

Assessing Trends and Impact of Digital Transformation: A Comprehensive Bibliometric Analysis

Dijital Dönüşümün Eğilimlerini ve Etkisini Değerlendirmek: Kapsamlı Bir Bibliyometrik Analiz

Abstract

Digital transformation is a process that generates significant value for organizations by integrating digital technologies with effective business strategies. Digital transformation has become a necessity for companies in today's competitive business environment. This study aims to present a broad perspective on academic research in digital transformation. A bibliometric analysis of 5706 articles, selected from the Web of Science (WoS) database, spanning the years 2015 to 2023, was conducted. Tools such as Biblioshiny and VOSviewer were utilized to process data and visualize the results. The graphical analyses present co-authorship relationships, keyword co-occurrences, growth in research topics, and the network of prominent scholars' digital transformation. The study includes publications from 1816 different sources with a total of 16,306 authors, of which 605 are single authored. An increase in publications has been observed since 2017, peaking in 2021, attributed to the digitalization processes closely linked with the COVID-19 pandemic. The study reveals that China is the leading country in terms of publications, while Germany ranks highest for citations. Most of the articles are in the fields of management (1104), business (790), and computer science (499), highlighting the multidisciplinary nature of the topic.

Özet

Dijital dönüşüm, dijital teknolojilerin etkili iş stratejileri ile entegrasyonunu sağlayarak organizasyonlar için önemli değer oluşturan bir süreçtir. Dijital dönüşüm, günümüzün rekabetçi iş dünyasında firmalar için bir zorunluluk haline gelmiştir. Bu çalışma, dijital dönüşüm konusundaki akademik araştırmalara kapsamlı bir bakış sağlamayı amaçlamaktadır. 2015-2023 yılları arasında yayımlanan ve Web of Science (WoS) veritabanından seçilen 5706 makale üzerinde kapsamlı bir bibliyometrik analiz gerçekleştirilmiştir. Analiz sürecinde Biblioshiny ve VOSviewer gibi araçlar kullanılarak verilerin işlenmesi ve sonuçların görselleştirilmesi sağlanmıştır. Grafik analizler, yazarlar arasındaki iş birliği ilişkilerini, anahtar kelimelerin eşzamanlılıklarını, araştırma konularındaki büyümeyi ve dijital dönüşüm alanındaki önemli akademisyenlerin ağ yapılarını ortaya koymaktadır. Çalışmada yer alan 605'i tek yazarlı olmak üzere toplamda 1816 farklı kaynağa ve 16.306 yazara ait yayınlar incelenmiştir. Yayın sayısında 2017 yılından itibaren bir artış gözlenmiş ve bu artış 2021 yılında zirveye ulaşmıştır, bu durum COVID-19 pandemisi ile ilişkili dijitalleşme süreçlerine bağlanmaktadır. Çalışma, en fazla yayının Çin'den, en fazla atıfın ise Almanya'dan geldiğini göstermiştir. Makalelerin büyük bir kısmı yönetim (1104), işletme (790) ve bilgisayar bilimi (499) alanlarında olup, bu durum dijital dönüşüm konusunun çok disiplinli doğasını vurgulamaktadır.

Introduction

In the rapidly evolving contemporary world technology environment, digital transformation has emerged as an essential aspect for enterprises, sectors, and societies at large (Kraus et al., 2021). This approach entails integrating digital technology into a variety of organizational components to fundamentally alter how the company functions and provides value to its stakeholders (Hanelt et al., 2021). The adoption of these digital technologies in society, industries, and organizational management has led to the emergence of a well-acknowledged research domain known as digital

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transformation (Shie et al, 2022; Nadkarni & Prügl, 2021; Verhoef et al., 2021; Vial, 2019; Zaoui & Souissi, 2018).

Over the global spread of the COVID- 19 pandemic, the field of digital transformation research has solidified its recognition, particularly among researchers who emphasize the utilization of digital technologies in socioeconomic endeavors (Chawla & Goyal, 2022). In several of their studies, Sulvian et al. (2021) have specifically examined the digital transformation in healthcare during this period. Additionally, they created "the digital coronavirus application" (DCOVA), a web-based program that securely gathers data on individuals under quarantine and builds a multiagency secure database. DCOVA has drawn the attention of numerous researchers spanning various disciplines within the social sciences, encompassing management and more. By this way, industries ranging from healthcare and banking to manufacturing and education have been transformed by digital technology. Digital transformation involves more than merely incorporating technology into current processes (Nadkarni & Prügl, 2021). Through the lens of digital capabilities, it denotes a thorough reinvention of an organization's strategies, procedures, and customer experiences (Vial, 2019). To make wise judgments and foster innovation, researchers, practitioners, and policymakers have all realized how crucial it is to comprehend the trends and advances in the digital transformation. Numerous organizations are undergoing digital transformation by innovating novel methods to create fresh income channels powered by digital age technology (Chawla & Goyal, 2022). Evidently, digital transformation isn't solely centered around technology; it predominantly centers on the synergies arising from integrating information generation, processing, and communication through interconnected systems facilitated by these technologies (Bharadwaj et al., 2013).

In order to fully harness the advantages of digital transformation, an appropriate strategy for this transformation is imperative. Successful integration of digital transformation within organizations is essential for attaining lasting competitiveness, making both the "design and management of digital transformation" are essential (Lee et al., 2021).

