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KEY SUCCESS FACTORS IN DIGITAL TRANSFORMATION: FUNDAMENTALS DEVELOPED FROM A BIBLIOMETRIC ANALYSIS

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Abstract

The article analyses a multidimensional digital transformation process. Digital transformation is a change or shift in operational and strategic frameworks necessitated by the rapid advancement of digital technology. Digital transformation is more than the implementation of advanced technology, it requires a cultural shift towards constant experimentation and openness to failure. Such changes make the organization agile, efficient, and customer-orientated, with the ability to quickly integrate new, comprehensive data into the entire decision-making and innovation process. The purpose of the research was therefore to analyse the key success factors in digital transformation. The analysis serves as a basis for further theoretical research in this field and for practical implementation in organisational systems. As part of this research, a bibliometric analysis was carried out using the open-source tool VOSviewer. The analysis shows that digital transformation is particularly relevant in the fields of Computer Science; Business, Management and Accounting; and Engineering, namely in Germany, China and the Russian Federation. We have come to the conclusion that the key success factors in digital transformation are as follows: corporate organization and technology, collaboration and cultural change, holistic strategy, leadership and organizational structure, continuous learning and conformity to best practises.

Keywords: digital transformation, advanced technologies, key success factors, bibliometric analysis, VOSviewer

1. INTRODUCTION

The digital transformation brings a massive change in the operational and strategic paradigms of organizational systems in various business areas. This paper consolidates the results of various studies on the process, challenges, enablers, and impact

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of digital transformation. Digital transformation is the change in organizational systems that infuses business processes with digital technology and significantly alters workflows and the delivery of customer value. In other words, it is a cultural change that involves continuous experimentation and innovation. The evolution described will enable the organizational systems to be agile, efficient, and customer-centric and use data for decision-making and innovation. Therefore, a holistic approach to digital transformation would transform customers' business processes and create a new customer culture and experience. It also ensures smoother business operations while increasing competitiveness.

Experts nowadays deal with digital transformation in various areas:

- Lokuge & Duan (2021) - The research aims to identify specific factors that enable or constrain the adaptation of digital technologies in SMEs.

- Egodawele et al. (2022) - This paper reviews the literature for 2013-2021 and proposes an a priori model to guide future research in this area. The model suggests an initial framework for some key areas and methodologies in digital transformation.

- Huang (2022) - This paper examines how artificial intelligence (from now on referred to as AI) is used in digital transformation. The study focuses on how digital technologies can improve technical processes.

- Wu & Li (2023) - The study examines the interrelationship between environmental, social, and management factors in digital transformation and sustainability.

Our paper discusses the key success factors in the digital transformation of organizational systems. The paper is organized as follows: first, we discuss the key technologies currently the cornerstones of digital transformation. Then, we present some key success factors for business process management. We conclude the literature review with the challenges of digital transformation and a summary of 3 case studies. Our research flowchart was presented in the "Data and Methodology" section. This was followed by comprehensive bibliometric analysis and visualization of digital transformation and its key success factors. We finished the paper with the conclusion.

2. LITERATURE REVIEW

2.1. Advanced technologies

Three predominant elements have emerged as the three pillars of digital transformation that will be an integral part of the world in which technology changes how we live and work: digital twins, AI, and smart factories. This will shape the future of many business sectors as the technologies support efficiency, reliability, and innovation. Digital twins connect the physical and virtual worlds for all stakeholders, AI drives change and innovation, and smart factories transform production by changing business models.

Figure 1 illustrates the path of technology trends. The diagram has been divided into four quadrants: 'Smart World', 'Critical Enablers', 'Privacy and Transparency', and 'Productivity Revolution'. Technologies include AI avatars, quantum processors, multimodal user interfaces, 5G networks, and human-centred AI based on self-directed learning. The time scale is graded according to the impact (from low to very high) and

other key aspects from today to eight years in the future. This figure shows that AI, digital twins, and smart factories will continue to shape the future in various business areas.

