Evolution of organisational agility: a bibliometric study

Vasja Roblek
Faculty of Organisation Studies in Novo Mesto, Novo Mesto, Slovenia
Vlado Dimovski
School of Economics and Business, University of Ljubljana, Ljubljana, Slovenia
Maja Mesko
Faculty of Management, University of Primorska, Koper, Slovenia and Faculty of Organization Sciences, University of Maribor, Maribor, Slovenia, and
Judita Peterlin
School of Economics and Business, University of Ljubljana, Ljubljana, Slovenia

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Abstract

Purpose – This study applies bibliometric analysis to explore the evolution of the research paradigm of agility related to management and organisations.

Design/methodology/approach – Authors prepared a quantitative study of the review of selected articles using co-citation analysis and bibliographic coupling. Based on the bibliometric analyses, the evolution of the agility field (past, present, and future of agility research) was prepared.

Findings – Emergent themes focus on the importance of agility in interpreting organisational responses in the context of issues as diverse as information systems and business intelligence systems, market orientation, strategic alignment and social computing. Future research needs to focus on digitisation in conjunction with informatisation, an important topic for creating a new organisational culture and knowledge management through increased collaboration between humans and machines.

Originality/value – As the authors are aware, this study is one of the first to choose to show the overall development and importance of agility through quantitative bibliometric methods used to assess the value and contribution of scientific productivity and its impact on development.

Keywords Management, Management information systems, Organisational science, Supply chain management

Paper type Research paper

Introduction

In the 21st century, organisations are part of rapidly changing economic, business and technological environments. To survive, organisations attempt to respond and adapt to changes or make organisational changes. Namely, flexible organisations have better chances of survival (Vrontis *et al.*, 2021). However, organisational flexibility leads to the question of understanding organisational agility in modern management. In management theory, agility represents the ability to adapt and evolve people and processes in response to rapid and unpredictable changes in the organisation's external and internal environments (Tallon *et al.*, 2019). Since the first mention of agility in 1982 (Brown and

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Agnew, 1982, p. 29) and the emergence of the concept of organisational agility in 1991, in the Lehigh Report of the Iacocca Institute (Nagel and Dove, 1991), it has become a crucial factor that shows how competitive the organisation is and whether it allows surviving in more volatile market conditions. Over the years, agility has gained importance in the organisation at the individual, strategic and organisational levels. It presents a complex research field covering different scientific areas such as management, business logistics, marketing, computer science, business information systems and digital transformation. Its core mission is to encourage the organisation to learn about and view changes in their environment as opportunities, respond promptly to them and use them to its advantage, thereby creating a competitive market advantage (Holbeche, 2018).

Representing and understanding the past, present and future drivers of the field of agility, we used three bibliometric approaches to prepare: (1) the method of co-citation analysis enables the identification of existing knowledge and the study of the role and with identifying clusters and connections between articles help us to comprehend the impact of articles on the development of agility in the 1991–2021 period (Small, 1981); (2) as part of a bibliographic coupling, we analysed recent articles in the field of agility (published between 2015–2021). The purpose of the analysis was to explore a topic that will influence future research into agility (Boyack and Klavans, 2010).

The main contribution of bibliometric study is an overview of the evolutionary development and understanding of agility across the period and the knowledge gained from company to survive in disruptive conditions if it tackles organisational adjustments and changes in a timely manner. Which include the digital transformation of business processes, changes in organisational culture and leadership styles and cyber-physical system adoption.

If we summarised the article goals, it should be noted that, based on the analysis of articles using bibliographic methods, the study has achieved the following: (1) identify the groups of the references (i.e. clusters) and (2) discuss the challenges of this literature (i.e. opportunities and difficulties) for future research opportunities on agility. According to the content of the study, the article is intended for researchers, practitioners and students. The article allows them to understand the importance of the agility field and opens up new topics for future research and managers to reflect on its future strategic and developmental direction.

The article consists of the following parts: after the introduction, the second part discussing the theoretical background follows. The third part includes research methodology and describes the methods and sources. The fourth section presents and discusses the results. The last section is the conclusion, which presents the main features and limitations of the research.

Research methodology

Study design

Bibliometrics is considered a scientific discipline for which several definitions, as well as designations, are known. For example, White and McCain (1989, p. 119) characterise it as "a quantitative study of literature reflecting bibliographies. Its purpose is to explain the evolutionary models of science, technology, and study."

Bibliometrics is considered a truly interdisciplinary research field, which covers almost all academic fields. The methodology includes bibliometric mathematics, social and natural sciences, engineering and other scientific disciplines (Zupic and Čater, 2015). Furthermore, authors such as Palumbo *et al.* (2021) use different literature review forms in the bibliographic analysis of the literature. Therefore, qualitative methods such as observation, interviews and metadata analysis are also used. In addition, the study is based on the science mapping approach. The approach applies to the generic process of visualisation and domain analysis. The approach allows the scientific mapping of both the scientific groups and the research

area or, as in our study, a thematic area related to the research questions posed (Chen, 2017). Co-citation analysis and bibliographic coupling (Boyack and Klavans, 2010) were used to represent the bibliographic methods. Applications of science mapping include topic mapping and overlay visualisation of historical, current (new and hot topics) and emerging topics in the field of agility (Waltman and Van Eck, 2012). In selecting the literature, we follow the approaches of authors such as Palumbo *et al.* (2021). Thus, authors developed a three-step protocol that is presented in Figure 1. The protocol includes (1) data collection: selecting articles published in scientific journals that were indexed in the WOS database; (2) data cleaning: a manual review of article titles and abstracts. Based on their content, we excluded articles inappropriate content; and (3) core analysis includes descriptive statistics and preparing mapping analyses. Figure 2 presents the science mapping workflow. It has consisted of (1) definition of the research design, (2) compilation of bibliometric data, (3) data analysis, (4) visualisation of results and (5) interpretation of results.

