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Systematic Review

A Quantitative Review of the Research on Business Process Management in Digital Transformation: A Bibliometric Approach

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Abstract: In recent years, research on digital transformation (DT) and business process management (BPM) has gained significant attention in the field of business and management. This paper aims to conduct a comprehensive bibliometric analysis of global research on DT and BPM from 2007 to 2022. A total of 326 papers were selected from Web of Science and Scopus for analysis. Using bibliometric methods, we evaluated the current state and future research trends of DT and BPM. Our analysis reveals that the number of publications on DT and BPM has grown significantly over time, with the Business Process Management Journal being the most active. The countries that have contributed the most to this field are Germany (with four universities in the top 10) and the USA. The Business Process Management Journal is the most active in publishing research on digital transformation and business process management. The analysis showed that "artificial intelligence" is a technology that has been studied extensively and is increasingly asserted to influence companies' business processes. Additionally, the study provides valuable insights from the co-citation network analysis. Based on our findings, we provide recommendations for future research directions on DT and BPM. This study contributes to a better understanding of the current state of research on DT and BPM and provides insights for future research.

Keywords: business process management; digital transformation; biblioshiny; bibliometrics

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1. Introduction

During the last decade, organizations have increasingly recognized the importance of effective management processes due to fierce global competition, shorter product life cycles, and the need for comprehensive information analysis to facilitate effective decision-making [1]. With increasing reliance on technology, enterprise information systems have become crucial tools for managing and processing vast amounts of information, automating repetitive tasks, and streamlining business processes. All this leads to a greater workload for the information system, an increased need for evolutionary maintenance, and a progressive decrease in the quality of the system [2]. In this context, business process management (BPM), often cited as "management of the (re-)design of individual business processes and how to develop a foundational BPM capability in organizations catering for a variety of purposes and contexts" [3], plays a crucial role in facilitating the integration of these systems with an organization's business processes, thus enabling a higher level of operational excellence and more effective responses to changing market conditions.

Despite the acknowledged significance of BPM as a research area [4–8], a research gap has been identified in connection with the area of digital transformation (DT), which encompasses the incorporation of digital technology across all aspects of a business, resulting

in fundamental operational and value delivery shifts, occurring in diverse contexts where companies pursue distinct strategies to enhance their digital presence. On the one hand, BPM research relies on three important logics: modeling, infrastructure, and procedural actor logic. While the three logics have proven useful in prior contexts, it is not evidenced how they work in the context of DT [9]. On the other hand, DT research highlights success factors with DT: a sustainable digital strategy, an operational backbone facilitating operational excellence [10], and a services platform enabling rapid innovation. Many BPM topics can contribute to these DT elements. However, empirical research remains relatively limited. The combination of traditional BPM paradigms and the recent business context of DT has triggered new directions in research on process management, including light-touch processes (processes), infrastructure flexibility, and agents.

To characterize the overlap section between BPM and DT, we first need to clarify the boundary of these concepts. In the context of enterprise information systems, both DT and BPM share many similarities, which are (1) common goals to improve the efficiency and effectiveness of an organization's operations, (2) heavy reliance on technologies, and (3) a requirement of a comprehensive and integrated view of the organization and its processes [11]. Dumas et al. emphasized the role of BPM as a preliminary stage of DT because both share the same goal of optimizing business information systems [11].

There is also a worth-mentioning difference between the concepts of DT and BPM. BPM focuses specifically on managing and improving business processes, whereas DT is a broader concept encompassing the integration of digital technologies into all areas of an organization. BPM is primarily focused on process improvement, while DT aims to drive fundamental change and innovation in an organization. Vial et al. highlighted the process aspect of DT, and the DT journey encompasses multiple stages and processes taking place in various contexts where BPM can fit into this process [12]. Many BPM topics can contribute to these process elements of DT; however, empirical research in this area is relatively limited. The combination of traditional BPM models and the recent business context of DT has triggered new research directions in process management, including lightweight (agile) processes, the flexibility of infrastructure, and stakeholder engagement.

To systemize the research on BPM in the DT context, a secondary study, i.e., a survey study or literature review is useful to capture current knowledge and present research gaps. To have some quantitative insight, we are interested in performing a bibliometric study. Bibliometrics has been widely applied in many fields to analyze and synthesize valuable insights and knowledge about the characteristics, patterns, and trends within a specific field of study or research [13]. This is a useful tool for quantitative and qualitative analysis of the published academic literature [2,13,14]. This study used the R package Biblioshiny Bibliometrix (https://www.bibliometrix.org/home/index.php/layout/biblioshiny, accessed on 21 July 2023) [15], which helps to visualize the research results in this paper.

There are several existing bibliometric studies in either BPM or DT. To name a few, Wohlhaupter [16] analyzed BPM articles in the period 2000–2020 and identified common topics on process mining, process flexibility, process modeling, process compliance, intelligent business, ERP, and SOA. The author included 624 articles in his bibliometric study. Chawla and Goyal conducted a comprehensive bibliometric study on DT in the business and management literature [17]. The study depicted the overall increasing trends of annual publications, author performance, publishing journals, relevant organizations, and countries driving the research, along with key insights from co-citation network analysis. Furthermore, the study evaluated four research domains, namely organizational impact, applied applications and deep understanding, operational processes, and societal aspects, encompassing major research directions within the DT context.

In this study, we aim at providing a report on scientific publications in research about BPM in the DT context. Two research questions (RQs) are defined:

- RQ1—What are the dominant research themes in research about BPM in the DT context?
- RQ2—What are the trends in research about BPM in the DT context?

The paper is organized as follows: Section 1 is the introduction. Section 2 presents our research methodology. Section 3 shows the detail of our findings, including general information, countries contributing to DT and BPM research, H-index analysis, authors' activities, level of publications, citation analysis, reference analysis, and keyword analysis. Section 4 discusses the results of the study and Section 5 concludes the paper.

2. Research Methods

Bibliometric analysis is among the popular types of secondary studies in business and information system research [18]. They reveal current and emerging trends in article and journal performance, collaboration patterns, and research constituents and explore the intellectual structure of a specific domain in the extant literature. Bibliometrics is a published statistical analysis tool that provides quantitative insight into the academic literature [16,19–21]. It includes various approaches such as citation analysis, co-citation analysis and bibliographic link citation [20], and co-synonym analysis for keywords [22]. Following a methodological guideline [18], we conducted the analysis in five steps:

- Step 1: Define aim and scope (Section 1) and choose analysis techniques (Section 2.4)
- Step 2: Define a data source and search strategies (Section 2.1)
- Step 3: Define inclusion criteria (Section 2.2)
- Step 4: Conduct the systematic search (Section 2.3)
- Step 5: Run the analysis and report the result (Sections 2.4 and 3)

2.1. Data Sources and Search Strategies

The first step was to construct a search string to apply to selected digital sources of articles. Deriving from the main RQs, our search string had two parts: digital transformation (C1), and business process management (C2). The synonyms of these terms were identified in the context of either information systems or entrepreneurship research by interviewing field experts. Several trial searches were conducted to adjust the scope of the search string so that we did not include many irrelevant studies from different research fields. With the aim of a broad review, we wanted to include as many studies as possible. After several trials, we ended up with the search string:

("Digital Transformation" OR Digitalization OR Digitization) AND ("business process model" OR "business process management" OR "Business process improvement")

We limited the scope of selection to studies published in English. Several digital databases were suggested by the second author, who had conducted several systematic literature reviews before. The list included Scopus, ISI Web of Science, IEEE Explore, Current Contents, Kluwer Online, Computer Database, Science Direct, Springer Link, Inspec, and ACM Digital Library. Considering the popular databases within BPM research, the previous experiences of the reviewers, the flexible formulation of search strings with unlimited clauses, and convenient exporting paper lists in various formats, we decided to select Scopus and ISI Web of Science. The search ranged from 1970 to 2022, so we could include the largest range of publications.

Regarding the systematic search strategy, we screened the sources based on the title, abstract, and keyword metadata to help us select studies relevant to our RQs.

2.2. Inclusion Criteria

After we retrieved a list of papers from the systematic search, we needed to select ones with relevant content. To do this, we defined inclusion criteria. We applied these criteria when reading the titles, abstracts, and keywords of the publications. The two main inclusion criteria were:

- The paper's main focus is BPM as "a management discipline that focuses on improving the efficiency of an organization by managing its component processes"
- The paper clearly describes [2] one of the transformation aspects: products, processes, and organizational aspects owing to new technologies [23].