Researchers in the field of digital transformation can look at publications, summaries, and collaborations to find models, identify influential names, and map the intellectual structure of a field. These techniques enable academics to study a particular area of research, considering elements such as words, common words, geographical distribution, and word frequency. They provide a variety of tools to evaluate scientific findings, effects and comparative effects. This helps to define the intellectual framework and path of development of the research subject. According to Díaz-García et al. (2022), it also facilitates the identification of subjects in the various sub-subjects of the field and their related conceptual frameworks.

Bibliometric analysis serves as a valuable method for identifying key organizations and leading researchers in the field of digital transformation. Researchers distinguished by their substantial body of work, high citation counts, and extensive collaborative networks often emerge as prominent contributors (Díaz-García et al., 2022; Pizzi et al., 2021). Mapping their institutional affiliations not only highlights the global distribution of influential contributors but also provides insights into collaborative trends that shape the research landscape. Such analyses support the understanding of how intellectual progress in digital transformation is achieved and sustained.

According to this study, United States, United Kingdom, India, and China are the most productive countries regarding the quantity of published articles.

This study aims to provide an in-depth review of scholarly investigations about digital change. The objectives encompass investigating the temporal evolution of research trends, exploring the prevalence of specific research subjects, and elucidating the worldwide interest in this field. The main objective is to establish an initial literature resource that can serve as a guide for researchers interested in undertaking similar studies. The subsequent sections delineate the study's data collection process, methodological approach, resultant findings, and subsequent insights pertaining to the historical, current, and prospective landscape of digital transformation focused research. Besides that, the distinctive aspect of this study is presenting the findings obtained by combining the strengths of two different tools, VOSviewer and Biblioshiny, in line with this direction.

1. Theoretical Background

1.1. Definition of Digital Transformation and Its Significance

It has been widely conceptualized that digital transformation means the process of integrating digital technologies into all aspects of a business, thereby ~~disruptively~~ fundamentally changing how an organization operates and delivers value to its stakeholders (Vial, 2019). The enterprise needs to adapt itself to the digital era regarding competitiveness, agility, and innovation in this modern and technology-saturated market. Once they adopt the strategies for digital transformation, it provides enterprises with enhanced process optimization opportunities and the ability to continuously innovate and improve customer experiences that were not imaginable in the past.

The flexibility of organizations has come with the journey of digital transformation, which enables continuous adaptation to new technologies along with the changes in the market conditions. Regarding this, Bharadwaj et al. in their research pinpoint that one broad-based approach or strategy which will not only influence the technological infrastructure but will change the ways of decision making, organizational culture and leadership, is digital transformation. Furthermore, it extends the critical role in value creation through the advancement of digital capabilities, thus enabling organizations to promote efficiency and reduce costs by becoming sensitive to customers' needs. Companies unable to digitize may struggle to be competitive in an increasingly digital world, where new entrants with digitally native business models disrupt traditional industries.

When literature is examined, it is possible to come across studies conducted in this field. For example, Pizzi et al. (2021) conducted a bibliometric analysis on the impacts of digital transformation on managerial auditing. Four major research areas are identified by the analysis: data analytics, fraud detection, continuous auditing, and technology innovation.

According to Mai and Jim Wu (2022), there is limited cooperation, and many research concepts are still in the early phases of development in this subject. Ogreaan and Herciu (2021) confirm that digital transformation goes beyond the already complex realms of digital technologies and their applications/solutions. Lee et. all (2021), tackles the challenge of comprehending trends in digital transformation by introducing a machine learning (ML) approach for topic modeling. Madzik et al. (2023) employ topic modeling utilizing the latent Dirichlet allocation with Gibbs sampling technique to uncover underlying themes in tourism related to digital transformation. Rana and Daultani (2022) recognize untapped possibilities and the scenarios in which AI and ML can be employed to digitally manage and transform supply chains in their studies.

1.2. Key Technologies Driving Digital Transformation

Organizations leverage technologies such as big data, analytics, artificial intelligence (AI), Machine Learning (ML), and the Internet of Things (IoT) to enhance their operations and decision-making processes. Big data and analytics enable real-time processing of vast data sets, providing insights for informed decision-making (Chawla & Goyal, 2022). AI and ML empower businesses to automate intelligent processes, predict trends, and deliver personalized customer experiences through advanced algorithms (Bharadwaj et al., 2013). Similarly, IoT fosters connectivity across devices and systems, optimizing operations through real-time data collection and processing (Lee et al., 2021). Cloud computing enhances scalability and flexibility in managing digital infrastructures, enabling companies to respond swiftly to changing demands while reducing reliance on traditional IT systems (Verhoef et al., 2021).

Though blockchain originally came into being with virtual cryptocurrencies, its rigid security and transparency have found applications across industries such as finance, supply chain management, and healthcare due to its tamper-evident transactions (Nakamoto, 2008; Tapscott & Tapscott, 2016). These features have enabled blockchain to become a cornerstone of digital transformation, driving exponential growth across industries by fostering innovation, automating processes, and delivering superior products and services (Iansiti & Lakhani, 2017; Swan, 2015). Chawla & Goyal (2022) describe how these technologies are changing traditional business models and enable organizations to think of new revenue streams in the face of rapid technological changes for competitiveness.

1.3. Models and Frameworks of Digital Transformation

The basis of digital transformation must be underpinned by theory which then guides the way business enterprises approach their journeys of transformation. Several models and frameworks have over time been developed while integrating digital technologies into the operations of organizations effectively. In this line, Nadkarni & Prügl (2021) present a framework that integrates digital transformation into strategic management processes. Their model emphasizes aligning technological development with an organization's strategic objectives, since digital transformation is not just a question of using technology but rather how to achieve long-term competitive advantage. Similarly, Bharadwaj et al. (2013) argue that digital business strategies must be viewed as integral components of broader corporate strategies, highlighting the interconnected nature of technology and organizational growth.

