Digital Transformation in SMEs: Pre and Post-Covid-19 Era: A Comparative Bibliometric Analysis

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Article

Digital Transformation in SMEs: Pre and Post-Covid-19 Era: A Comparative Bibliometric Analysis

Katerina Petropoulou, Erasmia Angelaki, Ioannis Rompogiannakis, Ioannis Passas * and Alexandros Garefalakis

Department of Business Administration and Tourism, Hellenic Mediterranean University,714 10 Iraklio, Greece

* Correspondence: ipassas@gmu.gr

Abstract: This paper presents a comparative bibliometric analysis of digital transformation in small and medium enterprises, focusing on the before and after the Covid-19 pandemic. Using data from the Scopus database, the study analyzes 1,566 articles published between 2001 and 2024, focusing on pre-COVID (2001–2018) and post-COVID (2019–2024). Bibliometric tools, including VOSviewer and Biblioshiny, were employed to conduct performance analysis, scientific mapping, and co-occurrence analyses of keywords and co-authorship. The results demonstrate a substantial increase in research output post-COVID, particularly in areas such as the Internet of Things (IoT), cloud computing, and e-commerce. These technologies have become vital for the survival and competitiveness of SMEs in the post-pandemic world. However, the study also highlights significant challenges, including limited financial resources and a lack of skilled personnel, which have hindered SMEs' ability to implement digital transformation fully. Government intervention, through financial assistance and strategic support, is identified as crucial in enabling SMEs to overcome these obstacles and successfully navigate the digital era. This analysis contributes to the growing body of literature on SMEs' digitalization, offering key insights for policymakers, researchers, and businesses aiming to adapt to the evolving digital landscape in a post-pandemic economy.

Keywords: Digital transformation; SMEs; pre-Covid period; post-Covid period; bibliometric analysis

1. Introduction

The digital transformation of small and medium enterprise has gained prominence as a critical area of inquiry in both academic and practical realms, particularly in the context of the COVID-19 pandemic, which has accelerated the need for digital adaptation. As digital transformation entails the comprehensive integration of digital technologies across all facets of business operations, it is no longer merely an option; rather, it has become essential for the survival and competitiveness of SMEs in an increasingly digitized economy *(Guo et al., 2022).*

This study is situated within the broader discourse on digital transformation, which has been characterized by a burgeoning body of literature that explores the implications of digital technologies for business efficiency, innovation, and market competitiveness. The significance of this research lies in its potential to illuminate the unique challenges and opportunities faced by SMEs during periods of crisis, as well as the long-term effects of such transformations on their operational frameworks.

Prior to the pandemic, the pace of digital technology adoption among SMEs was relatively slow, largely due to barriers such as limited financial resources, inadequate technological infrastructure, and a shortage of skilled personnel to implement digital solutions *(Stich et al., 2020).* Notably, many SMEs engaged with digital tools primarily for basic functions—such as maintaining customer databases and processing online payments—while advanced capabilities, including e-commerce and data analytics, remained largely underutilized *(Ragazou et al., 2022).*

The post – pandemic landscape has witnessed a significant upsurge in research focusing on this topic. Studies indicate that the volume of scientific publications addressing the digital transformation

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of SMEs has surged since 2020, reflecting a heightened awareness of the necessity for digitalization in this sector *(Pereira et al., 2024).* However, despite this growing emphasis, SMEs continue to confront persistent challenges, particularly regarding access to financing and the availability of a skilled workforce. Government support has become increasingly critical as policymakers implement financial aid, training programs, and strategic guidance to facilitate the digital adoption process *(Remuzzi, 2020).*

Diverging hypotheses have emerged in the literature regarding the effectiveness of digital transformation strategies in SMEs. Some studies suggest that proactive digital engagement can lead to significant competitive advantages, while others caution against the risks of over-reliance on technology without adequate infrastructure and training *(Smith & Jones, 2021).*

The primary aim of this study is to answer the research question: How did digital transformation affect SMEs before and after the COVID-19 era? Through a comprehensive analysis, this work seeks to contribute to understanding the dynamic interplay between digital transformation and the operational viability of SMEs in a post-pandemic context. The principal conclusions will highlight the essential role of strategic digital adoption and the necessity of supportive policies to foster resilience and competitiveness in this sector.

The paper is structured as follows: Section 2 highlights the significance of digitalization for SMEs before and after the pandemic crisis. Section 3 outlines the materials and methods employed in this research. Section 4 presents the study's significant findings, while Section 5 concludes by defining ongoing research needs and implications for policy and practice.