In other words, a paper should explicitly present both elements of BPM and DT in their content.

2.3. Conducting the Systematic Search

We adopted a Reporting Items for Systematic Review and Meta-Analysis (PRISMA) flowchart to document our process of systematic search and selection [24,25]. At the identification step, we found 268 articles from Scopus and 186 articles from Web of Science. To facilitate data use and analysis, before filtering the data, the data from the two database sources were merged, then filtering was carried out. This step resulted in a set of 339 unduplicated articles. We also applied the filter from Section 2.2 by manually examining each paper's abstract, title, and keywords. To have as comprehensive analysis as possible, we decided to include all articles, so long as they satisfied the requirement on relevancy. At the end of this step, we gathered a set of 326 studies for the bibliometric analysis. The study collection and analysis are described in Figure 1.

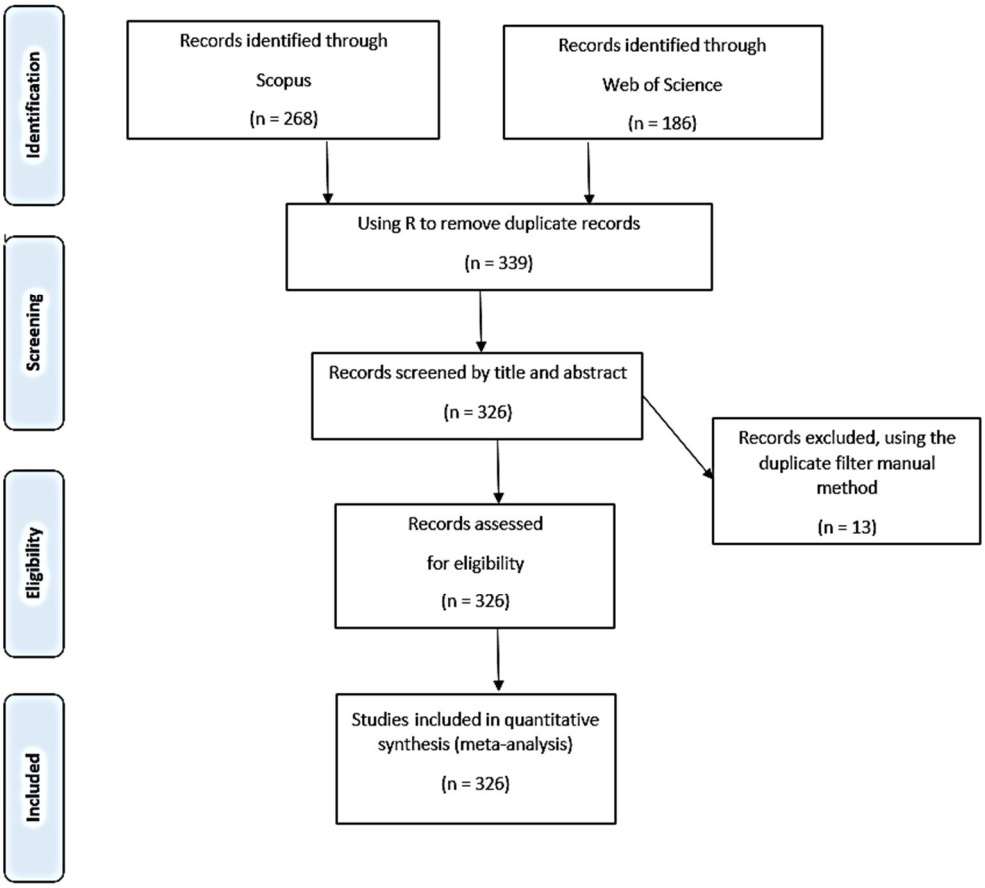


Figure 1. The systematic search and analysis process.

2.4. Bibliometric Analysis

The techniques for bibliometric analysis manifest across two categories: (1) performance analysis and (2) science mapping [26]. Performance analysis accounts for the contributions of research constituents, whereas science mapping focuses on the relationships between research constituents. Various metrics of performance can be found in existing bibliometric analysis studies. Publications' characteristics, including author, journal, institution, citation, H-index, M-index, and the author's country, are considered for reporting. The h-index is used to quantify the results of an individual's scientific research and to measure his citation impact [26]. The M-index is proposed to facilitate comparisons between scholars of different academic years: M-index = H-index/N (N is calculated as the

number of years since the first paper was published) [27,28]. In addition, the index can be used to predict future research by analyzing trending topics via keywords.

Science mapping includes several types of analysis:

- Citation analysis: a basic technique for science mapping that operates on the assumption that citations reflect intellectual linkages between publications that are formed when one publication cites the other [29]. In this analysis, the impact of a publication is determined by the number of citations that it receives.
- Bibliographic coupling: a technique for science mapping that operates on the assumption that two publications sharing common references are also similar in their content [30].
- Co-word analysis: a technique that examines "author keywords", or notable words from "article titles", "abstracts", and "full texts" for the analysis [31]. The co-word analysis assumes that words that frequently appear together have a thematic relationship with other words.
- Co-authorship analysis: examines the interactions among scholars in a research field. Since co-authorship is a formal way of intellectual collaboration among scholars, it is important to understand how scholars interact amongst themselves (including associated author attributes such as affiliated institutions and countries).

In addition, we also conducted network analysis to enrich the assessment of bibliometric analysis. In particular, network metrics shed light on the relative importance of research constituents (e.g., authors, institutions, countries), which may not necessarily be reflected through publications or citations.

We used the biblioshiny library, a Java software developed by Massimo Aria from the University of Naples Federico, for bibliometrix (https://www.bibliometrix.org/, accessed on 21 July 2023) [15]. Biblioshiny combines the functionality of the bibliometrix package with the ease of use of web applications using the Shiny package environment. The main systematic literature reviews of bibliography for bibliographic analysis are presented in Figure 2 [21].

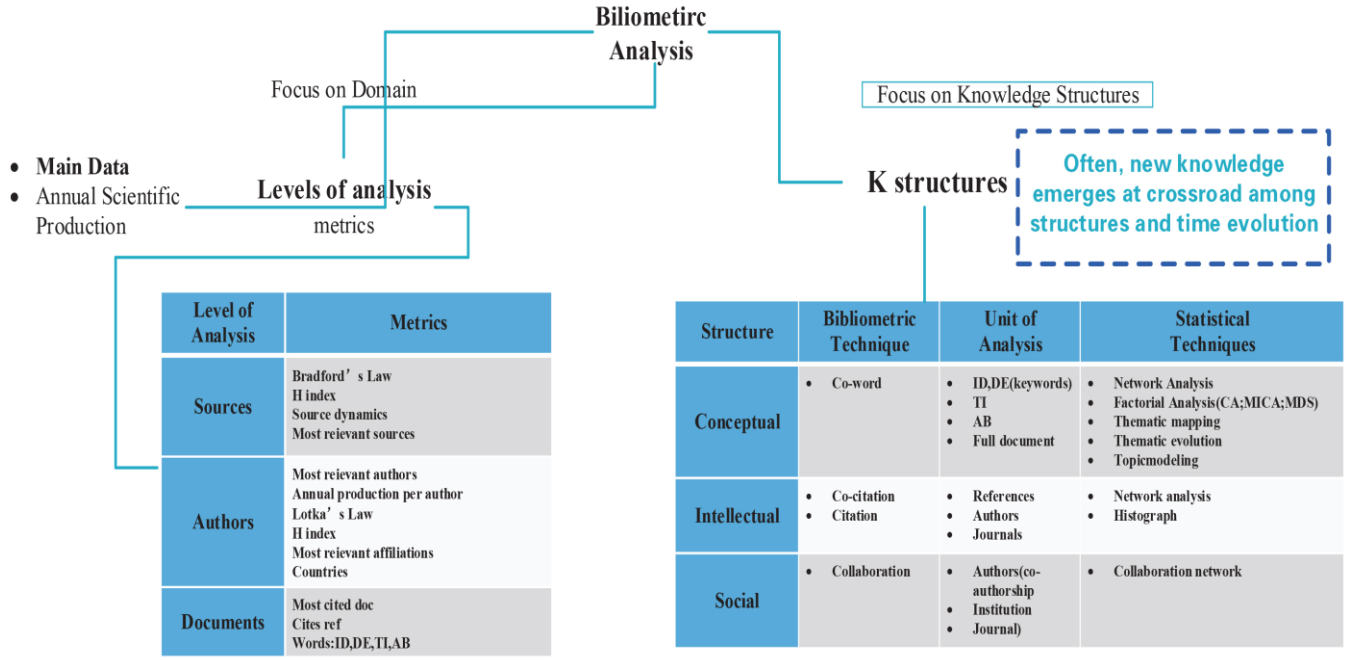


Figure 2. Bibliometric analysis for systematic literature reviews [21].