Verhoef et al. (2021) offer a multidisciplinary reflection on the meaning of digital transformation and propose a framework covering the technological dimensions of transformation along with the organizational, cultural, and market-related ones. This model emphasizes the need to create a digital culture within an organization in which leadership acts as the main driver for the transformation process. Leaders must ensure that employees have acquired the relevant competencies and mindset that will help them in the assimilation of new technologies and processes. In agreement, Westerman et al. (2014) stress the importance of digital leadership in fostering an innovative culture, where the effective use of digital tools is complemented by organizational adaptability. Furthermore, Kane et al. (2015) underline that organizations with a strong digital culture are more likely to succeed in adopting and sustaining digital transformation initiatives, particularly when leadership provides clear strategic guidance.

It will then be plausible when the digital transformation process can be perceived as a dynamic and iterative cycle, rather than a one-time event. Among the most successful models, stages include digital awareness, digital adoption, digital optimization, and digital innovation. This ensures that businesses not only adopt digital technologies but continuously improve their processes and look for new opportunities toward innovation. Organizations must also embed mechanisms for real-time feedback to assess the ongoing impact of digital transformation efforts, as suggested by Sebastian et al. (2017), ensuring alignment with dynamically changing market demand and customer expectations. Moreover, Vial (2019) proposes that firms adopt a holistic approach to digital transformation, integrating both external market trends and internal organizational capabilities to remain agile and responsive to technological changes.

1.4. Digital Transformation Applications by Industry

Digital transformation means different things for different industries, as each has its own challenges and opportunities to consider when implementing digital technologies. Within the health sector, it has changed the delivery of services and management with, in some cases, astonishing improvements in patient care and operational efficiencies. In COVID-19, Sullivan et al. (2021) documented that due to the pandemic, digital tools such as telemedicine, EHRs, and AI diagnostic systems were rapidly implemented to enable health care providers to continue their care with strict social distancing and highly congested facilities. These have made care organizations provide more personalized, timely, and efficient services, with reduced costs and improved outcomes. Similarly, Mesko et al. (2017) emphasize that digital health tools, including wearable devices and mobile applications, have empowered patients by enabling self-management and improving the overall quality of care.

Specific to manufacturing, digital transformation has resulted in the adoption of Industry 4.0 technologies, including IoT, robotics, automation, and advanced analytics. Frank et al. (2019) support the fact that these technologies have brought considerable change in production processes through real-time monitoring, predictive maintenance, and optimization of supply chain management. Integration of IoT sensors into manufacturing equipment allows the collection of data about the performance of equipment to predict failures and optimize maintenance schedules, reducing downtime and increasing efficiency. Similarly, automation and robotics have allowed manufacturers to increase productivity while reducing labour costs. Further, Xu et al. (2018) explore

how cloud-based manufacturing systems can provide scalable solutions, enabling smaller manufacturers to access advanced analytics and computational tools at reduced costs.

In turn, the financial sector has equally witnessed significant transformation in digital banking, mobile payments, blockchain, and AI-based fraud detection systems. More recently, blockchain technology has transformed transaction processing in financial institutions by providing secure and decentralized transaction systems (Tapscott & Tapscott, 2016). In addition, the implementation of AI-driven fraud detection tools has drastically improved the ability of financial institutions to identify and prevent fraudulent transactions in real-time (Zhang et al., 2020). In the retail arena, e-commerce, AI-driven personalization, and omnichannel customer experiences for the digital consumer will drive further change. According to Brynjolfsson et al. (2013), these applications have accelerated the pace of digital innovation, making digital transformation the chief driver of growth and adaptability in the face of rapidly changing consumer behaviours and market conditions.

1.5. Strategic Role of Digital Transformation

In essence, digital transformation is a strategic initiative taken up by organizations for driving growth, innovation, and competitiveness. It's more than just the adoption of new technologies; it is, in fact, a cultural change in corporate business, interaction with customers, and value creation (Hanelt et al., 2021; Verhoef et al., 2021). Lee et al. (2021) have emphasized that the process of digital transformation must be performed in tandem with long-term strategic actions since organizations that can integrate their digital strategies into their activities would be well positioned to achieve sustainable competitive advantage in the industries in which they participate.

Driving innovation is certainly one of the most important strategic benefits digital transformations can bring in. Using digital technologies, businesses can develop new business models, offer innovative services and products, and even expand to new markets (Verhoef et al., 2021). Digital technologies, such as AI and data analytics, will provide insight into customer preferences, thus enabling companies to offer more personalized and targeted products. Digital platforms enable firms to scale up operations rapidly at low cost and reach global markets with very minimal investments (Nambisan et al., 2019).

Customer experience plays a pivotal role as a strategic perspective in digital transformation, emphasizing its potential to enhance and personalize interactions. Today, customers seek seamless, omnichannel, and personalized experiences, and digital transformation provides a mechanism through which such expectations are met by organizations (Verhoef et al., 2021). By integrating customer data emanating from all touchpoints, businesses build better-focused marketing campaigns; they optimize product recommendations and give rise to elevated customer service. It not only increases customer satisfaction but also develops brand loyalty, leading to revenue.