Data collection

In the first research, phase was prepared the collection of articles information. Authors used the SCI and the SSCI WOS database as sources of scientific literature. The database is considered the most trustworthy and thorough source of data (Van Eck and Waltman, 2010; Zupic and Čater, 2015) and is frequently used in bibliometric research on the progress and evaluation of various scientific fields (Waltman and Van Eck, 2012).

The Boolean keyword combination: ((management* AND agility) AND (organisation* OR agility OR flexibility) was used for finding relevant articles. It was no temporal restrictions. The research limitation was set on research and review articles published in English refereed (SCII and SCI) journals.

Data cleaning

The papers' content (titles, abstracts, keywords and conclusion) was manually reviewed, and papers whose content did not match the research phenomenon were eliminated. From the 1,620 journal papers in WOS, 1,344 papers were chosen for the analysis.

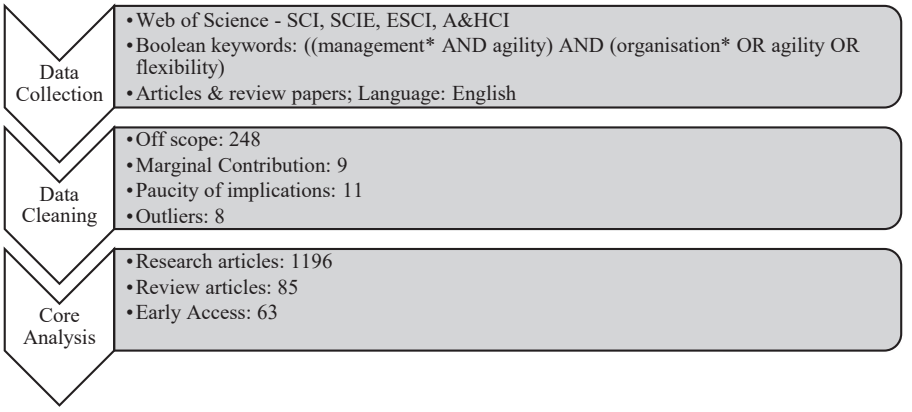


Figure 1.
Three-step protocol

Figure 2.
Science mapping workflow

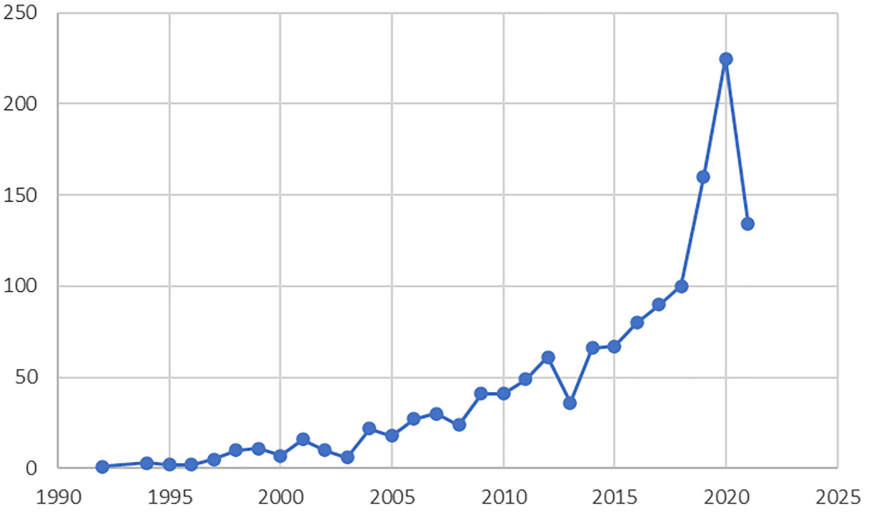
Core analysis

In the third phase (core analysis), the data of 1,344 articles published between 1992 and July 2021 were exported from WOS. The search was conducted on 1 August 2021. The final search step consisted mainly of a bibliometric analysis based on the similarity visualisation (VOS). The VOS required similar groups of scientific papers based on direct relationships by citation. The bibliometric analysis and mapping central part were performed using a VOSviewer (version 1.6.17) (Van Eck and Waltman, 2010).

Descriptive statistics

Figure 3 shows the number of articles published from 1992 to July 2021. As shown in Figure 1, the first article was published in 1992, and until 2012, the amount of published articles increased slowly until 2013, when there was a decrease, while after 2013, there was a steep increase in articles. The total citations of all published 1,344 articles are 46,456; without self-citations, 40,124, the average per article is 34.57, and H-Index is 104. Of the 1,344 articles, 1,177 had at least one citation.