2.2. Key success factors for business process management in organizational systems

Business processes are the building blocks for the success of digital transformation. They depend on many factors from the wider, narrower, and internal environment that influence their efficiency and effectiveness. The six sub-environments from the wider environment are legal-political, economic, cultural, technological, demographic, and environmental. They constrain the organizational system but provide opportunities to make the business process efficient and effective. The system's immediate environment, which also affects performance, includes the market for goods, labour demand, capital demand, and business and technical information. However, the primary identified impact relates to internal environment factors: business systems ownership, management and leadership, business systems organization, financial factors, infrastructure and working conditions, technical and technological factors, information and communication technologies, organizational culture, and

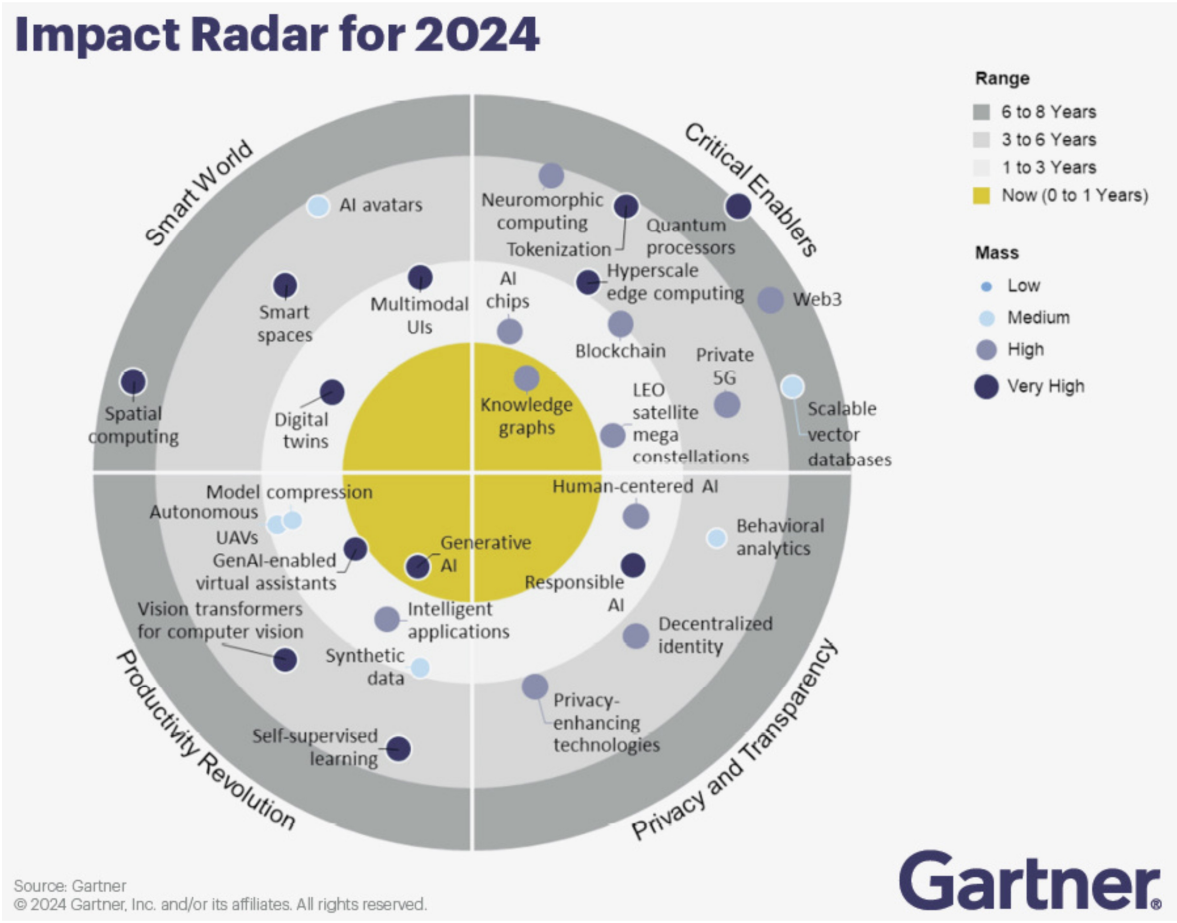

Figure 1. Advanced technologies based on quadrant, range, and mass (Gartner, 2024 in Perri, 2024)

quality factors. Together, these factors form a mosaic of the internal environment and, in combination, are necessary to lead organizational systems to efficiency and innovation (Urh, 2011).

