

BIBLIOMETRIC RESEARCH ON THE ECOSYSTEM OF DIGITAL BUSINESS PLATFORMS

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Abstract. Digital transformation led to the development of novel business models and enabled the establishment of the digital business platforms ecosystem. Research on this interdisciplinary topic is wide but lacks cohesion. This paper aims at disclosing trends in the assessment of the scientific literature about the ecosystem of digital business platforms by using bibliometric methods such as citation analysis and co-word analysis. A dataset of 649 papers extracted from Web of Science database was used. VOSviewer was used to create maps based on the generated bibliographic data, including authors' names, journals, and keywords. Our results show that the most influential authors in the field are Venkatraman, N. Venkat (815 citations), Bharadwaj, Anandhi (755 citations), and El Sawy, Omar (755 citations); the most influential journal is MIS Quarterly: Management Information Systems (2178 citations); and the main keywords are digital platform(s), digitalization, digital transformation, platforms, and business model – they are the tenets of the conceptual structure of the topic. This article contributes to a better understanding and profiling of the research bibliometrics in value co-creation in the ecosystem of digital business models.

Keywords: digital business platforms, ecosystem, bibliometric research, citation analysis, co-word analysis.

JEL Classification: O14, P13, Q55.

Introduction

Digital transformation of business led to the development of novel business models. Digital business platforms are key novel business models which as a ubiquitous phenomenon were enabled by broad technological advancement and extensive digitalization. Digital business platforms modified the process of value creation and moved from value creation within the borders of the single company or supply chain to the use of the ecosystem of autonomous external actors to co-create value (Hein et al., 2020). Moreover, Mair and Reischauer (2017) pointed out an important feature of digital platforms describing them as infrastructure providers which do not generate any particular resources.

The research of the ecosystem of digital business platforms is wide but lacks cohesion. The term ecosystem, originally used in biology, has been applied in a wide variety of contexts outside its original one, including the fields of economics (Gawer, 2014), industrial innovation (Autio & Thomas, 2014), and management research (Valdez-De-Leon, 2019). The understanding about digital

platforms is intersecting with understanding about its network, i. e. the ecosystem (Kapoor et al., 2021). Moreover, the focus on platform ecosystems varies from pure technological view (Hein et al., 2020; Tiwana, 2014) to social side investigation (Kapoor et al., 2021).

Regarding the wide range of the existing research streams, it is considered that bibliometric methods could be useful by adding objectiveness into the assessment of current scientific literature. Bibliometric methods can decrease the level of subjectivity while choosing papers for qualitative systematic literature review by increasing scientific accuracy and mitigating researcher bias by accumulating separate point of views (Zupic & Čater, 2015). Thus, we argue that the application of bibliometric methods in the field of ecosystem of digital business platforms will: (1) facilitate decent assessment to determine studies already attempted; and (2) provide better understanding about ecosystems of digital business platforms. The aim of this paper is to reveal trends in the assessment of the scientific literature about the ecosystem of digital business platforms by using bibliometric methods such as

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citation analysis and co-word analysis. Contributing research questions of this paper are as follows:

- RQ1: What are the most influential contributors in terms of authors, papers, and journals on the research topic of the ecosystem of digital business platforms?
- RQ2: What are the most commonly used keywords representing conceptual structure in the domain of the ecosystem of digital business platforms?

To answer these research questions, this paper is arranged as follows. First, an overview ecosystems of digital business platforms is presented. Second, research method is discussed in terms of data selection, collection, clarification, and analysis approach. Third, findings of the research are presented. Finally, the paper is concluded with a discussion of research contributions.

1. Overview of the ecosystem of digital business platforms

The pervasive digitalisation and widely spread technological disruptions have changed understanding and presence of existing business models. In general, business model is a holistic perspective on the complete setup of business including every process along the value chain (Göcke & Weninger, 2021), a representation of the strategic choices that characterize a business venture (El Sawy & Pereira, 2013), and can be presumed as the core logic of a company to create and deliver value for its customers and to capture value for itself (Zott et al., 2011). Due to the far-reaching advancement of digital technologies, execution of business and generation of revenues have been transformed (Veit et al., 2014) by adding digital dimensions. Although digital business models consist of digital elements, they might have notable connections with physical output and infrastructure.