We decided to divide the publication period into four intervals according to the yearly increase of published articles. The first interval was seven years long (1992–1999), the second interval was the shortest and lasted four years (2000–2005), the third interval was the longest, at nine years (2006–2015), and the fourth interval was five years (2016–2021). As can be seen in the last interval, the number of articles published is increasing. Of the 1,344 articles, 34 (2.53%) were published between 1992 and 1999, 79 (5.88%) between 2000 and 2005, 442 between 2006 and 2015 (32.89%), and 789 (58.71%) were published in the 2016–2021 period. Thus, the articles were published in 364 journals. The ten journals with the highest numbers of published articles are International Journal Of Production Research (48 articles, 3.57%), International Journal Of Production Economics (46 articles, 3.42%), International Journal Of Operations Production Management (41 articles, 3.1%), Sustainability (37 articles, 2.75%), Supply Chain Management (28 articles, 2.1%), Industrial Management Data Systems (27 articles, 2%), International Journal Of Information Management (25 articles, 1.86%),



Source(s): WOS

Figure 3.
Number of papers published from 1992 to 2021

Journal Of Business Research (25 articles, 1.86%), Production Planning Control (24 articles, 1.79%) and International Journal Of Logistics Management (19 articles, 1.42%).

Results

Bibliometric co-citation analysis

The co-citation analysis in this study is prepared at the document level. By analysing the documents cited together (co-citation), one can conclude that these works reveal an intellectual relationship between the prominent articles in the discipline and the mapping of the intellectual structure of the discipline (Calabretta *et al.*, 2011). The co-citation method is based on the frequency of two documents from earlier literature being cited in later work, assuming that the more often two documents are cited together, the closer the relationship between them; therefore, they can be considered part of the same research field. However, while this relationship indicates that the documents belong to the general broad research area, they do not necessarily agree with each other.

The co-citation analysis enabled us to find answers on: *Who are the primary, peripheral and bridging researchers in the agility field?* Furthermore: *How has the structure of an agility field developed over time?*

Data and procedure

For the co-citation analysis, 1,344 articles from the database WOS were used (see section descriptive statistics). Articles with ten or more citations were used for a more detailed analysis. VOSviewer software was used to visualise the analysis of the bibliometric agility network. According to Van Eck and Waltman (2010), only the first author's name was included in the analysis to avoid overly cluttered maps. The dataset was analysed with the use of a co-citation analysis with cited references, using articles as analysis items, due to the specificity and the fact that this is a relatively new topic (30 years old). Still, fewer articles of this type were found in development.

Therefore, only articles with ten or more citations were accepted for analysis. From the 56,794 cited references, 726 meet the threshold (secondary articles). It also needs to be mentioned that "co-citation builds on secondary, cited articles and is less sensitive to starting year" (Černe *et al.*, 2016). Table 1 presents the top twenty references with the greatest link strength, citations and number of links in the agility field. Table 1 also shows that the oldest cited article in the agile field (e.g. the secondary article) was Barney (1991), with 115 citations. The article was published in the Journal of Management. While the oldest articles are secondary articles, Armstrong and Overton (1977) and Fornell and Larcker (1981) were published in the Journal of Marketing Research. These articles deal with research approaches, solutions and methodology (evaluating structural equation models). Considering many citations, we conclude that one of the most important research approaches in agility is quantitative research, including structural equitation models.

Co-citation cluster analysis

Visualised results of the co-citation analysis are presented in Figure 4. Again, larger node and node labels reflect higher citations (and vice versa), and the colours and adjacent nodes represent the clusters of topic themes.

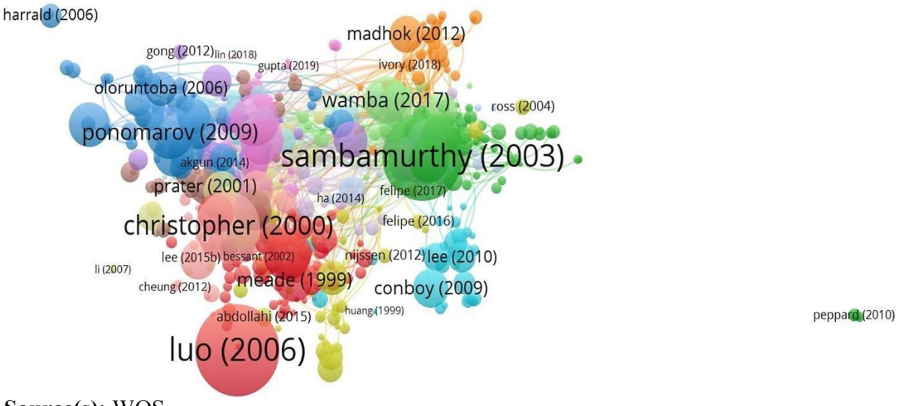
According to the visual map in Figure 3, four clusters of references co-citation relations emerged. A clusters overview is presented in Table 2.