Efficiency and effectiveness factors, on the other hand, can also be considered from the perspective of business process improvement approaches. Some of the most important factors are (Krhač Andrašec et al., 2024): decisive leadership and management commitment; project selection and project management skills; focus on customer satisfaction; organizational culture; established continuing education and training programs; team communication; motivation, commitment, and involvement of employees; use of information technology; an established system for continuous improvement; cooperation of the working environment; adequate resources (staff, budget and time); an established system for monitoring and measuring efficiency and effectiveness; implemented an appropriate change management system; understanding of methodology, techniques and tools.

2.3. Challenges of digital transformation

Organizational systems in digital transformation must overcome several challenges to realize their potential. The literature reviewed shows the most critical challenges faced by the various organizational systems:

- Organizational and cultural resistance: employees find it difficult to deviate from the status quo and prefer to work with legacy systems. This resistance stems from a deep-rooted organizational culture that perceives digital change as a threat (Xu et al., 2022).

- Lack of expertise: this challenge is particularly prevalent in developing countries and the public sector, where strict regulations and protocols make it difficult to recruit qualified staff (Huang, 2022).

- Security concerns: ensuring the security of digital services is paramount. Reliable tactics for information security are needed; failure in this area can lead to a loss of trust in digital technologies (Xu et al., 2022).

- Stakeholder relations: all employees must be involved in the digital transformation process, particularly in the public sector, where stakeholder engagement is critical to ensure accountability (Huang, 2022).

- Challenges of strategic differentiation and sustainable development: a strategic approach must align with the organization's broader goals and pursue a sustainable future. The recommended strategy includes expanding the digital infrastructure, strengthening the industrial database, and improving the traceability of services (Wu & You, 2021; Zhou et al., 2023).

2.4. Case studies on digital transformation

In recent years, Nike has sought to expand its direct-to-consumer channels and digital platforms through digitalization. They wanted to better understand and serve customers to remain competitive in the changing retail environment (Dhesi, 2021). At Johnson & Johnson, the mission says it all in one sentence: they must revolutionize how business is done. The company wants to improve surgical care, using advanced visualization, robotics, state-of-the-art instruments, and data analytics. This will enable easier access and rapid learning for surgical robots. Surgery 4.0 focuses on

digital innovations that can improve healthcare by providing real-time insights from well-collected data (Harvard Business School Digital Initiative, 2018). The other company, L'Oreal, has kept pace with digital technologies by reinventing consumer interaction and innovation in its product development process. For example, L'Oreal has increased funding for digital media and developed an 'e-commerce' strategy for many markets. The company has used consumer data analysis for product development, which has led to some successful launches. In 2014, L'Oreal Paris launched 'Makeup Genius', which allowed users to wear virtual makeup while enhancing their shopping experience with the brand when they are not in-store (Eckfeldt, 2016).

3. DATA AND METHODOLOGY

The study aims to identify the key success factors of digital transformation, which has been done through a bibliometric analysis. Bibliometric analysis is a comprehensive research technique that examines and analyses the growth of emerging trends in a given academic field. It is relatively new in research techniques, although its application is increasing (Donthu et al., 2021). Our literature searches were conducted in the Scopus database, known for its academic rigor and width of coverage.

This search was conducted from 2016 to 2023 in all languages and document types. The search terms were intentionally structured to capture articles on 'digital transformation' and many iterations of key success factors, which can be found under the search string in Figure 2. All 624 documents collected on the 4th of April 2024 were considered for the bibliometric analysis, which shows a considerable volume of research in this area. This bibliometric analysis revealed the most influential works, authors and the current emerging trends in the research field of digital transformation.

The tools used to study the data set are Microsoft Excel and VOSviewer, a software that helps develop and visualize bibliometric networks. VOSviewer supports the creation of maps from the provided bibliometric data and, at the same time, offers advanced options for visualizing different network structures, e.g., co-authorship, citation, and co-occurrence networks (Van Eck & Waltman, 2023).

