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Review

Current Perspectives on Responsible Digitalization: A Bibliometric Review of the Concept

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Abstract: Digitalization, digitalization, or digital transformation is a phenomenon without which it would be difficult to understand the reality of our time. Although it is often associated with the incorporation of technology into business, the economy, or our own lives, it goes further by involving a transformation process that can significantly improve sustainable corporate development. The work, from the perspective of bibliometric analysis, maps the state of the art in the area of study of digitization, digitization, digital transformation, and sustainability from 72 articles obtained from the Web of Science database, dating from the beginning of time to the year 2024, without limiting our search to a particular type of document or discriminating by year of publication. The software used to carry out this bibliometric analysis was SciMAT. The results allow us to establish digitalization as an area of research that is in full development and a link between different areas of research, with the areas of "Environmental Sciences" and "Green Sustainable Science Technology" being the most often addressed by academics. In addition, this study identifies digitalization and the blockchain as driving themes, leaving other topics such as challenges, artificial intelligence, information technology, or digital transformation with less importance. This allows researchers to expand existing knowledge in the field, position themselves in areas of high relevance and potential impact, and be a starting point for future research.

Keywords: digitization; digitization; digital transformation; sustainability; bibliometrics

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1. Introduction

Today, digitalization spans numerous domains of life, including the healthcare sector [1,2], education [3,4], culture [5], sport [6], the financial industry [7,8] and non-governmental organizations [9], among others. However, there are sectors such as agriculture, urban planning, or construction where barriers to digitization remain [10–15], as well as in sectors such as oil, where more than 60% of total future investments in digitization are expected to be made [16]. For example, in the healthcare sector, some studies conclude that the implementation of new digitalization initiatives leads to significant savings in healthcare costs and clinical services [17]. However, the healthcare supply chain and the need to invest in digital transformation (DT) is still fragile [18].

On the other hand, it is important to highlight firms' protection of the environment in gaining a sustainable competitive advantage through digitalization [19–22]. In this sense, digitalization leads to sustainable improvements such as the elimination of solid waste [23], a reduction in carbon emissions [24], reduced pressure on the natural

environment [25], or increased wastewater treatment [26]. In the same vein, other benefits of digitization include smart and sustainable manufacturing, green energy, energy savings, and renewable energy consumption [27]. Digitalization, increased by the development of the Industry 4.0 concept [28] and especially in the wake of the COVID-19 pandemic [29], implies a boost in environmentally friendly growth [30–32], leading to high-quality economic development [33,34], and offering solutions to achieve the Sustainable Development Goals [35,36]. Indeed, the 2030 Agenda states that digital technologies are tools for achieving the SDGs ([1]). In this regard, some studies [37,38] highlight governance models that promote the entrepreneurial inclusion of a sustainable business model through increased digitization [39]. Therefore, it is important to study the relationship between digital transformation and sustainable corporate development.

On the other hand, and in line with the wide range of digital transformation, the adoption of digital strategies by enterprises is strongly influenced by the current TD [40]. This is because organizations, to achieve their strategic goals and remain competitive [41,42], have to deal with digital technologies, which is a major challenge as it requires companies to create a digital perspective by leaving the traditional business model behind [43]. In addition, the selection of digital strategies to cope with the current digital transformation is not without constant concern, as businesses must choose strategies that increase their sustainable development and innovation capacity during the digital transformation process [44]. In this sense, digital transformation represents a boost to innovation, inclusion, and sustainable growth [38].

In turn, the current wave of digitization has brought about innumerable benefits such as the following: helping small and medium business to access foreign markets [45]; enhancing sustainable corporate development [46–48] and business efficiency and productivity [47]; increasing customer loyalty in the financial sector thanks to the high-quality management of digitalization [49]; a reduction in carbon emissions [50,51] and waste in food supply chains [52], etc. Along the same lines, academics, such as the authors of [53], highlight that, thanks to the adoption of digital tools, the food industry has been favored in terms of marketing, customer service, and e-commerce. Others, such as [54], conclude that the digitization of business activities helps service companies to overcome traditional service-related business constraints.

Some research works relate the concept of digitalization to the development of technological change within organizations and present it as the necessary condition for this change to occur with the trust of the workers [55]. Other authors, e.g., [56], position digitalization and entrepreneurship as key factors for stimulating competitiveness and boosting economic growth at the macro level. Others, e.g., [57], consider that companies need to integrate digitalization as the core of value creation in their business strategies in order to strengthen the currently most important organizational asset: sustainability. In this regard, authors such as [58] conclude that the following two imperatives are currently occupying policy agendas around the world: the speed of digitalization and the challenge of achieving the Sustainable Development Goals. Furthermore, many authors [59–62] consider that the degree of digitization affects sustainability, offering opportunities to advance it [63].