2. Literature Review

Over the past few years, there has been a noticeable rise in scholarly interest, which has led to a significant increase in articles exploring various organizational and technological aspects of digitalization *(Nadkarni et al., 2021).* As technology advanced, the internet became more widely used for diverse purposes, prompting businesses to initiate their own digital transformation strategies. These strategies often focus on creating customer value and developing operational models that leverage new technologies for competitive advantage *(Berman, 2012).*

The onset of the Covid-19 pandemic necessitated strict safety measures, resulting in many service professionals working remotely to maintain business operations *(Buhler et al., 2020).* This situation highlighted the need for digital transformation in crisis continuity planning, requiring a well-structured and methodical approach to crisis prevention and mitigation *(Das, 2021).* Numerous organizations and institutions managed to sustain service delivery, albeit on a reduced scale, by adopting digital technologies. Given the availability of diverse data sources, innovative technologies, and global distribution networks, there is a pressing need for robust mechanisms to facilitate continuous digital access, collaboration, and knowledge management *(Das, 2021).*

Digital transformation also significantly impacted the education sector. A case study conducted by *Bognady et al. (2020)* at Eszterhazy Karoly University demonstrated that the digital transformation implemented during the pandemic was deemed successful, with the integration of these advancements into future online courses. Following the pandemic, the development of digital transformation continued. *Picazo et al.'s (2024*) empirical study, which focused on 15 European countries, found that digitalization profoundly influenced the sustainable development of businesses in the post-pandemic era. However, *Rojas et al. (2024)* revealed that the absence of flexible and rapid implementation strategies for selecting and adopting digital technologies, particularly for SMEs, led to a decline in e-commerce sales growth, negatively affecting consumption and poverty alleviation efforts.

In a literature employing the PRISMA methodology, *Ivanir et. al., 2022* sought to evaluate the core concepts of sustainability and the role of digital transformation through enabling digital technologies. Their study of three leading Brazilian pulp and paper companies revealed that these firms were still in the developmental phase of integrating digital technologies into their sustainability initiatives. To meet the Sustainable Development Goals (SDGs), particularly in emerging economies,

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it is essential to enhance technological development and business practices to improve sustainability outcomes.

Similarly, *Linswati et.all (2024)* examined the role of green accounting in moderating the relationship between digital innovation and sustainability performance. They found that green accounting could enhance the impact of digital innovation on sustainability, although its role as a moderating factor diminished over time. The study highlighted the need for new digital innovation metrics for the industrial sector. It emphasized the importance of cultivating a digital culture that encompasses areas such as digital products, services, supply chains, and green accounting to improve sustainability performance.

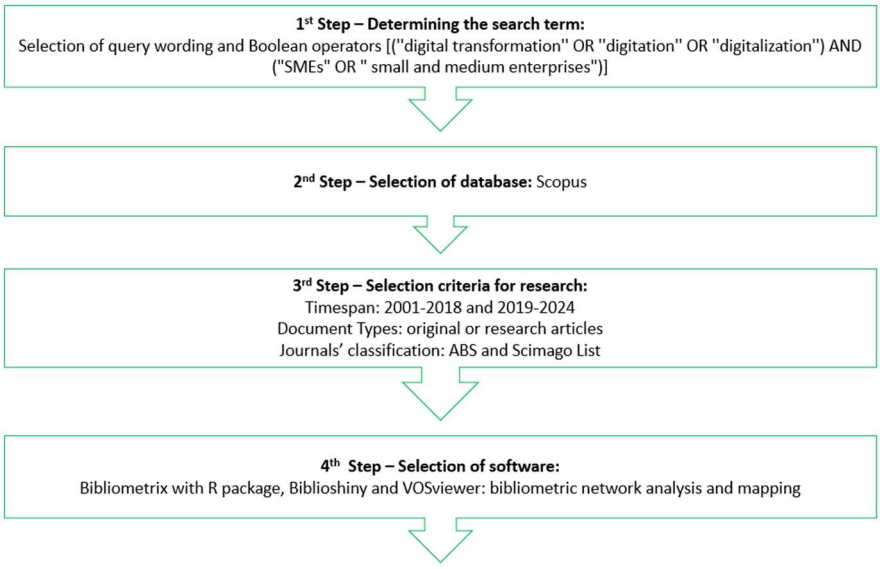
Lastly, a study by *Xiaoting et.all (2024),* which utilized panel data from 20 Chinese provinces between 2005 and 2020, investigated the effects of green technology innovation and green finance development on reducing regional carbon emissions through fiscal and taxation digital transformation. The study revealed that the green development effect of digital transformation in finance and taxation diminished as regional carbon emissions increased. Moreover, the effects of green development varied across cities, with differing levels of new energy development, government environmental regulation, industrial development, and economic advancement.