3. Results

This section reports the findings of our review. Sections 3.1–3.4 reports fundamental and basic performance metrics, including publications and citations per country and

organizations (Section 3.2), most active authors (Section 3.3), and most relevant journals (Section 3.4). Section 3.5 presents insights from the citation and narrative analysis of the most cited papers. Section 3.6 presents a co-word analysis. Section 3.7 is a factor analysis on keywords. Section 3.8 is an analysis of future prospects.

3.1. Fundamental Performance Metrics

Figure 3 shows key information about the data and document types from two database sources, Scopus and WOS. A total of 326 articles (published between 2007 and 2022) related to DT and BPM were obtained from Scopus and WOS. We have shown the number of articles per year in Figure 4a, which shows that the number of publications related to DT and BPM, in general, has increased. Furthermore, the overall trend increased from only one paper in 2007 to 77 articles in 2022. Furthermore, the annual growth rate reached 33.59%. In addition, the average number of citations per year in Figure 4b shows that the average number of citations for DT and BPM can remain stable (approximately 0.64% per year). Therefore, we can conclude that this sector is currently in a steady growth phase, following the global trend of publications.

Figure 3. Main information about the data and the document types from the Scopus and WOS.

3.2. Publications and Citations per Country and Organizations

Table 1 presents the top 10 countries contributing to the total number of citations. A total of 52 countries represent DT and BPM research. By counting the respective authors' countries, Germany contributed the most significant number of citations (250 or 21.7% of the total citations), followed by the United Kingdom (151 or 3.1%) and Italy (84 or 7.3%). The cooperative relationship between these countries is shown in Figure 5a. The thickness of the lines indicates the strength of the relationship. In general, European countries and the United States account for a large proportion. They always cooperate closely with each other, showing their importance to global cooperation. In the top 10 countries that research and contribute to DT and BPM, Asia has only one contributing representative, China (54, 4.7%). Note that the order of the average article citations is inconsistent with the total number of citations (Table 1). In the top 10 countries ranked by total citations, articles from the United Kingdom have the highest average number of article citations.

Table 1. The top 10 countries contributing to the total citations on DT and BPM research.

Rank	Country	TC	Average Article Citations
1	Germany	250	4.63
2	UK	151	37.75
3	Italy	84	5.60
4	France	76	15.20
5	Finland	73	18.25
6	Denmark	72	12.00
7	USA	60	5.45
8	China	54	9.00
9	Romania	37	6.75
10	Belgium	34	3.40

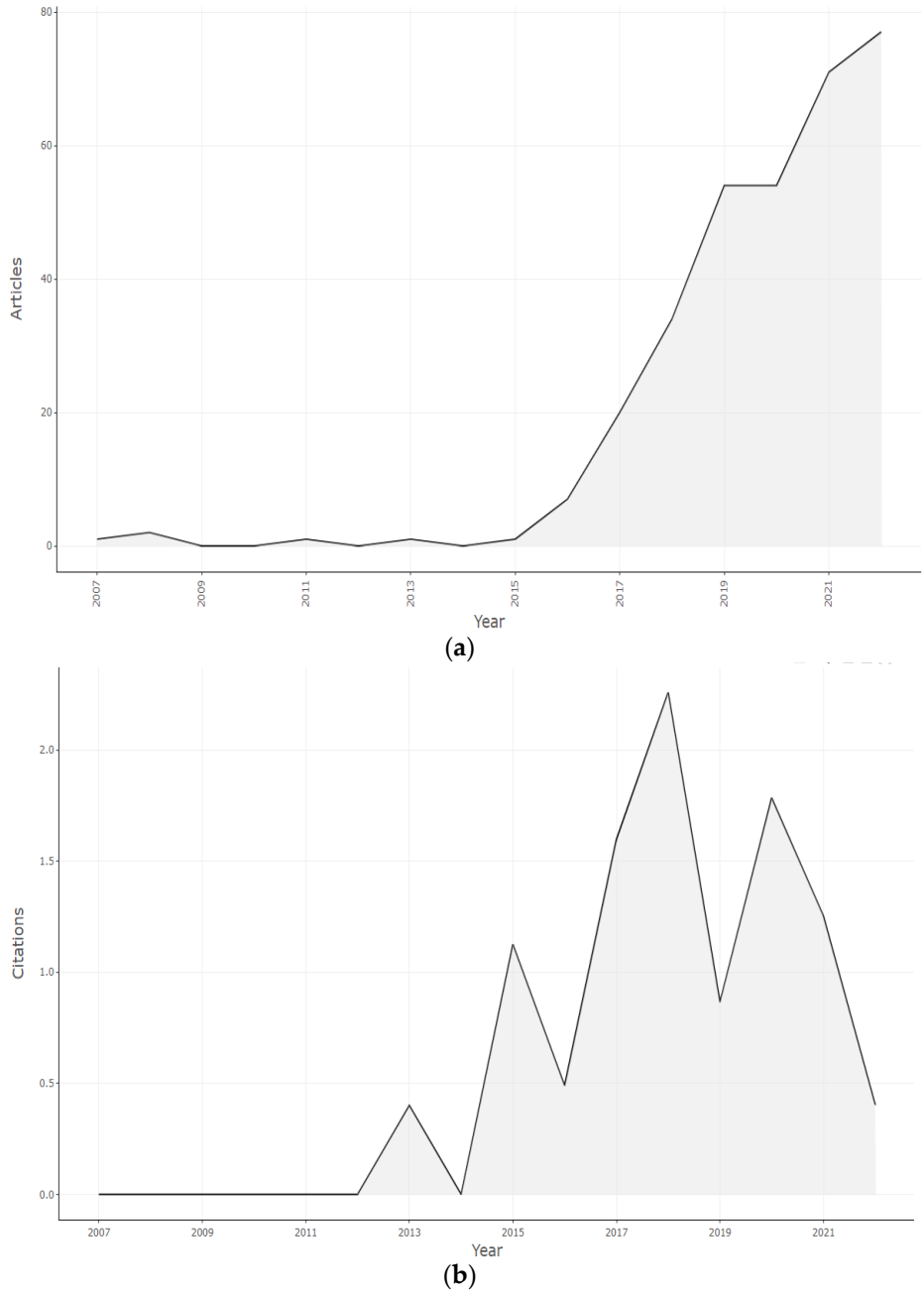
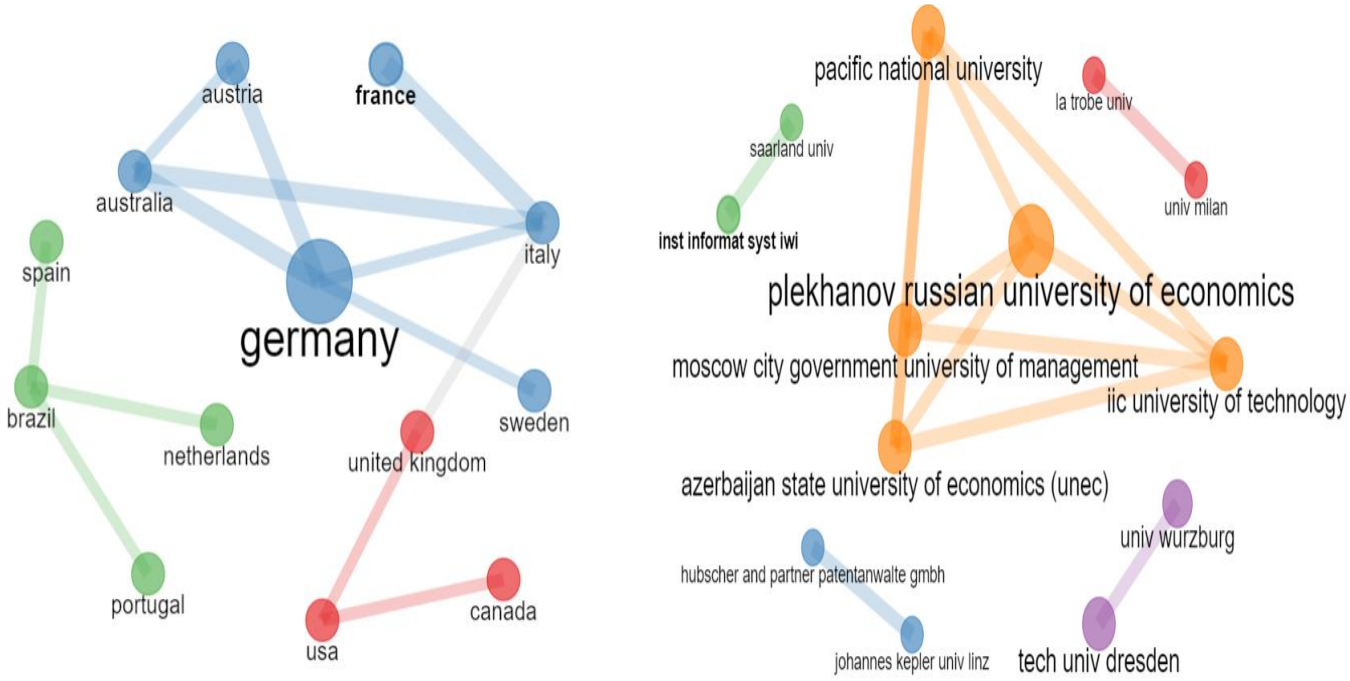