Besides, digital transformation makes organizations agile, and through this agility, they can respond much quicker to changes in the marketplace, new technologies, and competitive dynamics (Sebastian et al., 2017). Agility is just what the modern business world requires, due to the fast and continuous changes in the form of disruptive innovations and changing consumer expectations that demand continuous evolution in business. Slow-moving organizations will easily lose market share to more agile competitors who are in a better position to leverage digital opportunities.

2. Method

In this study, bibliometric analysis is used to explore the research landscape related to the subject of digital transformation. According to Demirkol et al. (2022) bibliometric analysis can be explored through two primary categories: performance analysis and mapping.

This study's method provides a systematic mapping that gives an overview of the publication trend, contributing authors, influential papers, and the evolution of key themes within the topic. The data analysis for the identification of patterns and the establishment of relationships among these data gives an overview of how this field has developed over time. This approach will focus on conducting research about the landscape of the field of digital transformation and will therefore allow for the systematic mapping of existing literature to provide insight into publication trends, key contributing authors, influential papers, and the evolution of key themes within the topic. The

analysis tends to outline the patterns and relationships within the data itself, providing an overview of how the field has developed over time.

2.1. Data Description

Bibliometric analysis involves extracting and analyzing data from scholarly literature databases to gain insights into research trends and patterns. Wang et al. (2014) assert that bibliometric analysis serves as a valuable tool for discerning growth paths, innovative uses, priorities for research, and references within a given topic. This analytical approach considers geographical locations and research networks, offering comprehensive insights into the subject.

For this analysis, a comprehensive search of scholarly databases was conducted using keywords related to "digital transformation.". The main aim of this study is to analyze the research trends related to Digital Transformation. To achieve this, the initial step involves selecting the existing academic literature that pertains to this subject. For this purpose, the "Web of Science (WoS)" database has been selected due to its high relevance in the field of Social Sciences. First and foremost, publication year was not used as an exclusion criterion without considering any time constraints, research has been conducted covering studies from the past to 2023. Observing that the publication count was significantly low before the year 2015, the time frame was narrowed down to the period from 2015 to 2023 to capture the most recent developments in the field.

Subsequent refinement of the results was performed, retaining only published and early access articles, conference proceedings and book chapters were excluded. This selection process included peer review, ensuring the scientific quality of the chosen articles in English. Initially, there were a total of 6663 documents. To ensure high publication quality, criteria from WOS indexes such as "SSCI (Social Sciences Citation), ESCI (Emerging Sources Citation Index), and SCI-Expanded (science Citation Index-Expanded)" were incorporated.

After a rigorous filtering process conducted, which eliminated duplicates and articles not directly related to the study's focus, a final selection of 5706 articles was made for the bibliometric analysis. "Bibliometric visualization methods" were used to illustrate the results of the "bibliometric analysis" approach, which was used to examine the pertinent publications.

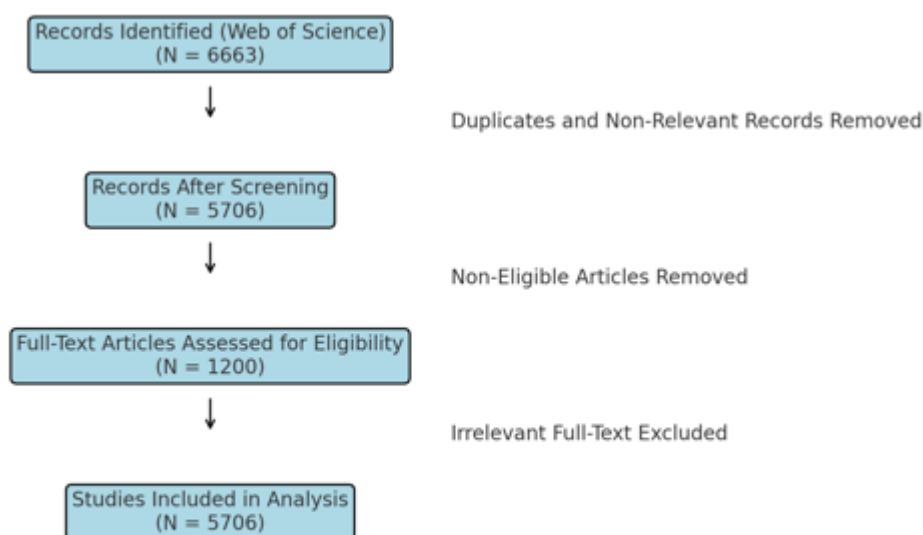


Figure 1a. Prisma Flow Diagram for Data Selection

The steps of the data selection process, as outlined in the PRISMA framework and illustrated in Figure 1a. Initially, 6,663 records were identified from the Web of Science database. After removing duplicates and non-relevant records, 5,706 records remained for screening. Full-text eligibility assessment reduced the dataset further, excluding irrelevant or ineligible studies. Ultimately, 5,706

peer-reviewed articles published between 2015 and 2023 were included in the bibliometric analysis, focusing on digital transformation research. This structured process highlights the rigor and precision applied in curating the dataset for analysis.

2.2. Data Analysis

In order to do bibliometric analysis, two tools have been used to highlight significant features and the development of research in the area of digital transformation. The VOSviewer was used to do the mapping analysis, bibliographic coupling, co-authorship analysis, and the study of keyword co-occurrences. VOS Viewer's functionality is particularly helpful for displaying large bibliometric maps in a way that is easy to understand. (Van Eck & Waltman, 2010). The second tool for analysis is Biblioshiny. Biblioshiny is a shiny R-language application that offers a web interface within the Bibliometrix package (Aria and Cuccurullo, 2017), was used to examine: intellectual and social structure of the field. The R codes developed on RStudio (RStudio, 2023).