3. Materials and Methods

A snapshot of the current literature was obtained in August 2024 by accessing the Scopus database using a bibliometric resource that offers abstracts and citations for academic publications published in respectable scientific journals *(Passas, 2024)*. Over 11,628 publishers from over 34,346 peer-reviewed journals in fields like science, medicine etc. have contributed over 36,377 volumes. In Ragazou et., all quantitative and statistical techniques are used to analyze bibliographic data *(Donthu et. al.,2022).*

In addition to descriptive statistics, these include performance and cluster analysis and scientific mapping. While performance mapping deals with issues related to publication and citation, scientific mapping looks at the relationships and effects of article attributes such as total strength and co-occurrence weight *(Tamala J.K.K et.all.,2022).* He used techniques like keyword analysis, citation analysis, bibliographic coupling, and co-authorship analysis in his research. To find 1566 articles, the final research formula in the Scopus database was: [("digital transformation" OR "digitation" OR "digitalization") AND ("SMEs" OR " small and medium enterprises")].

VOSviewer and Biblioshiny were generally used to visualize and analyse data from publications published between 2001 and 2024. The pro-COVID era, which runs from 2001 to 2018, is the first time frame, and the pro-COVID era, which runs from 2019 to 2024, is the second time frame.



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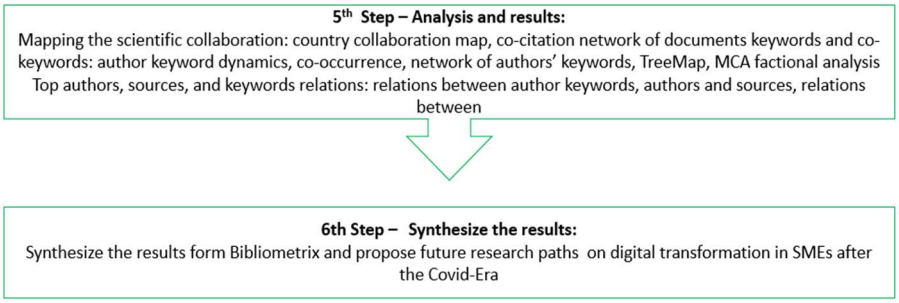

Figure 1. Methodology flow.

4. Results

A thorough summary of the quantity of the scientific publications released prior to and following the COVID-19 pandemic's start can be found in Table 1. It draws attention to the notable rise in post-COVID scientific output over pre-COVID levels. Prior to Covid-19, this scientific field had 104 publications; however, as of right now, 1462 papers have been published in total.

Table 1. Total number of articles from 2001 to 2024. Author's own collaboration.

Covid Era	Year	Number of articles	Total number of articles
Before Covid-19	2001	1	104
	2002	0	
	2003	0	
	2004	1	
	2005	2	
	2006	0	
	2007	0	
	2008	1	
	2009	1	
	2010	2	
	2011	6	
	2012	1	
	2013	6	
	2014	3	
	2015	4	
	2016	11	
	2017	12	
After Covid-19	2018	53	1462
	2019	78	
	2020	149	
	2021	219	
	2022	316	
	2023	421	
	2024	279	

Figure 2 shows the yearly production of scientific literature in the field under study for 2001–2018 and 2019–present. The publications fluctuated between 2011 and 2017 during the pro-COVID period, indicating an overall higher trend in publications annually, indicating a growing interest and research activity in these fields. In line with Rawan Masoud et al. Between 2011 and 2017, big data and computing saw tremendous advancements that allowed businesses to store and handle enormous volumes of data more effectively and economically. This change encouraged innovation in

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data analytics and business intelligence while enabling enterprises to scale their IT resources dynamically. In contrast, starting in 2020, the right graph shows a sharp increase in scientific articles. After publishing more than 400 articles, this trend peaks in 2022 and slightly declines in 2023. This impulse can be linked to the urgent worldwide response to the COVID-19 pandemic, which required quick research dissemination of virus-related discoveries.

