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Tracing the evolution of digitalization research in business and management fields: bibliometric analysis, topic modeling, and deep learning trend forecasting

Abstract

Research on digitalization trends and digital topics has become one of the most prolific streams of research within the fields of business and management during the course of the past few years. The purpose of the current study is to provide a general picture of the intellectual structure and the conceptual space of this research realm. To this purpose, 6067 publications related to digital topics, indexed in the business and management categories of Web of Science (WoS), and dated from 1990 to 2020 are explored based on the approaches of bibliometric analysis, topic modeling, and trend forecasting. The results of the bibliometric analysis comprise insights into the publication and citation structure, the most productive authors, the most productive universities, the most productive countries, the most productive journals, the most cited studies, and the most prevalent themes and sub-themes on digitalization in business and management. In addition, the outcomes of the topic modeling give new knowledge on the latent topical structure along with the rising, falling, and fluctuating trends of this literature. Additionally, the results of the trend forecasting enable readers to have a glimpse of how the underlying trends of the literature will likely change within the next years until 2025. These results provide guidance and orientation for both academics and practitioners who are initiating or currently developing their efforts in this discipline.

Keywords: digitalization, digital X, digital transformation, business and management, bibliometric analysis, topic modeling, trend forecasting.

1. Introduction

Over the course of the last few years, various digital issues such as digital transformation [1], digital innovation [2, 3], digital platform [4], digital entrepreneurship [5], digital business strategy [6], and digital marketing [7] along with different digital technologies such as analytics [8], internet of things [9, 10], artificial intelligence [11], and blockchain [12, 13] have become buzzwords in the business and management disciplines. Research on these topics stands amongst the most prolific streams of scholarship within the organizational sciences. This can be attributed to the importance and awareness devoted to the topics by business and management scholars. As conceived from the conceptualizations of previous works such as Caputo et al. [14], Rodrigues [15], and Trittin-Ulbrich et al. [16], the digital* or digital X topics can be explored under the umbrella of digitalization notion which is considered as an inclusive and broad digital conception reflecting societal, economic, industrial, and organizational aspects of the increased use of digital technologies. Digitalization is defined as “the use of digital technology, and probably digitized information, to create and harvest value in new ways” [17, p. 56]. In the past decade, this concept has garnered increasing attention from both academics and professionals of organizational sciences [18]. The digitalization phenomenon is introduced as the fourth industrial revolution after mechanizing production based on the use of water and steam power, creating mass production based on the use of electric power, and automating production based on the use of electronics and information technology [19, 20]. This phenomenon is identified as the most important technological trend all around the globe [21, 22] that has brought about both invaluable opportunities and demanding challenges for firms [16]. Leading to new ways for revenue generation and value creation [23], introducing new trajectories for improvements in performance and reductions in costs based on the use of digital tools for automating certain activities, optimizing the control of production units, and enhancing human resource management [18], providing new approaches for accessing new markets and expanding the number of customers [24], opening new windows for creating new products, services, and business models [25], and offering new methods for commerce, sales, communication, and marketing [18] are some instances of the opportunities aroused by digitalization. In contrast, causing digital disruptions in terms of altering the consumer behavior and expectations, disrupting the competitive landscape, and increasing the availability of data that forces organizations to change their value creation paths [1] are some examples of the challenges brought about by digitalization. Accordingly, to harness these opportunities and tackle these challenges, business and management scholars have investigated the different aspects of the digitalization phenomenon through their studies that have led to a significant increase in the research output and the emergence of numerous digital topics. However, due to our best knowledge, there has not been an attempt to provide a general understanding and overall grasp of the state of the art of these topics and their evolutionary trajectories in the business and management fields. Taking the aforementioned into account, the current study aims at tracing the evolution of digitalization research in business and management to provide a holistic understanding of the phenomenon that might be beneficial for building a reference framework for academics’ studies and professionals’ policies.

To the aim, the current study employs the bibliometric analysis approach which is useful and appropriate for providing a general picture in a certain scientific area [26]. Bibliometric analysis is a tool for quantitatively describing, evaluating, and monitoring the evolution of the scientific realm under study based on the statistical analysis of bibliographic material [27]. Due

to the utility of this type of analysis in exploring large volumes of scientific data and generating high research impact [28], bibliometric studies have gained immense popularity across different areas of business and management such as business model [29, 30], intellectual capital [31], entrepreneurship [32, 33], dynamic capabilities [34], and operations [35]. Traditional review methods such as qualitative techniques for structured literature review are often time-consuming and prone to researchers' subjective bias [27], so we prefer to not use them in this study aimed at exploring a vibrant area with a large number of pieces of research and giving an objective and informative view about this extensive research. In other words, due to the discussion provided by Donthu et al. [28], we should use bibliometric analysis to meet our aim because the scope of our review is broad and our dataset is too large for manual review. Besides bibliometric analysis, some methods of text analytics such as text clustering [36-38], topic modeling [39-43], and co-word analysis [44-46] have recently been used extensively for exploring the themes and trends of broad research scopes and large-scale literatures from a general perspective. These methods are state-of-the-art computational techniques that have high potentials for automatic content analysis of a large scale and unstructured collection of documents such as a big scientific corpus. Accordingly, with regard to the aim of the current study, a text analytics approach namely topic modeling is used in addition to bibliometric analysis for the sake of unlocking the topics and trends of the literature under study. "Topic modeling is a type of statistical model for discovering the latent topics that occur in a collection of documents through machine learning" [47, p. 767]. This text analytics approach has been widely acknowledged by management and organization scientists as a powerful tool with high potentials for extracting grounded conceptual relationships and phenomenon-based knowledge from textual data [48, 49]. Topic modeling as a reliable and innovative tool has recently gained a highly upward popularity among researchers across different disciplines for analysis of scientific documents along with other forms of textual data [47, 50]. Our investigations of the previous bibliometrics and topic modeling studies indicate that such studies usually lack foreseeing how underlying trends of the literature under study will change within the course of the next years. These studies often could depict the evolutionary trajectories of the underlying topics within the timeframe of the corpus under study. However, it was a challenging task for them to extend their timeframe to upcoming years. In this regard, a very recent and powerful neural network-based time-series forecasting analysis is employed in the present study in order to predict the next waves of the underlying trends on digitalization in organizational science. Our knowledge shows that it is for the first time that such an advanced artificial intelligence technique is combined with the topic modeling outcomes to forecast the further trends in a literature.

The contributions of the current work are two-fold: 1. It contributes to advance the knowledge on digitalization research in business and management based on comprehensively analyzing the bibliographic data of the related publications and accordingly, presenting insight into the publication and citation structure, the most productive authors, the most productive universities, the most productive countries, the most productive journals, the most cited studies, and the most prevalent themes and sub-themes at the height of our knowledge. In addition, the topic modeling of the publications offers new understanding on the latent topical structure along with the rising, falling, and fluctuating trends of this literature. Besides, applying a state-of-the-art deep learning-based time-series forecasting method on the results of the topic modeling gives reliable predictions on the next waves of the underlying trends. Due to our best knowledge, the current study is the first attempt to perform such a comprehensive analysis

on digitalization in business and management from the bibliometrics, topic modeling, and trend forecasting perspectives. 2. The current research can be considered as a complementary study expanding the scope of the contributions of previous works which carried out different scientometrics and content analyses on the specific and limited areas of digitalization in business and management such as digital transformation [51], digital innovation [52], digital marketing [53-55], digital business [56], and digital supply chain [57].

The rest of the study proceeds as follows. The second section presents the methodology. The third section reports the results of bibliometric analysis, topic modeling, and trend forecasting. Finally, the fourth section summarizes and discusses the conclusions and limitations of the study.

2. Methodology

2.1. Bibliometric analysis

To carry out the bibliometric analysis of digitalization research in business and management, the current study followed the six steps proposed by Albort-Morant and Ribeiro-Soriano [58]. According to these steps, a bibliometric analysis includes: 1) defining the field under study, 2) choosing the database, 3) adjusting the search criteria, 4) compiling the categories of bibliographic information, 5) codifying the material retrieved, and finally, 6) analyzing the information, the details of which are explained in the following. In the current study, we chose Web of Science (WoS) as the database because it is considered as the most influential scientific database [59-61] with the greatest quality of standards [62-64]. This database includes information on over 50000000 articles indexed in about 150 research areas and about 250 categories across all fields of science including “Business” and “Management” [65]. One of the main advantages of WoS is its great capabilities in compiling the categories of bibliographic information, codifying the material retrieved, and analyzing the information automatically. Following the search protocol of Caputo et al. [14], we used “digital*” as our search keyword to find the publications on digitalization research. This keyword represents all terms derived from the digital stem such as digitalization and all terms including the digital word such as digital transformation. The search keyword was used in the topic section of the search engine including title, abstract, and keywords. Then, the result of this search was refined by choosing the “Business” and “Management” categories among the WoS categories, and the timespan was limited until the beginning of 2021. This search was conducted in April 2021. Applying this search protocol returned 6067 publications on digitalization in business and management including 5370 articles, 296 editorial materials, 222 reviews, 199 early accesses, 145 book reviews, 88 proceeding papers, 13 corrections, 9 new items, 6 letters, 4 book chapters, 2 hardware reviews, 2 meeting abstracts, 1 retracted publication, 1 retraction, and 1 software review. These publications comprise various languages including 5850 English, 76 Portuguese, 58 Spanish, 55 Russian, 9 German, 7 French, 3 Czech, 3 Polish, 2 Croatian, 2 Unspecified, 1 Korean, and 1 Lithuanian. To provide a holistic picture of the digitalization research in the business and management fields, none of these document types and languages was excluded. Next, the most significant and common indicators were considered for the bibliometric analysis of our information. These indicators accord with three types of bibliometric measures defined by Cadavid Higueta et al. [66] and employed by others such as Rey-Martí et al. [32], Albort-Morant et al. [34], Albort-Morant and Ribeiro-Soriano [58], Mulet-Forteza et al. [60], and

Merigó et al. [63]. That is, quantity indicators measuring productivity, quality indicators measuring influence or impact, and structural indicators measuring relationships between bibliographical units such as author keywords. First, we used the number of publications and citations which are considered as the most popular bibliometric indicators [63]. The number of publications usually reflects productivity, and the number of citations usually represents influence in the scientific community [34, 60, 63, 67, 68]. Then, we utilized the h-index [69] and the number of citations per paper each of which combines publications and citations into one indicator [60]. H-index measures the h number of publications with h citations or above [60, 69, 70], and the number of citations per paper quantifies the impact of each study [60, 63]. Note that the h-index is the most popular index for evaluating the quality of research of a set of publications [35]. In addition, various citation thresholds were considered to present the number of articles with a certain degree of influence [60, 63]. Moreover, in some cases, the study included other bibliometric measures to analyze the material clearly. These analyses were carried out on different categories of our bibliographic information including publication, year, author, university, country, and journal. Most of the analyses relied on the analytics capabilities of the WoS database, and some of them were conducted by using the statistical computations in the excel spreadsheets containing the retrieved data. Alongside these prevalent analyses, we also conducted the co-occurrence analysis of author keywords [71] by using the VOSviewer software [72]. The main idea behind the method is that the co-presence of two keywords in a document imply that there is a semantic relationship between the concepts represented by the keywords, so the frequent co-occurrence of two or more keywords in a set of documents reflects a salient theme in the corpus [73, 74]. Accordingly, this method allows us to depict a network of concepts and their relations that graphically illustrates the core conceptual space and main scientific knowledge of the realm under study [60, 75-78]. The VOSviewer software follows three key steps including normalization, mapping, and clustering to generate a clustered bibliometric network such as keywords co-occurrence network. First, this software carries out the association strength normalization explained by Van Eck and Waltman [79] to normalize the high differences between nodes in the number of links they have. Second, the software depicts normalized network based on a distance-based approach in a two-dimensional space. That is, the distance between two nodes indicates the similarity or relatedness of them. For this aim, VOSviewer recruits the VOS mapping technique argued by Van Eck et al. [80]. Finally, this software clusters the nodes in the mapped network in such a way that a cluster contains a group of tightly related nodes without any overlap with any other cluster. The VOS clustering technique has been thoroughly explained by Waltman et al. [81]. For more explanations of the technical procedures of VOS mapping and clustering approach, see Van Eck and Waltman [82]. Note that this wide range of bibliometric analyses was performed in the current study with the aim of providing an overview of digitalization research in business and management which is as complete as possible and fits with the special interests of each reader.