4. RESULTS AND DISCUSSION

Table 1 contains a detailed list of document types within a data set of 624 publications on the success factors of digital transformation. Articles are most frequently represented with 255 or 40.87 % of the dataset. This is closely followed by conference contributions with 248 documents, which account for 39.74 %. Book chapters are also strongly represented with 63 documents or 10.10 % of the total. The compilation contains 31 conference reports (4.97%), 17 reviews (2.72%), six books (0.96%), three notes (0.48%), and one editorial (0.16%), which together account for 9.29% of the total. This list shows how diverse sources are key success factors of digital transformation.

Figure 3 shows the line chart 'Documents by year' - the publication output from 2016 to 2023, showing a remarkable upward trend in the production of documents over the years. Starting with only six documents in

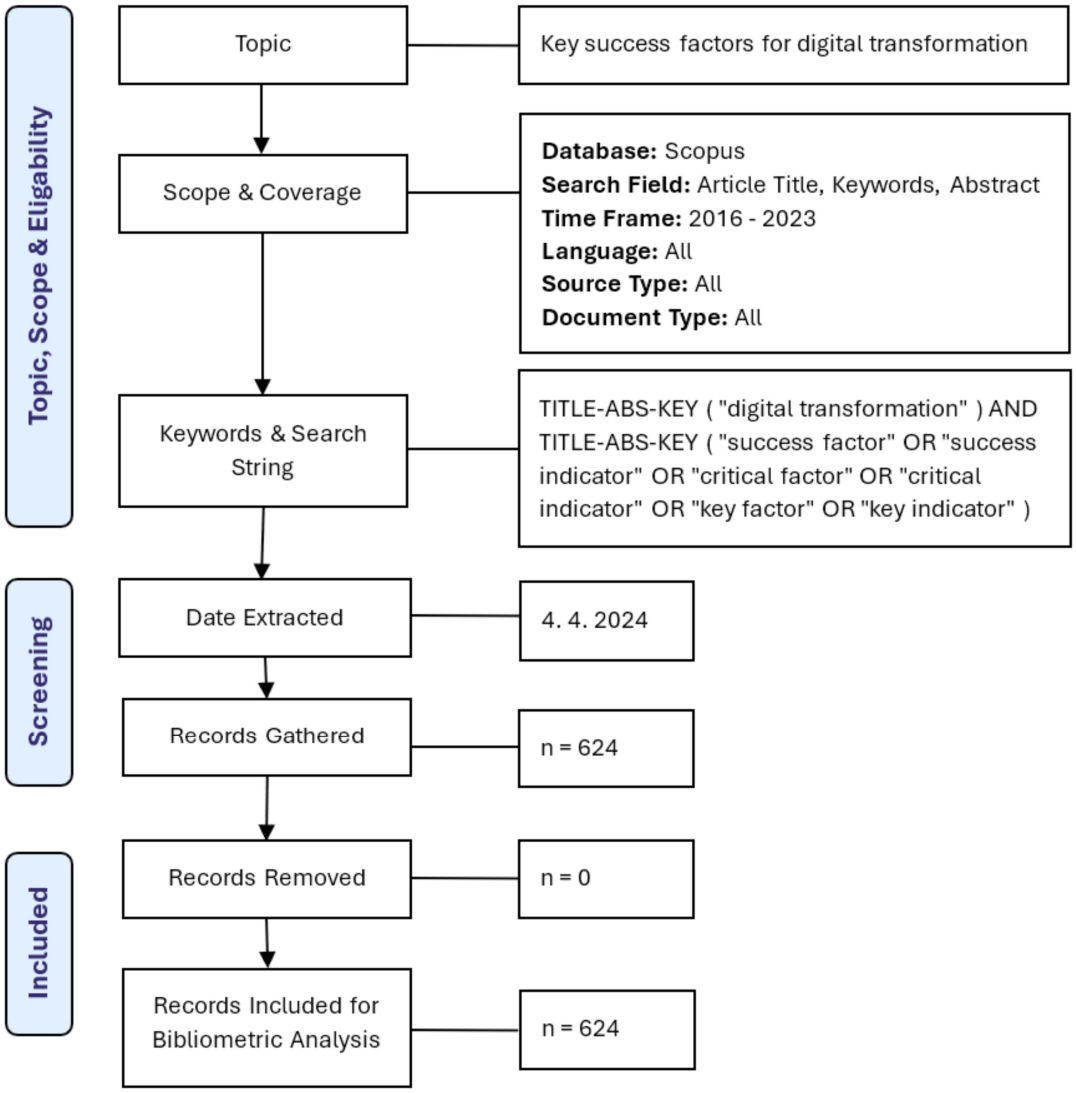

Figure 2. PRISMA flow-chart outlining the research process

Table 1. Document types

Document Type	Total Publications	Percentage (%)
Article	255	40.87
Conference Paper	248	39.74
Book Chapter	63	10.10
Conference Review	31	4.97
Review	17	2.72
Book	6	0.96
Note	3	0.48
Editorial	1	0.16
Total	624	100.00

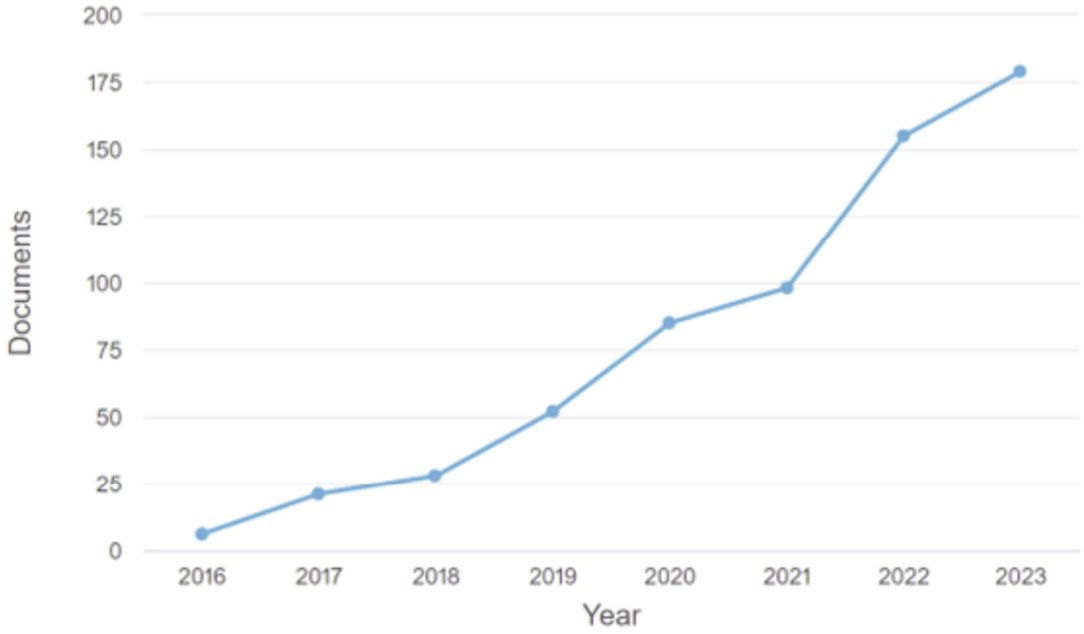

Figure 3. Documents by year from the Scopus database

2016, the number has increased yearly: 21 in 2017, 28 in 2018, 52 in 2019, 85 in 2020, a significant jump to 98 in 2021 and further to 155 in 2022, up to 179 in 2023. This trend underlines the growing interest and commitment in this area, as shown by the increasing number of annual publications.

Table 2 represents the number of subject areas, the total number of publications, and the corresponding percentage of the documents. 'Computer Science' leads with 328 publications, accounting for over half of the total. This is closely followed by 'Economics, Management and Accounting' with 229 publications (36.70%) and 'Engineering Sciences' with 194 publications (31.09%). In addition, 133 publications (21.31%) are in 'Decision Sciences', 118 (18.91%) in 'Social Sciences', 91 (14.58%) in 'Economics, Econometrics and Finance', and 56 (8.97%) in 'Energy'. Smaller contributions can be seen in areas including 'Environmental Sciences', 'Mathematics', 'Earth and Planetary Sciences' and 'Medicine', down to areas such as 'Neuroscience', which has only one publication, representing 0.16% of the total. These data provide a clear, quantitative overview of the interdisciplinary nature of the publications relevant to the study's focus area.