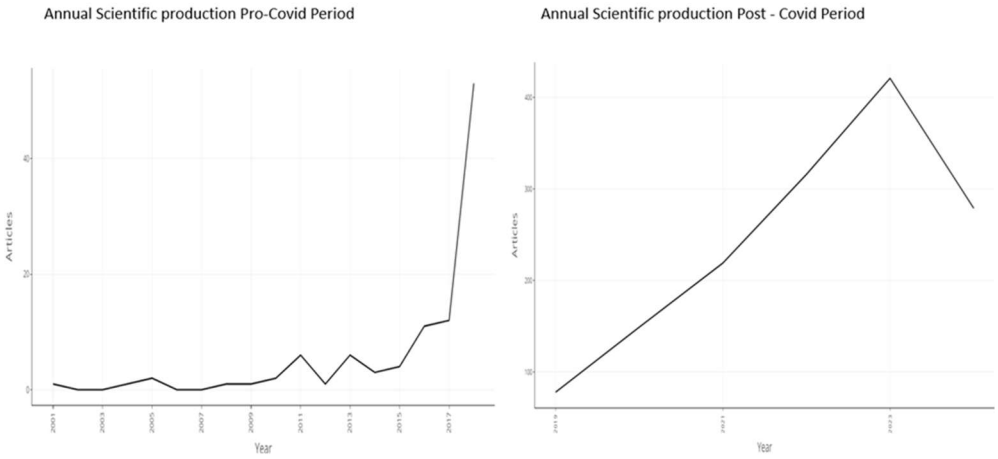

Figure 2. Graphs of annual scientific production before and after Covid-19 period - Bibliometrix.

The co-citation analysis map in Figure 3 depicts the five clusters of the most pertinent publications in the digital transformation research field for SMEs both before and after Covid-19. Because of this, the Journal of Marketing and Mis Quarterly are emphasized as the journals containing the greatest amount of relevant research on the subject of SMEs' digital transformation prior to the Covid-19 pandemic. In contrast, the second map, which is organized into 4 clusters with the most prestigious business research and sustainability journals, shows the most important publications following COVID-19.

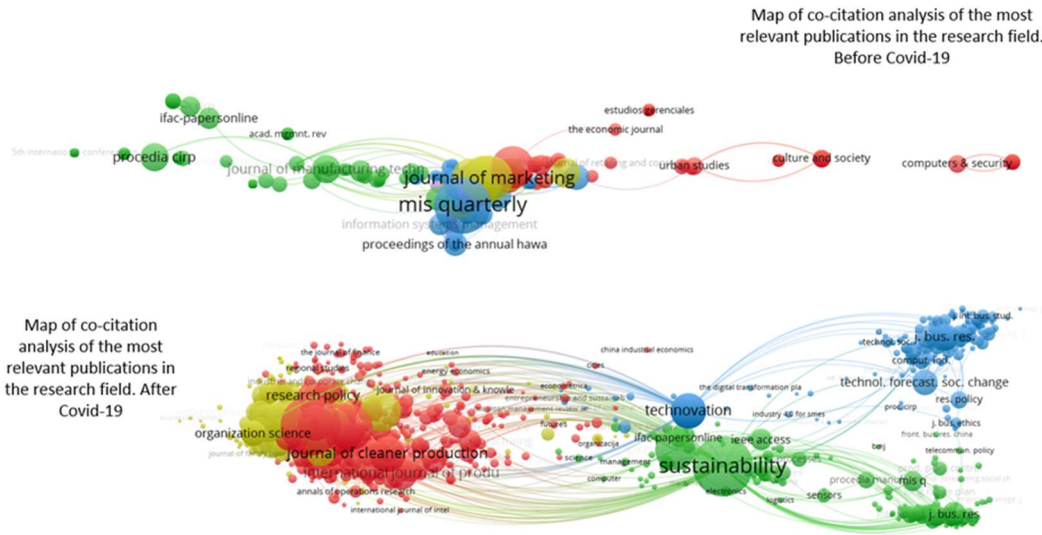

Figure 3. Map of co-citation analysis before and after Covid-19**.**

Figure 4 shows which nations, between 2011 and 2018 and from 2019 to 2024, produced the greatest number of scientific papers on the digital transformation of SMEs. Germany was noted as having produced the most research on the digitization of small and medium-sized businesses among the nations before the COVID-19 pandemic. Paul Pfister et al. (2023) state that Germany has a strong

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industrial base, with its "Mittelstand"—highly specialized, export-focused SMEs—being especially well-known. These businesses have a history of innovation and invest in cutting-edge technologies to stay ahead of the competition. Research and development, including efforts for digital transformation, are motivated by an emphasis on efficiency and innovation. Furthermore, the German government is actively promoting digitization.