Progress in business transformation took focus from the design of information systems to the design of business models for services provided through digital platforms (El Sawy & Pereira, 2013). In digital platforms, value is created outside the company and its supply chain during the utilization of an ecosystem of autonomous actors, which are functioning online (platform and its owner, complementors – providers or producers, and consumers) (Hein et al., 2020), communities and offline actors (e. g. investors or policy makers) in open network structures with multiple layers of openness (Fehrer et al., 2018). This infrastructure is presented and constantly developed by central actor (Kenney & Zysman, 2016), and is characterized by network externalities (Van Alstyne & Parker, 2017) such as increased attractiveness for consumers (when number of complementors increases) and increased attractiveness for complementors (when number of consumers increases) (Farrell & Klemperer, 2006).

Digital platform business model expanded beyond tech start-ups (Fehrer et al., 2018), including a growing number of incumbent mature organizations in a diversity of industries in various environments in which they either need to

operate as a platform provider or integrate into a business ecosystem governed by platforms (Altman, 2015). Moreover, the success of the digital platform business model belongs to its ecosystem of enablers and complementors (Bassole, 2009) and the ability to orchestrate and manage digital platforms (Schiafone et al., 2021).

Digital platforms ecosystem broadens the scope from solely technological infrastructure to include partnerships of horizontally collaborating autonomous actors with specific roles and responsibilities (Kortmann & Piller, 2016) considering particular process of governing when not only the owner of the platform but also the other autonomous agents contribute to system governance (Fehrer et al., 2018). This business model is based on the design of continuously emerging, non-hierarchical collaboration among various actors (Ketonen-Oksi et al., 2016) where inner regulations are substituted by orchestration of external sources of value (Kapoor et al., 2021). On the whole, platform-based ecosystem can be characterized as an industrial open architecture with an infrastructure in the centre that facilitates value co-creation among different agents and a set of rules regulating their interdependencies (Tiwana, 2014) through the use of modular and digital artifacts (Mini & Widjaja, 2020). In the field of management research, the concept of ecosystem describes groups of heterogeneous, yet complementary, organizational actors which collectively generate ecosystem-level output (Autio & Thomas, 2014) through multiple interactions (Romestant, 2020). Considering that the generic goal of business ecosystem is to co-create value through innovation (Iansiti & Levien, 2004) and to materialize co-created value by several autonomous actors that cannot be achieved by any one of these actors in isolation (Jacobides et al., 2018).

2. Bibliometric analysis as a tool to capture the topicality and dynamics of the research field

The appropriate synthesis of past research is a core for any possible future research. In general, structured literature review as a qualitative method and meta-analysis as a quantitative method (Schmidt, 2008) are applied in order to advance in a specific field of research. There are two directions in using bibliometric methods in terms of purpose: to carry out performance analysis or to make maps of science. Bibliometric methods allow to evaluate the performance of the research and publications (performance analysis) or allow to draw network of relationships (science mapping) in the field, owing to the systematic, transparent, and reproducible review process (Zupic & Čater, 2015). The use of these methods provides quantitative rigor of written papers (Ellegaard & Wallin, 2015) and allows to diminish possibility of subjectively collected papers to appear for a structured literature review. Objective criteria including but not limited to number of citations, number of co-citations, bibliographical coupling or co-word appearance allow assessing and analysing quality of existing scholarly production in many

ways, including progress-made, finding reliable sources of papers, proposing foundation for new developments or determining major scholars in the field (Martínez et al., 2015). In spite of aggregated bibliographic data, scholars are welcomed to ground their findings by the use of other scholars' opinions through citation, collaboration, and writing (Zupic & Čater, 2015). Varying from the single paper study to the exploration of the entire structure of intellectual knowledge base (Donthu et al., 2021) the use of bibliometric methods gives an understanding about the dynamics in the field together with orientation to the most influential concepts or authors. Diverse bibliometric methods are not a novelty itself and have been attracting scholar attention since the 1950s (Wallin, 2005), but recently the interest in these methods significantly increased (Donthu et al., 2021) and attracted attention from management scholars (e.g. Ellegaard & Wallin, 2015; Zupic & Čater, 2015). The reason why bibliometric methodology is gaining more attention is connected to the emergence of well know and reliable Web of Science and Scopus databases containing huge amounts of statistical data as well as popularity and uncomplicated use of freely available specific software necessary for processing the extracted data. It is noteworthy to mention that the use bibliometric methods is not about to dispose the use of structured literature review and/or meta-analysis, but is to strengthen the findings based on these methods.