Figure 4 represents a bibliometric network focussing on digital transformation. The largest and most central node is digital transformation, the central theme to which all related terms and concepts are connected. Minimum number of keyword occurrences had to be at least 10.

Notable nodes associated with digital transformation are 'success factors' and 'critical success factors', indicating the extensive research on the conditions that influence a successful digital transformation. There is a cluster around 'Industry 4.0',

Table 2. Subject area

Subject area	Total publications	Percentage (%)
Computer Science	328	52.56
Business, Management and Accounting	229	36.70
Engineering	194	31.09
Decision Sciences	133	21.31
Social Sciences	118	18.91
Economics, Econometrics and Finance	91	14.58
Energy	56	8.97
Environmental Science	54	8.65
Mathematics	53	8.49
Earth and Planetary Sciences	22	3.53
Medicine	20	3.21
Materials Science	14	2.24
Physics and Astronomy	13	2.08
Arts and Humanities	12	1.92
Psychology	12	1.92
Chemical Engineering	9	1.44
Health Professions	6	0.96
Multidisciplinary	6	0.96
Biochemistry, Genetics and Molecular Biology	4	0.64
Chemistry	4	0.64
Agricultural and Biological Sciences	3	0.48
Neuroscience	1	0.16

‘machine learning’ and ‘Internet of Things’, critical technological components of digital transformation. Terms such as ‘e-learning’, ‘digital economy’, and ‘cloud computing’ are more far-reaching effects of digital transformation. The query examines the pandemic's impact on digital transformation because ‘COVID-19’ also happened during the represented years. Other nodes, e.g., sustainable development and innovation, point to more prominent socio-economic topics.

The sophistication of this network, as indicated by the number of nodes and the links they contain, shows that research in the field of digital transformation is interdisciplinary and encompasses a variety of topics, including technology, economics, social sciences, and others. The visualization reflects the main themes identified and the connections found throughout the literature on digital transformation.

The network visualization, as seen in Figure 5, was developed to illustrate the relationships between countries based on research findings and citation links in digital transformation. Each node represents a country, with larger nodes indicating a greater volume of documents from that country.

Countries such as Germany, the United Kingdom, and the Russian Federation have larger nodes, indicating their significant contributions in terms of documents. The different colours of the nodes may indicate different clusters or regions with similar research interests.

The lines connecting the countries represent citation relationships and indicate that researchers in these countries refer to the