The map on the right, which shows a general increase in scientific output in numerous nations, suggests that there will be a global focus on studying and implementing digital transformation in SMEs in the wake of the pandemic. More specifically, with 480 publications, Germany greatly increased its scientific output; Italy also made a significant contribution with 396 documents, and China made another significant contribution with 331 documents. SMEs, which are essential to the Italian economy, are widely distributed. According to the European Investment Bank, SMEs make up more than 95% of all businesses in Italy and significantly boost GDP and employment. (2021). How the economy is set up has sparked a lot of research and interest in using digitalization to boost business performance. Additionally, considering the high death toll in Italy (12,462 confirmed cases), businesses urgently needed to implement digital transformation to serve customers from the comfort of their homes and prevent the virus from spreading (A. Remuzzi et.all., 2020). Together with notable technological advancements, China has seen rapid economic growth. To stay competitive on the domestic and international stages, this environment encourages intensive research.

In addition, China's focus on innovation as a major engine of economic growth has led to the expansion of published topics related to digitalization, which substantially impacts SMEs *(B. Gutola., 2023).*

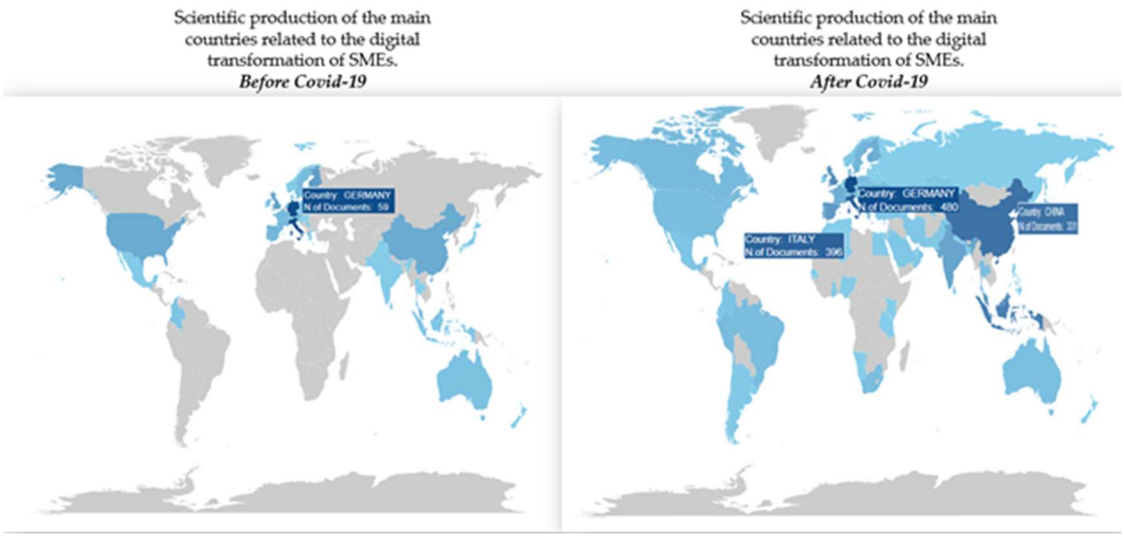

Figure 4. Scientific production of the main countries related to the digital transformation of SMEs before and after COVID-19, by Biblioshiny.

Figure 5 further illustrates the geographic collaboration among scholars researching the digital transformation of SMEs, segmented into two periods: before and after the COVID-19 pandemic. The Biblioshiny tool was employed to map scientific collaborations globally. The map on the left depicts collaborative efforts primarily between Spain and Italy and between Spain and Germany. In contrast, the map on the right showcases a more extensive network of global collaborations, highlighting the pandemic's widespread impact on fostering international cooperation in this research field.

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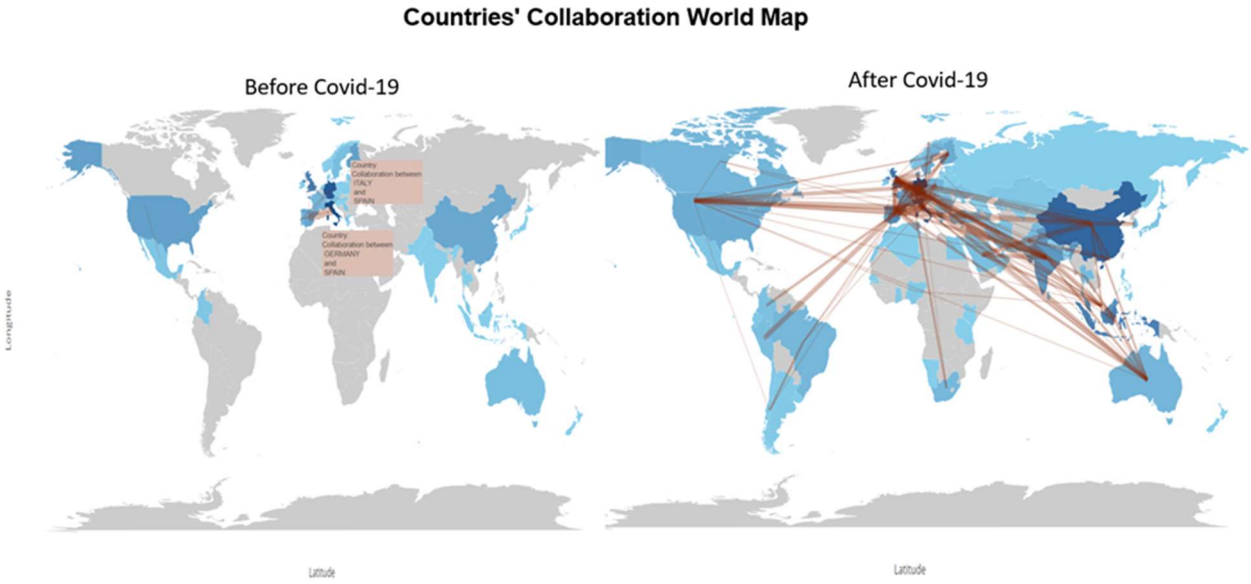