3. Research methodology

3.1. Bibliometric methods

To answer research questions, citation analysis and co-word analysis are used in this paper. Citation analysis uses citation data and shows most influential contributors (corresponding to RQ1); co-word analysis uses actual content and reveals network of concepts originating from paper titles, keywords, and abstracts (corresponding to RQ2).

Citation analysis as a bibliometric method is based on the presumption that scholars cite only those papers which they consider as important and influential to their implications (Zupic & Čater, 2015) and that citations indicate network of links originating from one paper citing the other (Donthu et al., 2021). This type of analysis is useful because the field of platforms ecosystem research is wide and scattered. Hence, finding the most influential papers would benefit in understanding the knowledge base. The unit of analysis is a piece of scholarly production. The influence of the scholarly production, scholars or journals is described by the number of citations a particular paper, author or journal receives and, as a result, the most significant contributors can be identified and introduced to further research.

Co-word analysis is effective in creating conceptual structure (Zupic & Čater, 2015) of platforms ecosystem domain by finding existing or possible to appear links among topics. Compared to citation analysis, in co-word analysis, a unit of research is not a scholarly production

but an actual content from titles, keywords and/or abstracts (Donthu et al., 2021). As Assefa and Rorissa (2013) stated that the co-word analysis is based on identification of pairs of words, which leads to the identification of key topics within the research field, opening the topical network without relying on the original definition of the topic. Given the above, it appears that words which go in synchronisation have a similar theme between them and they can be used to draw a network of content in the field of interest.

3.2. Source selection

This research is based on high quality scientific literature of social sciences indexed in the Clarivate Web of Science (WoS) database. The WoS database is considered as the oldest, containing the most comprehensive records and having useful tools for chosen types of analysis (Ellegaard & Wallin, 2015). Moreover, the focus of the research is made on international science level, so the choice of WoS database was considered as pragmatic.

Please note that not all journals display keywords of papers, so in the WoS search profile, it is obligatory to choose the topic option which includes bibliographical data from title, abstract, author, and keywords. To collect a core document set for further investigation, the following search command was created.

TS = (("digital business") OR ("digital platform*") OR ("platform* ecosystem*") OR ("business platform*") OR ("digital business platform* ecosystem*") OR ("digital ecosystem*"))

Timespan: 1964–2022

Indexes = SSCI or CPCI-S or SCI-EXPANDED

WoS category: Management or Business

Research areas: Business Economics or Operations
Research in Management

Search results were not defined by authors, publishers, or any other criteria from the WoS filter list. Timespan covers 59 years since 1964. The reason for choosing this starting date was that at that time citation indexing was introduced (Ellegaard & Wallin, 2015). Search results were limited to management or business categories and research areas due to intention to eliminate not relevant papers from other fields and to focus only on scientifically most reliable sources in the field of management.

In total, 650 results (as of February 2022) were extracted from the WoS database as a core dataset and exported to MS Excel for data cleaning.

3.3. Data processing procedure and analysis tools

Pre-processing is the first step for conducting any bibliometric analysis, citation and co-word analyses are no different. First, the core dataset was sorted alphabetically by paper title to find out duplicate values. One duplicated record has been identified (id = 580) and removed. Second, authors' names were sorted to check for inconsistencies in abbreviations of names. After this step, no

entries were found as incorrect. There was no need to clean more of this dataset, so once returned to WoS, two blocks (id = 1–579 and id = 581–650) of the research results were exported as plain text file (2 files).

For further analysis the freely available VOSviewer 1.6.0 software (van Eck & Waltman, 2015) was applied to visualize networks based on the bibliographical data. This software has been effectively applied in several studies before (Fahimnia et al., 2015; Leung et al., 2017) and was considered as user friendly for beginners in the bibliometric research.

4. Data analysis and results

From 649 papers investigated, 531 papers were journal articles (81.81%), 116 papers were conference proceedings (17.87%), and 2 papers were series (0.32%). Created dataset was used to conduct citation and co-words analyses which findings were presented in the form of visualized maps of networks. To obtain higher validity of bibliometric maps and propose more meaningful structures, thresholds of limited values were used (Goksu, 2021). The threshold of limited value determines the lowest number of reoccurred elements to be included in the selection of research units for further analysis. The use of thresholds adjusts the size of selection from wider (lower threshold) to more extant (higher threshold).