2.2. Topic modeling

In this study, Latent Dirichlet Allocation (LDA) [83] as the most prevalent algorithm for topic modeling [84] was employed in order to reveal the dominant topics and trends in the business and management literature on digitalization. This algorithm supposes that a set of documents (i.e., a corpus) contains a limited number of topics with different proportions, each of which is a probabilistic distribution over a fixed set of words [85]. Based on this assumption, the LDA

algorithm tries to use the words of the given documents to render the latent topical structure of the corpus. To this end, LDA defines the conditional probabilistic distribution of hidden topical structure variables given the observed words and uses a technique, such as Gibbs sampling [86] to approximately compute it. To implement a LDA-based topic modeling, we followed the stages described by Talafidaryani [43]. In the first stage, we gathered the abstracts of our collection of studies which was described in the previous section as the input corpus for topic modeling. We only used the abstract section of the publications because this section reflects the main ideas and core findings of a study. In the next stage, we prepared the gathered corpus for topic modeling. This stage is necessary to enhance the quality of input data that will lead to a higher-quality output. In doing so, we performed some routine text preparation tasks including transforming uppercases to lowercases; removing punctuations, digits, and whitespaces; eliminating stopwords (i.e., commonly occurring trivial words); reducing words to their stems; and deleting relatively unimportant words based on the Term Frequency-Inverse Document Frequency (TF-IDF) measure. In this study, we followed the approach proposed by Jiang et al [87] to calculate the TF-IDF index which is one of the best term valuing approaches in automatic text retrieval [88]. In the third and final stage, the prepared corpus was transformed to Document-Term Matrix (DTM) as the required input of LDA algorithm. Next, a widely adopted `lda` package¹ developed based on the Gibbs sampling estimation algorithm was utilized to generate per-topic word distributions and per-document topic proportions as the main results of topic modeling (i.e., the topical composition of the corpus). In this stage, following the Griffiths and Steyvers [86] suggestion, the number of topics was tuned based on the log-likelihood measure. Also, the model's hyper-parameters were set equal to the reciprocal of number of topics. It is worth noting that we used the resulted per-document topic proportions to identify the topical trend of the corpus based on the approach proposed by Sun and Yin [89]. Note that in the current study, all of the above-described computational tasks in corpus cleaning and topic modeling stages were performed by using python programming language.

2.3. Trend forecasting

As a result of the topic modeling analysis, we were able to uncover the temporal trends of the underlying topics over the timeframe of the corpus (i.e., until 2020). Next, a time-series prediction analysis was carried out in order to forecast the trends until 2025. In doing so, we developed a python script to employ a powerful deep learning-based algorithm called `NeuralProphet`² which was introduced in 2021 by Triebe et al. [90]. `NeuralProphet` is a hybrid framework for time-series forecasting that makes a bridge between interpretable traditional statistical methods and scalable highly accurate deep learning models [90]. This recently introduced algorithm is a pretty convenient and explainable tool fusing the classical time series components of its precursors (e.g., Facebook Prophet [91]) with neural network modules into a hybrid model enabling it to fit to non-linear dynamics [90]. We chose `NeuralProphet` because it is the first hybrid predicting solution which meets the previously set standards for interpretability, accuracy, automation, scalability, and simplicity-of-use [90]. For learning more about the technical components and computational details of this algorithm, see the algorithm's seminal article by Triebe et al. [90].

¹ <https://pythonhosted.org/lda>

² <https://neuralprophet.com>

For the sake of summarization and more clarification, **Table 1** provides an overview of the analyses in the current study.

Table 1. An overview of the analyses in the present study

Analysis	Result	Technique and unit of analysis	Tool
Bibliometric analysis	The publication and citation structure	Descriptive statistical and temporal analyses of number of studies and citations along with the average number of citations per publication per year	WOS and Excel
	The most productive authors	Descriptive statistical analysis of total number of publications, total number of citations, average number of citations per study, and h-index	WOS and Excel
	The most productive universities	Descriptive statistical analysis of total number of publications, total number of citations, average number of citations per study, h-index, and world ranking	WOS and Excel
	The most productive countries	Descriptive statistical analysis of total number of publications, total number of citations, average number of citations per study, h-index, population, total number of publications per person, and total number of citations per person along with the temporal analysis of total number of publications	WOS and Excel
	The most productive journals	Descriptive statistical analysis of total number of publications, total number of citations, average number of citations per study, h-index, and 2-year and 5-year impact factors	WOS and Excel
	The most cited studies	Descriptive statistical analysis of total number of citations and average number of citations per year along with the type of study	WOS and Excel
	The most occurred and hottest keywords along with the themes and sub-themes	Occurrence and co-occurrence analyses of keywords	VOSviewer
Topic modeling	The latent topical structure along with the rising, falling, and fluctuating trends	Text analysis of abstracts based on the LDA algorithm	Python
Trend forecasting	The trends of the underlying topics within the next years	Time-series forecasting of per-year topic proportions based on the NeuralProphet algorithm	Python

3. Results

3.1. Publication and citation structure

Table 2 includes the number of studies published and the general citation structure that appeared for digitalization research in business and management fields since 1990. Also, **Figure 1** shows the publication and citation trends of the research. As this table and figure indicate, digitalization research has had four main waves in the business and management fields. Within the beginning years, only a handful of papers and citations was appeared and received on the topic. Then, the number of publications and citations increased slightly from the mid-1990s to 2014. However, a remarkable burst occurred in the research outcomes from 2014 to 2018. In a similar vein, in the period of 2018-2020, a stronger expansion took place in the total number of studies and citations which can be interpreted as an inevitable consequence of the advent of novel digital technologies and the appearance of immense attention on “Digital X” notions such as digital innovation and digital transformation in business and management fields. The results also say that the majority of highly-cited papers were published during the

2010-2016 period. 1.85% of the articles obtained more than 150 cites, 3.44% more than 100, 7.29% more than 50, 18.74% more than 20, 31.10% more than 10, and almost half of the papers received more than five citations. Approximately, only a quarter of the articles did not obtain any citation. It is evident to all that the recently published studies need more time to reach the threshold of the highly-cited papers. Within the last two years, it can be clearly seen that over 1000 studies have yearly appeared for the business-related and managerial research on digitalization, and the research has annually received over 10000 citations during the last three years. These figures imply the superior productivity and influence of digital topics in business and management research. Note that in **Table 2**, the total citations feature has two columns. The left column shows the total number of citations received by the research until a specific year. The values of this column were used for depicting the right panel of **Figure 1**. However, the right column shows the total number of citations received by the research of a specific year until the date on which our data were retrieved (i.e., April 2021). For example, consider the record of the year 2020. The value of the left column shows that all studies that were published until 2020 received 25093 citations until this year. However, the value of the right column indicates that all papers that were published in only 2020 obtained 3400 citations until now. The values of the right column were used for calculating the average citations per publication per year (ACPY) index following Laengle et al. [92] to understand the yearly advancement of the research. The importance of this index is that it normalizes the number of citations by dividing it by the number of studies. Also, the number of citations is divided by the age of publications, so a fairer judgment can be presented about the influence of publications of a specific year. From the ACPY view, the studies of 2012 have obtained the greatest impact in the business and management research on digitalization. Also, the publications of 2011 and 2013 occupy the second and third positions in this ranking.

Table 2. General citation structure on digitalization in business and management

Year	> 150	> 100	> 50	> 20	> 10	> 5	> 1	Total studies	Total citations	ACPY	
1990	0	0	0	0	0	1	1	6	0*	6**	0.0323
1991	0	0	0	0	0	1	1	3	0	7	0.0778
1992	0	0	0	1	3	6	7	7	0	69	0.3399
1993	0	1	1	2	3	5	8	11	3	204	0.6623
1994	0	0	0	2	4	5	7	7	8	93	0.4921
1995	1	1	2	3	5	6	8	12	14	536	1.7179
1996	0	0	2	2	3	5	6	12	18	136	0.4533
1997	0	2	3	5	8	9	13	25	40	396	0.6600
1998	0	1	2	5	6	7	15	35	47	383	0.4758
1999	2	3	6	8	11	14	22	37	48	1098	1.3489
2000	6	6	9	18	21	26	35	61	80	2697	2.1054
2001	5	8	13	19	24	28	37	64	146	2733	2.1352
2002	5	7	14	20	25	28	35	45	204	2147	2.5111
2003	7	9	17	28	36	40	46	55	243	4203	4.2455
2004	1	3	9	23	28	33	40	48	336	1675	2.0527
2005	4	8	19	33	43	45	49	58	618	3087	3.3265
2006	7	7	16	29	42	50	53	58	801	4279	4.9184
2007	3	11	18	35	47	54	56	61	1022	3070	3.5948

2008	8	11	23	48	67	80	93	98	1334	5590	4.3878
2009	3	9	19	40	56	71	89	101	1692	2993	2.4695
2010	9	16	24	49	80	94	113	122	2166	5011	3.7340
2011	10	16	24	58	77	89	103	112	2409	5621	5.0188
2012	9	13	22	55	79	87	98	105	2816	5525	5.8466
2013	9	14	25	64	92	119	137	150	3599	5972	4.9767
2014	5	12	23	59	94	126	143	150	3983	4290	4.0857
2015	4	12	30	89	146	195	266	302	5045	6858	3.7848
2016	5	19	42	115	179	254	346	405	6546	8338	4.1175
2017	5	9	34	120	196	304	447	520	8233	7931	3.8130
2018	4	9	28	107	221	354	595	694	10854	7904	3.7964
2019	0	2	16	78	215	433	905	1128	16840	7191	3.1875
2020	0	0	1	22	76	197	853	1575	25093	3400	2.1587
Total	112	209	442	1137	1887	2766	4627	6067	94238	103443	
%	1.85%	3.44%	7.29%	18.74%	31.10%	45.59%	76.27%	100%			

Note: compiled by the authors according to WoS; data collection was performed in April 2021; the symbols > 150, > 100, > 50, > 20, > 10, > 5, and > 1 refer to the number of studies with greater than 150, 100, 50, 20, 10, 5, and 1 citation(s) respectively; % = percentage of studies; ACPY = average citations per publication per year = (total citations) / [(total publications) * (2020 - year + 1)].

* The total number of citations received by the research until 1990.

** The total number of citations received by the publications of 1990 until the date of data retrieval.

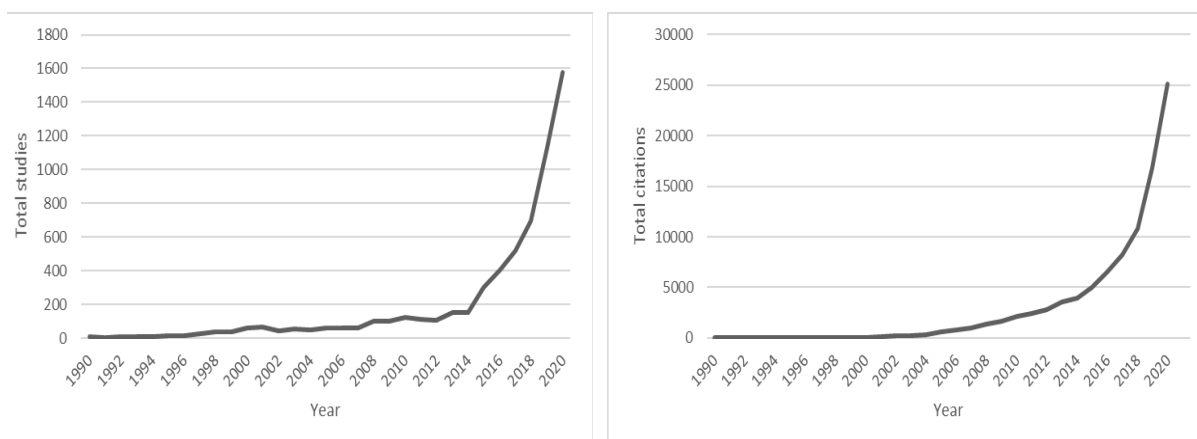


Figure 1. Publication and citation trends on digitalization in business and management

3.2. The most productive authors

Table 3 lists the 25 most productive authors on digitalization in business and management. By the most productive authors, we mean researchers with the greatest number of documents that appeared on our topic. The table includes the number of studies published on the topic by a highly productive author, the number of citations received by the studies, average citations per a study, the h-index of the productive author obtained by the studies, and the number of highly cited items among the studies. Also, this table points out the country and institution where a top author is currently working. **Table 3** shows that the majority of most productive authors are from the USA (16 items), and others in the list are from the European countries including Italy (4 items), Denmark (1 item), Sweden (1 item), Liechtenstein (1 item), Finland (1 item),

and Germany (1 item). Moreover, the table indicates that the institution with more top authors is the Polytechnic University of Milan, with three researchers in the ranking: Daniel Trabucchi, Antonio Ghezzi, and Tommaso Buganza. It is surprising to see that the Italian scholars and their institutions are so well positioned in this ranking. Robert J. Kauffman is the most productive author with 21 studies. Also, he has the greatest h-index signifying the high quality of his studies. However, Kalle Lyytinen with 2384 citations and Vallabh Sambamurthy with 237.50 average citations per study are the most influential ones. Regarding Kalle Lyytinen, it is worth noting that he could publish the highest number of influential papers including eight ones with above 50 citations and seven ones with over 150 citations.