Figure 4. (**a**) Global trends in publications on DT and BPM from 2007 to 2022; and (**b**) average article citations per year.

A total of 282 institutions participated in the DT and BPM research. Among the top 10 institutions contributing to DT and BPM research, most papers originate from the German branches (4 branches) (Table 2). Meanwhile, the University of Pennsylvania, USA produced the highest number of papers (14 records, 4.29%) on DT and BPM, followed by Ghent University, Belgium (10 records, 3.06%) and Queensland University of Technology, Australia (7 records, 2.14%). In addition, the connectivity between these institutions is shown through the link in Figure 5b.



(**a**) (**b**)

Figure 5. Collaboration network analysis of countries and institutions: (**a**) the network map of countries, and (**b**) the network map of institutions.

Table 2. The top 10 institutions contributing to the total publications on DT and BPM research.

Rank	Institutions	Articles	Proportion
1	University of Pennsylvania—USA	14	4.29%
2	Ghent University—Belgium	10	3.06%
3	Queensland University of Technology—Australia	7	2.14%
4	Financial University Under the Government of the Russian Federation—Russia	6	1.84%
5	Dresden University of Technology—Germany	5	1.53%
6	Technical University of Munich—Germany	5	1.53%
7	University of Würzburg—Germany	5	1.53%
8	University of Zagreb—Croatia	5	1.53%
9	Aalen University—Germany	4	1.22%
10	Russian University of Economics—Russia	4	1.22%

3.3. Results of Analysis about the Authors

A total of 906 authors contributed 326 publications related to DT and BPM. Among the number of publications by authors (Table 3), Kirchmer, M. is the most productive author, with 13 articles (3.9% of total articles), followed by Van, L.A. (2.7% of total articles) and Franz, P. (2.1% of total articles). In terms of citations in the field, Bienhaus, F. and Haddud, A. come in first (with 120 citations together), followed by Poras, J. (69 citations), Roglinger, M. (66 citations), Kirchmer, M. (65 citations), and Khakurel, J. (60 citations). Note that from Table 4, although Oberhauser, R. does not have the highest number of citations, this author has the highest H-score. In addition, Figure 6 presents the lead authors' production from 2015 to 2022. We can conclude that most of the top authors' articles have been published in the past decade. On the other hand, the results show that more and more scientists are interested in DT and BPM, while Kirchmer, M. and Van, L.A. continue to contribute and contribute to this field. Besides, there is the appearance of potential research from scientists

such as Imgrund, F., Janiesch, C., Fischer, M., Rosemann, M., and Winkelmann, A. These are authors who have been making new contributions to research on DT and BPM. This means that research on DT and BPM will continue to be an area of interest.

Table 3. The top 10 most active authors on DT and BPM research.

Rank	Authors	Articles	Fractionalized
1	Mathias Kirchmer	13	8.00
2	Raul Valverde	9	5.67
3	Peter Franz	7	2.67
4	Cheap Gusain	5	1.67
5	Florian Imgrund	5	1.45
6	Christian Janiesch	5	1.45
7	Matthias Lederer	5	2.25
8	Michael Rosemann	5	1.25
9	Werner Schmidt	5	1.67
10	Peter Fettke	4	1.01

Table 4. H-index and M-index of publications from different authors, and total citations in the research files from different authors.

Rank	Authors	H-index	Authors	M-index	Authors	Total Citations
1	Oberhauser, R.	4	Ingaldi, M.	0.667	Bienhaus, F.	120
2	Rosemann, M.	3	Mangler, J.	0.667	Haddud, A.	120
3	Fischer, M.	3	Rinderle-Ma, S.	0.667	Porras, J.	69
4	Imgrund, F.	3	Rudan, S.	0.667	Roglinger, M.	66
5	Janiesch, C.	3	Rosemann, M.	0.6	Kirchmer, M.	65
6	Winkelmann, A.	3	Oberhauser, R.	0.571	Khakurel, J.	60
7	Lederer, M.	3	Fischer, M.	0.5	Melkas, H.	60
8	Schmidt, W.	3	Imgrund, F.	0.5	Baiyere, A.	57
9	Vom, B.J.	3	Janiesch, C.	0.5	Salmela, H.	57
10	Kirchmer, M.	3	Winkelmann, A.	0.5	Tapanainen, T.	57

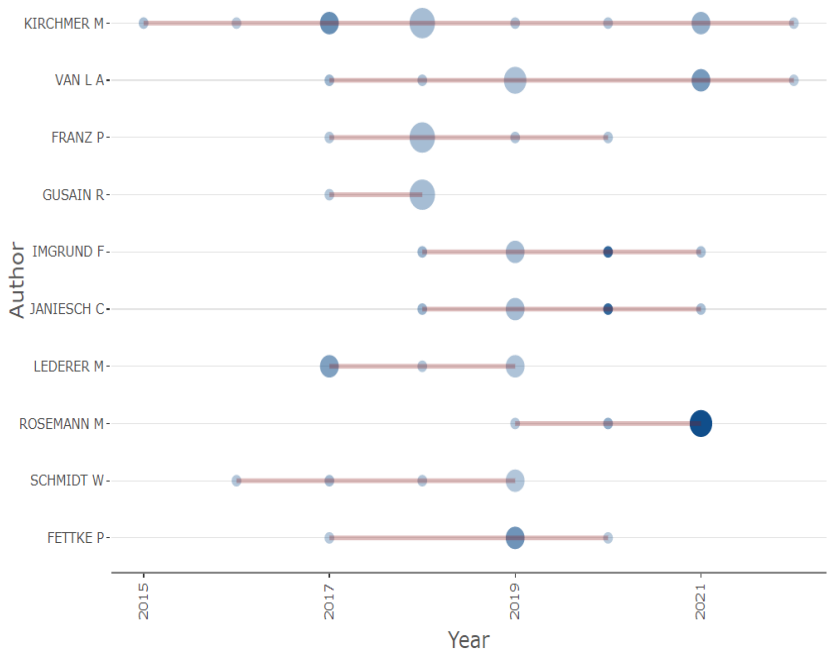


Figure 6. Top authors' production from 2015 to 2022.

We analyzed a total of the top 50 authors who had co-authored in more than three publications, and a network diagram of co-occurrence among authors in the DT and BPM study is shown in Figure 7. The findings indicate a partnership of authors (specifically as follows: Mathias Kirchmer, Wil van der Aalst, Michael Rosemann, Marlon Dumas, and Jan vom Brocke) is mainly limited to the European region.