All of the above has aroused the interest of academics, and, consequently, the academic literature on digitization, digitalization, and digital transformation has grown. The reason is that this new reality, as discussed above, brings innumerable benefits in different areas, especially in the area of sustainability. For this reason, these concepts are being increasingly studied by researchers who seek to analyze them within different real-life scenarios.

The aim of this paper is to compile all the research conducted thus far on sustainability, digitization, digitalization, and digital transformation, to contribute to the literature, and to discover the most recurrent and significant themes, with the intention of subsequently ana-

lyzing the relationship between these terms and sustainability, thereby filling a gap in the literature. We aim to respond to academics such as [64,65], who suggest that more research should be carried out to explore the nexus between digitalization and sustainability.

To be able to talk about the concepts of digitization and digital transformation, it is necessary to define them. To do so, first of all, we must distinguish that the term digitization is made up of two different concepts: (1) digitization and (2) digitalization. The former refers to the process of changing from analog to digital form and the latter refers to the use of digital technologies to change to a digital business model ([2]). On the other hand, the term digital transformation is understood by [66] as changes that digital technology brings or changes that affect all aspects of human life. Moreover, sustainability means maintaining wellbeing over a long, perhaps even indefinite, period [67].

Therefore, this paper aims to answer the following question: What is the state of the art in sustainability, digitization, digitalization, and digital transformation from 1990 to the present day? To answer this question, this article performs a scientific mapping by collecting documents from the Web of Science (WoS) database of Clarivate Analytics until 2024, performing a bibliometric analysis, as in [68]. The SciMAT software (v1.1.04) was used for this analysis.

2. Materials and Methods

Data contained in literature reviews and scientific cartographic analyses are the basis of most bibliometric analyses, which measure scientific activity and the dimensions of research and its sources [69,70]. Many articles are responsible for developing the state of the art in scientific research on digitalization [68,71–77]. The results can be grouped into activity metrics and impact metrics. Activity metrics present the real situation of the researched field, including the number and location of publications, productivity, distribution of publications, collaborations in publications, the average age of citations or how old they are, and how authors are connected, among others. Authors like [78] show that these indicators can be used to evaluate the most cited articles and the impact factor of a journal, with the impact factor being the most used measurement [79].

To understand the future trends of the topic analyzed in this work, the SciMAT software has been used. The reason behind this choice is that it allows for the visualization of co-word and co-citation networks, which are useful for mapping the state of the art in a research field. It also has the capacity to handle large volumes of data and focuses on the graphical representation of the relationships between concepts. Bibliometric reviews are used to try to quantify the different aspects that are included in academic production [80]. We used this technique because the objective of this work is to map the current state of research and emerging trends, which is most effectively achieved through bibliometric analysis. In addition, this study has an exploratory nature, allowing us to identify areas of interest and gaps in the literature that could be the subject of future research. In bibliometrics, there are two analysis techniques: performance analysis and scientific mapping [81]. Performance analysis focuses on identifying and locating the different agents involved in the subject being researched (countries, universities, departments, and researchers) and the impact of their activity on the databases commonly used by the scientific community to disseminate research. Scientific mapping aims to give visibility to the structural characteristics and dynamics of scientific research and reveals the cognitive structure of the area investigated [82]. Different authors [70,83] have designed different tools to construct scientific maps, the most commonly used being document co-citation measurements and the analysis of co-words.

This paper analyzes general research on the main topics and trends of digitalization, digitalization and digital transformation, and sustainability. The steps followed [84], as set out in previous research [69,85,86], are shown in Figure 1 below.

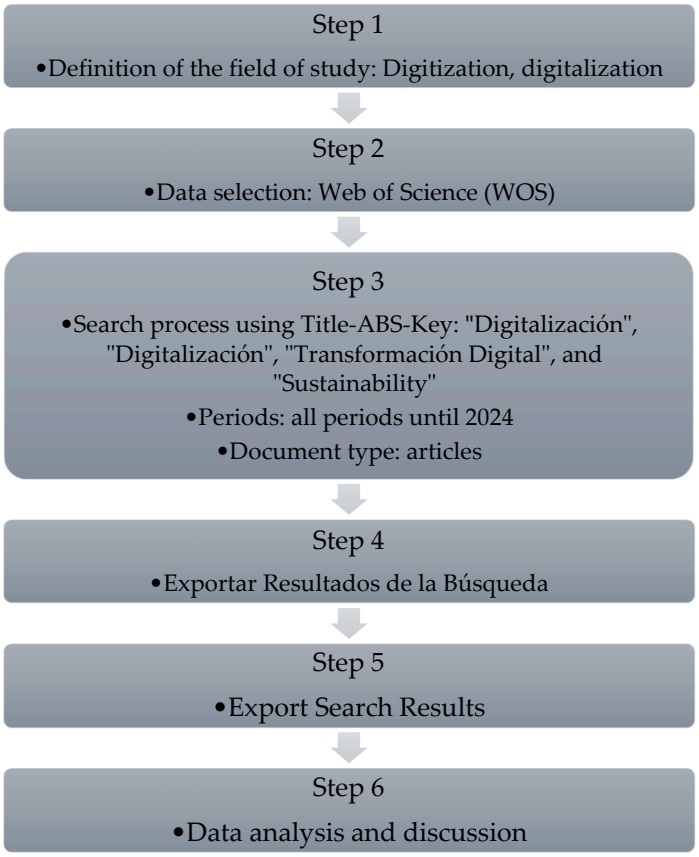

Figure 1. Flowchart of the methodology applied—source: own elaboration.