Table 3. The most productive authors on digitalization in business and management

R	Name	Institution	Country	TP	TC	TC/TP	H	> 50	> 100	> 150
1	Kauffman, RJ	Copenhagen Business Sch	Denmark	21	702	33.430	12	5	1	1
2	Lyytinen, K	Case Western Reserve U	USA	15	2384	158.93	11	8	7	7
3	Henfridsson, O	U of Miami	USA	15	1147	76.470	10	7	3	2
4	Parida, V	Lulea U of Tech	Sweden	15	322	21.470	10	2	0	0
5	Kraus, S	Free U of Bozen-Bolzano	Italy	14	261	18.640	9	1	0	0
6	Trabucchi, D	Polytechnic U of Milan	Italy	14	115	8.2100	7	0	0	0
7	Smith, MD	Carnegie Mellon U	USA	13	681	52.380	9	3	1	1
8	Kannan, PK	U of Maryland	USA	12	1327	110.58	9	5	4	3
9	Ghezzi, A	Polytechnic U of Milan	Italy	12	224	18.670	7	2	0	0
10	Buganza, T	Polytechnic U of Milan	Italy	12	105	8.7500	6	0	0	0
11	Ghose, A	New York U	USA	11	1549	140.82	8	4	3	3
12	Rai, A	Georgia State U	USA	10	1594	159.40	9	6	3	3
13	El Sawy, OA	U of Southern California	USA	10	1092	109.20	8	4	4	3
14	Nambisan, S	Case Western Reserve U	USA	9	1271	141.22	8	5	4	4
15	Whinston, AB	U of Texas at Austin	USA	9	527	58.560	6	2	1	1
16	Telang, R	Carnegie Mellon U	USA	9	321	35.670	5	3	1	0
17	vom Brocke, J	U of Liechtenstein	Liechtenstein	9	248	27.560	7	1	0	0
18	Weill, P	MIT Sloan Sch of Management	USA	9	241	26.780	6	1	1	0
19	Kohtamaki, M	U of Vaasa	Finland	9	125	13.890	6	0	0	0
20	Gebauer, H	Fraunhofer IMW	Germany	9	108	12.000	5	0	0	0
21	Arli, D	U of Minnesota Duluth	USA	9	81	9.0000	5	0	0	0
22	Fulgoni, G	comScore, Inc	USA	9	75	8.3300	5	0	0	0
23	Sambamurthy, V	U of Wisconsin-Madison	USA	8	1900	237.50	8	4	4	3
24	Pavlou, PA	U of Houston	USA	8	1303	162.88	6	5	5	5
25	Grover, V	U of Arkansas	USA	8	1300	162.50	4	1	1	1

Note: compiled by the authors according to WoS; data collection was performed in April 2021; R = rank based on the number of studies; TP = total publications; TC = total citations; TC/TP = average citations per item; H = h-index; the symbols > 50, > 100, and > 150 refer to the number of studies with greater than 50, 100, and 150 citations respectively.

3.3. The most productive universities

In order to identify the most productive universities on digitalization in business and management, **Table 4** presents a list including the top 25 universities with the highest number of papers published on the topic. Alongside the number of publications, this table includes some other indicators including the number of citations received by the publications, average citations per publication, the h-index of a highly productive university, and the number of publications reaching the citation threshold of 50, 100, and 150. Also, **Table 4** presents the location and the current global ranking of these universities according to the Academic Ranking of World Universities (ARWU) and the Quacquarelli Symonds (QS) World University Rankings. ARWU and QS are considered as quality indicators for universities and provide a reference on the worldwide position of a university [61]. Accordingly, in the current analysis, the aim of these two indicators is to indicate the global position of the leading universities on digitalization in business and management. In this ranking, two American giants, i.e., Massachusetts Institute of Technology (MIT) and Harvard University with 65 and 64 publications occupy the first and second positions following by the Copenhagen Business School, a Danish university with 61 publications on the topic. Harvard University with 4678 citations, Temple University with 4096 citations, and University of Maryland with 3738 citations are the most influential universities. Also, these three universities are the top three impactful ones regarding the normalized number of citations and the number of highly influential studies. Moreover, University of Maryland, Harvard University, and MIT have the highest h-indices of 27, 24, and 23 reflecting their high-quality publications. **Table 4** shows that most of the top universities on our topic are established in the USA (12 items) although other ones are universities located in the European countries such as England (5 items), Sweden (2 items), Denmark (1 item), Finland (1 item), Italy (1 item), Switzerland (1 item), and Netherlands (1 item), except the Queensland University of Technology which is an Australasian university with 1 item in the list. It is interesting to note that most of these universities have prestigious worldwide ranks. However, some of them do not get high positions in the world university rankings which means that digitalization is a diverse topic in business and management academia and has not only influenced the world-leading universities.

Table 4. The most productive universities on digitalization in business and management

R	Name	Country	TP	TC	TC/TP	H	ARWU	QS	> 50	> 100	> 150
1	Massachusetts Inst of Tech	USA	65	2570	39.54	23	4	1	11	7	4
2	Harvard U	USA	64	4678	73.09	24	1	3	18	13	10
3	Copenhagen Business Sch	Denmark	61	1308	21.44	15	801-900	N/A	7	4	2
4	New York U	USA	53	3203	60.42	22	27	35	13	8	5
5	U of Warwick	England	50	1243	24.86	18	101-150	62	10	3	1
6	Aalto U	Finland	50	911	18.22	17	401-500	127	3	1	1
7	U of Maryland	USA	49	3738	76.29	27	53	152	19	12	8
8	U of Texas at Austin	USA	48	1607	33.48	18	41	71	9	4	2
9	Polytechnic U of Milan	Italy	48	568	11.83	12	201-300	137	3	0	0
10	Carnegie Mellon U	USA	46	1952	42.43	20	95	51	10	5	3
11	U of Minnesota	USA	46	1514	32.91	18	40	177	9	3	3
12	U of Southern California	USA	44	2509	57.02	17	61	121	9	8	6
13	U of St. Gallen	Switzerland	43	531	12.35	13	N/A	428	0	0	0
14	U of Pennsylvania	USA	42	3034	72.24	19	19	16	13	7	4

15	Temple U	USA	40	4096	102.4	21	301-400	701-750	14	12	10
16	Georgia State U	USA	40	2477	61.93	18	401-500	751-800	11	5	5
17	Queensland U of Tech	Australia	38	478	12.58	13	301-400	217	2	0	0
18	U of Cambridge	England	37	1203	32.51	16	3	7	9	4	1
19	U of Gothenburg	Sweden	37	578	15.62	12	101-150	202	3	1	0
20	Tilburg U	Netherlands	34	770	22.65	17	601-700	368	3	1	1
21	City, U of London	England	33	772	23.39	12	701-800	350	4	3	1
22	London Sch of Economics	England	32	1234	38.56	16	151-200	49	6	4	3
23	U of California, Berkeley	USA	32	891	27.84	13	5	30	6	2	1
24	University of Manchester	England	32	552	17.25	14	36	27	2	0	0
25	Stockholm Sch of Economics	Sweden	32	419	13.09	10	401-500	N/A	1	1	0

Note: compiled by the authors according to WoS; data collection was performed in April 2021; R = rank based on the number of studies; TP = total publications; TC = total citations; TC/TP = average citations per item; H = h-index; ARWU = 2020 world ranking according to the Academic Ranking of World Universities; QS = 2021 world ranking according to Quacquarelli Symonds World University Rankings; the symbols > 50, > 100, and > 150 refer to the number of studies with greater than 50, 100, and 150 citations respectively.

3.4. The most productive countries

Next, our analyses are going to be focused on the most productive countries on digitalization in business and management. In this regard, **Table 5** ranks the top 25 countries with the highest number of publications on the topic. This analysis is based on similar measures to those in the author-level and university-level analyses. However, following the suggestion of Merigó et al. [63], this investigation includes the population of a productive country to understand its productivity per the country's inhabitants. Note that a country refers to the origin of an institution where its affiliated researchers have written a paper but does not consider the nationality of the researchers. Thanks to having a large size of academia, including a high number of business and management schools, and enjoying great access to journals and databases, the USA is the most productive and influential country on digitalization in business and management. With respect to the number of publications and citations, the USA is the only country that was responsible for over 1000 articles and over 50000 citations. It has published more than twice the number of publications of the second country and has received four times more citations. Following the USA, England and Germany are placed as the second and third most productive and influential countries in the list. Also, these three countries have achieved the highest values of the h-index. However, considering the average citations per item leads to some changes in this ranking. Although the USA is again the leader with a ratio of 32.73 citations per publication, it is followed by the Singapore and Netherlands with the ratios of 26.00 and 21.80 respectively. In contrast with the publications and citations frequency analyses, if the number of publications or citations per person is considered as the criteria for ranking, smaller countries such as Finland and Denmark obtain the most remarkable positions in the list. However, **Table 5** implies that the most influential papers with more than 50, 100, or 150 citations have mainly been published by the researchers of populous countries including the USA, England, and China. It is interesting to note that most of the places in **Table 5** are occupied by the European countries (15 out of 25 items). Also, five Asian countries including China, India, South Korea, Taiwan, and Singapore have appeared in the list although none of them are in the top five. Other places of this ranking belong to the USA, Australia, Canada, Brazil, and New Zealand originated in the other geographical areas of the world. These results

clearly indicate that digitalization has diffused all around the academic world of business and management within the recent years, and this topic has not remained behind the borders of a specific geographical academia.

Table 5. The most productive countries on digitalization in business and management

R	Name	TP	TC	TC/TP	H	P	TP/P	TC/P	> 50	> 100	> 150
1	USA	1811	59282	32.73	116	331002.650	5.470	179.10	261	148	89
2	England	754	14137	18.75	57	67886.0100	11.11	208.25	68	28	15
3	Germany	474	5790	12.22	37	83783.9400	5.660	69.110	21	9	2
4	Australia	332	3975	11.97	30	25499.8800	13.02	155.89	10	3	2
5	Italy	314	4075	12.98	33	60461.8300	5.190	67.400	22	5	0
6	China	284	4754	16.74	33	1439323.78	0.200	3.3000	22	9	6
7	France	262	3846	14.68	30	65273.5100	4.010	58.920	14	6	6
8	India	257	1694	6.590	18	1380004.39	0.190	1.2300	5	3	2
9	Sweden	240	3551	14.80	30	10099.2700	23.76	351.61	18	4	1
10	Canada	225	3496	15.54	29	37742.1500	5.960	92.630	16	6	2
11	Finland	212	2935	13.84	27	5540.72000	38.26	529.71	12	3	2
12	Spain	206	2398	11.64	26	46754.7900	4.410	51.290	9	3	1
13	Netherlands	205	4469	21.80	32	17134.8700	11.96	260.81	16	10	5
14	Brazil	149	472	3.170	11	212559.420	0.700	2.2200	1	0	0
15	South Korea	144	2632	18.28	25	51269.1900	2.810	51.340	11	6	3
16	Denmark	141	2296	16.28	25	5792.20000	24.34	396.40	10	6	2
17	Russia	135	639	4.730	11	145934.460	0.930	4.3800	3	1	0
18	Switzerland	133	2173	16.34	24	8654.62000	15.37	251.08	8	5	1
19	Taiwan	102	1255	12.30	18	23816.7800	4.280	52.690	5	1	1
20	Norway	95	1737	18.28	20	5421.24000	17.52	320.41	5	2	2
21	Austria	81	1394	17.21	19	9006.40000	8.990	154.78	8	3	0
22	Poland	80	366	4.580	9	37846.6100	2.110	9.6700	1	1	0
23	New Zealand	79	1179	14.92	19	4822.23000	16.38	244.49	5	1	1
24	Portugal	69	885	12.83	16	10196.7100	6.770	86.790	5	0	0
25	Singapore	68	1768	26.00	21	5850.34000	11.62	302.20	10	4	1

Note: compiled by the authors according to WoS; data collection was performed in April 2021; R = rank based on the number of studies; TP = total publications; TC = total citations; TC/TP = average citations per item; H = h-index; P = 2020 population in thousands according to Worldometer; TP/P = average productivity per person multiplied by one million; TC/P = average citations per person multiplied by one million; the symbols > 50, > 100, and > 150 refer to the number of studies with greater than 50, 100, and 150 citations respectively.