2.3. Findings

This section encompasses a comprehensive descriptive analysis and bibliometric assessments of the publications. An overview of the documents obtained in Figure 1 is presented by Biblioshiny. It can be observed that articles existing between 2015 and 2023 have been examined. These publications, originating from 1816 different sources, with 605 being single authored, involve a total of 16,306 authors. The proportion of collaborative authorship through international cooperation is determined to be 28.22%.



Figure 1b. Main Description of Documents

Additionally, the annual growth rate of studies in the relevant field is found to be 81.63%, indicating that the domain of digital transformation is a highly regarded area of interest. It can be observed that authors have employed a total of 14517 keywords.

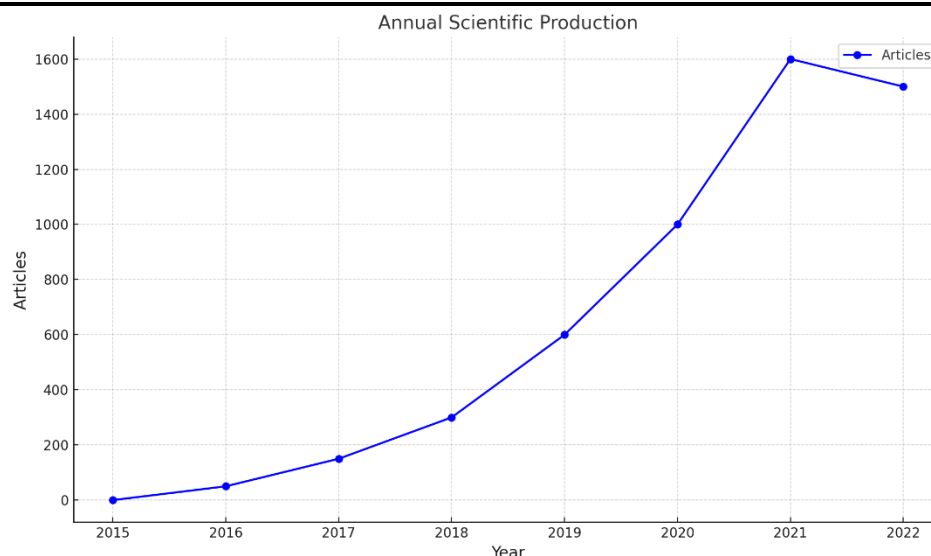


Figure 2. Annual Scientific Production

The yearly output of scientific research in the study's field from 2015 to 2023 is displayed in Figure 2. The graph indicates that until 2017, there was minimal concern in literature. This is the first year that the number of academic articles has increased. There was a significant increase in literature in 2020, and this trend has maintained in 2021. By the analysis, it can be inferred that there has been an accelerated pace of research activities on this subject since 2017, and this momentum increased in 2021, and peaked in 2022. This result can be attributed to the reflection of all processes moving towards digitalization due to the integration of the COVID-19 pandemic into our lives. COVID-19 crisis, coupled with the necessity to embrace new methodologies.

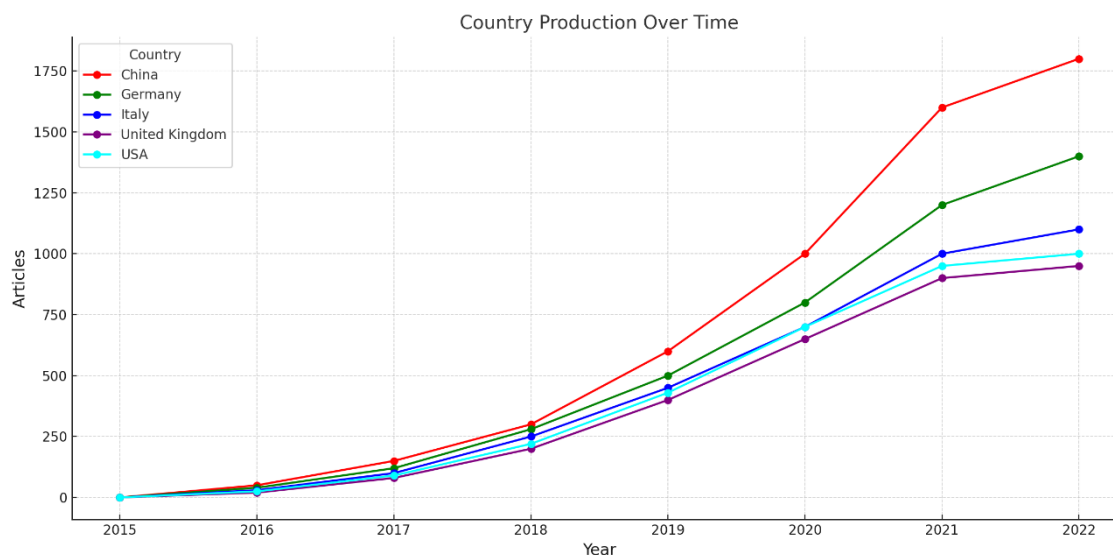


Figure 3. Country Production Over Time

As seen in Figure 3, which represents the productivity of countries, is examined, it is evident that as of 2021, there has been a significant increase in research activities related to the subject, particularly in China. The notable impact of the COVID-19 pandemic, originating in China, should not be overlooked. Following China in sequence countries are Germany, the United States, Italy, and the United Kingdom.