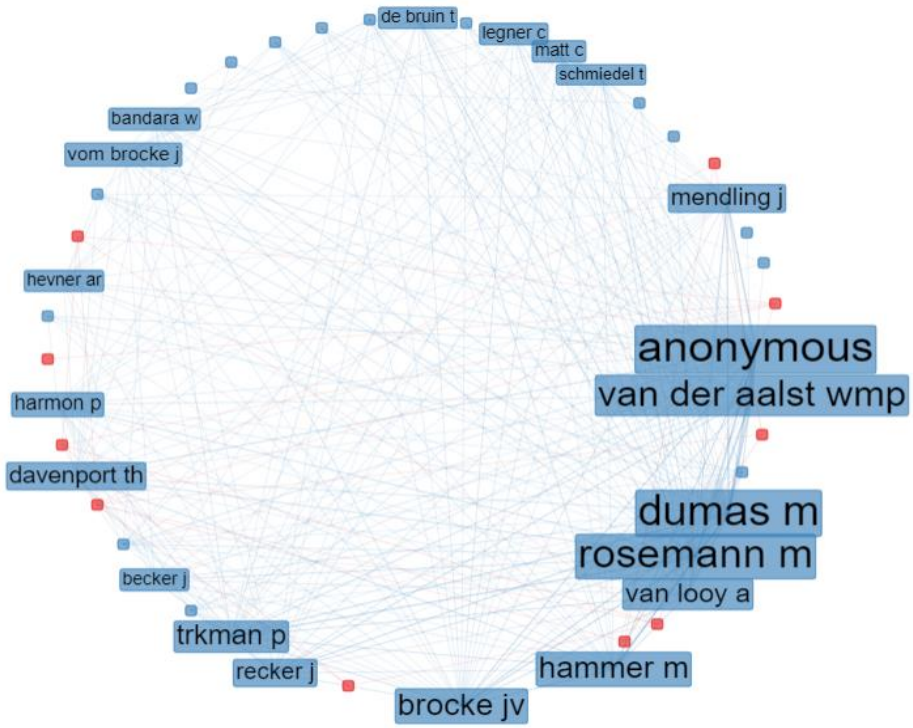


Figure 7. Network map of co-occurrence between authors' keywords on the DT and BPM research.

3.4. Results of the Analysis of the Activities of Journals

The 326 articles were published in a total of 200 journals and conferences, with over 15 journals having published more than 3 articles on DT and BPM research. The top 10 journals by number of publications are shown in Figure 8a. The number of 38 articles published in the "Business Process Management Journal" is the largest, followed by the "CEUR Worksop Proceedings" (17 publications). In addition, the top 10 journals ranked by total citation index are shown in Figure 8b and Table 5. The *Business Process Management Journal* has a total of 430 citations for DT and BPM research, which is the highest number, followed by *Business and Information System Engineering*.

Table 5. The top 10 journals ranked by total citation index.

Rank	Journal	TC
1	*Business Process Management Journal*	430
2	*Business and Information System Engineering*	85
3	*Information Technology and People*	60
4	*European Journal of Information System*	57
5	*Lecture Notes in Business Information Processing*	52
6	*Information and Management*	47
7	*High Performance Through Business Process Management, Third Edition*	35
8	*Matec Web of Conferences*	28
9	*Designs*	27
10	*Production Planning and Control*	24

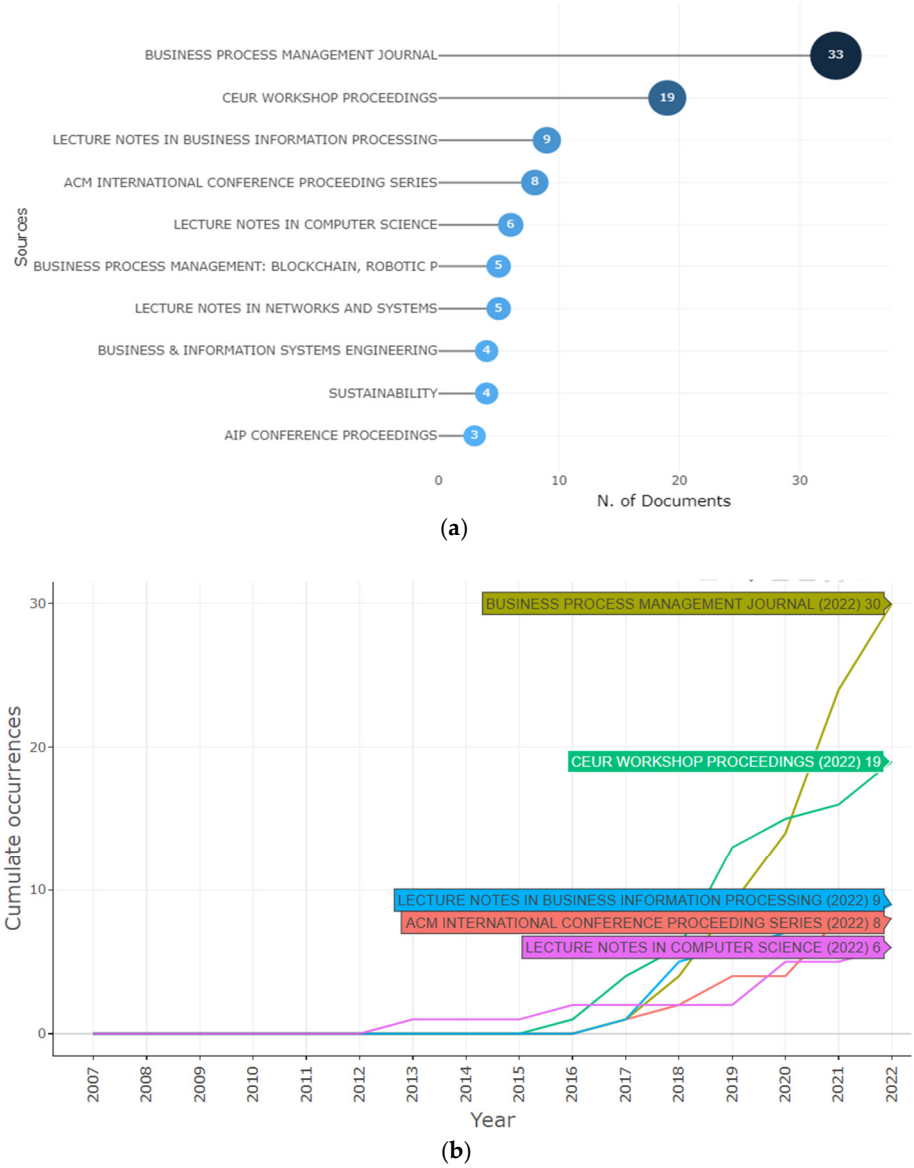


Figure 8. Analysis of sources: (**a**) Most relevant sources; (**b**) Source growth on DT and BPM research from 2007 to 2022.

3.5. Citation and Narrative Analysis

We report analysis on the most cited articles (Section 3.5.1) and the most referred articles (Section 3.5.2) in this section. Besides reporting the descriptive statistics, we also summarize and present the content of the most cited and referred articles.

3.5.1. The Most Cited Documents

Table 6 shows the most cited data from a globally cited perspective. Florian Bienhaus et al. is the most cited and has specifically explored the potential impacts, barriers, and aids of technology in processes. Procurement 4.0 has attracted the most interest and is the most cited [32]. Table 6 also gives hints for themes that stand out from this list of publications, i.e., how to select and identify the right digital technologies for a particular business process [33]; applying new management methods (new logical methods) to the specific context of DT [9]; applying new methods to help organizations harness the potential of digitizing business processes [34]; impact of digitalization on business performance [35]; using the role and capabilities of BPM in different stages of DT [10]; an organization's need for a suitable management method in a digital business environment, need to execute its business

strategy quickly and reliably, and need to establish business process management as a discipline real management [36]; the important role new information technology platforms (machine learning or artificial intelligence (AI)) play in automating BPM in the era of digital transformation [37]; the development, in the era of data-driven business, of managers into scientist-managers, who will possess the combined skills of data management, engineering, and analysis/modelling tools, as well as business, big data analytics and data science will be DT trigger points for organizations [38]; that DT takes place in different contexts and companies follow different strategies to become more digital [10]; and that a conceptual framework built on design principles and BPM methodology will be the ultimate tool to help organizations implement Industry 4.0 and digital transformation [39].

Table 6. Most Global Cited Documents.