Then, **Table 6** presents the temporal evolution of the number of papers that each of the top 10 most productive countries, introduced in **Table 5**, has published since 1990. This table shows that the USA established the research on digitalization in business and management in 1990. Afterward, this country has continued its research on the topic regularly and has always been the main leader of the research. After the USA, England, France, Sweden, and Canada started to contribute to the discourse in 1992 and 1993. Also, Germany, Australia, China, Italy, and India were the late-comer contributors within the next years. However, they could not publish regularly in that period. Conversely, during the last five years, it can clearly be seen that all of

these countries have regularly and increasingly published on digitalization in business and management, and based on this trend, it can be anticipated that the progress of the topic will similarly be continued globally within the upcoming years.

Table 6. Publication evolution of leading countries on digitalization in business and management

Year	USA	England	Germany	Australia	Italy	China	France	India	Sweden	Canada
1990	2	0	0	0	0	0	0	0	0	0
1991	1	0	0	0	0	0	0	0	0	0
1992	3	1	0	0	0	0	1	0	1	0
1993	6	0	0	0	0	0	0	0	0	1
1994	4	0	0	0	0	0	0	0	0	0
1995	5	2	0	0	0	0	0	0	1	0
1996	6	1	0	0	0	0	0	0	0	0
1997	10	0	0	0	0	0	0	0	0	1
1998	7	3	0	0	0	0	0	0	0	1
1999	9	4	1	1	0	0	0	0	0	0
2000	21	5	0	0	0	1	1	0	1	2
2001	32	3	0	0	1	2	3	1	0	0
2002	24	4	1	4	1	0	0	0	0	2
2003	29	3	0	0	2	2	2	0	0	1
2004	28	6	0	0	1	2	1	1	0	2
2005	27	8	1	1	1	1	0	0	0	2
2006	27	6	2	1	4	2	0	2	1	2
2007	34	3	0	1	0	4	1	1	0	2
2008	52	6	3	7	3	3	1	0	1	3
2009	48	11	3	3	2	3	0	0	2	4
2010	54	18	9	8	3	3	2	0	2	6
2011	54	5	1	3	1	10	2	2	5	2
2012	51	11	3	3	1	2	5	1	2	2
2013	69	25	9	5	5	6	7	0	4	3
2014	61	29	13	5	5	9	13	0	5	7
2015	100	44	23	18	14	13	9	14	10	9
2016	143	54	22	32	15	14	20	21	16	18
2017	137	61	51	40	22	26	17	30	30	16
2018	190	81	59	45	35	32	25	30	29	24
2019	266	159	98	60	75	51	60	44	52	51
2020	311	200	175	93	123	98	92	110	78	64

Note: compiled by the authors according to WoS; data collection was performed in April 2021.

3.5. The most productive journals

Table 7 shows the 25 journals with the greatest rate of productivity on digitalization in business and management. This rate of productivity has been measured through different indicators including the number of publications and highly-cited papers published by the journal with

regard to the topic, the number of citations, the ratio of citations per paper, and the h-index achieved by the publications. With regard to these indicators, it can be seen that Technological Forecasting and Social Change, Journal of Business Research, and Information Systems Research with 199, 111, and 110 publications are the most productive journals in the research. MIS Quarterly, Information Systems Research, and Management Science with 8864, 7708, and 3795 citations are the most influential journals in the research. Also, these three journals have the highest citations per publication ratios of 91.38, 70.07, and 64.32 respectively, and were responsible for most of the highly-cited papers in the research. In total, they have 102 papers with more than 50 citations, 62 papers with more than 100 citations, and 39 papers with more than 150 citations. MIS Quarterly, Information Systems Research, and Technological Forecasting and Social Change with the h-indices of 44, 44, and 30 have published the papers with the highest quality in the research. In addition to these indicators, **Table 7** presents the impact factor (IF) of the highly-productive journals. This measure which is annually reported by the Thomson Reuters Journal Citations Report (JCR) uses the number of citations achieved by a journal's publications during the last two years divided by the number of articles of the journal published within the current year. In the case of 5-year IF, the number of citations received during the last five years is considered [26]. This indicator provides researcher with objective insight into the value and importance of a specific journal in a particular research area [32]. Accordingly, from the IF perspective, all of the productive journals in the research on digitalization in business and management are valuable and important journals in their index categories. They have an IF range of 2.135-5.846 and a 5-year IF range of 2.232-9.917. Among these journals, Technological Forecasting and Social Change has the best IF value and MIS Quarterly has the best 5-year IF value. As mentioned above, these two journals are respectively the most productive and the most influential ones in the research. By investigating **Table 7**, it can be understood that the journals can be categorized into five main categories: 1. the journals which are generally related to the business and management fields and are not specified to a specific area of these fields such as Journal of Business Research. 2. the journals which are related to the technology and innovation management area such as Technological Forecasting and Social Change. 3. the journals which are related to the information systems area such as Information Systems Research. 4. the journals which are related to the marketing area such as Journal of Advertising Research. And, 5. the journals which are related to the administrative sciences such as Public Relations Review. These results refer to the interdisciplinary nature of digitalization research in the business and management fields. Also, it is interesting to say that the information systems area has a notable number of journals on the list (10 out of 25). This fact implies that the digitalization discourse is more vibrant in this area in comparison with the other sub-fields of business and management.

Table 7. The most productive journals on digitalization in business and management

R	Name	TP	TC	TC/TP	H	IF	5Y-IF	> 50	> 100	> 150
1	Technological Forecasting and Social Change	199	3714	18.66	30	5.846	5.179	14	4	3
2	Journal of Business Research	111	2038	18.36	26	4.874	5.484	8	3	1
3	Information Systems Research	110	7708	70.07	44	3.585	5.634	42	27	19
4	MIS Quarterly	97	8864	91.38	44	5.361	9.917	41	23	14
5	Journal of Advertising Research	84	1010	12.02	15	2.169	3.182	3	2	0
6	Journal of Management Information Systems	72	2243	31.15	27	3.949	5.399	13	3	1

7	Harvard Business Review	68	1597	23.49	22	5.694	6.849	8	5	1
8	Public Relations Review	62	1134	18.29	17	2.321	2.232	3	2	1
9	Business Horizons	61	2900	47.54	18	3.444	4.311	10	5	3
10	Management Science	59	3795	64.32	29	3.931	5.467	19	12	6
11	Electronic Markets	59	352	5.970	9	2.981	4.417	0	0	0
12	Electronic Commerce Research and Applications	58	1120	19.31	20	3.824	4.300	3	1	1
13	Industrial Marketing Management	57	1324	23.23	18	4.695	5.868	8	4	1
14	Journal of Retailing and Consumer Services	57	700	12.28	15	4.219	N/A	1	1	0
15	MIT Sloan Management Review	54	537	9.940	14	2.706	3.990	2	1	0
16	European Journal of Information Systems	53	1677	31.64	17	2.600	5.131	7	5	3
17	Internet Research	52	1229	23.63	19	4.708	5.355	5	2	2
18	Research Policy	50	1971	39.42	21	5.351	7.927	11	6	3
19	MIS Quarterly Executive	50	1004	20.08	17	4.088	3.722	5	1	0
20	Information & Management	49	2440	49.80	20	5.155	6.714	7	4	3
21	Journal of Business Ethics	49	1108	22.61	17	4.141	5.453	5	3	2
22	European Journal of Marketing	48	414	8.630	10	2.135	2.611	0	0	0
23	Journal of Information Technology	44	943	21.43	18	3.625	6.804	5	2	1
24	International Journal of Electronic Commerce	42	973	23.17	16	2.488	5.143	4	3	1
25	Research-Technology Management	42	415	9.880	10	2.449	3.677	2	1	0

Note: compiled by the authors according to WoS; data collection was performed in April 2021; R = rank based on the number of studies; TP = total publications; TC = total citations; TC/TP = average citations per item; H = h-index; IF = 2019 impact factor; 5Y-IF = 5-year impact factor; the symbols > 50, > 100, and > 150 refer to the number of studies with greater than 50, 100, and 150 citations respectively.

3.6. The most cited studies

Table 8 presents the top 25 studies with the highest number of citations. By observing this table, the most significant, influential, and popular contributions to the digitalization topic in the business and management fields can be identified. However, it should be asserted that this analysis has a limitation. That is, the most cited articles are not always the most relevant ones [60]. In this list, the title, author(s), publisher, publication year, total citations obtained, average citations per year, and type of the most cited studies are presented. Accordingly, the study by Sambamurthy et al. [93] published in MIS Quarterly in 2003 is the most cited paper in the research. The aim of this paper was to argue the impact of information technology competence on firm performance. To this end, the researchers conceptualized a nomological network in which information technology competence enable competitive actions through three significant organizational capabilities (i.e., agility, digital options, and entrepreneurial alertness) and strategic processes (i.e., capability building, entrepreneurial action, and coevolutionary adaptation), and these competitive actions are significant drivers of firm performance. And, the study by Berman [94] published in Business Horizons in 2012 has the greatest ratio of 93.20 citations per year. This study presented an overall insight into the process of 3-D printing as a digital manufacturing process, its current and potential applications, its advantages in comparison with other technologies, its limitations, and practical considerations on its adaptability. It is interesting to say that both of these papers are conceptual contributions. Also, most of the highly-cited studies are conceptual researches (13 out of 25). Among the remaining, most of the papers are empirical quantitative works (8 out of 25), and others are empirical

qualitative studies (4 out of 25). It is worth noting that all of the most cited studies on digitalization in business and management are journal articles, and other types of publications such as book chapters on the topic are not present in this list.