Country Scientific Production

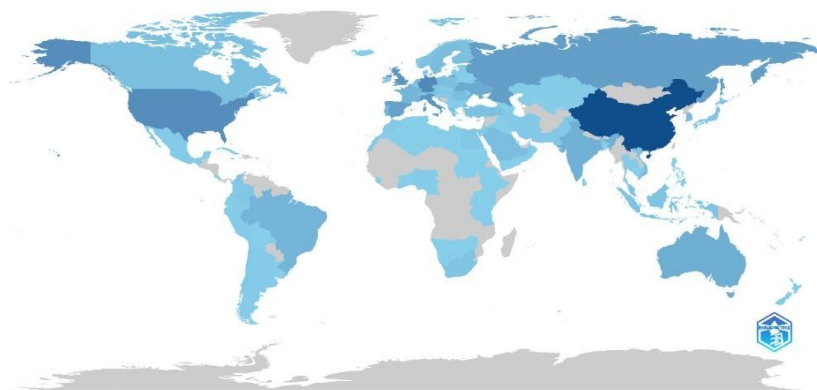


Figure 4. Country Scientific Production Map

Biblioshiny reflects the most productive countries on the map (Figure 4) as dark blue. As the shade of blue softens, there is a decrease in productivity. So, we can see that China is the most productive country. Germany, USA, and UK are also seen as productive in the related field. The analysis focuses on the collaboration patterns, specifically co-authorship, among authors contributing to MMR publications. Table 1 illustrates the assessment of “single country publications (SCP)”, “multiple country publications (MCP)”, and the “MCPRatio (MCPR)” based on the corresponding authors' countries. Notably, among the 680 studies from China, only 159 opted for MCP.

Table 1. Corresponding Author's Countries

Country	Articles	SCP	MCP	Freq	MCP_Ratio
CHINA	839	680	159	0.147	0.190
GERMANY	404	297	107	0.071	0.265
ITALY	321	221	100	0.056	0.312
RUSSIA	291	259	32	0.051	0.110
USA	289	193	96	0.051	0.332
UNITED KINGDOM	279	141	138	0.049	0.495
SPAIN	267	222	45	0.047	0.169
AUSTRALIA	160	97	63	0.028	0.394
UKRAINE	137	122	15	0.024	0.109
INDIA	127	94	33	0.022	0.260

In Ukraine, a mere 15 out of 137 publications embraced MCP, resulting in the lowest MCPR value (0.109) within the top 20 corresponding author countries. In contrast, the United Kingdom demonstrated a strong inclination toward collaborative efforts, with 138 out of 141 publications being MCP and the highest MCPR value (0.495) among the listed countries. The leading countries in terms of MCP were the UK (0.495), Australia (0.394), and the USA (0.332), respectively. These findings provide a comprehensive overview of international collaboration trends in MMR publications, highlighting the varying degrees of engagement across different countries.

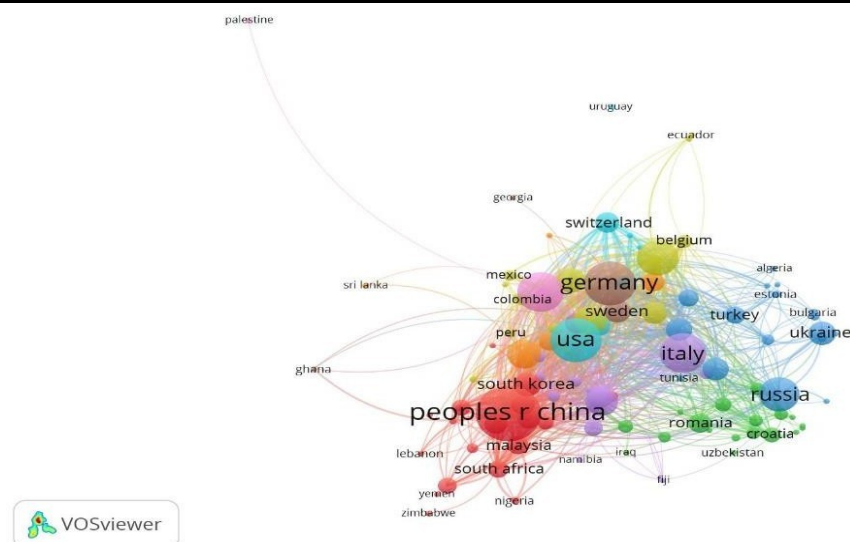


Figure 5. Co-occurrence of Countries

Figure 5 illustrates the collaborative network among countries. At this point, it can be observed that China possesses the widest network with a total link strength of 7001, engaging in collaborative efforts with numerous countries such as the USA, Germany, and Russia. Following China, Germany (total link strength 6640) and the USA (total link strength 5677) trail closely with expansive network presence.



Figure 6. Word Tree Map

According to Biblioshiny TreeMap, most of the articles in this selection (1104) have been published in the field of management expertise, as shown by Figure 6. Additional areas of relevance include Business (790), Environmental Sciences (606), Environmental Studies (528), Green Sustainable Science Technology (502), Computer Science Information Systems (499).

2.3.1. Keyword Network Visualization

The construction of keyword maps based on co-occurrence data was facilitated using VOSviewer. A network analysis of word co-occurrence was generated to comprehend the primary topics and trends within this field of study. Keywords are displayed in node labels. The importance of the keyword percentage increases with the size of the node. The distance between nodes reveals the degree of links that bind them. We set the minimum threshold of keyword frequency as two. Results showed 21 clusters with 999 items seen in Figure 7.