The first cluster (represented in red in Figure 3) consisted of 347 documents. Depending on the content of the articles, Cluster 1 is labelled as *Agility, dynamic capability and information*. Researches in the first cluster included an explanation of the vital role of

References (author, year, publication)	Number of links	Citation	Total link strength
Fornell, C., 1981, J. Marketing Res. V18, P39	691	200	3,685
Sambamurthy, V. 2003, Mis Quart. V27, P237	676	216	3,646
Swafford, P.M., 2006, J. of Oper. Man., V24, P170	419	149	3,367
Teece, D.J., 1997, Strat. Man., V18, P509	691	179	3,355
Braunscheidel, M.J., 2009, J. Oper. Man., V27, P119	628	119	2,855
Podsakoff, P.M., 2003, J. App. Psychol., V88, P879	661	144	2,852
Christopher, M., 2000, Ind. Market Manag., V29, P37	347	137	2,818
Swafford, P.M., 2008, Int. J. Prod. Econ, V116, P288	640	121	2,801
Eisenhardt, K.M., 2000, Strat. Man., V.21, P 1105	646	121	2,801
Overby, E., 2006, Eur. J. Inform. Syst., V15, P120	623	119	2,317
Yusuf, Y.Y., 1999, Int. J. Prod. Econ., V62, P33	605	123	2,237
Armstrong, J.S., 1977, J. Marketing Res., V14, P396	635	99	2,147
Lee, H.L., 2004, Harvard Bus. Rev., V81, P102	603	94	2,120
Barney, J. 1991, J. Man., V17, P99	634	115	2059
Lu, Y., 2011, Mis Quart., V35, P931	535	121	2041
Blome, C., 2013, Int. J. Prod. Res. V51, P1295	575	75	1905
Sharifi, H., 1999, Int. Prod. Econ., V62, P7	569	104	1894
Teece, D.J., 2007, Strat. Man., V28, P1319	616	106	1892
Goldman, S.L., 1995, Agile Comp. and Virt. Organisations (book)	574	110	2,659
Van Hoek, R.I., 2001, Int. J. Oper. Prod. Man., V21, P126	544	83	1803
Tallon, P.P., Mis Quart., 2011, V35, P463	537	92	1,635

Source(s): Created by author based on the VOSviewer analysis

Table 1.
Top 20 references with the greatest link strength, citations and number of links in the agility field



Source(s): WOS

Figure 4.
Visualisation network of the agility field; co-citation analysis (by the first author; citation ≥10)

information technology (IT) and to argue that IT investment and dynamic competencies influence firm performance through three organisational competencies (agility, digital options and entrepreneurial vigilance) and strategic processes (capability building, entrepreneurial action and coevolutionary adoption) (Sambamurthy *et al.*, 2003). Overby *et al.* (2006) defined enterprise agility and the role of IT and digital solutions, analysed the capabilities that support an enterprise's agility and proposed an approach for measuring it. Tallon and Pinsonneault (2011) addressed the importance of competitive views on the link between strategic IT coordination and organisational agility. Lu and Ramamurthy (2011)

Table 2.
Summary of agility co-citation network (Cluster 1–4)

Cluster	Label	Representative authors	Content	Core theoretical backgrounds
1	Agility, dynamic capability and information	Sambamurthy *et al.* (2003), Teece *et al.* (1997), Overby *et al.* (2006), Eisenhard and Martin (2000), Barney (1991), Teece (2007), Lu and Ramamurthy (2011) and Tallon and Pinsonneault (2011)	IT, dynamic capabilities, firm performance, organisational agility	Strategic management, informatics, business industrial economics
2	SCA and information technology	Swafford *et al.* (2008), Agarwal *et al.* (2007), Narasimhan *et al.* (2006), Van Hoek *et al.* (2001), Yusuf *et al.* (1999), Christopher (2000), Fisher (1997), Naylor *et al.* (1999)	SCA, IT, competitive performance, leanness, agile manufacturing, performance capabilities	Informatics, technology management
3	Flexible manufacturing and SCI	Swafford *et al.* (2006), Lee (2004), Braunscheidel and Suresh (2008), Blome *et al.* (2013), Gligor *et al.* (2015), Lee (2002), Li *et al.* (2008), Christopher and Lee (2004), Flynn *et al.* (2010)	SCI, flexibility manufacturing, logistic processes, triple-A supply chain, cultural antecedents, learning orientation, firm's SCA, process compliance	Logistic, management, organisational psychology
4	Organisational knowledge and inter-firm relationships	Dyer and Singh (1998), Fugate *et al.* (2009), Vickery *et al.* (2010)	Inter-firm relationships, competitive advantage, knowledge sharing, operational and inter-operational performance, knowledge management process, supply chain information technologies, supply chain organisation initiatives, manufacturing firms, agility performance	Knowledge management, Technology management, Organisational psychology, organisational sociology, organisational communication studies

found that more investment in IT does not lead to greater agility when deployed to enhance and promote IT capabilities; they argue for the conjecture of a contradictory effect of IT on agility. Teece *et al.* (1997) focus on the dynamic ability to analyse the methods and resources for wealth creation and attainment by private firms operating in the context of rapid technological change. Eisenhard and Martin (2000) defined dynamic capabilities and presented a general view of a firm based on a resource-based view. Barney (1991) examined the relationship between a firm's resources and long-term competitive advantage based on the assumption that strategic resources are distributed heterogeneously across firms and that these differences are stable over time. The article identified four empirical indicators of a firm's potential to create durable competitive advantage: value, rarity, imitability and substitutability. Teece (2007) explained the concept of dynamic capability and its role by outlining the micro-foundations of (sustainable) enterprise performance. Fornell and Larcker (1981) and Podsakoff *et al.* (2003) address research methodology.