Table 8. The most cited studies on digitalization in business and management

R	Title	Author(s)	Publisher	Year	TC	C/Y	Type of study
1	Shaping agility through digital options: reconceptualizing the role of information technology in contemporary firms	Sambamurthy et al.	MIS Quarterly	2003	1188	62.53	Conceptual
2	Electronic word-of-mouth in hospitality and tourism management	Litvin et al.	Tourism Management	2008	1157	82.64	Conceptual
3	Capabilities, cognition, and inertia: evidence from digital imaging	Tripsas & Gavetti	Strategic Management Journal	2000	1110	50.45	Empirical - qualitative
4	3-D printing: the new industrial revolution	Berman	Business Horizons	2012	932	93.20	Conceptual
5	Firm performance impacts of digitally enabled supply chain integration capabilities	Rai et al.	MIS Quarterly	2006	812	50.75	Empirical - quantitative
6	Examining the relationship between reviews and sales: the role of reviewer identity disclosure in electronic markets	Forman et al.	Information Systems Research	2008	711	50.79	Empirical - quantitative
7	We're all connected: the power of the social media ecosystem	Hanna et al.	Business Horizons	2011	610	55.45	Conceptual
8	From multi-channel retailing to omni-channel retailing introduction to the special issue on multi-channel retailing	Verhoef et al.	Journal of Retailing	2015	593	84.71	Conceptual
9	Digital business strategy: toward a next generation of insights	Bharadwaj et al.	MIS Quarterly	2013	552	61.33	Conceptual
10	The new organizing logic of digital innovation: an agenda for information systems research	Yoo et al.	Information Systems Research	2010	552	46.00	Conceptual
11	Unbundling the structure of inertia: resource versus routine rigidity	Gibert	Academy of Management Journal	2005	546	32.12	Empirical - qualitative
12	We are what we post? Self-presentation in personal web space	Jensen Schau & Gilly	Journal of Consumer Research	2003	534	28.11	Empirical - qualitative
13	Extended self in a digital world	Belk	Journal of Consumer Research	2013	497	55.22	Conceptual
14	Service innovation: a service-dominant logic perspective	Lusch & Nambisan	MIS Quarterly	2015	490	70.00	Conceptual
15	Understanding generation Y and their use of social media: a review and research agenda	Bolton et al.	Journal of Service Management	2013	468	52.00	Conceptual
16	Organizing for innovation in the digitized world	Yoo et al.	Organization Science	2012	454	45.40	Conceptual
17	Through a glass darkly: information technology design, identity verification,	Ma & Agarwal	Information Systems Research	2007	441	29.40	Empirical - quantitative

	and knowledge contribution in online communities						
18	Bundling information goods: pricing, profits, and efficiency	Bakos & Brynjolfsson	Management Science	1999	438	19.04	Empirical - quantitative
19	Customer engagement, buyer-seller relationships, and social media	Sashi	Management Decision	2012	434	43.40	Conceptual
20	Consumer surplus in the digital economy: estimating the value of increased product variety at online booksellers	Brynjolfsson et al.	Management Science	2003	418	22.00	Empirical - quantitative
21	Privacy in the digital age: a review of information privacy research in information systems	Bélanger & Crossler	MIS Quarterly	2011	417	37.91	Empirical - qualitative
22	Demand heterogeneity and technology evolution: implications for product and process innovation	Adner & Levinthal	Management Science	2001	388	18.48	Empirical - quantitative
23	An empirical investigation of net-enabled business value	Barua et al.	MIS Quarterly	2004	382	21.22	Empirical - quantitative
24	Determinants of user acceptance of digital libraries: an empirical examination of individual differences and system characteristics	Hong et al.	Journal of Management Information Systems	2002	370	17.62	Empirical - quantitative
25	Closing the marketing capabilities gap	Day	Journal of Marketing	2011	357	32.45	Conceptual

Note: compiled by the authors according to WoS; data collection was performed in April 2021; R = rank based on the number of citations; TC = total citations; C/Y = citations per year.

3.7. Keyword occurrence and co-occurrence analyses

This section presents the results of keyword occurrence and co-occurrence analyses performed by the VOSviewer software. In these analyses, author keyword was considered as the analysis unit. **Table 9** lists the most occurred keywords of publications on the digitalization topic in the business and management fields. This list ranks the top 50 keywords according to their occurrences. The ranking is led by the digitalization keyword with 296 occurrences followed by social media (267 occurrences), innovation (218 occurrences), digital transformation (182 occurrences), and digital marketing (140 occurrences). It is not surprising to see the keywords digitalization and digital transformation among the top five keywords because these are considered as the umbrella terms in the research. However, it is very interesting to see that social media as a technology, innovation as a concept, and digital marketing as a field are placed so well in this list.

Table 9. The most occurred keywords on digitalization in business and management

R	Keyword	Occurrences	R	Keyword	Occurrences
1	digitalization	296	26	sme	66
2	social media	267	27	blockchain	64
3	innovation	218	28	platform	58
4	digital transformation	182	29	strategy	52
5	digital marketing	140	30	trust	51
6	electronic commerce	138	31	knowledge management	50

7	digital technology	126	32	sustainability	49
8	business model	122	33	open innovation	48
9	industry 4	118	34	sharing economy	48
10	big data	108	35	social network	48
11	technology	108	36	co-creation	46
12	internet	100	37	digital entrepreneurship	43
13	digitization	93	38	pricing	43
14	digital platform	92	39	ecosystem	41
15	digital innovation	91	40	marketing	41
16	digital economy	89	41	privacy	39
17	information technology	85	42	digital media	38
18	entrepreneurship	82	43	e-government	37
19	information and communication technology	79	44	business model innovation	36
20	case study	78	45	dynamic capability	36
21	digital	77	46	technology adoption	36
22	digital divide	76	47	cryptocurrency	34
23	artificial intelligence	75	48	fintech	34
24	internet of things	69	49	network	34
25	consumer behavior	67	50	servitization	34

Note: compiled by the authors according to WoS; data collection was performed in April 2021; R = rank based on the number of occurrences.

It may be interesting for scholars to see the most occurred digital terms in **Table 10**. In this table, the “Digital X” keywords are presented and ranked based on their occurrences. It is worth noting that an extended version of this table can be considered as a digital thesaurus which may be useful for digital researchers and thinkers to identify the relevant concepts and expressions.

Table 10. The most occurred digital terms in business and management

R	Keyword	Occurrences	R	Keyword	Occurrences
1	digitalization	296	26	digital business model	12
2	digital transformation	182	27	digital era	12
3	digital marketing	140	28	digital revolution	11
4	digital technology	126	29	digital banking	10
5	digitization	93	30	digital channel	10
6	digital platform	92	31	digital currency	10
7	digital innovation	91	32	digital distribution	10
8	digital economy	89	33	digital literacy	10
9	digital	77	34	digital servitization	10
10	digital divide	76	35	digital signage	10
11	digital entrepreneurship	43	36	digital skill	10
12	digital media	38	37	digital work	10
13	digital piracy	25	38	digital business strategy	9

14	digital good	23	39	digital government	9
15	digital product	23	40	digital identity	9
16	digital native	22	41	digital manufacturing	9
17	digital infrastructure	20	42	digital rights management	9
18	digital service	19	43	digital age	8
19	digital advertising	17	44	digital capability	8
20	digital strategy	17	45	digital disruption	8
21	digital content	15	46	digital fabrication	8
22	digital ecosystem	15	47	digital inequality	7
23	digital communication	14	48	digital influencer	7
24	digital music	14	49	digital learning	7
25	digital business	12	50	digital library	7

Note: compiled by the authors according to WoS; data collection was performed in April 2021; R = rank based on the number of occurrences.

Also, **Table 11** includes the most occurred digital technologies. This table presents the highly occurred keywords representing some kinds of digital technologies. In this regard, it should be mentioned that to the best of our knowledge, there is not a consensual definition of the digital technology notion in the pertinent literature. Therefore, other researchers may include some other keywords as digital technologies in this list and exclude some of the reported keywords from the list. For detecting these digital technologies among the frequent keywords, we adopted the definition provided by Bharadwaj et al. [6] describing digital technologies as a combination of information, computing, communication, and connectivity technologies. In addition, we considered the different categories of digital technologies including social, mobile, analytics, cloud, internet of things, platforms, internet, software, and blockchain technologies introduced in previous studies such as Sebastian et al. [95] and Vial [1]. This list is led by social media technology with 267 occurrences followed by big data (108 occurrences), internet (100 occurrences), artificial intelligence (75 occurrences), and internet of things (69 occurrences).

Table 11. The most occurred digital technologies in business and management

R	Keyword	Occurrences	R	Keyword	Occurrences
1	social media	267	26	chatbot	11
2	big data	108	27	data mining	11
3	internet	100	28	instagram	11
4	artificial intelligence	75	29	mobile	11
5	internet of things	69	30	website	11
6	blockchain	64	31	online platform	10
7	platform	58	32	youtube	10
8	cryptocurrency	34	33	video game	10
9	facebook	33	34	software	9
10	machine learning	32	35	amazon	8
11	mobile app	28	36	cyber-physical system	8
12	3d printing	27	37	mobile phone	8

13	bitcoin	25	38	social media analytics	8
14	text mining	22	39	smartphone	7
15	twitter	22	40	web 2.0	7
16	additive manufacturing	21	41	digital twin	6
17	augmented reality	18	42	robot	6
18	analytics	16	43	airbnb	5
19	cloud computing	15	44	cryptography	5
20	algorithm	14	45	eye tracking	5
21	big data analytics	14	46	google	5
22	data analytics	13	47	mobile internet	5
23	sentiment analysis	12	48	robotics	5
24	social networking site	12	49	topic modeling	5
25	virtual reality	12	50	wikipedia	5

Note: compiled by the authors according to WoS; data collection was performed in April 2021; R = rank based on the number of occurrences.

Next, **Figure 2** indicates the co-occurrence network of author keywords. This network includes the highly occurred keywords with a threshold of 10 occurrences. Each keyword is represented by a node the size of which is correlated with the number of occurrences of the keyword among the publications on digitalization in business and management. In the network, the co-occurrence of two keywords is shown by a link the thickness of which is defined by the number of co-occurrences of the keywords among the publications. The graphical visualization of this network is based on a distance-based approach in which the most co-occurred keywords are placed close to each other. Also, in the network, eight clusters are distinguished by different colors. Each cluster contains the keywords which are frequently co-occurred with each other among the publications. Therefore, each cluster can represent a specific theme in the research. **Table 12** shows these clusters, their theme (label), and their top 20 keywords. These keywords have been sorted based on the number of their occurrences. The label of each cluster has been chosen based on the respective top keywords. However, it is evident that this is subjective labeling and others may choose another title for a cluster.

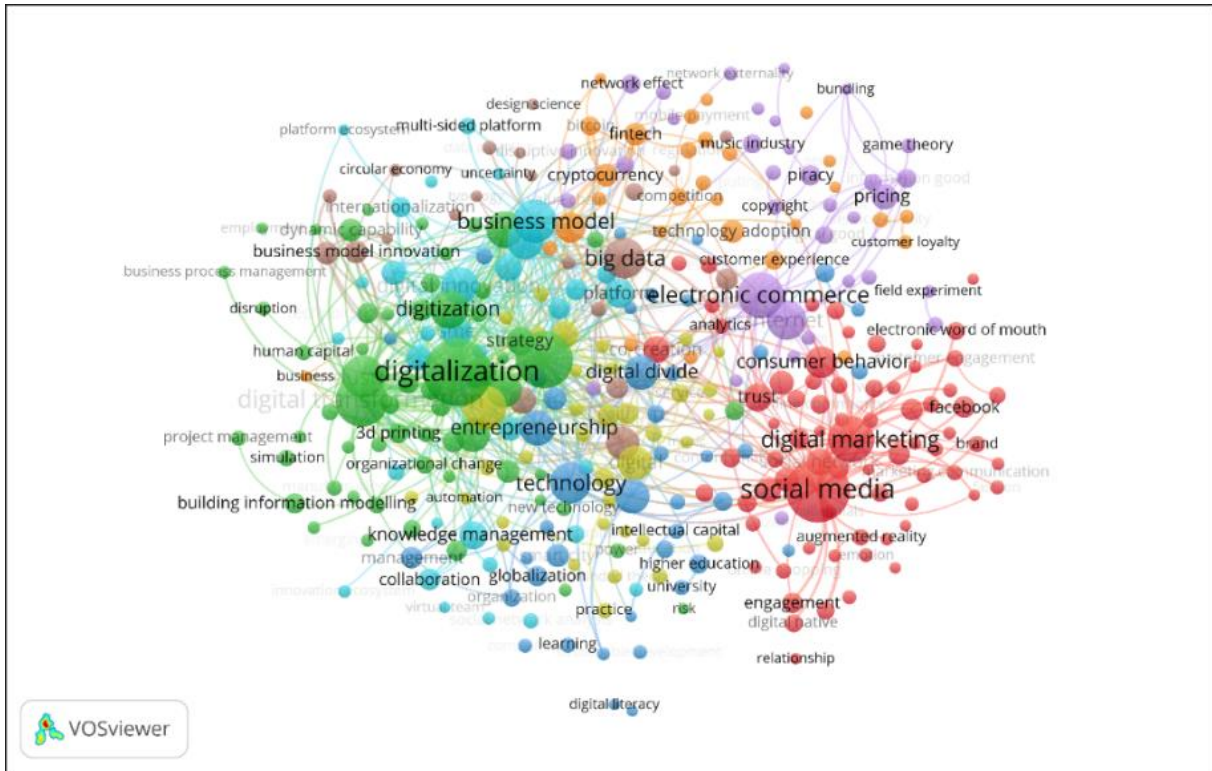


Figure 2. Co-occurrence network of author keywords

The presence of the keywords digital marketing, consumer behavior, marketing, advertising, social media marketing, electronic word of mouth, online advertising, customer engagement, mobile marketing, marketing strategy, word of mouth, brand, customer relationship management, marketing communication, branding, etc. in cluster 1 implies that digital marketing is the main theme of the first cluster. In this regard, the top keywords of this cluster refer to two worth noting sub-themes including the notions related to social media (e.g., social network, digital media, and online community) and the concepts related to consumer behavior (e.g., trust, engagement, and acceptance). On top of that, if all keywords of this cluster are considered, it can be seen that social media, mobile app, augmented reality, analytics, social networking site, virtual reality, and chatbot are present in this cluster as the most prevalent digital technologies in the marketing realm. In cluster 2, some keywords such as digitalization, innovation, digital transformation, digitization, digital economy, technological change, organizational change, change management, disruptive technology, digital strategy, technological innovation, new technology, disruption, digital business, fourth industrial revolution, digital revolution, and some digital technologies such as internet of things and 3d printing or additive manufacturing can be seen, so digital transformation was chosen as the label of this cluster. The industrial and organizational keywords of this cluster (e.g., industry 4 and dynamic capability) imply that this cluster relates to digital transformation at both the industry and organization levels. Digital development was chosen as the label of the third cluster because of the presence of societal, governmental, and educational terms such as digital divide, e-government, smart city, globalization, higher education, education, governance, digital infrastructure, university, culture, e-learning, learning, sustainable development, digital era, information society, public policy, public sector, digital literacy, and digital skill in this cluster. In cluster 4, some keywords such as digital technology, digital, sharing economy, value