Cluster 1 (99 items) is marked in pink and contains the keywords Digital transformation is mentioned 999 times with a total link strength of 22,737. digital technology, industry 4.0, etc. Cluster 2, marked in green, contains education, e-learning, digital learning, knowledge, and 84 items like these. Cluster 2 focuses on the digital adaptation of education. Cluster 3 marked in grey with 83 items consist of financial performance, digital services, digital revolution. Cluster 4 marks in soft green consist of 79 items like internet of thins, machine learning, deep learning, big data. It focuses on exploring essential technologies. Cluster 5 contains 77 items. It contains the words like accounting, e- government, development, and digital maturity.

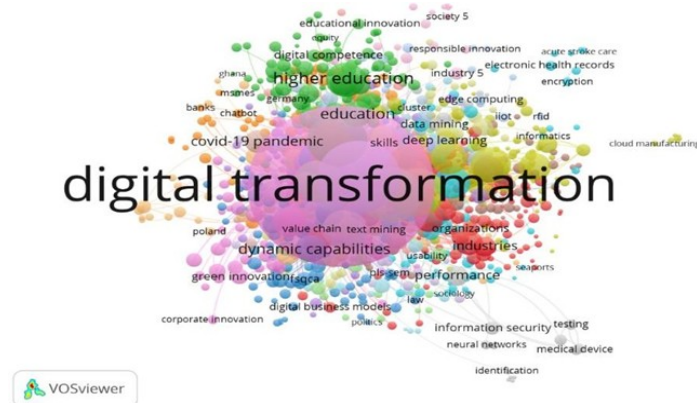


Figure 7. Keyword Network Analysis

2.3.2. Citation by Authors

Based on total citations, the authors Kraus and Sascha emerge as the most cited, with the total link strength 600. Following that, Arias-Perez and Jose with the total length strength 92. These are indicated in the density map of Figure 8 with yellow markings.

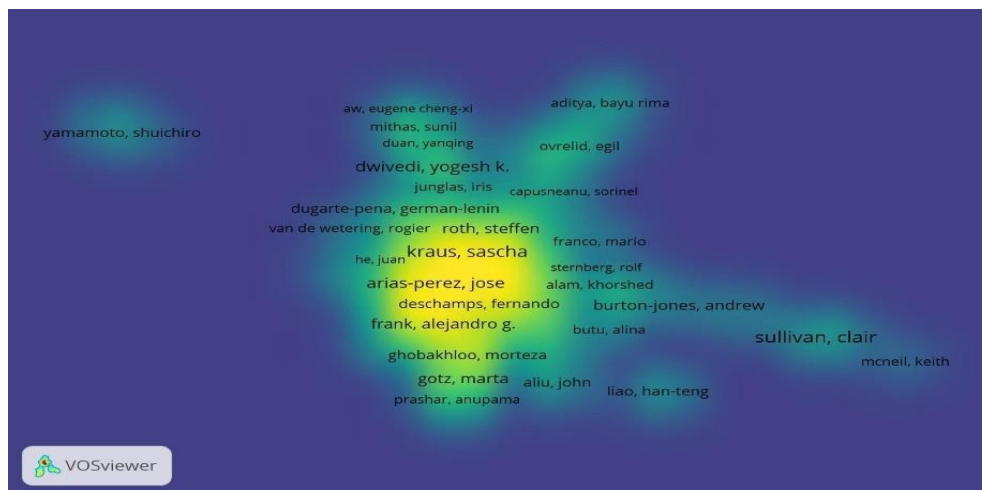


Figure 8. Authors' Density Visualization

2.3.3. Citations of Documents

The study also analyzed the most cited documents by setting 5 as the minimum citation threshold (Figure 9). The ones that met this requirement included in the analysis. Each of the clusters was expressed in a different color according to the year included. The node's size corresponds to the ratio of the number of citations in a journal. The link connecting two points signifies co-citation between two selected papers.

Furthermore, the length of the link indicates the correlation between the two journals. A shorter connection distance indicates a stronger correlation between them. According to Figure 9, "Frank, 2019" with 942 citations aims to generalize implementation of digital technologies, is observed as the most cited work. "Matt, 2015" (746 citations) discuss about digital information technologies, "Nambisan & Agarwal 2010", 471 citations aim to understand the transformation of the economy into a digital landscape requires the incorporation of multiple levels and cross-levels of analysis.

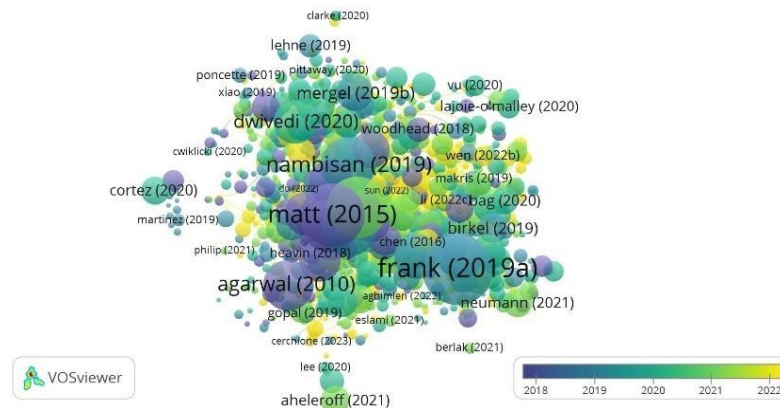


Figure 9. Most Cited Documents Visualization

3. Discussion

Digital transformation has become a strategic requirement for firms looking to flourish in the digital age in the face of extraordinary technical innovation. It involves reinventing corporate models, procedures, and consumer experiences, not just implementing new technologies. Organizations can open new doors for growth, innovation, and competitiveness by embracing this path, ultimately influencing a future that is both digital and revolutionary.