Cluster 2 (green) includes 204 documents. We labelled cluster 2 as *supply chain agility* (*SCA) and IT*. This cluster's papers focus on integrating IT that enables firms to increase SCF, leading to greater SCA and improved competitive performance (e.g. Swafford *et al.*, 2008). Agarwal *et al.* (2007) elaborated insights on the interrelationships of variables that influence SCA. Narasimhan *et al.* (2006) prepared a literature review in which they discussed leanness and agility in regard to both manufacturing paradigms and performance capabilities. Van Hoek *et al.* (2001) examined agility in the supply chain (SC). Christopher (2000) focused on the survival of firms in turbulent and volatile markets that affect SC instability. Yusuf *et al.* (1999) outline agile manufacturing paradigms, identifying the drivers of agile manufacturing and presenting the importance of the competitive advantages that result from changing manufacturing requirements. Naylor *et al.* (1999) focused on incorporating lean and agile manufacturing paradigms throughout the SC. Fisher (1997) suggested that companies consider the nature of their demand and products before designing a SC.

Cluster 3 (blue) consisted of 196 documents. Cluster 3 can be labelled as *flexible manufacturing and SCA*. Within the topics discussed in Cluster 3, it is necessary to mention that Flynn *et al.* (2010) focused on the importance of supply chain integration (SCI), which is the degree to which a manufacturer strategically collaborates with its SC partners. Li *et al.* (2008) prepared a literature review in which the need for a comprehensive conceptual model of SCA was identified. In their empirical study, Swafford *et al.* (2006) determined that the SCA of a firm is directly and positively impacted by the degree of flexibility present in the manufacturing and procurement/sourcing processes of the SC; while it is indirectly impacted by the level of flexibility within its distribution/logistics process. Christopher and Lee (2004) pointed out that better end-to-end transparency is one of the key elements of any SC risk mitigation strategy. Lee (2004) presented a triple-A SC. According to Lee (2004), companies need to provide a fresh attitude and a new culture for their SCs to deliver triple-A performance. Braunscheidel and Suresh (2009) investigated the impact of two cultural antecedents, market orientation and learning orientation and three organisational practices at augmenting the SCA of a firm. Blome *et al.* (2013) examined the elementary building blocks of SCA constructed as supply-side and demand-side capabilities. They also examine the impact of SCA on operational performance and its mediating role in the relationship between supply-side and demand-side capabilities and performance. Gligor *et al.* (2015) prepared a study based on archival data about the moderating effects of environmental munificence, dynamism and complexity. The authors (Gligor *et al.*, 2015) determined that SCA can also lead to superior performance for firms operating in stable environments. The study results also provided a better understanding of how FSCA contributes to firm financial performance. Lee (2002) predicted that the right SC strategy should be prepared following the demand and supply uncertainties. The biggest challenge for companies is innovative products, as the demand for them is highly unpredictable and poses the biggest

challenge to SC processes. Armstrong and Overton (1977) prepared a methodological text about estimating nonresponse bias in mail surveys.

Cluster 4 (yellow) can be labelled as *organisational knowledge and inter-firm relationships*. The article by Anderson and Gerbing (1988) focused on the use of structural equation modelling. Churchill (1979) proposed a paradigm for developing better measures of marketing constructs. Hair *et al.* (2014) also wrote a theoretical-methodological article describing the use of partial least squares structural equation modelling. Given these frequently cited methodological articles, we can conclude that empirical methods predominate over qualitative methods for the articles in Cluster 4. Dyer and Singh (1998) formulate a position in which they suggest that a firm's critical resources may transcend its boundaries and be embedded in inter-firm resources and routines. As part of an empirical study, Fugate *et al.* (2009) investigated the importance of knowledge management processes for operational and inter-operational performance (OPERF). Vickery *et al.* (2010) empirically examined the role of SC information technologies (SCITs) and SC organisation initiatives (SCOIs) in promoting agility and firm performance in manufacturing firms.