Data Collection

We examined published articles derived from a single-stage composite search of the Web of Science database's core collection, using "Digitalization", "Digitization", "Digital Transformation", and "Sustainability" as keywords. The reason for this choice is that WoS is a "global database of top-tier articles" that includes the "most relevant and commonly accepted journals in the scientific field" [70,87]. By focusing on a single database, we ensure that the selected articles share similar bibliographic characteristics, which improves the consistency and reliability of the results. The search was not limited to a particular type of article, nor was it discriminated by year of publication, or by minimum number of citations; all kinds of works were considered. The chosen time period was from the beginning of time to the year 2024. Finally, a total of 72 publications were obtained, which were transferred to SciMAT. Data for bibliometric analysis were downloaded in RIS and TXT format from the WoS database and processed using SciMAT (v1.1.04) while in RIS format.

3. Results

3.1. Problem Detection and Thematic Networks

When searching previous literature reviews, as far as we know, we have not specifically found any work that performs joint word analysis to map issues related to the terms digitalization, digitalization, or digital transformation and sustainability, although there are indeed works that have carried out a systematic review of the literature on digitalization within companies, as is the case for Reference [88]. Other similar works, e.g., [89], have

carried out a bibliometric study of the studies published to date that relate to digitalization as a driver of organizational change in companies, and, in References [90,91], the authors carried out a systematic review of the literature on the relationship between entrepreneurship and digital innovation. To perform the mapping analysis using SciMAT, groups of keywords and their connections were obtained; these groups are called themes. Each topic is identified by two parameters of density and centrality, and the median and mean of density and centrality are found. According to Reference [80], four types of themes can be found. Driving themes are topics that are well-developed and important to the structure of the research field; they have high density and strong centrality. These are issues that are strongly related to each other. Highly developed topics have well-developed internal links, but unimportant external links. They are of marginal importance only to the peripheral, as they do not link to other topics; they are specialized. Emerging or disappearing issues are weakly developed topics without much internal linkage. Finally, core and cross-cutting themes are topics that are important to a field of research but are underdeveloped. Reference [84] describes how, within a topic, the keywords and their interrelationships create a network graph, called a thematic network. Each thematic network is named for the most significant keyword within the topic (usually identified by the most central keyword in the topic). We proceed to describe the results of our analysis.

3.2. Areas of Study

Figure 2 shows the identified areas according to the number of articles in each, according to the attached graphs. Environmental Sciences, Environmental Studies, and Green Sustainable Technology are the areas with the highest amount of papers, with 31, 25, and 29 articles each, followed by Business, Economics, and Management.

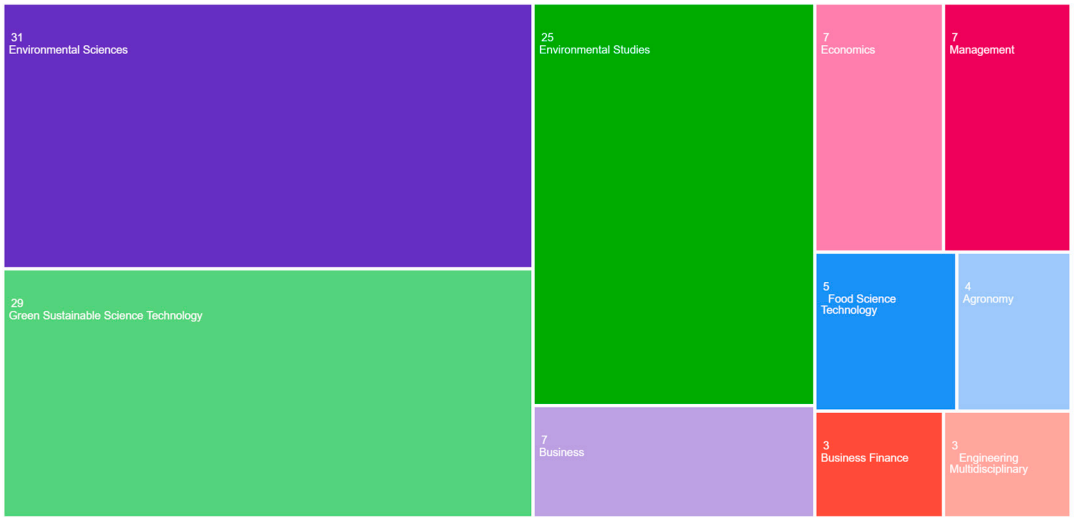

Figure 2. Main areas of research by article numbers. Source: Authors' elaboration based on WoS data.