Rank	First Author	Title	Ref	Total Citations
1	Florian Bienhaus	Procurement 4.0: factors influencing the digitization of procurement and supply chains	[32]	120
2	Jayden Khakurel	Tapping into the wearable device revolution in the work environment: a systematic review	[36]	60
3	Abayomi Baiyere	Digital transformation and the new logics of business process management	[9]	57
4	Marie-Sophie Denner	How to Exploit the Digitalization Potential of Business Processes	[34]	41
5	Zulqurnain Ali	Does supply chain finance improve SMEs performance? The moderating role of trade digitization	[35]	40
6	Marcus Fischer	Strategy Archetypes for Digital Transformation: Defining Meta Objectives Using Business Process Management	[40]	35
7	Mathias Kirchmer	High Performance Through Business Process Management Strategy: Execution in a Digital World. Third Edition	[41]	35
8	Daniel Paschek	Automated business process management—in times of digital transformation using machine learning or artificial intelligence	[42]	28
9	Kevin Daniel André Carillo	Let's stop trying to be "sexy"—preparing managers for the (big) data-driven business era	[43]	27
10	Javaid Butt	A Conceptual Framework to Support Digital Transformation in Manufacturing Using an Integrated Business Process Management Approach	[44]	27

3.5.2. The Most Referenced Documents

Table 7 shows the top 10 most-cited references on DT and BPM research. After systematizing related documents, Vial unified the concepts of digital business strategy—DBS and digital strategy. In his work, Gregory Vial shows dynamism in DT as a new research direction in the future [12]. Peter Trkman uses dynamic capacity theory to point out the key success factors of BPM in its publication [45]. Vom Brocke et al. emphasized research on identifying and describing business context for BPM research [46]. More specifically, in DT, BPM is the driving force behind innovation in the digital world, a powerful frame of reference that separates the complexities of a holistic approach [47]. Research to explore and develop information systems is also encouraged [48], and research methods on information systems (the science of process model design) are also of interest and consulted. The landscape of digital disruption has also spurred studies on new BPM models [49]. In addition, there are studies related to strategic angles (information technology strategy, digital business strategy, and DT strategy) to reform the information system and processes. The digitalization processes for companies are also well referenced and cited [11,12,23]. Matt stated that the use of technology, changes in value creation, structural changes, and financial aspects are elements of an organization's DT strategy [23]. Emerging as a bright spot and attracting the interest of, references to, and citations by many studies is a series of theories on BPM [11]. The authors showed that the term "strategy" is the bridge for all the resources of the organization. To achieve efficiency in digitalization, organizations must flexibly and creatively apply management methods combined with sound strategies.

Table 7. Most-cited references of documents on DT and BPM research.

Rank	Authors	Titles	Refs	Citations
1	Peter Trkman	The critical success factors of business process management	[45]	19
2	Jan vom Brocke, Sarah Zelt Theresa Schmiedel	On the role of context in business process management	[46]	13
3	Christian Matt, Thomas Hess, Alexander Benlian	Digital Transformation Strategies	[50]	13
4	Marlon Dumas, Marcello La Rosa, Jan Mendling and Hajo A. Reijers	Fundamentals of Business Process Management	[11]	11
5	Michael Rosemann and Jan vom Broke	The Six Core Elements of Business Process Management	[51]	11
6	Anandhi Bharadwaj, Omar A. El Sawy, Paul A. Pavlou and N. Venkatraman	Digital business strategy: towards a next generation of insights	[52]	10
7	Christine Legner, Torsten Eymann, Thomas Hess, Christian Matt, Tilo Böhmann, Paul Drews, Alexander Mädche, Nils Urbach and Frederik Ahlemann	Digitalization: Opportunity and Challenge for the Business and Information Systems Engineering Community	[53]	10
8	Michael Rosemann	Proposals for future BPM research directions	[47]	10
9	Wil MP van der Aalst	Business Process Management Demystified: A Tutorial on Models, Systems and Standardsfor Workflow Management	[54]	10
10	Gregory Vial	Understanding digital transformation: A review and a research agenda	[3]	10

3.6. Co-Word Analysis

We analyzed 972 keywords and identified the top 10 most frequently cited ones, as shown in Figure 9. The keyword "Enterprise Resource Management (ERM)" has the highest number of occurrences, showing a holistic approach to managing an organization's resources, including people, processes, and technology, to improve operational efficiency and achieve strategic goals. ERM emphasizes the integration of resources, streamlining processes, and data-driven decision-making to achieve operational excellence, align strategy, and improve business results. Some of the perspectives on ERM can be considered from different angles, such as a management perspective, IT perspective, operational perspective, financial perspective, human resource perspective, customer perspective, etc. The phrases "digital transformation", "business process management", and "business processes" appear with a frequency of 40–50 times. The group of keywords which occur from 18 to 21 times includes: "business process model", "process management", "administrative data processing", "framework", "information systems", and "systems engineering". In particular, the content of these keywords shows the correlation between activities of organizing, managing, and optimizing resources and processes of organizations.

Figure 10 shows the frequency of co-occurring words and their relationships in relevant clusters. While fields related to the linkage and interaction of "digital transformation", "business process management", and "digitalization" continue to be fundamental areas that require further research and development, in another cluster, keywords related to "business process management", "bpm-business process management", and "digitalization" begin to move away from the center and seem to be declining. This is reasonable because processes within an organization must evolve to a higher level than just "digitalization" to "digital transformation". Comparing the two clusters of "digitalization, bpm-business process management, business process modeling" and "digital transformation, business process, BPMN" shows that for the cluster of "DT, business process, BPMN" with the assistance of BPMN tools, DT has been successfully completed from the perspective of the business processes that have been represented in graphical symbols. BPMN has performed well in providing detailed information about activities, data flow, conditions, and business processes. However, in the cluster of "digitalization, bpm-business process management, business process modeling", digitalization is still underway, while the need for managers and analysts to model and improve business processes using business process modeling emerges as a feasible option when modeling the business processes of an organization or enterprise. During the modeling process, information about activities, data flow, access

rights, and business requirements are identified and described. Business process modeling helps optimize business processes, increase efficiency, and reduce costs. This is also a new point that needs to be paid more attention in the future.

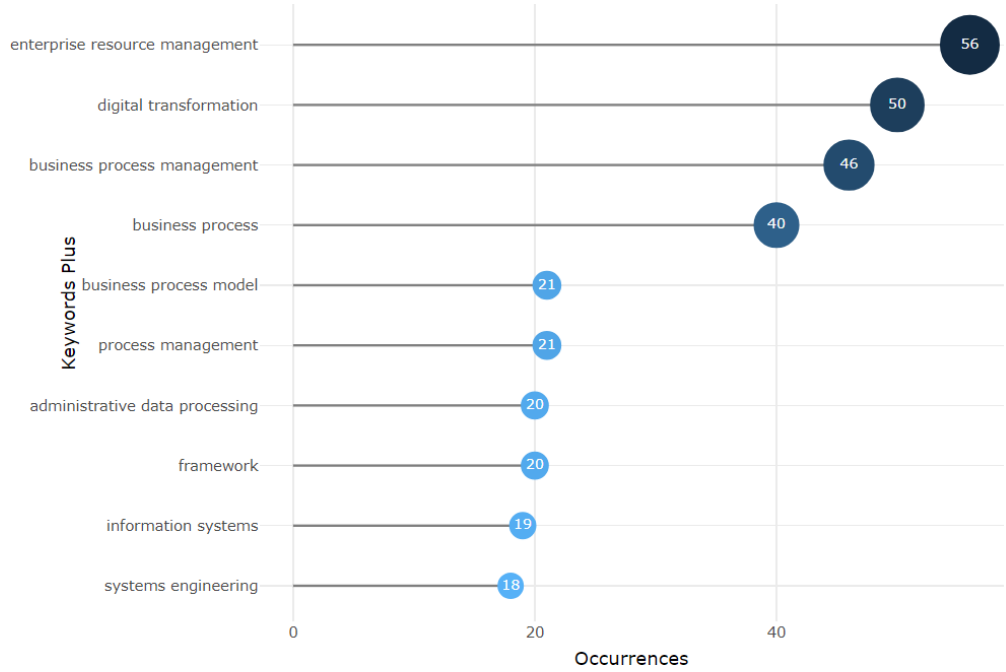


Figure 9. Analysis keywords on DT and BPM research with the most-frequent keywords on DT and BPM research from 2007 to 2022.