Bibliographic coupling

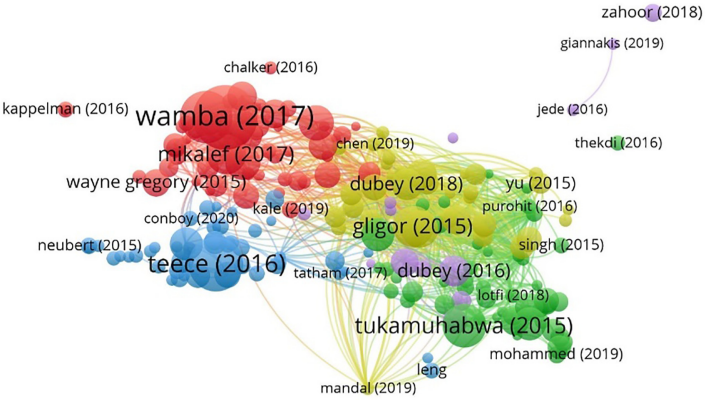
For the second bibliographic analysis, we chose bibliographic coupling, which occurs when two articles refer to a common, third article in their bibliographies. This reference indicates the likelihood that both articles deal with a related topic; the "linked strength" of these two articles increases with the more common articles they cite (Kessler, 1963). There has been criticism of the use of bibliographic coupling in cases where authors have used the method to show future searches based on current trends (hot topics, which have been criticised for speculation about the future), but Ferreira (2018) points out that bibliographic coupling remains a useful tool for positioning current contributions to the field despite this criticism. Garfield (2009) pointed out the danger that two articles in the third can refer to a completely unrelated topic and therefore applies the co-citation method to the better indicator of topic similarity. However, Ferreira (2018) believes that the two methods are complementary, as the bibliographic coupling method is "retrospective" and the co-citation method is "prospective".

As part of the preparation of the bibliographic coupling, following the recommendations on the application of this method (Zupic and Cater, 2015), we decided to design a limited time frame of published articles from the previous seven years. As a result, as mentioned above, we found 1,344 articles in the field of agility, of which 633 articles were published between 2015 and 2021.

Bibliographic coupling by articles

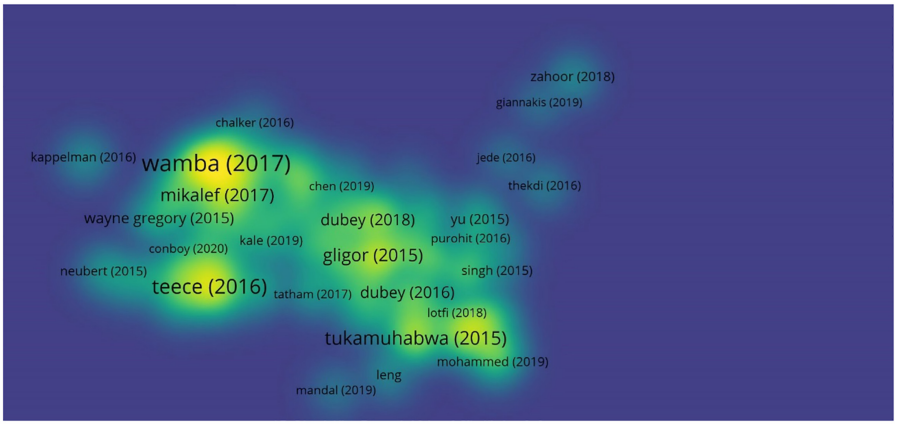
Of the 633 articles, 228 primary articles with at least ten citations were used in the analysis, but the largest group of linked articles consists of 208 articles that were analysed with the goal that the results would contribute to an understanding of the fundamentals of the agility field. The total number of links in all nine clusters was 9,543, with a total link strength of 34,084. Figure 5 shows the fragmented situation of the agility field after 2015 and until today. The circles represent the significant articles/topics and researchers in the research field. As shown in Figure 5, four larger (dominant) fields (circles) have developed alongside five smaller fields. Figure 6 shows a visualisation of the cluster density.

The first cluster (represented in red in Figure 4) consisted of 57 articles. We labelled it *IT impact on firm performance*. Based on citations, links and link strength, the most important documents in Cluster 1 are Brusset (2016), which prepared a survey of French SC managers. The study's main findings are that their framework applies the dynamic capabilities approach, that visibility through reports or web platforms does not improve agility, and



Source(s): WOS Visualisation: Voswiever

Figure 5.
Bibliographic coupling network of the field by documents



Source(s): WOS Visualisation: Voswiever

Figure 6.
Cluster density visualisation of bibliographic coupling

that internal and cross-organisational processes improve agility. In the study, Mikalef and Pateli (2017) sought to explain how IT can help build competitive advantage in uncertain environments. As part of their empirical research, they investigated the relationship between competitive performance and IT-enabled dynamic capabilities. Corte-Real *et al.* (2019) and Mikalef and Pateli (2017) researched the value chain of big data analytics (BDA). In their article, Narayanan *et al.* (2015) aimed to demonstrate that trust facilitates the effects of collaboration on agility performance, but meanwhile, the indirect effect of collaboration on agility performance through trust is only significant beyond the threshold level of collaboration. Akter *et al.* (2016) presented a BDA capability (BDAC) model in their study. The model was developed based on firm performance (FPER) and resource-based theory (RBT) and the interconnectedness view of "sociomaterliasm". The study results confirm the impact of BDAC on FPER and the role of corporate strategy alignment.