To better visualize all the data processed in SciMAT, this work is divided into two periods. The first period covers all years until 2022 and the second sub-period covers from 2023 to 2024. Considering the sample analyzed, the first subperiod includes 32 articles, while the second subperiod consists of 40 articles; the total includes 72 works with 453 keywords. It is worth noting from this first analysis that the production of scientific articles indexed in WoS on digitalization and digital transformation related to sustainability occurred almost entirely (90%) in the period 2018–2024. See Table 1 and Figure 3.

Table 1. Distribution of documents and keywords by year. Source: Own elaboration.

Statistical Information		
Periods	**Documents**	**Words**
Every year	72	453
2023–2024	40	289
Until 2022	32	164

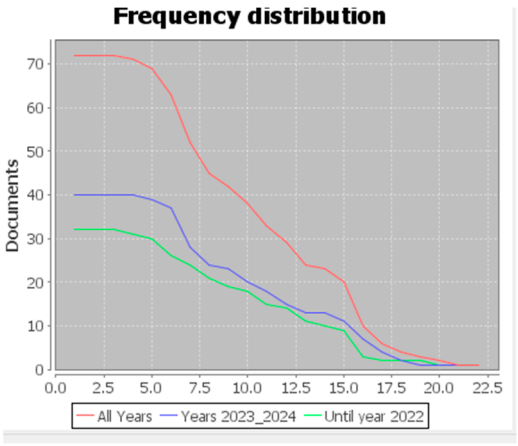

Figure 3. Temporal distribution of documents by keywords. Source: Own elaboration.

3.3. Evolution of the Themes

It should be noted that a thematic area is defined as a group of themes evolving over different sub-periods [84]. We must specify that, depending on the interconnections between topics, one of them may belong to a different thematic area or not come from any of any thematic areas. Thus, within the longitudinal view shown in the SciMAT analyses, we find the Overlay map, where we can see the growth of keywords over the specified time period, including those that are contained, those that are excluded, and those that enter new thematic areas. Figure 4 shows the evolution of the analyzed topics, divided into three groups: a group including all years represented by the study sample and two more subgroups divided into intervals of years (Stage 1: articles published until 2022 subgroup; Stage 2: 2023–2024 subgroup; Stage 3: all articles subgroup). Of the 231 keywords for the period until 2022, 67 are excluded and 164 are integrated into the next stage, which results in a total of 289 for the period from 2022 to 2024; therefore, the overall total is 453.

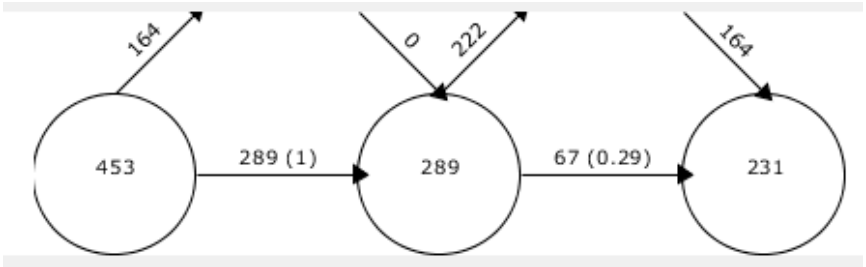

Figure 4. Documents per keyword. Distribution over time. Source: Own elaboration.

Taking the data from the first period up to 2022, SciMAT produces the first strategic diagram (Figure 5 and Table 2). Within each quadrant, a distribution of topics is framed. The upper right quadrant represents the driving topics. Those topics are well-developed and important to the structure of the research field, with high density and strong centrality. They are topics that are strongly related to each other. The upper left quadrant contains highly developed topics. They have well-developed internal links, but unimportant external links.

They are of marginal importance only in the periphery, as they do not link with other external topics. They are specialized and peripheral in nature. The lower left quadrant contains emerging or missing topics. They are weakly developed and do not have many internal relationships. They may be marginal but they must be taken into account. Finally, the lower right quadrant contains basic and cross-cutting topics. These are important topics in the research field, but are underdeveloped.

The strategic diagram shown in Figure 5 only represents articles published in the first sub-period, comprising all the years up to 2022. It presents three driving themes (Digital Transformation, Innovation, and Digitalization), one highly developed theme (Challenges), two emerging or disappearing themes (Information Technology and Intelligence) and a basic or central theme (Technologies), which are also known as transversal themes. The size of the circles is proportional to the h-index of each topic.