Figure 5. Countries collaboration map in the research field before and after Covid-19.

The co-occurrence of the author keywords associated with SMEs' digital transformation before the pandemic is shown in Figure 7. This visualization provides insights into the research trends and focal points before the pandemic by highlighting the interconnectedness of various topics and keywords used by the authors in the field. This map shows three highlighted clusters. The Internet of Things comes in second, followed by manufacturing and industry, and other ancillary issues come in third. Figure 7 presents the co-occurrence of authors' keywords related to the digital transformation of SMEs before the pandemic. The central themes in this map are digital transformation, SMEs, and COVID-19.

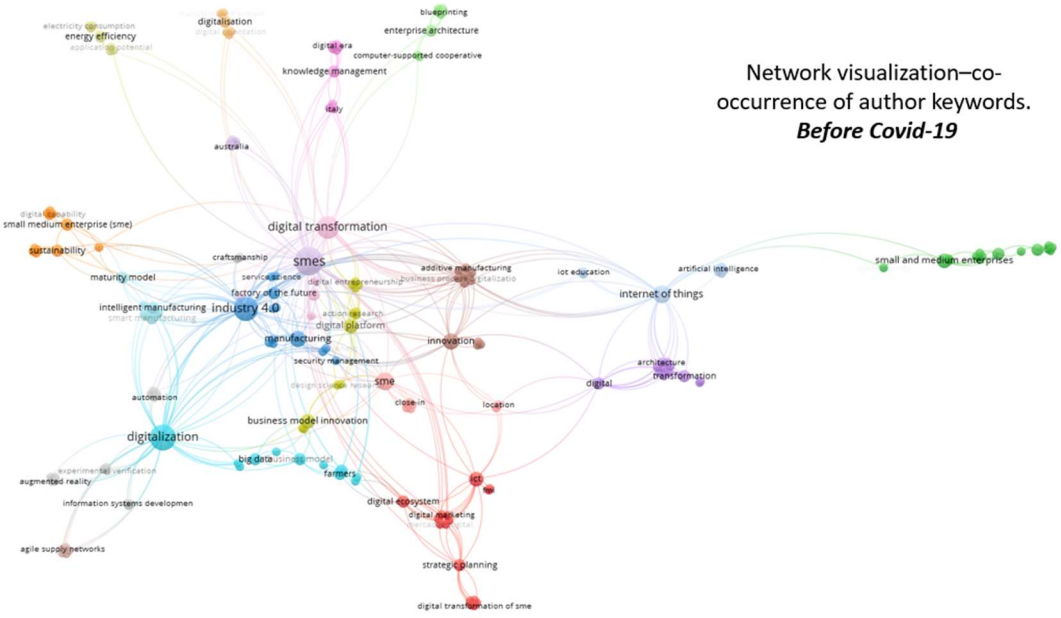

Figure 6. Network visualisation before Covid-19.

