the organization's activities, from competition to market fluctuations.

Digital transformation: links 175. It includes the study of the processes of digital transformation of organizations, the application of technology, and organizational changes.

Technology: links 175. It focuses on the technologies used, their impact on business, and the technological application of the organization.

Industry 4.0: links 172. It focuses on the theme of the fourth industrial revolution, including the latest technologies, automation, and more efficient management of production processes.

Big date: links 166. The topic includes the study of big data analytics, the use of big data in business, and data-driven decision-making in organizations.

Circular economy: links 161. Topic is related to the sustainability of natural resources, waste reduction, and product recycling.

Future: links 159. Topic includes research into future business models, the impact of technology, and the challenges of organizational adaptation to the future.

Model: links 158. The topic focuses on various business models or concerns conceptual models and structures in organizations.

So, the keywords with the highest number of links are those that have been used 297–158 times.

3.3. Essential themes of formed clusters

After refining the 8 clusters, the authors of this paper noticed that each of them emphasizes different themes, which are listed in Table 3.

The first cluster focused on management principles, impact analysis, and organizational performance. This cluster explores topics related to dynamic capabilities, financial performance, and sustainable business solutions.

Table 3. Essential themes of constructed clusters

No of cluster	Themes of the clusters
1	Management, impact, performance
2	Digitalization, innovation, transformation
3	Information, information technology, entrepreneurship
4	Big data, circular economy, sustainable development
5	Sustainability, framework, challenges
6	Model, business, artificial intelligence
7	Digital transformation, technology, digitalization
8	Future, blockchain, adoption

The second cluster focused on digitalization, innovation, and business transformation. Research includes the impact of digital technologies, the interaction between innovation and business, and organizational adaptation to change.

The third cluster focused on information technology and entrepreneurship topics. Research examines the role of information in organizations, technology's impact on business, and the importance of entrepreneurship.

The fourth cluster includes big data analytics, circular economy, and supply chain topics. Research includes the use of data, sustainability practices, and supply chain efficiency.

The fifth cluster is dedicated to sustainability, structure, and challenges. The cluster studies the impact of the SDGs, organizational structures, and business environment challenges.

The sixth cluster covers business, artificial intelligence, and COVID-19 topics. Research includes business processes, artificial intelligence, and organizational responses to the pandemic.

The seventh cluster focuses on digital transformation, technology, and digitalization. This cluster examines the transformation of organizations in the digital age.

The eighth cluster covers topics and research such as future business models, blockchain, and innovation adoption.

This study identified eight clusters that reveal rich organizational and business themes. Each cluster is distinguished not only by its unique subject matter but also by emphasizing specific aspects that allow a deeper understanding of the challenges and opportunities of the modern business environment.

4. Conclusions

The authors investigated the impact of digital technologies on sustainable business development. The theoretical analysis showed that sustainability is a complex concept and that businesses often do not take into account all the necessary aspects of sustainability that are directly related to the organisation, and that it is important to include and balance the ecological, social, economic, and

cultural value creation aspects in business models. To achieve this, businesses should identify company-specific sustainability aspects and analyse balanced sustainability indicators and their impact on market performance. New models based on circular economy indicators and principles are important for sustainable business development.

The authors also looked at the digital transformation experiences of market-leading companies in developing sustainable development processes and the importance of introducing new digital technologies and innovations in building a sustainable and profitable business, gaining a competitive advantage, and maintaining a high market share.

The theoretical analysis found that the authors focused on integrating digital technologies into sustainable business processes and a sustainable circular economy but lacked differentiation by management principles and organisational activities in terms of strategic orientations, innovation and big data analysis, and the description of smooth digitisation transformation processes.

A cluster analysis based on keyword associations identified eight distinct groups of terms, each representing a group of related concepts and keywords.

The identified eight clusters are assigned to different subject areas, indicating directions from management principles and organizational activities from management principles and organizational activities to digitization, innovation, and big data analysis. The content of each cluster reflects important areas of modern business related to efficient work and adaptation to changing market conditions. It provides useful insights to researchers, business analysts, and managers, enabling them to understand key trends better and develop more effective business development strategies.

The research has some limitations. The publications were analysed for 10-year period and for bibliometric map construction this period was narrowed to the revision of papers published between 2022–2023, however the conferences on sustainable development started in 2012 and since 1992 were yearly summits dedicated to environmental development.

The future research could be dedicated to revision of the effect of specific digital technologies on the achievement of sustainable development goals and their classification.

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Contribution

Conceptualization, X. Y.; methodology, G. H.; investigation, A. L.; writing—original draft preparation A. L.; writing—review G. H. and editing, X. Y. All authors have read and agreed to the published version of the manuscript.

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