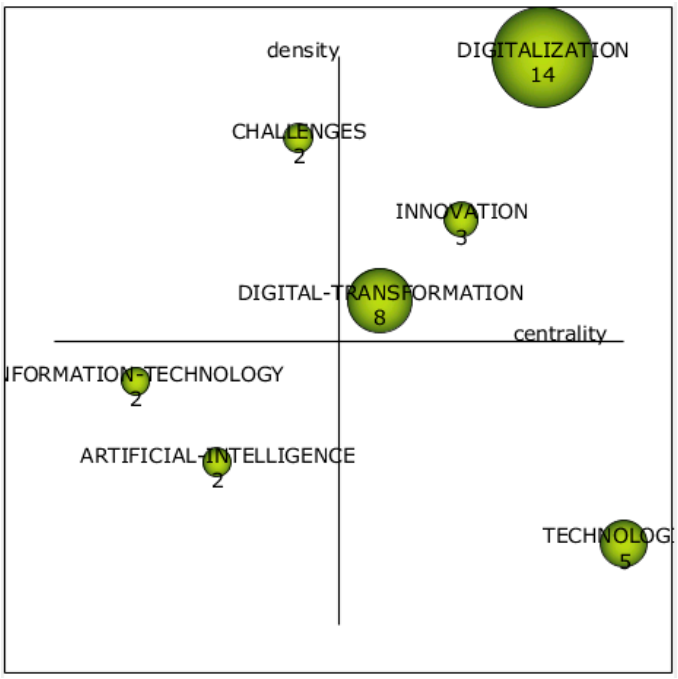

Figure 5. Strategic keyword diagram for articles published until 2022. Source: Own elaboration.

In this first subperiod, it is observed that Digitalization and Innovation, with values of 1 and 0.71, respectively, presented with high densities (Table 2), so they have a strong number of citations and are closely related to the rest of the topics of their node. In addition, we observe that Information Technology and Artificial Intelligence are emerging or disappearing topics. This clarification will be addressed when analyzing the next period, to see if these topics are maintained or disappear.

Table 2. Characteristics of the topics in the strategic diagram of articles published until 2022. Source: Own elaboration.

Cluster	Centrality	Range of Centrality	Density	Density Range
Innovation	58.34	0.71	53.12	0.71
Challenges	40.45	0.43	62.5	0.86
Digitalization	83.88	0.86	62.82	1
Digital Transformation	57.76	0.57	31.25	0.57
Technologies	93.68	1	9.52	0.14
Information Technology	23.84	0.14	13.89	0.43
Artificial Intelligence	37.94	0.29	12.5	0.29

The second sub-period, from 2023 to 2024 (Figure 6 and Table 3), contains three driving themes, two central themes, two emerging themes, and two peripheral or developed themes.

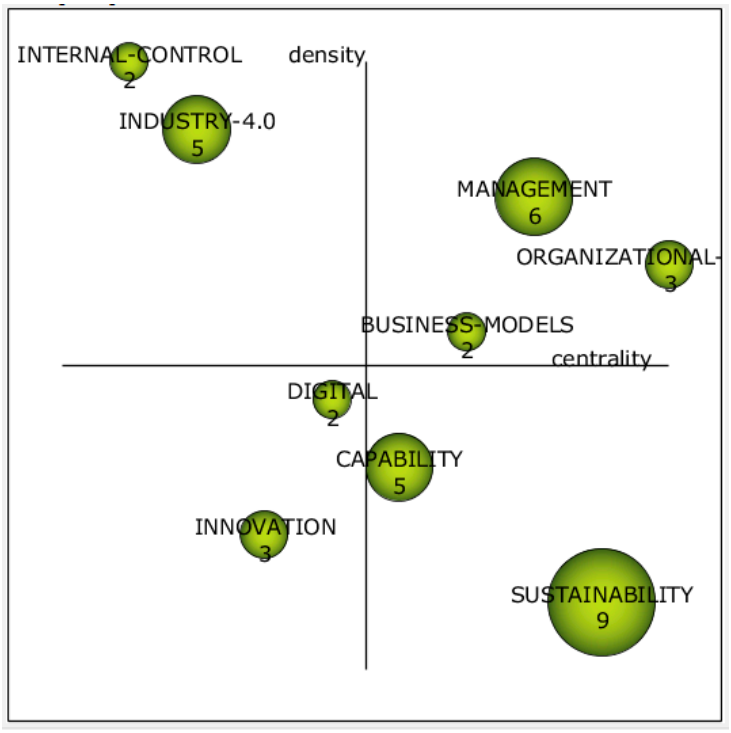

Figure 6. Strategic keywords diagram for articles published in 2023–2024. Source: Own elaboration.

Table 3. Characteristics of the topics in the strategic diagram for the years 2023–2024. Source: Own elaboration.