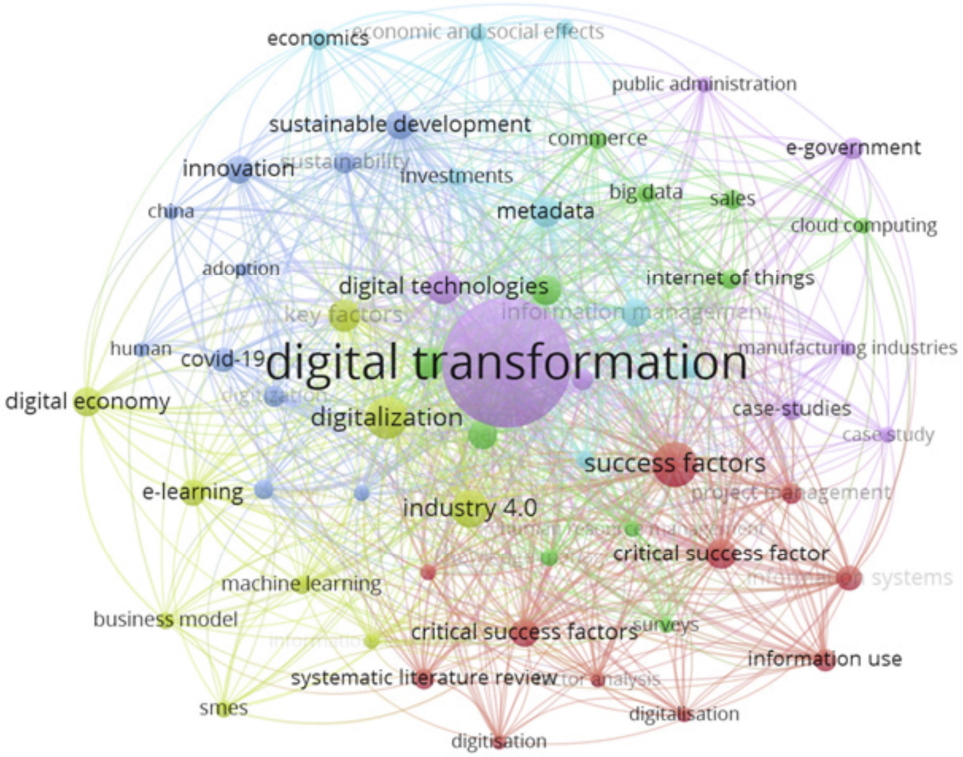

Figure 4. Network visualization map of keywords

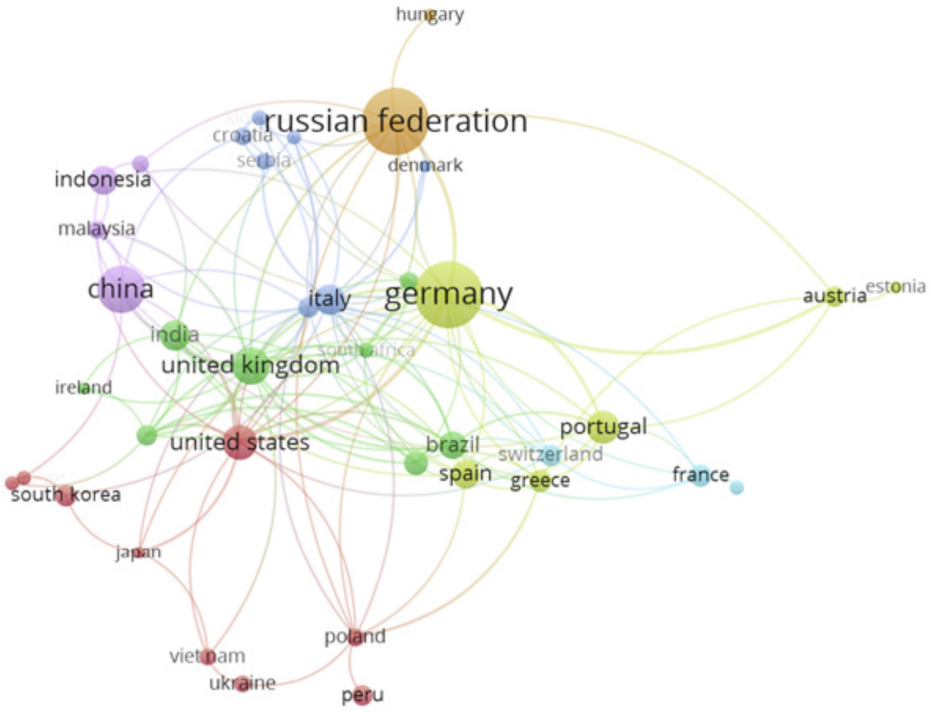

Figure 5. Network visualization map of the co-authorship of countries

work of their international colleagues. The network includes only countries with at least five documents and ten citations, thus focusing on the most active and influential authors in this research area.

This map is a valuable tool for understanding the global dynamics of collaboration and influence within the research community, identifying key "players", and highlighting potential avenues for international collaboration.

Table 3 represents a research corpus based on bibliometric data for 2016-2023. 624 papers were published during this period and received 3675 citations. The impact is spread over eight years of citations and averages 459.38 annually. This can be further broken down into individual papers, i.e., each was cited almost 5.89 times on average, demonstrating good referencing and, therefore, the relevance of the work in this area. These data are characterized by the outstanding fact that they have an h-index of 31, meaning that at least 31 of these papers have been cited 31 times or more. This means that the papers influence academic discourse both horizontally and vertically.