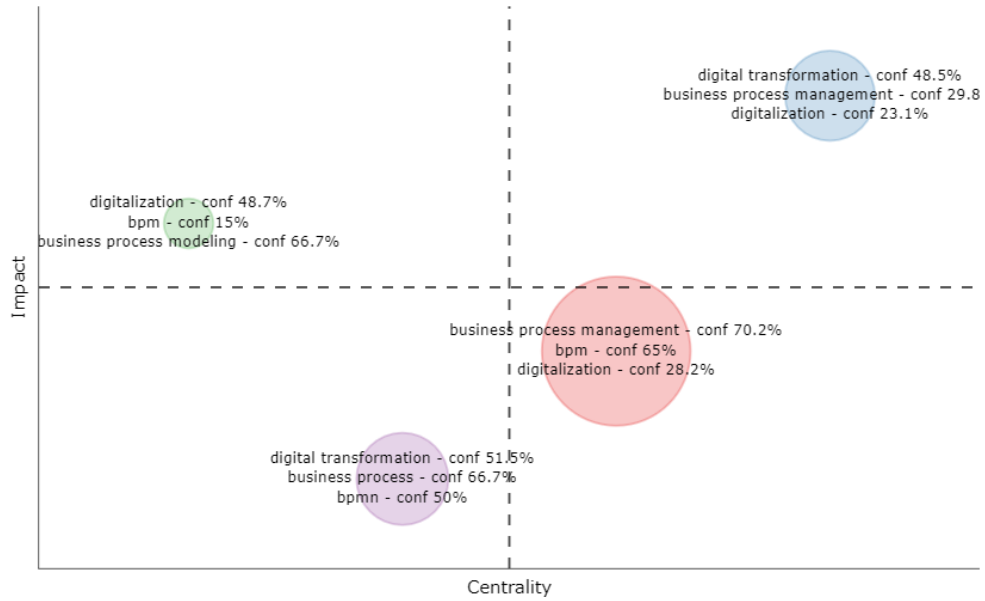


Figure 10. Analysis and co-occurrence network of keywords on DT and BPM research with a clustering by coupling on DT and BPM research from 2007 to 2022.

3.7. Factor Analysis on Keywords

Biblioshiny for Bibliometrix allows using the concept structure function to perform multiple correspondence analyses (MCA) to plot the conceptual structure of the field and K-means clustering to identify clusters of documents representing common concepts [15]. MCA is an exploratory multivariate technique for graphical and numerical analysis of multivariate categorical data [55,56]. Figure 11 shows that the team had "value. realization"

and "process improvement", respectively, with contributions from theory to practice on new BPM methods and models in the context of DT.

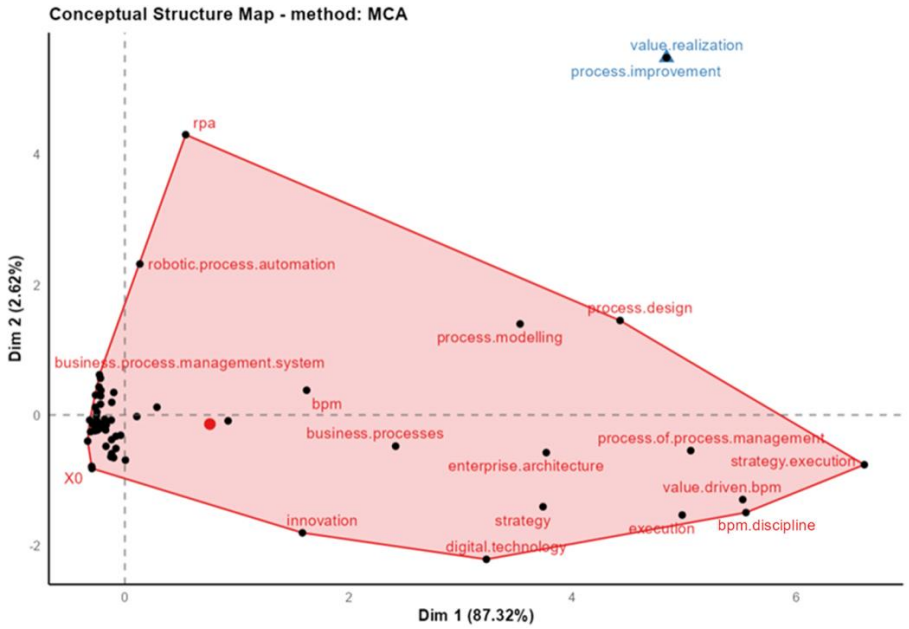


Figure 11. Conceptual structure map with multiple correspondence analysis of keywords (authors' keywords) on DT and BPM research.

3.8. Analysis of Future Prospects

Our network maps, clustered by topic areas or publication date, highlight current trending topics as well as future directions in DT and BPM research (as shown in Figure 12). The topics "administrative data processing", "information systems", and "systems engineering" received more attention from 2017 to 2018, while "business process model" gained more attention in 2019. From 2018 to 2022, "business process management", "future", and "enterprise resource management" emerged as prominent themes, with "business process management" and "enterprise resource management" being researched more extensively.

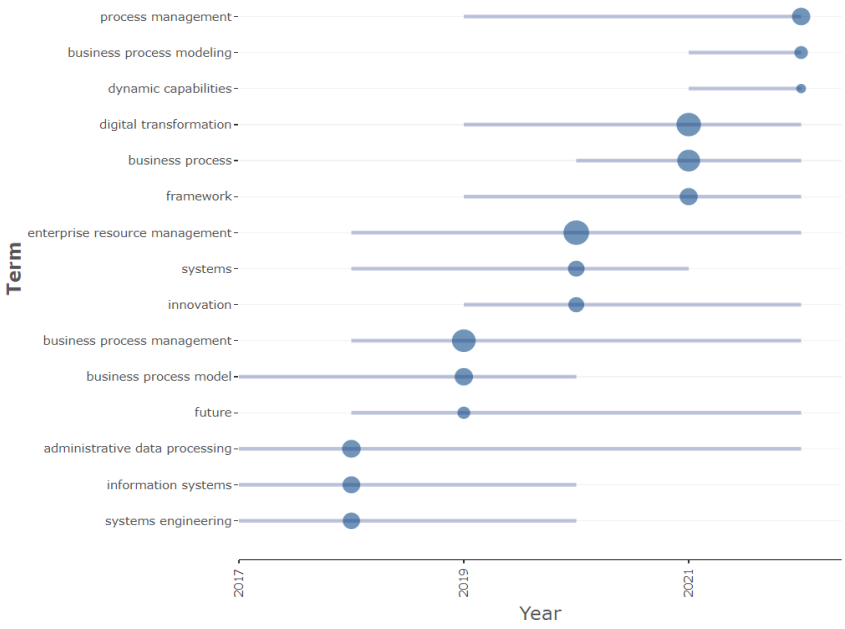


Figure 12. Trend topics of keywords on DT and BPM research from 2007 to 2022.

The period from 2019 to 2022 also featured notable topics such as "innovation", "framework", "digital transformation", and "process management". While the period from 2019 to 2020 was dominated by "innovation", the period from 2020 to 2021 was marked by "framework" and "digital transformation", with the latter appearing to be more dominant. The topic of "process management" first emerged in 2019, but it was not until 2022 that it became prominent. The period from 2020 to 2022 was dominated by "business process", which became particularly prominent in 2021. In the period from 2021 to 2022, in addition to "process management", two other noteworthy topics emerged, namely "business process modeling" and "dynamic capabilities".

Thus, by analyzing the trends of the topics that appeared from 2017 to 2022, a comprehensive picture of 15 main topics has emerged. The origins began with information systems, followed by business process management, and gradually the emergence of DT. In particular, with the emergence of the three latest trends, "process management", "business process modeling", and "dynamic capabilities", it can be seen that there has been a certain intersection and integration between DT and BPM.

In Table 8, the trending topic keywords with the highest frequency are "enterprise resource management" (56 times), "digital transformation" (50 times), and "business process management" (46 times). A fact from the data shows that there is a cross-link, reflecting an inter-relationship between "enterprise resource management", "digital transformation", and "business process management". In the context of digital transformation, managing business processes to achieve efficiency is always a difficult problem for organizations. Achieving this requires organizations to manage and exploit resources effectively. DT stimulates innovation and changes in business models and has a profound impact on "process management". A notable future research direction is "process management"—the keyword appeared in 169 out of the 326 publications. This is reasonable as it explains that the term "business process management" is a subset of "process management". The shift in keyword trends from "business process management" to "process management" might imply that research in the field has extended to broader issues related to process management and process exploitation in various fields of life, not just in business. For example, in the healthcare field, process exploitation with new technology platforms has significantly improved efficiency [57–61]. The popularity of the topic is also demonstrated in the education and training field [62–65]. Particularly, in fields that requires certainty, caution, meticulousness, and high accuracy, such as astrophysics, process management has also been explored scientifically [66].

Table 8. Trending topics on keyword occurrences on DT and BPM research from 2007 to 2022.