co-creation, service, creativity, service innovation, algorithm, automation, collaborative consumption, service-dominant logic, customer service, and online platform led us to select digital service as the title of this cluster. In this cluster, service automation and digital value creation were detected as two sub-themes of the cluster. Cluster 5 was named as digital commerce because of the keywords electronic commerce, internet, pricing, piracy, information good, digital good, digital product, new product development, digital advertising, intellectual property, copyright, digital content, two-sided market, digital music, media, online, electronic market, willingness to pay, e-book, mobile, video game, etc. Also, it is worth noting that digital product and digital content are two sub-themes of this cluster. In cluster 6, there are some keywords such as business model, digital platform, platform, digital entrepreneurship, ecosystem, value creation, collaboration, multi-sided platform, startup, digital ecosystem, digital business model, platform economy, and platform ecosystem, so digital platform would be an appropriate title for this cluster. These keywords show that digital business model and digital entrepreneurship are two prominent sub-themes of this cluster. Moreover, it is worth noting that some innovation-related concepts such as digital innovation, open innovation, and innovation ecosystem are also present in this cluster, so digital innovation can be considered as another sub-theme of the cluster. Blockchain, cryptocurrency, fintech, bitcoin, regulation, financial inclusion, financial service, mobile payment, cloud computing, mobile commerce, bank, digital banking, and digital currency are some of the top keywords of cluster 7. Accordingly, digital economy was selected as the major theme of this cluster. With regard to the top keywords of this cluster, it can be asserted that digital currency, digital finance, and digital banking can be considered as the sub-themes of this cluster. Also, it is interesting to see that some terms of this cluster are customer-related notions (e.g., customer experience and customer satisfaction) which are present in this cluster with regard to the adoption and diffusion of blockchain-related technologies. Finally, cluster 8 has mainly a focus on digital analytics theme because of the keywords big data, artificial intelligence, machine learning, text mining, big data analytics, data analytics, sentiment analysis, forecasting, etc. Based on these keywords, big data and artificial intelligence can be introduced as the main sub-themes of this cluster.

Table 12. The thematic clusters on digitalization in business and management

Cluster	Label	Top 20 keywords
Cluster 1 in red	Digital marketing	social media, digital marketing, consumer behavior, trust, social network, co-creation, marketing, privacy, digital media, advertising, facebook, social media marketing, mobile app, engagement, technology acceptance model, communication, content analysis, online community, electronic word of mouth, ethics
Cluster 2 in green	Digital transformation	digitalization, innovation, digital transformation, industry 4, digitization, digital economy, information technology, case study, internet of things, strategy, dynamic capability, supply chain management, information systems, literature review, building information modelling, covid-19, 3d printing, innovation management, supply chain, technological change
Cluster 3 in dark blue	Digital development	technology, entrepreneurship, information and communication technology, digital divide, e-government, smart city, management, globalization, higher education, digital piracy, gender, organization, adoption, education, governance, digital infrastructure, structural equation modeling, university, attitude, quality
Cluster 4 in yellow	Digital service	digital technology, digital, sharing economy, healthcare, value co-creation, india, service, motivation, qualitative research, creativity, institutional

		theory, practice, service innovation, gig economy, resource-based view, algorithm, creative industry, developing country, human resource management, social entrepreneurship
Cluster 5 in purple	Digital commerce	electronic commerce, internet, pricing, piracy, network effect, information good, music industry, digital good, digital product, new product development, disruptive innovation, digital advertising, intellectual property, transformation, value chain, copyright, digital content, game theory, two-sided market, digital music
Cluster 6 in light blue	Digital platform	business model, digital platform, digital innovation, sme, platform, knowledge management, open innovation, digital entrepreneurship, ecosystem, network, crowdsourcing, value creation, collaboration, internationalization, crowdfunding, social capital, multi-sided platform, startup, design, digital ecosystem
Cluster 7 in orange	Digital economy	blockchain, technology adoption, cryptocurrency, fintech, customer experience, bitcoin, competition, regulation, financial inclusion, efficiency, financial service, mobile payment, service quality, cloud computing, customer satisfaction, diffusion, internet marketing, systematic literature review, telecommunication, customer loyalty
Cluster 8 in brown	Digital analytics	big data, artificial intelligence, sustainability, business model innovation, servitization, china, machine learning, text mining, survey, big data analytics, product-service system, data analytics, international business, sentiment analysis, circular economy, design science, digital servitization, forecasting, research agenda, taxonomy

Note: compiled by the authors according to WoS; data collection was performed in April 2021; keywords of each cluster were sorted based on their occurrences.

Alongside **Figure 2**, **Figure 3** shows the temporal co-occurrence network of author keywords. The structure of this network is as same as the structure of the network in **Figure 2**, but in this network, colors represent the average publication year (APY) of the keywords according to the color bar of the figure. The color bar shows that the publications containing the network's keywords have averagely been published between 2015-2019. Accordingly, the blue color indicates the keywords of publications of the 2015-2017 period so can be called cold terms, and the red color indicates the keywords of publications of the 2017-2019 period so can be called hot terms. By using the APY of keywords of a cluster, the APY of the cluster and theme can be calculated. The result of this calculation is reported in **Table 13**. According to this result, cluster 8: digital analytics, cluster 6: digital platform, and cluster 2: digital transformation are respectively the hottest themes in the research. However, cluster 5: digital commerce, cluster 3: digital development, and cluster 7: digital economy are the coldest ones. Moreover, **Table 14** lists the 50 hottest keywords sorted based on their APY. This ranking is led by the covid-19 keyword followed by digital servitization, platform ecosystem, chatbot, and fourth industrial revolution. This list is useful for those who want to trace the emerging and trendy concepts on digitalization in business and management. Due to the discussion provided by Verma and Gustafsson [96] on the emerging research trends brought about by covid-19 in business and management, the position of the term covid-19 as the hottest keyword on digitalization in business and management can be explained from two main facets: 1. digital technologies such as big data and advanced analytics have provided us with some invaluable opportunities such as data-driven decision making and digital health solutions for tackling the repercussions of the outbreak. 2. during the pandemic, digital technologies such as chatbots have caused a new form of professional life and work for us in response to the unprecedented ongoing challenges.

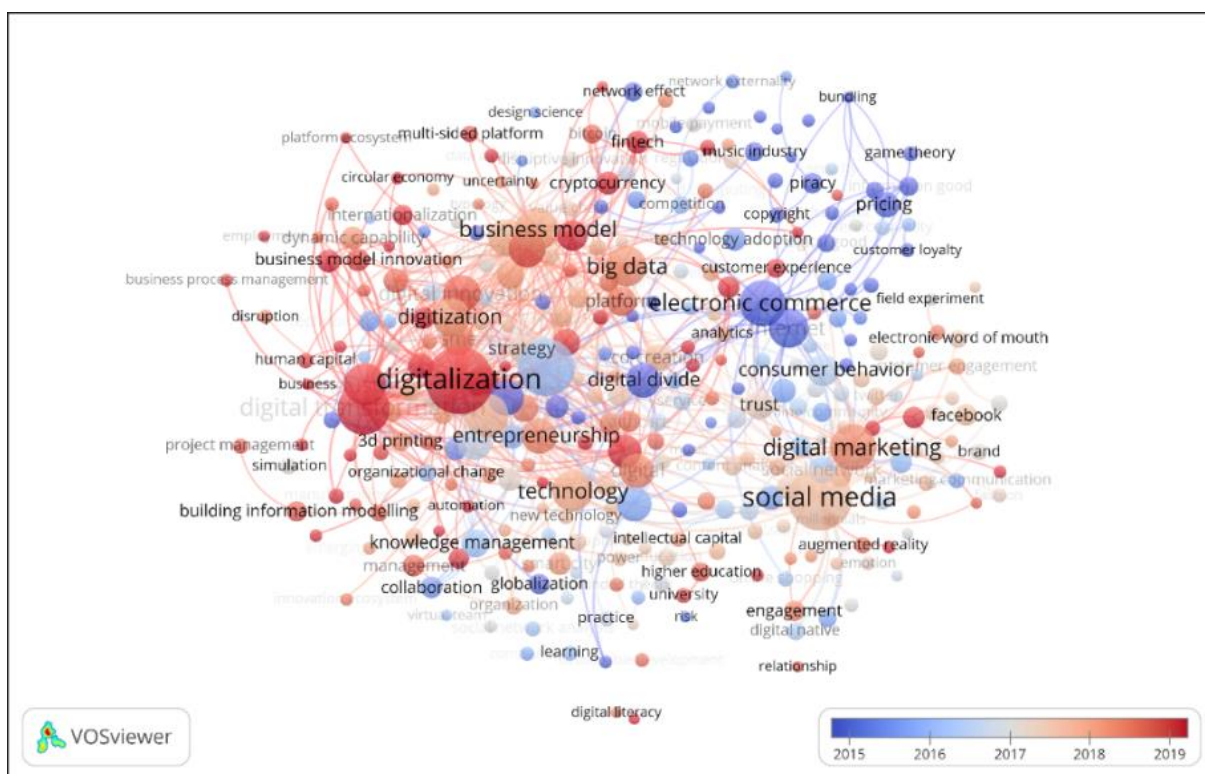


Figure 3. Temporal co-occurrence network of author keywords

Table 13. Average publication year of the identified themes

Cluster and theme	APY
Cluster 1: digital marketing	2017.326
Cluster 2: digital transformation	2017.650
Cluster 3: digital development	2016.587
Cluster 4: digital service	2017.542
Cluster 5: digital commerce	2014.172
Cluster 6: digital platform	2017.847
Cluster 7: digital economy	2016.639
Cluster 8: digital analytics	2018.110

Note: compiled by the authors according to WoS; data collection was performed in April 2021; APY = average publication year of the cluster and theme = sum of APY of keywords of the cluster / the number of keywords of the cluster.

Table 14. The hottest keywords on digitalization in business and management

R	Keyword	APY	R	Keyword	APY
1	covid-19	2020.0000	26	digital skill	2019.0000
2	digital servitization	2019.7000	27	digital work	2019.0000
3	platform ecosystem	2019.7000	28	manufacturing	2019.0000
4	chatbot	2019.6364	29	retail	2019.0000
5	fourth industrial revolution	2019.5833	30	servitization	2019.0000

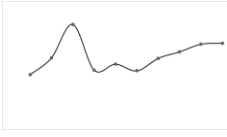





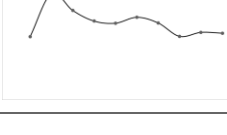


6	bank	2019.5000	31	survey	2019.0000
7	global value chain	2019.5000	32	internationalization	2018.9655
8	gig economy	2019.4667	33	digitalization	2018.9426
9	artificial intelligence	2019.4267	34	financial inclusion	2018.9412
10	accounting	2019.4000	35	digital entrepreneurship	2018.9302
11	employment	2019.4000	36	systematic literature review	2018.9286
12	industry 4	2019.3898	37	automation	2018.9167
13	data analytics	2019.3846	38	digital business model	2018.9167
14	circular economy	2019.3636	39	integration	2018.9167
15	agile	2019.3000	40	social media marketing	2018.9062
16	digital transformation	2019.2857	41	internet of things	2018.8986
17	blockchain	2019.2812	42	customer experience	2018.8846
18	machine learning	2019.1875	43	human capital	2018.8750
19	fintech	2019.1471	44	sharing economy	2018.8542
20	literature review	2019.1333	45	multi-sided platform	2018.8500
21	cryptocurrency	2019.1176	46	digital strategy	2018.8235
22	satisfaction	2019.1176	47	university	2018.8235
23	consumer engagement	2019.0909	48	business process management	2018.8182
24	instagram	2019.0909	49	business model innovation	2018.8056
25	business	2019.0000	50	digital banking	2018.8000

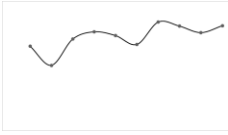




Note: compiled by the authors according to WoS; data collection was performed in April 2021; R = rank based on the average publication year; APY = average publication year of the keyword.