Bibliometric analysis provides a potent lens through which we can study the landscape of digital transformation. The analysis emphasizes how the discipline is expanding, how it is interdisciplinary, and how new ideas are emerging. These factors all help us comprehend this important phenomenon. Staying aware of these trends and insights is crucial for individuals navigating the always shifting world of innovation and technology as digital transformation continues to impact sectors, society, and research agendas.

A bibliometric analysis covering the years 2015 through 2023 was conducted, utilizing a sample of 5706 articles that featured the term "digital transformation" in their titles or keywords from the Web of Science (WoS) database. These publications originated from 1816 different sources, with 605 being single authored, involving a total of 16,306 authors. The number of publications experienced an increase from 2017 onwards, reaching its highest level in 2021. This increase is attributed to the acceleration of digitalization processes, closely linked to the COVID-19 pandemic.

According to keyword co-occurrence analysis, "digital transformation," "digital technology," and "Industry 4.0" were the most frequently used terms. In the literature, "Industry 4.0," "digitalization," "big data," and "e-commerce" emerged as the most prominent keywords. This suggests that digital transformation research has focused on technological advancements and their applications in business and industry.

According to the analysis, China is the country with the highest number of publications in this field, while Germany has been identified as the most cited country. This may be since foundational studies in the field originated from Germany. That finding confirms the result of Shi et al. (2022), which suggests that researchers with significant collaboration are predominantly from German institutions. Meanwhile, Chawla and Goyal (2021) identified the United States as the most contributing country in terms of articles published in the digital transformation research area, followed by Germany and Sweden. Similarly, both studies identify Russia as one of the most leading nations in the field of digital transformation research.

3.1. Theoretical Implications

This study contributes to the literature on digital transformation in three key ways. First, it conducts a bibliometric analysis of academic trends in digital transformation, examining the growth in publications and the structure of academic collaboration networks. Second, it identifies the most cited studies and key concepts, thereby establishing the theoretical framework of the field. Third, it explores the technological and strategic factors shaping digital transformation, highlighting major themes that define its evolution. Future research should adopt multidisciplinary approaches to refine models and frameworks that provide a more comprehensive understanding of digital transformation and its implications across various domains.

3.2. Practical Implications

The primary limitation of this study is its reliance on the Web of Science database, which excludes potentially valuable publications from other sources. Future research should consider the following directions: Companies implementing digital transformation should align new technologies with organizational culture and leadership strategies. Digital transformation is reshaping learning and development strategies. Businesses should invest in e-learning and remote training programs to enhance employees' digital competencies. With the increasing importance of data, organizations should adopt big data analytics and AI-powered decision-making systems to enhance strategic planning.

3.3. Limitations and Future Research Directions

The primary limitation of this study is its reliance on the Web of Science database, which excludes potentially valuable publications from other sources. Future research should address this limitation by incorporating additional databases such as Scopus and Google Scholar to broaden the scope of analysis and provide a more comprehensive overview of digital transformation literature. Additionally, the geographical distribution of research on digital transformation varies significantly, with limited studies focusing on developing economies. Future studies should explore the applications and strategic management of digital transformation in these regions, examining the challenges and opportunities unique to emerging markets.

Another promising direction for future research involves investigating interdisciplinary connections between social sciences, engineering, and information sciences to develop a holistic understanding of digital transformation. Furthermore, emerging technologies such as blockchain, artificial intelligence, and online learning platforms are reshaping business models, and their impact should be further examined to understand their role in driving digital innovation and transformation. By addressing these gaps, future research can provide deeper insights into the evolving landscape of digital transformation and its implications for different industries and economies.

Additionally, for guiding future research, expanding the selection of keywords could be recommended. Considering the latest advancements in digital technology, it is anticipated that Digital Transformation will evolve into an extensive and deeply integrated interdisciplinary research domain across both academic and practical areas.

Conclusion

Digital transformation continues to be a dynamic and rapidly evolving field. This study provides valuable insights into the current state of research and highlights key areas for future exploration. As digital transformation becomes an integral part of organizational strategy worldwide, ongoing research will be essential to understanding its full potential and addressing the challenges it presents.

The study's findings emphasize the importance of digital transformation in enhancing business agility, operational efficiency, and customer experience. With the increasing adoption of technologies such as artificial intelligence, big data, blockchain, and cloud computing, organizations are finding new opportunities to innovate and create competitive advantages. However, the rapid pace of technological advancements also brings challenges, such as cybersecurity risks, ethical concerns, and the need for continuous skill development.

Additionally, the role of policymakers and regulatory bodies in shaping digital transformation strategies cannot be overlooked. Governments and industry leaders must collaborate to establish frameworks that encourage responsible digital transformation while ensuring data security and privacy. Future research should focus on examining these regulatory challenges and identifying best practices for sustainable digital transformation.

Moreover, this study highlights gaps in the literature regarding the impact of digital transformation on small and medium-sized enterprises (SMEs) and developing economies. While large corporations often have the resources to adopt digital strategies effectively, smaller organizations may face financial and technical barriers. Addressing these disparities through tailored research and policy recommendations can help ensure that digital transformation benefits all organizations, regardless of size or location.

In conclusion, digital transformation is not just a trend but a fundamental shift in how businesses and industries operate. By continuously evaluating its progress and addressing associated challenges, researchers, business leaders, and policymakers can work together to drive meaningful change and innovation in the digital era.

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