Citation analysis in the research of ecosystem of digital business platforms was used to identify the most influential contributors in terms of authors, papers, and

journals. In total 1626 authors contributed to 649 articles. In spite of this, only 6 scholars wrote 5 or more papers (a threshold of minimum 5 occurrences of author's name was applied) (Table 1). This result may indicate that this topic is emerging and not many authors have already contributed to this scholarly stream.

Table 1. The most productive authors in the ecosystem of digital business platforms (compiled by the authors)

Author	No. of papers	No. of citations
Trabucchi, Daniel	10	105
Buganza, Tommaso	8	87
Mithas, Sunil	5	255
Weill, Peter	5	239
Benlian, Alexander	5	139

From 649 papers, 56 of them were cited at least 50 times. The top 10 of the most influential papers are presented in Table 2. Nine out of the top 10 papers were published in the journals indexed in the Academic Journal Guide (AJG) introduced by Chartered Association of Business Schools (Academic Journal Guide, 2021). The majority of these papers are published in the highest ranked journals (level 4* and level 4). This indication allows presuming that topics related to the ecosystem of digital business platforms are acknowledged and considered as significant to the existing body of knowledge.

Table 2. The most influential papers in the ecosystem of digital business platforms (compiled by the authors)

No.	Authors	Title	Year published	Source	AJG 2021	Keywords	No. of citation
1	Bharadwaj, Anandhi; El Sawy, Omar A.; Pavlou, Paul A.; Venkatraman, N.	Digital business strategy: toward a next generation of insights	2013	MIS	4*	Digital business strategy; scope of digital business strategy; scale of digital business strategy; speed of digital business strategy; digital business strategy value creation and capture	755
2	De Reuver, Mark; Sorensen, Carsten; Basole, Rahul C.	The digital platform: a research agenda	2018	JIT	4	Digital platforms; digital infrastructures; digital ecosystems; digital innovation; research agenda	308
3	Ceccagnoli, Marco; Forman, Chris; Huang, Peng; Wu, D. J.	Cocreation of value in a platform ecosystem: the case of enterprise software	2012	MIS	4*	Platform ecosystem; partnership; business value; sales; ipo; intellectual property rights; downstream capabilities	297
4	Al-Debei, Mutaz M.; Avison, David	Developing a unified framework of the business model concept	2010	EJIS	4	Business model; conceptual framework; content analysis; taxonomy; information systems	291
5	Thomas, Llewellyn D. W.; Autio, Erkkö; Gann, David M.	Architectural leverage: putting platforms in context	2014	AMP	4	Product development; qualitative research; systems competition; cocitation analysis; innovation; design; strategies; technology; proprietary; compatibility	239
6	Kache, Florian; Seuring, Stefan	Challenges and opportunities of digital information at the intersection of big data analytics and supply chain management	2017	IJOMP	–	Challenges; supply chain management; big data analytics; delphi study; opportunities; digital information	228

No.	Authors	Title	Year published	Source	AJG 2021	Keywords	No. of citation
7	Nambisan, Satish; Wright, Mike; Feldman, Maryann	The digital transformation of innovation and entrepreneurship: progress, challenges, and key themes	2019	RP	4*	Digital transformation; innovation; entrepreneurship; digital innovation; digital platforms; openness; generativity; affordance	205
8	Vendrell-Herrero, Ferran; Bustinza, Oscar E; Parry, Glenn; Georgantzis, Nikos	Servitization, digitization and supply chain interdependency	2019	IMM	3	Servitization; digitization; interdependencies; dpublishing industry; payment card	200
9	Helfat, Constance E.; Raubitschek, Ruth S.	Dynamic and integrative capabilities for profiting from innovation in digital platform-based ecosystems	2018	RP	4*	Dynamic capabilities; multi-sided platforms; digital ecosystems; business models; value creation; value capture; complementary assets; integrative capabilities; network effects	164
10	Setia, Pankaj; Venkatesh, Viswanath; Joglekar, Supreet	Leveraging digital technologies: how information quality leads to localized capabilities and customer service performance	2013	MIS	4*	Customer service; capabilities; information quality; process; customer response; customer orientation; business value of it	157

Notes: MIS – MIS Quarterly: Management Information Systems, JIT – Journal of Information Technology, EJIS – European Journal of Information Systems, AMP – Academy of Management Perspectives, IJOPM – International Journal of Operations & Production Management, RP – Research Policy, IMM – Industrial Marketing Management.