3.8. Topic model

This section reports the results of topic modeling of business and management studies on digitalization. The algorithm that was used for topic modeling identified 14 dominant topics the characteristics of which are presented in **Table 15**. First, the algorithm automatically introduced the topics' most representative terms (i.e., the terms that have the highest probabilities in the topic) and most correlated studies (i.e., the studies in which the topic has the highest proportion) based on the computations described in the method section. Next, the researchers used these terms and studies in order to choose a representative name and formulate a short description for each topic. Also, the topics' sizes were calculated based on the number of documents in each topic divided by the total number of studies. This result shows that the digital innovation and digital platform topics are respectively the biggest and smallest topics in the business and management literature on digitalization. Besides, the topic modeling gave us the ability to reveal the temporal trend of each topic. These trends are reported for the time period 2010 - 2020 in the last column of **Table 15**. By considering these results, we can recognize the rising trends (e.g., digital supply chain, digital platform, and digital work), the falling trends (e.g., digital commerce), and the fluctuating trends (e.g., social media and digital education). It is interesting to note that based on the topic modeling's results, the digital work and digital platform topics are clearly emerging topics in this field of research because they are very small but have highly rising trends.

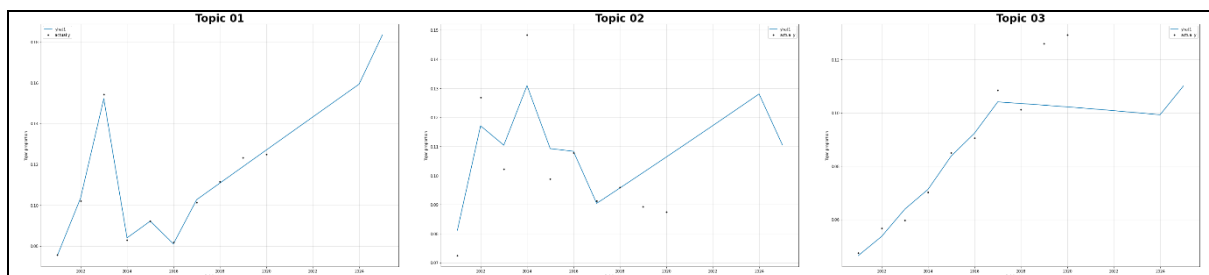
Table 15. The dominant topics on digitalization in business and management

Topic no.	Topic name	Topic terms	Topic description	Topic size	Topic trend (2010 - 2020)
1	Digital innovation	innov, digit, firm, busi, technolog, model, capabl, valu, process, industri	This topic mainly gives insight into the roles of digital and information technologies in achieving organizational innovation and creating business value (e.g., Du [97] and Urbinati [98]).	12.61%	
2	Digital theory	digit, technolog, research, practic, work, theori, new, organ, social, process	This topic aggregates studies that mainly focus on proposing new theories or renewing existing ones in order to understand digital phenomena in social and organizational contexts (e.g., Baskerville et al. [99]).	10.39%	
3	Digital supply chain	digit, valu, design, manag, industri, technolog, futur, chain, develop, suppli	This topic dominantly overviews research issues regarding management of supply chain in industry 4.0 and digital era (e.g., Zekhnini et al. [100]).	10.13%	
4	Digital development	digit, develop, countri, technolog, use, economi, econom, ict, level, factor	This topic mainly discusses impacts of use of digital, information, and communication technologies on developmental level of countries and their economy (e.g., Rodriguez-Crespo et al. [101]).	9.256%	
5	Digital commerce	product, market, price, consum, model, digit, effect, music, onlin, content	This topic brings together various issues with regard to digital commerce such as digital product, digital market, digital channel, digital content, and pricing and sale strategy (e.g., Danaher et al. [102]).	8.215%	
6	Digital disruption	technolog, market, digit, new, busi, compani, chang, industri, internet, disrupt	This topic mainly talks about digital revolution of businesses and companies in response to digital disruption in their markets and industries (e.g., Bughin [103]).	7.910%	
7	Digital advertising	consum, effect, advertis, digit, behavior, use, product, brand, intent, onlin	This topic predominantly explores effects of digital advertisings on consumers' behavior specifically use of products (e.g., Rauwers et al. [104]).	7.641%	
8	Digital system	data, use, system, model, process, develop, base, design, project, inform	This topic mainly discusses development of efficient digital systems such as building information modeling on the basis of using data analytics and modeling techniques specially for managing applied projects (e.g., García de Soto et al. [105]).	7.193%	
9	Social media	social, media, brand, comun, market, use, onlin, content, consum, engag	This topic dominantly offers investigations on social media and online communities especially regarding user-generated content, branding, and users' engagement (e.g., Oliveira and Panyik [106]).	7.085%	

10	Digital service	servic, custom, use, mobil, retail, bank, digit, onlin, channel, model	This topic mainly studies digital services such as mobile services and their usage by customers specifically in banking and retail sectors (e.g., Ananda et al. [107]).	4.825%	
11	Digital education	educ, learn, public, student, use, univers, citi, smart, digit, develop	This topic mainly investigates digital transformation of educational and learning activities along with students' experience in universities (e.g., Gubiani et al. [108]).	4.377%	
12	Digital privacy & security	inform, data, health, privaci, risk, secur, govern, system, protect, use	This topic includes studies that mainly focus on investigating data and information privacy and security-related concerns in the new digital age specifically regarding commerce contexts (e.g., Zhang et al. [109]).	3.462%	
13	Digital work	work, manag, employe, organ, knowledg, digit, perform, worker, use, skill	This topic mainly argues issues concerned with digital transformation of work such as worker's skills and job characteristics in digital era (e.g., Petter et al. [110]).	3.462%	
14	Digital platform	platform, digit, busi, entrepreneurship, entrepreneur, entrepreneuri, ecosystem, network, blockchain, share	This topic gathers works that mainly focus on digital platforms such as blockchain platforms and platform ecosystems (e.g., Korhonen et al. [111]) along with digital entrepreneurship (e.g., Cavallo et al. [112]).	3.444%	

3.9. Trend forecast

Figure 4 presents the results of the trend forecasting analysis. In this figure, one box is dedicated to every topic that was identified in the previous section. In each box, a trend forecast is shown in a blue chart. The vertical horizons of the charts indicate per-year topic proportions, and the horizontal horizons show publication years from 2010 to 2025. Accordingly, we could extend the timeframe of the topics' trends which were reported in the last column of **Table 15** for five years. Also, in these charts, the real values of per-year topic proportions are noted by black dots. These real values belong to the timeframe of the corpus (i.e., 2010 to 2020). If the predicted charts are compared with the real values, it is known that the employed time-series forecasting algorithm has had a pretty good prediction performance. By considering these results, we are able to understand what topics will emerge, disappear, or go up and down in the coming years. Also, it is interesting to investigate if the coming trend of a topic is consistent with the topic's current trend in the literature under study or not.



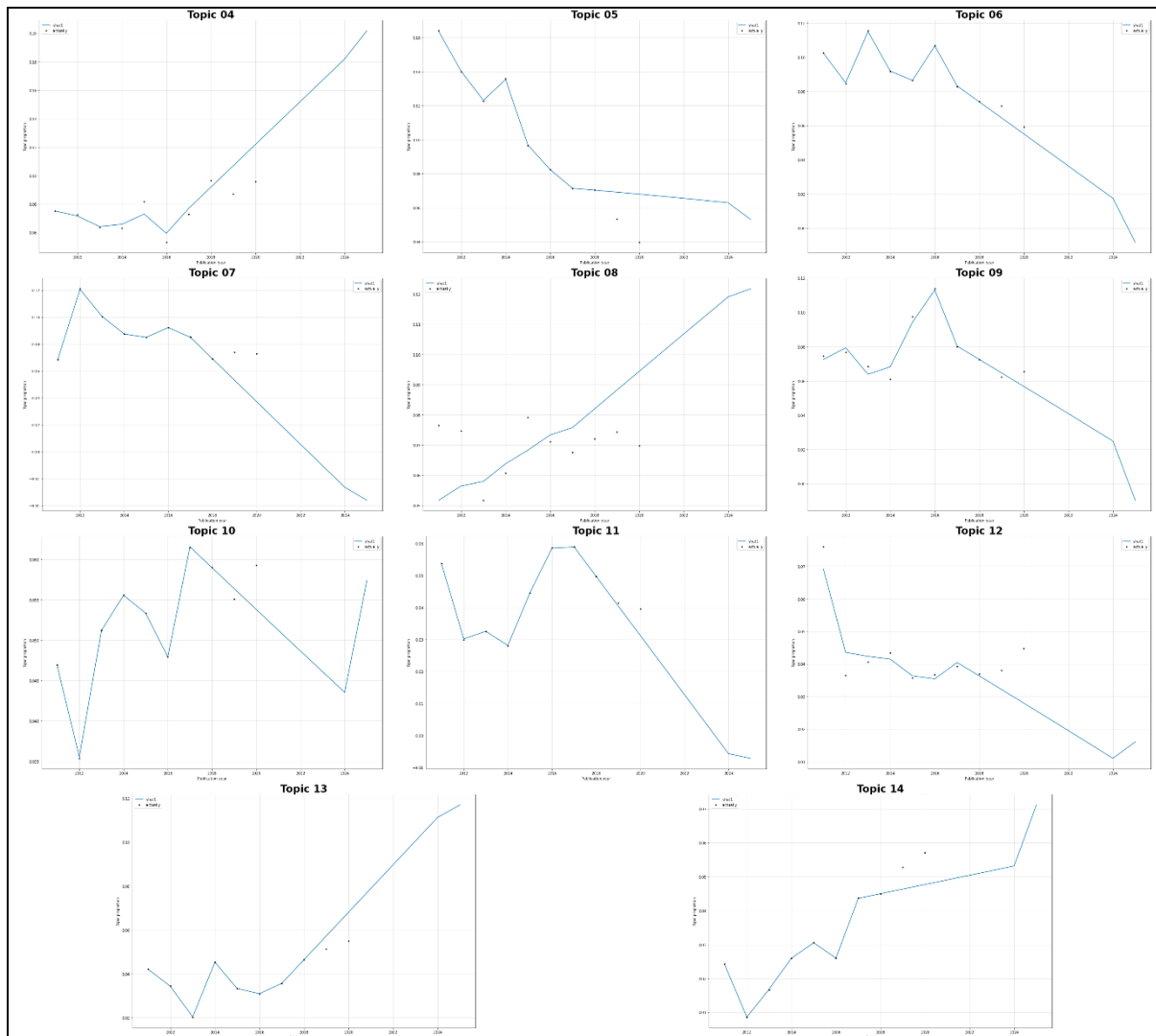


Figure 4. The forecasts of coming five-years trends on digitalization in business and management

4. Discussion and conclusion

This study gives a general overview of the digitalization research in the business and management fields based on the various bibliometric indicators, the topic modeling approach, the time-series forecasting and the data retrieved from the WoS database. First, the general publication and citation structure of the research was explored, and accordingly, it was realized that how the digitalization research has been evolved in the business and management fields through different temporal periods and continued until the recent years in which over 1000 publications have yearly published by scholars, and over 10000 citations have annually obtained by the publications that imply the superior productivity and influence of the topic. Afterward, the most prolific and influential authors, universities, countries, and journals were identified and reported in terms of a wide range of bibliometric indicators such as the number of publications, the number of citations, average citations per a study, and h-index. In this regard, **Table 16** summarizes the results of these analyses. This table presents the top authors, universities, countries, and journals in the digitalization research in the business and management fields. On top of that, the most cited studies as the most significant, influential, and popular contributions to the digitalization topic in the business and management fields

were reported. Accordingly, it was known that the studies carried out by Sambamurthy et al. [93], Litvin et al. [113], and Tripsas and Gavetti [114] are respectively the most cited ones, and Berman [94] has the greatest ratio of citations per year.