The second cluster (represented in green in Figure 4) consisted of 47 articles. We labelled the cluster as SC *risk management*. Based on citations, links and link strength, the most important documents in Cluster 2 are the following. Jajja *et al.* (2018) determined that

companies manage SC risk by using integrative practices with suppliers and customers that boost the performance of agility. Sharma *et al.* (2017) prepared a review paper about the SCA classification. Gunasekaran *et al.* (2019) prepared a literature review about agile manufacturing in which authors marked agile manufacturing as a centre of achieving sustainable competitive advantage. Brusset and Teller (2017) presented the SC capabilities, risks and resilience. Study based on the dynamic capabilities approach. Munir *et al.* (2020) prepared a study about the enabling role of SCI. The study results show that SC risk management partially mediates the relationship between operational performance and internal integration and completely mediates the association between supplier and customer integration and operational performance.

The third cluster (represented in blue in Figure 4) consisted of 44 articles. We labelled it the third cluster *business model innovation*. Based on citations, links and link strength, the most important articles in Cluster 3 are focused on digital transformation is "an ongoing process of using new digital technologies in everyday organisational life, which recognises agility as the core mechanism for the strategic renewal of an organisation's (1) business model, (2) collaborative approach, and eventually, the (3) culture" (Warner and Wäger, 2019), Conforto *et al.* (2016) prepared a novel and comprehensive definition of agility, stating that it: (1) combines rapid project planning change and active customer involvement; (2) is a team's ability not only an attribute of "agile methods or practices"; performance may not be a direct result from adopting "agile methods"; and (3) has different intensities and depends on multiple organisation factors. Battistella *et al.* (2017) prepared a multiple case study about the possibilities of using focused capabilities to cultivate business model agility. Ghezzi and Cavallo (2020) determined that lean startup approaches (LSAs) can be employed as agile methods to enable business model innovation in digital entrepreneurship. Oliva *et al.* (2019) proposed a model for integrating knowledge management and dynamic capabilities in agile organisations (startups).

The fourth cluster (represented in light green in Figure 4) consisted of 37 articles. We labelled it SC *management*. Based on citations, links and link strength, the most important documents in Cluster 4 are the following. Wamba *et al.* (2020) produced an empirical study investigating the moderating effect of environmental dynamics in the context of the performance effects of BDA and SC ambidexterity. Dubey *et al.* (2019) found that BDAC has a significant and positive effect on SCA and competitive advantage and that organisational flexibility (OF) has a positive and significant moderation effect on the path joining BDAC and SCA. Gligor *et al.* (2015) empirically determined how FCSA contributes to a firm's financial performance. Finally, Wamba and Akter (2019) found out in their study that SC management, technology and talent are important antecedents of big data-driven SC analytics capability (SCAC).

The fifth cluster (represented in purple in Figure 4) consisted of 10 articles. We labelled it *the humanitarian* SC *(HSC)*. Based on citations, links and link strength, the most important documents in cluster 5 are the following. In their study about the HSC, Altay *et al.* (2018) examined the SCA effects and supply chain resilience (SCR) on performance under the moderating effect on organisational culture. Dubey *et al.* (2020) prepared an empirical study about the agility in the HSC from the perspective of organisational information processing. Dubey and Gunasekaran (2016) also researched the sustainable HSC design and their differences in commercial SCs; they found the following to be the main characteristics of an HSC network: agility, adaptability and alignment. Schniederjans *et al.* (2016) prepared an empirically and theoretically validated model depicting the connections between CC use, collaboration, agility and inter-organisational trust in HSCs. Finally, Oloruntoba and Kovács (2015) prepared a literature review about the evolution of humanitarianism and the environment of humanitarian organisations.

The sixth cluster (represented in light blue in Figure 4) consisted of six articles. We labelled cluster sixth *industrial cloud computing*. Based on citations, links and link strength, the most important documents in Cluster 6 are the following. Giannakis *et al.* (2019) introduced comprehensive cloud-based SC management and presented how companies can enhance the responsiveness of their SC. In a systematic literature review, Jede and Teuteberg (2016) presented the main opportunities and risks of using cloud computing in SC processes, focussing on the SC aspects of cloud computing sustainability. Morariu *et al.* (2016) present manufacturing execution systems (MES) virtualisation and shop floor architecture as intermediate manufacturing layers. The article also discusses the benefits that this approach offers to manufacturing companies. In a previous paper, Morariu *et al.* (2015) prepared an introduction to the virtualisation layer for virtualised MES. In their presentation, the authors mentioned the integration of a manufacturing service bus (MSB) in a cloud environment, a method to scale the private cloud for workload MES intelligently. Finally, Zhou *et al.* (2016) focused on the comprehensive survey of state-of-the-art approaches for performance optimisations and improvements and the portability management for network I/O virtualisation.

The seventh cluster (represented in orange in Figure 4) consisted of three articles. We labelled cluster seventh *sustainable* SC *practices*. Based on citations, links and link strength, the most important documents in Cluster 7 are the following. Based on empirical research, Geyi *et al.* (2020) found that sustainable SC practices allow predicting both sustainable and operational performance. Importantly, the impact of sustainable practices also increases when agile practices mediate relationships. Thekdi and Aven (2016) related key performance management and risk management principles, proposing an enhanced framework to unify thinking of performance and risk. The framework was applied to a public-private partnership case study.