In 2013, Bharadwaj, El Sawy, Pavlou, Venkatraman published “Digital business strategy: toward a next generation of insights” in MIS Quarterly: Management Information Systems which is the most cited paper, i. e. cited two times more as compared to the second most popular article by de Reuver, Sorensen, Basole “The digital platform: a research agenda” (2018). Both the most influential articles are published in the highest ranked journals. The approval of these journals might have added more confidence in citing these authors as definitely reliable. Four papers from the top 10 of the most cited articles were published during the last five years, the others are published slightly earlier. Recent papers are at a disadvantage due to the lack of time to be cited at this point.

The network of relationships between papers has been created using the VOS mapping technique provided by VOSviewer where a distance-based bubble chart has been created to visualise existing links between papers (van Eck & Waltman, 2010). The bubble chart indicates stronger links by smaller distances between the elements, and the size of a bubble reflects the influence of the article (Colurcio et al., 2017). Figure 1 maps the relationships between dataset papers represented by first author's last name where the largest green bubble indicates the most influential paper of Bharadwaj et al. (2013). The papers of Bradley, Changsu, Jongheon, Lee “Toward an evolution strategy for the digital goods business” (2012),

Gandini “Labour process theory and the gig economy” (2019) and Zhu, Jingyao, Gang “Governance mechanisms implementation in the evolution of digital platforms: a case study of the Internet of Things platform” (2020) are considered as the least influential and having the weakest links to other papers from the dataset.

The citation analysis also helped to identify the most influential authors in terms of the total number of citations combining different papers from the same dataset. Venkatraman, N. Venkat (2 papers, 815 citations), Pavlou Paul A. (2 papers, 760 citations), Bharadwaj, Anandhi

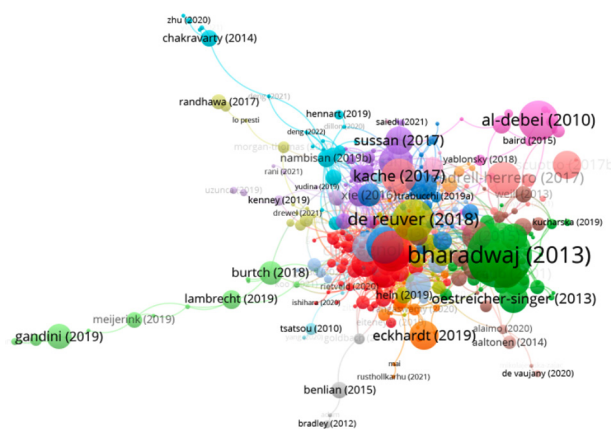


Figure 1. The network of papers in the ecosystem of digital business platforms

(1 paper, 755 citations), and El Sawy, Omar (2 papers, 755 citations) are considered as the most influential authors (Table 3).

Table 3. The most influential authors in the ecosystem of digital business platforms (compiled by the authors)

Author	No. of papers	No. of citations
Venkatraman, N. Venkat	2	815
Pavlou, Paul A.	2	760
Bharadwaj, Anandhi	1	755
El Sawy, Omar	2	755
Nambisan, Satish	4	371
Sorensen, Carsten	4	368
Huang, Peng	3	338
Basole, Rahul C.	1	308
De Reuver, Mark	1	308
Forman, Chris	2	303

Furthermore, the citation analysis allowed identifying the most influential sources in the ecosystem of digital business platforms. The dataset from WoS database consisted of 649 papers which were published in 223 different sources including journals, conference proceedings and series. The conducted citation analysis allowed identifying prominent journals in publishing research on the ecosystem of digital business platforms. After applying a threshold of a minimum of 5 documents within the same source, 36 sources were filtered. This feature demonstrates the top 10 sources which are focused on the topic (Table 4). MIS Quarterly: Management Information Systems stands out significantly with 22 papers published and 2178 citations received. The number of citations is significantly higher as compared to the second source (the ‘‘Information Systems Research’’ journal). Both leading journals are ranked as the highest level (4*) journals according to AJG 2021 (Academic Journal Guide, 2021). It is noteworthy to mention that all the most influential sources are journals which are ranked in AJG 2021. Most of these journals are ranked in the highest levels (level 4* and level 4).