Table 16. Top authors, universities, countries, and journals on digitalization in business and management

	TP	TC	TC/TP	H
Authors	Kauffman, RJ Lyytinen, K Henfridsson, O	Lyytinen, K Sambamurthy, V Rai, A	Sambamurthy, V Pavlou, PA Grover, V	Kauffman, RJ Lyytinen, K Henfridsson, O
Universities	Massachusetts Inst of Tech Harvard U Copenhagen Business Sch	Harvard U Temple U U of Maryland	Temple U U of Maryland Harvard U	U of Maryland Harvard U Massachusetts Inst of Tech
Countries	USA England Germany	USA England Germany	USA Singapore Netherlands	USA England Germany
Journals	TFSC JBR ISR	MISQ ISR MS	MISQ ISR MS	MISQ ISR TFSC

Note: compiled by the authors according to WoS; data collection was performed in April 2021; TP = total publications; TC = total citations; TC/TP = average citations per item; H = h-index; TFSC = Technological Forecasting and Social Change; JBR = Journal of Business Research; ISR = Information Systems Research; MISQ = MIS Quarterly; MS = Management Science.

Also, the results of keywords occurrence and co-occurrence analyses were discussed. The analyses let us know the most occurred author keywords, the most occurred digital terms, and the most occurred digital technologies. However, the most significant finding of these analyses was to reveal the prevalent themes and sub-themes in the digitalization research in the business and management fields. These themes and their respective sub-themes are indicated in **Figure 5**. More importantly, the temporal evolution trend of these themes was investigated, and this result was obtained that digital analytics, digital platform, and digital transformation are respectively the hottest themes in the research. In addition, the latent topical structure along with the rising, falling, and fluctuating trends of our scientific corpus were revealed on the basis of the topic modeling approach (see **Figure 6**). The results of this investigation showed that the digital innovation and digital platform topics are respectively the biggest and smallest topics in the business and management literature on digitalization. Besides, it was known that the digital work and digital platform topics are emerging topics in this field of research. Finally, by using a deep learning-based time-series forecasting algorithm, the timeframe of the revealed trends was extended to the next five years (i.e., until 2025) for the sake of clarifying if the underlying topics of the digitalization literature in the business and management fields will rise, fall, or fluctuate within the coming years.

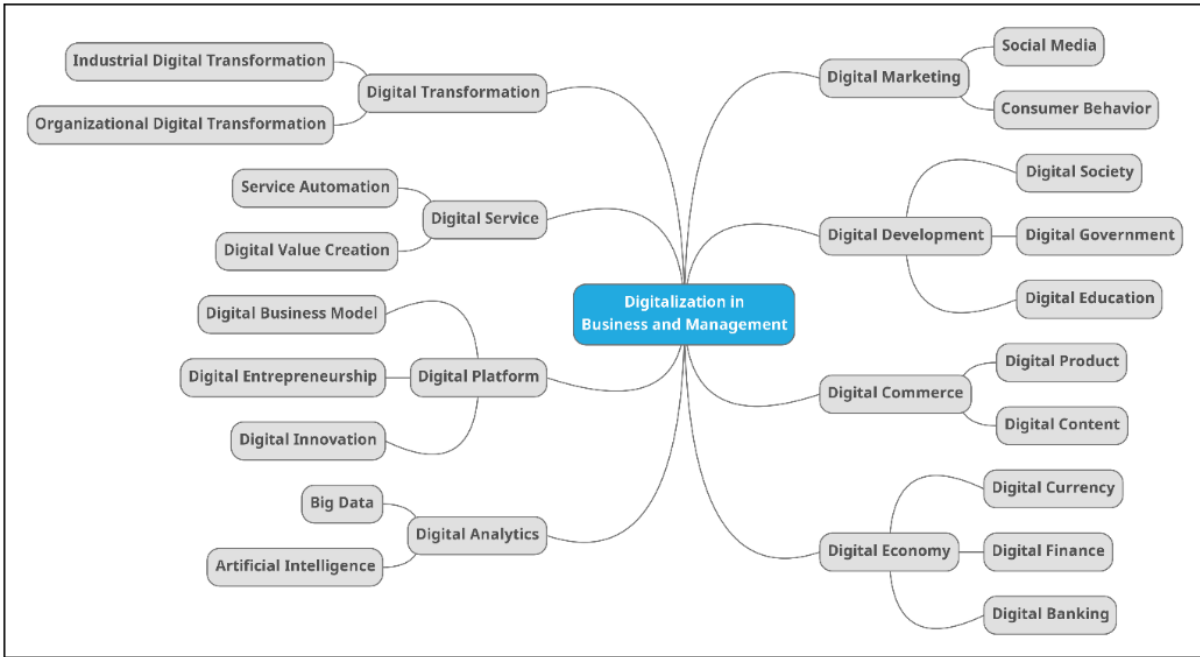


Figure 5. Themes and sub-themes on digitalization in business and management figure was produced in mindmup.com

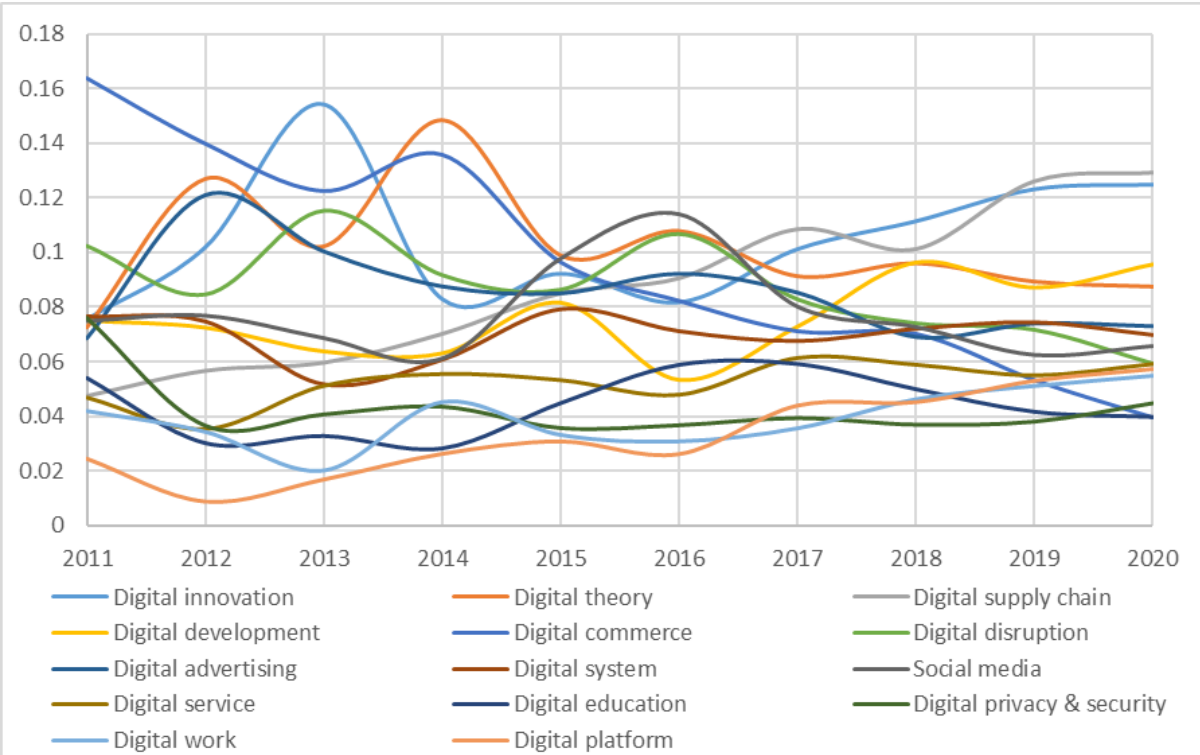


Figure 6. Rising, falling, and fluctuating trends on digitalization in business and management

In line with the implications of previous scientometrics studies such as Albort-Morant et al. [34], Merigó and Yang [35], Albort-Morant and Ribeiro-Soriano [58], Merigó et al. [59], Mulet-Forteza et al. [60], Zurita et al. [61], Bonilla et al. [62], Merigó et al. [63], Coronado et al. [65], Alfaro-García et al. [115], Merigó and Yang [116], Merigó et al. [117], and

Valenzuela-Fernandez et al. [118], the results and findings of this research are insightful mainly for researchers, policymakers, and institutions. The current study can provide researchers especially less experienced ones and newcomers in the field with some insights about the intellectual structure and conceptual space of the research that can be considered as a good starting point for their future academic efforts and a good ground for directing their further publication activities. They can identify the central universities and authors and accordingly, try to establish some networks with them and create appropriate platforms for research exchange. Also, researchers can identify the leading journals and contributions facilitating and consolidating their publications and studies. By being familiar with the top countries and their affiliated institutions, academicians working on the digitalization topic in the business and management fields can find conditions and environments which are conducive to their tenure success. More importantly, the themes and trends of the literature introduced in this study can direct the further explorations of scholars. In addition, our results and findings can be served as a good reference for science policymakers and scientific institutions to make their scholarly decisions such as whether to adopt a certain academic strategy, design a certain scientific policy, and finance a certain research project. On top of that, it is interesting to say that this work may be insightful for businessmen and entrepreneurs. They can be familiar with the digital issues and technologies related to their businesses and fields of activity, so attract the incumbent experts for collaboration and decide where to initiate their digital projects.

The limitations of our work are similar to the limitations of previous bibliometric studies such as Albort-Morant et al. [34], Merigó and Yang [35], Albort-Morant and Ribeiro-Soriano [58], Merigó et al. [59], Mulet-Forteza et al. [60], Zurita et al. [61], Bonilla et al. [62], Merigó et al. [63], Coronado et al. [65], Alfaro-García et al. [115], Merigó and Yang [116], Merigó et al. [117], and Valenzuela-Fernandez et al. [118]. First, it should be mentioned that the current study is only an informative study and gives a general orientation of the evolution of digitalization research in business and management. However, it is evident to all that exactly evaluating the state of research is more complicated than characterizing the research by using a range of simple bibliometric indicators, and other issues that cannot be easily quantified by these indicators should be taken into account in the exploration. As a case in point, publishing 10 single-authored papers definitely is not equivalent to publishing 10 papers in collaboration with others. However, the bibliometric indices consider equal levels of productivity and influence for the authors of both types of papers. This is because of this fact that scientific databases usually use a full counting system. That is, they give one publication and citation unit to each author of a paper regardless of the number of authors. As other instances, it is worth noting that the citation level of subfields of a specific area is different, so depending on which topic a scholar is studying, she/he will obtain more/less number of citations, or due to the recent expansion in the use of digital media and social network, it is easier for scholars to receive impact and citation today in comparison with the past decades. However, these issues are not considered by these types of bibliometric analyses. Another important limitation is that this work was carried out only based on WoS. However, a part of the research may be not indexed by this scientific database. Therefore, some important information may have been lost. In addition to these limitations, it is worth noting that the results and findings of this study are time-dependent. That is, this study presents the current status of the research. However, the evolutionary trajectories of the area may change, specifically with regard to the research outcomes of the last two or three years that still have to progress. Another important issue is

that the scope of our explorations is limited by the boundaries of the business and management fields, so researchers should be cautious in generalizing our results and findings to other fields.

As a further study, it is suggested that researchers consider other databases such as Scopus and Google Scholar in addition to WoS to provide a more holistic picture of the digitalization research in the business and management fields. They can also compare the results of using other databases with those of this research. Also, it is suggested that scholars utilize other bibliometric techniques such as co-citation analysis, co-authorship analysis, and bibliographic coupling or other forms of topic modeling such as structural topic modeling and dynamic topic modeling to give a more complete view of the intellectual structure of the research. In addition, by utilizing some extensive reading methods and fine-grained content analysis, researchers can build a complementary understanding of the eminent themes and trends of digitalization in business and management.

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