Cluster	Centrality	Range of Centrality	Density	Density Range
Administration	95.75	0.78	0.64	0.78
Industry 4.0	55.06	0.22	58.88	0.89
Organizational Culture	103.45	1	41.67	0.67
Digital	56.33	0.44	37.5	0.44
Internal Control	32.46	0.11	98.33	1
Business Models	78.83	0.67	38.19	0.56
Capacity	71.97	0.56	35.17	0.33
Innovation	55.15	0.33	15.34	0.22
Sustainability	100.66	0.89	6.43	0.11

In this second period, the main theme is Organizational Culture, which is present in 40 articles, followed by Sustainability. Organizational Culture is the theme most in focus and, therefore, the one that best relates to all the other themes, as can be seen in Figures 7 and 8. We allude here to the concept of centrality; as presented in the strategic diagrams of the topics, a focused topic is well-related to the other topics in the research area [80]. In this sense, the concept of Internal Control is a fairly dense topic and has many relationships within its node. In addition, during this period, the other driving theme in research is Management, which is more dense than focused.

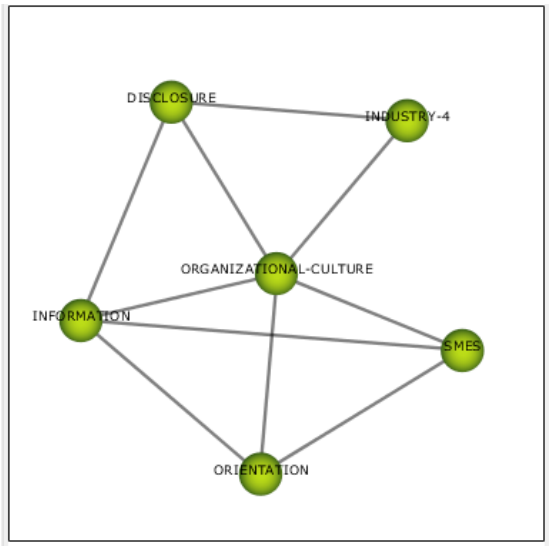

Figure 7. Organizational Culture node cluster. Source: Own elaboration.

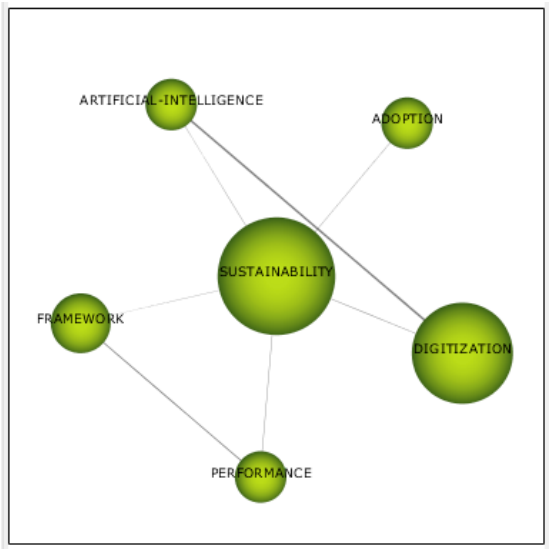

Figure 8. Sustainability node cluster. Source: Own elaboration.

Concerning the basic themes, i.e., those found in the lower right quadrant of the strategic diagram, Sustainability is shown to be more centralized than dense. We can also to consider Innovation to be an emerging theme during this period. Regarding the analysis of all periods (Figure 9, Table 4), we observe that the structure of the strategic diagram of the topics for the period 2023–2024 is not maintained. The development of the Sustainability theme disappears; therefore, we can conclude that Sustainability is not as relevant a topic in studies from 2023–2024. This relevance is taken by Digitalization, which is the most in focus topic as its range of centrality is one. Being the most in focus topic, it is also the best related to all other topics shown in Table 4; this relationship of centrality is shown in Figure 10. On the other hand, we point to Blockchain as the densest topic, as shown in Figure 11.

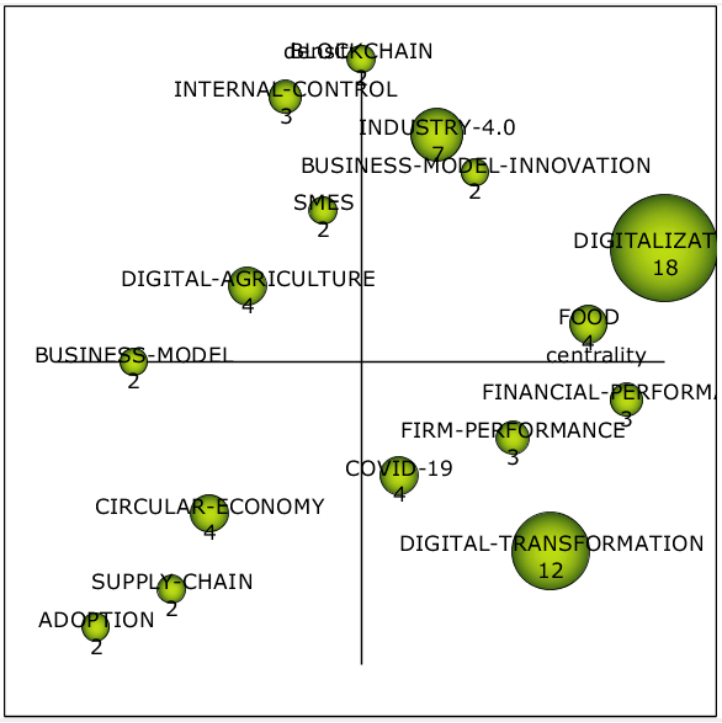

Figure 9. Strategic diagram of keywords from all periods. Source: Own elaboration.