The co-word analysis extracted data from actual content, including titles, keywords, and description. This type of analysis showed how different words are connected based on occurrence in different sources together (co-occurrence). The units of analysis represented by nodes and shorter distances between these nodes reflect closer connections between the analysed keywords (Zupic & Čater, 2015). The dataset generated 2100 keywords, 74 of these keywords met the requirement of minimum 5 occurrences and formed 7 clusters. The full counting method has been applied meaning that each co-occurrence of keywords has the same weight and the links between the co-occurred words are not fractionalized (van Eck & Waltman, 2015). The generated clusters consist of related information about the research topic (Goksu, 2021).

Table 4. The most influential journals in the ecosystem of digital business platforms (compiled by the authors)

No.	Source	AJG 2021	No. of papers published	No. of citations
1	MIS Quarterly: Management Information Systems	4*	22	2178
2	Information Systems Research	4*	18	893
3	Journal of Information Technology	4	16	625
4	Journal of Business Research	3	24	495
5	Research Policy	4*	10	488
6	European Journal of Information Systems	4	12	439
7	Technological Forecasting and Social Change	3	31	429
8	Management Science	4*	12	337
9	Journal of Management Information Systems	4	8	286
10	International Journal of Operations & Production Management	4	6	249

The results shown in Figure 2 indicate the largest cluster (red coloured, 17 items in total) where words digital platforms, business model, two-sided markets, multi-sided markets, or entrepreneurship are identified as frequently appeared together. The second cluster (green coloured, 15 items in total) contains words digitalization, platforms, ecosystems, digital servitization, network effects. In the third largest cluster (blue coloured, 13 items), words innovation, digital economy, digital ecosystem, blockchain, and co-creation are found. Given the results of the co-word analysis, it appears that the novel business models such as digital platforms are gaining importance in multi-sided markets by exploiting networks and creating ecosystems.

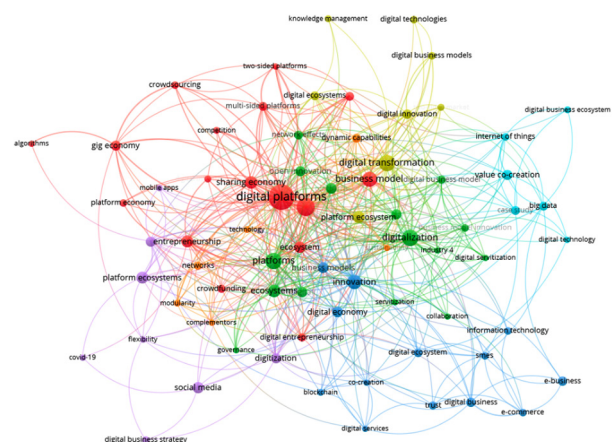


Figure 2. The network of co-occurring keywords

together. In total, 2100 keywords were generated, whereof 74 keywords occurred at least 5 times and 7 clusters were formed. Given the results of the co-word analysis, it appears that digital transformation enabled novel business models such as digital platforms and they are gaining importance in digitalized multi-sided markets by exploiting networks and creating ecosystems. These keywords were identified as frequently appearing together and can be identified as the tenets of the conceptual structure of this topic.

Moreover, as a result of the co-word analysis, an overlay visualization map was formed. This type of mapping and its analysis allowed distinguishing the tendencies in the research topics during the last five years and it appears that researchers have changed the direction of research from being interested in innovation, e-commerce, digitization, and digital business strategy to being interested in digital platforms, digital transformation, digitalization, sharing economy, platform economy, and digital entrepreneurship.

Limitations and future research

The conducted bibliometric analysis on the ecosystem of digital business platforms has several limitations. First, the selection of keywords for creating the core dataset from the WoS database was predefined by the authors. To increase the level of reliability of the conducted bibliometric research, the domain representing the keyword selection analysis (Chen & Xiao, 2016) could be performed. Second, only two bibliometric methods have been included in this research. The scope of the bibliometric research can be broadened by introducing science mapping to reveal a whole structure and dynamics of the scientific field (Cobo et al., 2011; Zupic & Čater, 2015). Third, the scope of the research can be expanded by adding the Scopus database. The reason for doing so is that not all papers are indexed only in WoS, thus, the additional sources could expand the sample size of candidate papers in the field of management. Finally, additional criteria, e. g. h-index, which measure the performance of the research components, could be used (Donthu et al., 2021).

Disclosure statement

Authors declare that they do not have any competing financial, professional, or personal interests from other parties.

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