Item	Occurrence	Years		
administrative data processing	20	2017	2018	2021
information systems	19	2017	2018	2020
systems engineering	18	2017	2018	2020
business process management	46	2018	2019	2022
business process model	21	2017	2019	2020
future	8	2018	2019	2022
enterprise resource management	56	2018	2020	2021
systems	16	2018	2020	2021
innovation	14	2019	2020	2022
digital transformation	50	2019	2021	2022
business process	40	2020	2021	2022
framework	20	2019	2021	2022
process management	21	2019	2022	2022
business process modeling	8	2021	2022	2022
dynamic capabilities	6	2021	2022	2022

Another interesting keyword is business process modeling. This term is closely linked to the adoption of a BPMN (business process model and notation) tool in making business processes more transparent through the effective exploitation and use of technological resources [46,67,68]. Additionally, BPMN is very useful in graphically representing gaps in information flows and serves as a foundation for automating business processes, designing flexible and adaptive processes, and enhancing dynamic and intelligent capabilities for systems [69–72].

Furthermore, BPMN is not only flexible but can also be extended and used in conjunction with other models to enhance business performance [73–75]. The trigger for business processes is always present in BPMN, which enables the integration of new technologies into digital processing, ensuring harmony between data and IT [28,40,76,77]. BPMN helps to simulate effectively, and differentiate and compare between, business process reengineering (BPR) and business process optimization (BPO) [78].

The term "dynamic capabilities" has gained considerable attention, especially after being recommended by Vial Greg [3]. Research on related theories of dynamic capabilities has since gained momentum, coinciding with an increase in the number of firms focusing on digitalization in recent years. The application of management theories to improve business operations has always been emphasized. The theory of dynamic capabilities can be valuable in understanding how digitalization benefits business operations. Therefore, studies on the dynamic capabilities of firms, and their subsequent integration with the reality of digitalization in firms, will always be important topics of interest [59].

Based on the view of strategic management capabilities, dynamic capabilities are used to classify the capabilities of BPM when associated with the benefits of digitalization [79]. Dynamic capabilities can also be understood as organizational agility (OA). As DT brings changes and disruptions [12], the ability of companies to adapt and respond to these disruptions promptly is essential. Understanding the interactive relationship between digitalization and organizational agility in processes will help companies find better management solutions [80].

An interesting finding is that the research trends "process management", "business process modeling", and "dynamic capabilities" are all related to "enterprise resource management", "digital transformation", and "business process management". The literature in our research shows that there are always tangible links between the digital landscape, process management, and an organization's ability to adapt, integrate, and reconfigure its components. In particular, business strategy and digitization solutions enable organizations to efficiently integrate and manage their core business processes and resources. A series of new management methods and models that integrate, combine, and hybridize business process management, technology, digitalization, or business administration have been researched and implemented by organizations. For example, digitization and BPM are based on a strategic management perspective [41] or a study of BPM culture [49]. A study of the effective implementation of process modeling in BPM for knowledge-driven DT and social digitization requires rethinking how to structure and model processes in the current context. The study emphasizes the process model and its foundational principles (such as project management and BPM) combined with organizational strategy [81]. A structured assessment of the success of a process digitization project based on the perspective of BPM and project management is also included [82]. Meanwhile, Stravinskiene and Serafinas are interested in interdisciplinary research on the link between BPM and quality management [83]. In a study on the shipping industry, Feibert et al. demonstrate the concept of integrated digital and BPM to improve supply chain performance for shipping companies [84]. To develop methods for the successful implementation of digital solutions, Martinez used the concept of "digital path" to refer to the process by which an organization can adopt and deploy digital strategies and technologies to transform their operations and business models [85]. It involves leveraging digital tools, technology, and data to enhance efficiency, improve customer experience, and drive innovation.

4. Discussion

4.1. Discussion of Findings

The results of analyzing publications from a chronological perspective show that the publication process of research papers is divided into two main stages. The first stage was before and including 2015, during which the number of research papers on DT and BPM was only in the tens. However, there was a significant increase after 2015, with publications appearing more frequently, steadily increasing, and reaching nearly 80 publications in 2022 [86–88]. Temporal statistics also helped determine the level of author contribution and influence through the number of publications and impact indices, such as the H-index and the M-rank index.

We also observed that the top 10 countries contributing the most to DT and BPM research were all countries with relatively high scientific and technological foundations. Interestingly, the focus on DT and BPM seemed to be leaning towards Europe since, of the top 10 countries, eight were from Europe, one was from Asia (China), and one was from America (USA). This demonstrates a particular interest and emphasis on DT and BPM in Europe. A notable highlight in the DT and BPM research picture was the contribution of organizations. In the top 10 organizations with the most contributions, representatives from Europe still accounted for the vast majority, with nine organizations. This is entirely consistent with and provides data to explain why countries from Europe continue to lead.

We revealed the most cited publications from various perspectives, i.e., "Procurement 4.0: factors influencing the digitisation of procurement and supply chains" by Florian Bienhaus and colleagues and "A Quantitative Study of the Link Between Business Process Management and Digital Innovation" by Amy Van Looy et al. Among the top 10 journals in terms of the number of citations, the *Business Process Management Journal*, *Business and Information System Engineering*, and *Information Technology and People* lead the pack. However, when considering their impact factors, they are average, with impact factors of 3.464, 4.532, and 3.879, respectively. These journals publish research related to information systems, BPM, and the interaction between information technology and people, which are developed by scholars globally. This shows that research on DT and BPM is always comprehensive and closely related to the organization, processes, and resources of businesses.

The results of the keyword analysis identified that "business process management" has the highest frequency of occurrence, followed by "digital transformation" and "digitalization". The literature analysis suggests three potential research topics for the future. The first one is a growing interest in process management, demonstrated by studies on DT and BPM. This applies not just to business processes but also to other fields in life. In the digital age, managing and integrating processes is crucial for organizations to exploit vast amounts of data. The second topic concerns business process modeling, which has become important again due to digitalization and the need for higher adaptability in the face of change and disruption. The accurate use of process modeling tools can help businesses achieve DT. Finally, the topic of "dynamic capabilities" is important for BPM issues in the context of DT, according to our primary studies. DT is bringing about evolution and innovation for BPM, and research on dynamic capabilities will encompass broader issues of information systems, BPM, and DT. Organizations' abilities and agility will require further research and development in this volatile business environment.

4.2. Threats to Validity

Similar to other secondary studies, this literature review is not exempt from limitations [28,89]. Firstly, the data collection only includes the directory metadata from the Web of Science (WoS) and Scopus databases, which represent only a subset of the total publications. Therefore, this study is limited to these databases. Secondly, the results of this study only describe and classify the literature. Although we have analyzed and evaluated the content and quality of the selected documents, these analyses do not fully reflect all the values of these documents. Thirdly, although the keywords used for search and analysis were carefully considered and selected, they are still based on the perspective of the ana-

lysts, which may lead to subjectivity in the evaluation process. Finally, the bibliometric data in the selected databases were only available up to 2022. In the future, research publications on DT and BPM will continue to evolve and develop, requiring further directory analysis studies to ensure the timeliness, effectiveness, and accuracy of the analysis results.

5. Conclusions

A bibliographic analysis of 326 publications from the Scopus and Web of Science (WOS) databases has provided comprehensive visual insights into the research of digital transformation (DT) and business process management (BPM). Through data visualization and mapping approaches, an examination of countries, organizations, authors, journals, documents, and a network of 972 co-occurring keywords was undertaken to identify interconnected trends related to DT and BPM. This analysis answered two research questions: RQ1—What are the primary research topics in the study of DT and BPM? and RQ2—What are the emerging research trends in DT and BPM? The findings indicate that the main research topics in DT and BPM are centered around "business process management", "digital transformation", and "digitization". The exploration of relationships between these topics underscores the theoretical and practical contributions of new business process management methods and models in the context of digital transformation, which are evident in numerous publications from various authors and organizations. It is recognized that digital transformation is an ongoing journey rather than a singular project, encompassing various tasks that are intricately linked to an organization's business processes. In this context, new business models supported by digital transformation and digitization should be founded upon a robust business process management framework.

Moreover, the bibliographic analysis reveals emerging trends in BPM within the domain of digital transformation. These trends include "administrative data processing", "business process modeling", "resource management", "entrepreneurship", and "dynamism". The revealed trends suggest that managing organizational challenges always requires multiple optimal solutions. Core elements such as "Business Process Management", "Digital Transformation", and "Digitalization" always remain essential factors in an organization's management approaches. From a management perspective, the study of process management issues, process modeling, and the examination of organizational dynamic capabilities in the context of DT will persistently be of paramount importance. Efficient and high-performing operational organizations will benefit from well-managed and executed business processes and dynamic capabilities, highlighting the critical role of BPM and DT in the success of an organization's information systems and its adaptability to rapidly changing business environments.

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