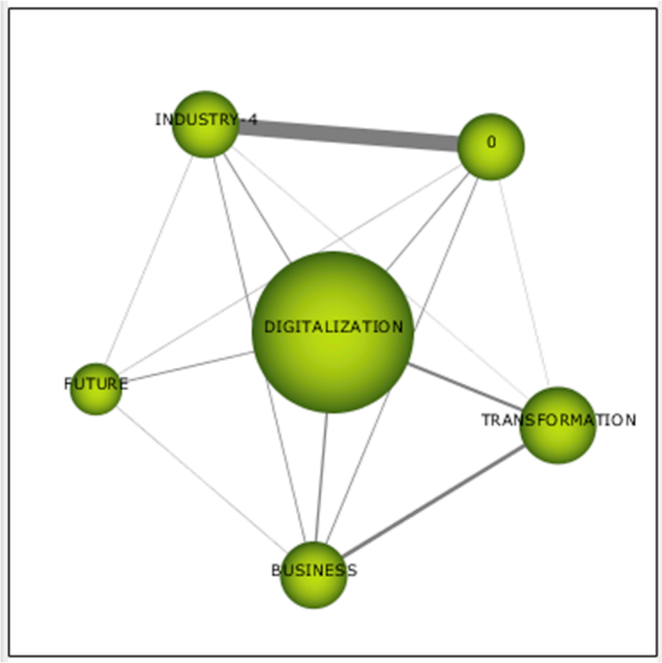

Figure 10. Digitalization node cluster. Source: Own elaboration.

Table 4. Characteristics of the topics in the strategic diagram for all time periods. Source: Own elaboration.

Cluster	Centrality	Range of Centrality	Density	Density Range
Plural of payment	74.72	0.44	37.5	0.75
Blockchain	77.02	0.5	75	1
Innovation In Business Models	86.45	0.69	37.5	0.81
Internal Control	62.04	0.38	66.67	0.94
Digital Agriculture	57.55	0.31	35.19	0.62
Financial Performance	102.41	0.94	20.83	0.44
Industry 4.0	77.65	0.62	39.54	0.88

Table 4. *Cont.*

Cluster	Centrality	Range of Centrality	Density	Density Range
Food	97.51	0.88	30.96	0.56
Company Performance	87.18	0.75	18.98	0.38
Business Model	43.23	0.12	30	0.5
COVID-19	77.06	0.56	18.06	0.31
Digitalization	121.37	1	36.09	0.69
Digital Transformation	89.48	0.81	12.37	0.19
Circular Economy	53.99	0.25	14.12	0.25
Supply Chain	51.27	0.19	11.61	0.12
Audience	18.25	0.06	8.33	0.06

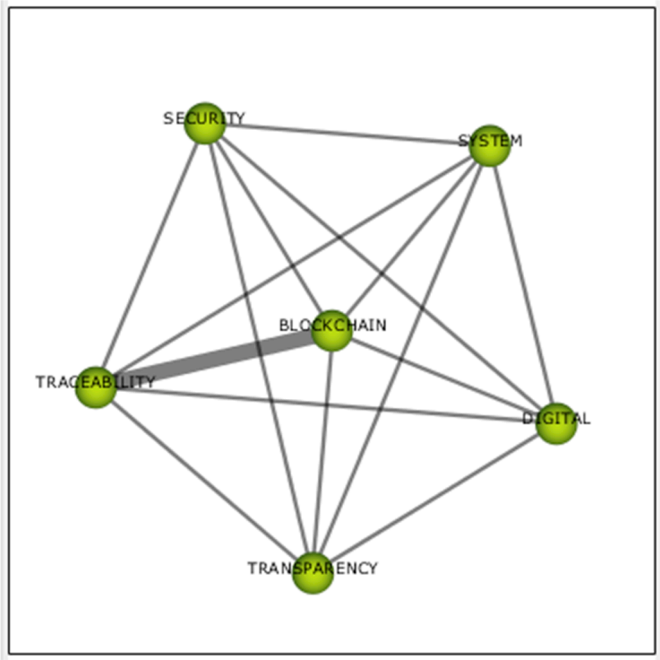

Figure 11. Blockchain node cluster. Source: Own elaboration.

With this work, it has been possible to demonstrate the existence of a wide range of existing topics related to the central theme throughout the sample analyzed.