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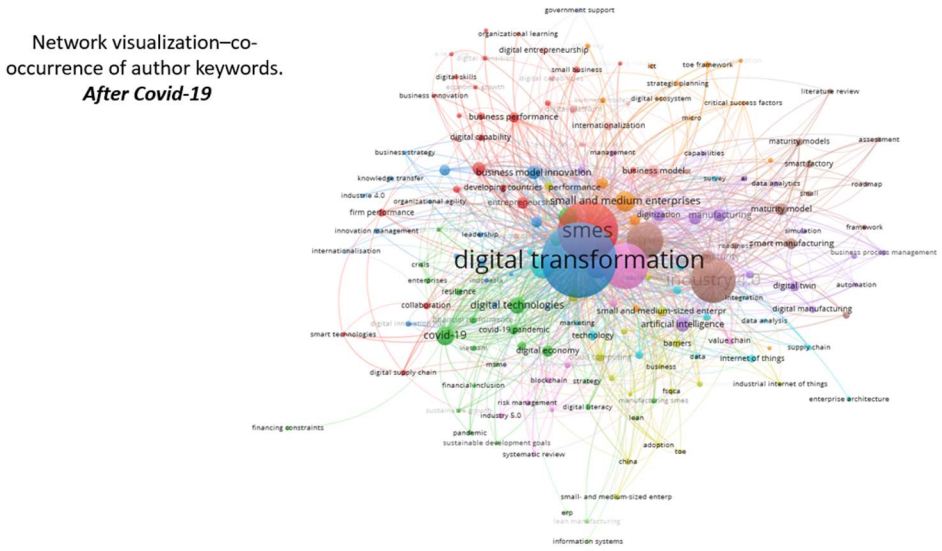

Figure 7. Network visualisation after Covid-19**.**

Figure 8 illustrates the comparison between the pre -and-post Covid-19 landscapes. The map on the left represents the conditions before the pandemic, emphasizing the growing importance of digital transformation for small and medium-size enterprises (SMEs). Before the pandemic, digital transformation was used more generally, and there were no clear distinctions between specific areas. However, following the onset of COVID-19, SMEs have developed a deeper understanding of digitalization, recognizing its essential role in their operations. It has become evident that achieving success without embracing digital technologies is no longer feasible. SMEs stand to gain significant benefits in employment, competitiveness, and business resilience *(S. Stitch, 2020*). Consequently, the COVID-19 pandemic has fostered a new digital culture in which digital transformation is perceived as a strategic necessity for SMEs rather than merely an "opportunistic move" *(K. Ragazou, 2022).*

Figure 8. Word Tree Map before & after Covid-19**.**

Figure 9 presents thematic maps generated using VOSviewer and Scopus, offering a visual representation of the evolution of research on digital transformation in SMEs before and after the Covid-19 pandemic. The map on the left highlights key areas of focus for SMEs regarding digitization

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in the pre-pandemic era. According to the motor themes, much of the research concentrated on exploring how SMEs could implement digital transformation, emphasizing the role of e-commerce and information and communication technologies (ICT) in facilitating this transition. These themes are essential as they establish the theoretical and practical foundations of the field. However, further investigation is required to fully integrate emerging yet underdeveloped areas, such as decision-making and cloud services, into the broader context of digital transformation. The map on the right, reflecting the post-pandemic period, continues to underscore SMEs and digital transformation as central themes, with the addition of a significant focus on Industry 4.0. The increased complexity and prominence of these topics indicate a growing emphasis on digital strategies to ensure business continuity and resilience in response to the challenges posed by the pandemic. Critical themes such as decision-making, sustainable development, and SMEs have become increasingly important in this context.