Table 3. Citation metrics

Metrics	Data
Publication years	2016-2023
Citation years	8 (2016-2023)
Papers	624
Citations	3675
Citations/year	459.38
Citations/paper	5.89
h-index	31

5. CONCLUSION

Companies focus on digital transformation to be sustainable and competitive in the ever-changing digital environment. This includes several key success factors related to organizational structure, technology adoption, and appropriate strategic management. Below are just a few of these, as identified in research by experts in these fields (Vogelsang et al., 2018; Guinan et al., 2019; Ramesh & Delen, 2021):

- Corporate organization and technology: the role of corporate culture, top management support, and a unified corporate digital strategy, vision, and long-term goals.

- Collaboration and cultural change: this means working with customers, suppliers and other companies to promote a cultural change that enables flexible working environments with interdisciplinary activities.

- Holistic strategy: companies should develop a holistic approach incorporating technology, innovation, and dimensions.

- Leadership and organizational structure: the key capabilities required to implement today's digital business strategy successfully are in the areas of leadership, innovation, and organizational structure that support digital initiatives.

- Continuous learning and conformity to best practises: constant learning and compliance with best practices by building an innovation base to create innovative digital project teams is a condition for digital transformation.

A deeper understanding of the key success factors for digital transformation emerges from the bibliometric analysis conducted in this study between 2016 and 2023. Drawing on the extensive Scopus database to search for the most relevant literature, the study summarises 624 articles with a total of 3675 citations that demonstrate the growing interest and influence in this area. These

remarkable figures, with an average of 459.38 citations per year and 5.89 per article, and an h-index of 31, leave no doubt about the level of influence and academic engagement in the field. Analysis tools such as Microsoft Excel and VOSviewer have made the analysis more accessible by providing many reflections on the extensiveness of interdisciplinary research on digital transformation at the intersections of technology, economics, and social sciences. The keyword visualization maps show the key themes, while the geographical co-authorship networks highlight the rapid changes in the international landscape driving the field forward. Our paper not only represents the current state of research in the field of digital transformation but also provides a solid foundation for future scholarly work reflecting emerging trends in academic research.

We have found that successful digital transformation is a multi-faceted concept. It must be considered in collaboration with organizational culture, strategy, leadership, and technology deployment to achieve an effective implementation outcome. It is a broad field that surrounds a range of technologies and strategies aimed at transforming business in today's digital world - either with the introduction of digital twins in product lifecycle management, the use of AI for better decision making, or the implementation of innovative factory principles for manufacturing excellence. As organizations are guided by the challenges and opportunities of digital transformation, it is important to focus on strategic alignment, cultural change, and the proper use of technology to achieve sustainable development and remain competitive. The most important factors for a successful digital transformation continue to drive the efforts of many companies in Industry 4.0, and understanding of them is constantly growing.

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КЉУЧНИ ФАКТОРИ УСПЕХА У ДИГИТАЛНОЈ ТРАНСФОРМАЦИЈИ: ОСНОВЕ РАЗВИЈЕНЕ ИЗ БИБЛИОМЕТРИЈСКЕ АНАЛИЗЕ

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Извод

У чланку се анализира вишедимензионални процес дигиталне трансформације. Дигитална трансформација је промена оперативних и стратешких оквира која је неопходна због брзог напретка дигиталне технологије. Дигитална трансформација је више од имплементације напредне технологије, она захтева културни помак ка сталном експериментисању и отворености за неуспех. Такве промене чине организацију агилном, ефикасном и оријентисаном на купца, са способношћу да брзо интегрише нове, свеобухватне податке у цео процес доношења одлука и иновација. Сврха истраживања је стога била анализа најважнијих фактора успеха у дигиталној трансформацији. Анализа служи као основа за даља теоријска истраживања у овој области и за практичну примену у организационим системима. У оквиру овог истраживања извршена је библиометријска анализа помоћу алата отвореног кода "VOSviewer". Анализа показује да је дигитална трансформација посебно релевантна у областима рачунарских наука; пословање, менаџмент и рачуноводство; и инжењеринг, посебно у Немачкој, Кини и Руској Федерацији. Дошли смо до закључка да су кључни фактори успеха у дигиталној трансформацији: корпоративна организација и технологија, сарадња и културна промена, холистичка стратегија, лидерство и организациона структура, континуирано учење и усклађеност са најбољим праксама.

Кључне речи: дигитална трансформација, напредне технологије, кључни фактори успеха, библиометријска анализа, VOSviewer

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