When analyzing the most cited works and authors in this area (Table 5), we observe that the most highly cited article is "Digitalization to achieve sustainable development goals: Steps towards a Smart Green Planet" [92,93], with 262 citations according to WoS, which was published in the journal *Science of The Total Environment*; the second most highly cited article is "Sustainability impact of digitization in logistics", with 161 citations in WoS, which was published in the journal *Procedia Manufacturing*.

Table 5. Most highly cited articles in WoS. Source: Own elaboration.

Article	Authors	Total Citations
Digitalization to achieve the Sustainable Development Goals: Steps towards a smart green planet [92]	Mondéjar, Mary A.; Avatar, Carnero; Diaz, excursionist Lelani Baños; Dubey, Rama Kant; Esteban, Jesus; Gomez-Morales, Abigail; Hallam, Brett; Mbungu, Tracer of Nasilulu; Okolo, Chukwuebuka Christopher; Prasad, Kumar Arun; Ella, Qianhong; Garcia-Segura, Sergi	262
Impact of digitalization in logistics on sustainability [93]	Kayikçi, Yasanur	161
Is digitalization a driver for improving environmental performance? Empirical research on European countries [19]	ja, Le Thanh; Huong, Tran Thi Lan; Thanh, To Trung	76

Table 5. *Cont.*

Article	Authors	Total Citations
Can corporate digitalization promote green innovation? The moderating functions of internal control and institutional ownership [94]	Lee, Dukanki; Sean, Weitao	64
Strategic plan for participation in social networks, organizational agility, and digitalization to improve the performance of SMEs [95]	Rojak, Hassan; Adyatma, Ardion; Facharunnisa, Olivia; Stay, three	47
The agricultural systems of the future and the role of digitalization in achieving sustainability goals. A review [96]	MacPherson, José; Voglhuber-Slavinsky, Ariane; Olbrisch, Mathias; Schoebel, Philipp; Doenitz, Ewa; Mouratiadou, Ioanna; Dirección, Katharina	44

It is worth noting, as a milestone of this work, the achievement of the main driving axes into which this area of research can be divided. To address this problem, an analysis of the co-occurrence of keywords has been carried out using the SciMAT software [68,84,97], in which the two major driving themes of research on digitization, digitalization, digital transformation, and sustainability have been obtained, which are Digitalization and Blockchain.

4. Conclusions, Implications, Limitations, and Future Lines of Research

In order to give visibility to such an important area as the analysis of digitization, digitalization, digital transformation, and sustainability, this work has carried out a bibliometric analysis in which the performance of the scientific production of the area has been evaluated and the topics that compose this scientific production have been analyzed through a keyword co-occurrence analysis. The results have shown the future direction that research in the analyzed area should take, from the perspective of the driving themes, as taken from the analysis, which used SciMAT software.

On the one hand, this work concludes that digitization, digitalization, digital transformation, and sustainability are a nexus for several research areas; however, those most commonly discussed by academics are Environmental Sciences and Green Sustainable Science Technology, with 31 articles in the first area and 29 in the second. Furthermore, it was not until the period 2018–2024 that the first papers related to the keywords of our study were carried out, with only 32 research studies carried out between the beginning of the WoS records until 2022. There are currently a total of 72 publications on the topic under study.

It has been observed that the analysis carried out is on an area of research that is in full development and, in this regard, the main contribution of this work is the establishment of axes that support the current research on the subject. We obtained a total of two driving themes in digitization, digitalization, digital transformation, and sustainability research, using SciMAT software; these are Digitalization and Blockchain. The blockchain acts as a key driver in digitalization and sustainability. Providing a secure and transparent framework for transactions not only improves operational efficiency through digitalization but also contributes to more sustainable practices across various industries. The interconnection of these elements is critical for addressing current environmental and social challenges and promoting more sustainable development in the future. Furthermore, digitalization is a key driver of sustainability, as it allows organizations to optimize their resources, reduce waste, improve energy efficiency, and innovate in products and services.

Digitalization is the most in focus topic, and blockchain is gaining special importance, as shown during our analysis of all research on this topic. Therefore, we declare the study of digitization, digitalization, digital transformation, and sustainability to be a recurring theme and of special importance to the rest of the topics. On the other hand, digitization is understood as progress, while digital transformation, in the studies reviewed, emphasizes a sustainable approach to all environmental issues.

When analyzing all the studied time periods from a bibliometric perspective, although, in recent years, there have been a good number of works of all types and fields, to our knowledge, we have not found a perspective that, as this work does, provides clarity and sources that support theoretical frameworks for future work in the thematic area of digitization, digitalization, digital transformation, and sustainability research. We feel, given the importance of the subject, that it should be a trend in future research, as well as a possible limitation when it comes to developing this work well. Similarly, we understand that bibliometric studies, although useful, have limited limitations, such as reliance on specific databases that may not capture all relevant scientific output. Furthermore, they may not reflect the quality of the studies, as they are based on quantitative metrics.

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