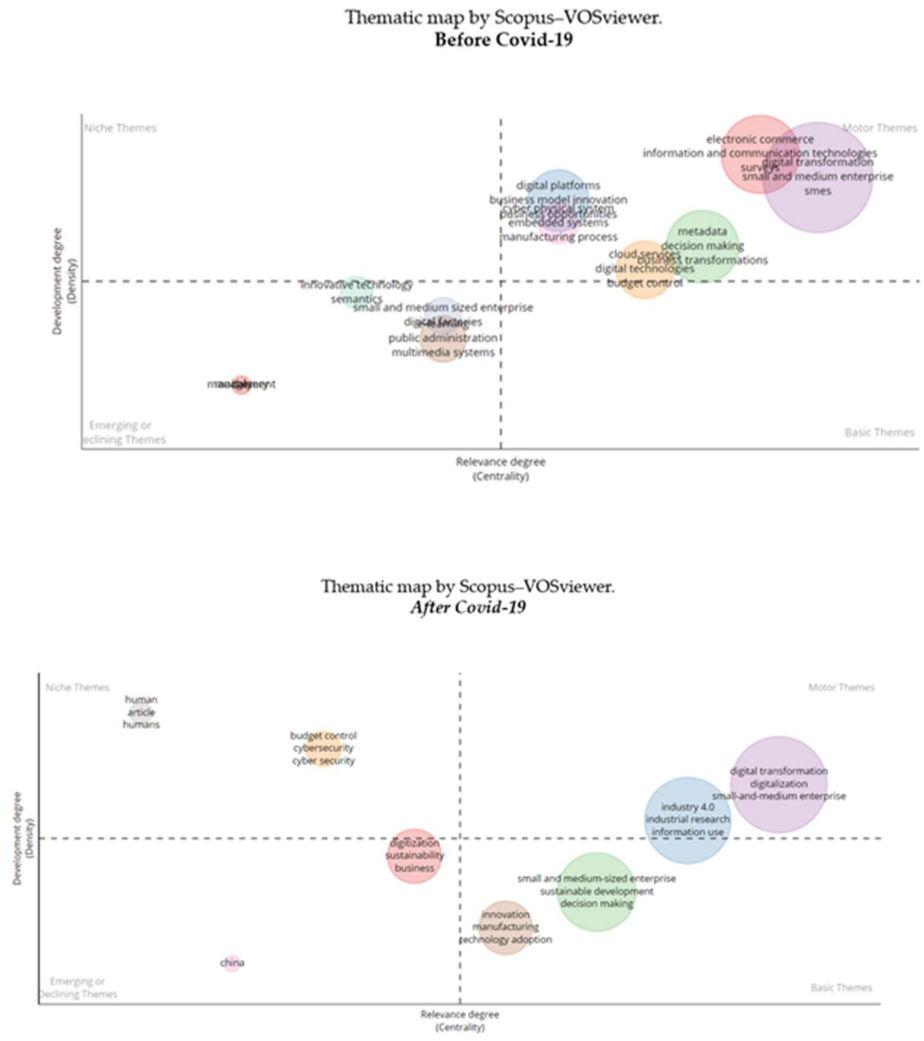

Figure 9. Thematic Map before & after Covid-19**.**

5. Discussion

The Covid-19 pandemic has profoundly impacted the digital transformation of SMEs. Due to the crisis and the restrictive measures implemented to contain the virus, businesses needed to adopt various technologies, such as online or contactless ordering, which became essential for their sustainable operation. This necessity forced businesses to undertake vital changes to ensure their survival. These changes included installing new software, training human resources, and other critical steps to integrate digital transformation into their operations.

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However, implementing these changes was a challenge for SMEs. They often lacked two essential resources for successful digital transformation: the capital needed to invest in technology and trained personnel capable of adapting to the demands of a digital environment. Training employees requires time and financial resources, which are often limited in smaller businesses. In contrast, larger enterprises could implement these changes more easily due to their greater access to capital and skilled labor.

Given these challenges, it became imperative to study the specific issues surrounding the digital transformation of SMEs, as demonstrated by the research discussed in this paper. These studies are divided into various categories, with the most critical focusing on the steps SMEs must take to adopt digital transformation. Other research examines how certain technologies are applied and the benefits these technologies provide to SMEs. Additionally, literature reviews comparing studies on digital transformation before and after the COVID-19 pandemic provide valuable insights into the changing landscape for SMEs.

The rapid increase in studies on digital transformation in SMEs during the pandemic reflects the situation's urgency. The total number of relevant papers stands at 1,529, with 93% published from 2019 onwards. Only 7% (104 papers) were written before 2019, underscoring the significance of digital transformation in the post-pandemic world, especially for SMEs that are more vulnerable due to limited financial resources and specialized personnel.

The role of government is vital in facilitating this transformation. Governments can emphasize the importance of digitalization for SMEs and provide clear guidance and financial support to help businesses smoothly transition into the digital era. In an increasingly globalized world, where competition transcends borders, the ability of SMEs to embrace digital technologies is critical for their survival and competitiveness. This is particularly true during times of crisis, such as the COVID-19 pandemic, where additional pressures, such as restrictive measures and lockdowns, have forced businesses to adopt new technologies like big data, the Internet of Things (IoT), cloud computing, and 3D printing.

The year 2020 marked a significant shift in this landscape. The number of published papers on digital transformation increased by 72%, from 78 in 2019 to 149 in 2020, reflecting the urgency and importance of this topic during the pandemic.

6. Conclusions

In summary, this study highlights the critical role that digital transformation has played in the resilience and recovery of SMEs during the Covid-19 pandemic. The pandemic acted as a catalyst, forcing SMEs to adopt digital technologies to survive. However, the disparity in resource availability between SMEs and larger companies has posed significant challenges for the former, particularly in terms of funding and skilled labor.

The findings suggest that government intervention is crucial in addressing these gaps, offering financial and strategic support to ensure SMEs can fully embrace digital transformation.

Future research should focus on comparative analysis between different nations, exploring how governmental policies and financial incentives influence SMEs' digital success in a post-pandemic world. Furthermore, as digital transformation continues to evolve, understanding its long–term impact on SMEs' sustainability and growth will be essential for guiding future strategies.

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