The eighth cluster (represented in brown in Figure 4) consisted of two articles. Cluster 8 can be labelled as *organisational learning systems*. Based on citations, links and link strength, the most important documents in Cluster 8 focused on the influence of the capabilities of big data analytics management on SC preparedness, alertness and agility. According to the findings, BDA planning, BDA coordination and BDA control are critical enablers of SC preparedness, SC alertness and SCA. In contrast, BDA investment decision making had no significant influence on SC resilience (Mandal, 2019). Mehmood *et al.* (2017) prepared research about smart societies' personalised ubiquitous teaching and learning systems.

The ninth cluster (represented in pink in Figure 4) consisted of two articles and was labelled as *business logistics*. Based on citations, links and link strength, the most important documents in Cluster 9 are the following. Pan *et al.* (2019) studied the design and implementation prospects of smart product service systems in interoperable logistics. In addition, Leng *et al.* (2021) proposed a novel digital twin-driven joint optimisation approach for warehousing in a large-scale automated high-rise warehouse product-service system. They have developed a digital twin system that allows real-time data aggregation from a physical storage services system and their mapping into a cybernetic model. A common optimisation model is integrated into the digital twin system, how to optimise the allocation of folding packaging and storage systems for warehouse services in a timely manner.

Bibliographic coupling by source

The following is an analysis of the journals in which articles were published between 2015 and 2021. The analysis considered the threshold of one source article and at least ten citations per article. The result was that the largest group of related articles consisted of 102 journals. After the bibliographic linkage analysis by source, the most relevant journals between 2015 and 2021 were identified (i.e. the journals with the highest number of links and the highest total link strength). The list of journals is shown in Table 3.

Source	Documents	Citations	Total link strength
International Journal of Production Economics	21	1,050	9,800
Supply Chain Management – An International Journal	16	197	6,275
International Journal of Production Research	15	568	5,581
International Journal of Operations and Production Management	14	321	5,309
Journal of Manufacturing Technology Management	14	186	4,911
Sustainability	33	144	4,409
International Journal of Logistics Management	12	122	3,916
Production Planning and Control	15	236	3,251
Journal of Business Research	17	1,027	3,210
Business Process Management Journal	10	128	2,818
Journal of Enterprise Information Management	10	116	2,102
IEEE Access	12	68	244

Source(s): Created by author, based on the VOSviewer analysis

Table 3.
Bibliographic coupling by source

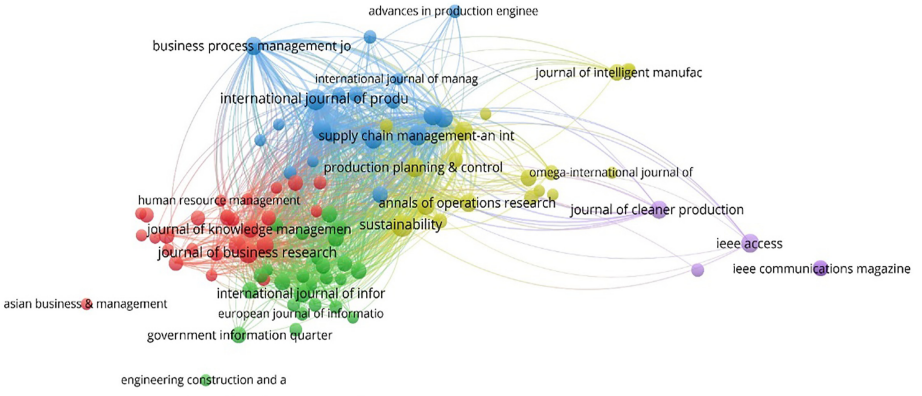
Figure 7 presents a network visualisation. It shows that relatively uniform size of circles of major journals by clusters, with the largest circle containing an International Journal of Production Economics. Circles decrease in the remaining journals, suggesting that agile research has entered other fields to a lesser extent.

Bibliographic coupling by authors

In the analysis of authors in the agility field, we identified 643 related authors in 501 articles from 2015 to 2021. We selected the condition that the author has at least one article with ten or more citations. Table 4 shows the authors with the highest number of articles, citations and total link strength per author. The first three most important authors are Gunasekaran and Dubey with nine articles and Childe with six published articles. The first three authors also have the highest total link strength. Key geographical areas covering agility were the USA, England, the People's Republic of China, France and Australia, followed by India as an emerging area.

Discussion and conclusion

The article focuses on showing a systematic map of the evolution of the agility field. With the help of co-citation analysis, we analysed the agility field in the period from 1991 to 31 July,



Source(s): WOS Visualisation: Voswiever

Figure 7.
Bibliographic coupling network of the field by journals

2021, and with the aid of bibliographic coupling, we analysed the period from 2015 to 31 July, 2021. It should be noted that the key limitations in the study are related to the selection of scientific articles and review articles and the selection of only the WOS database and the evaluation of the impact on citations covered by SCI and SCII. Thus, the study was limited by article type and impact factor and did not cover all scientific journals and other publications. In our opinion, it will be necessary to prepare a bibliometric analysis in the future, including papers from scientific conferences, chapters from books, books and scientific journals that do not have an impact factor. Another limitation is the determination of thresholds (e.g. number of citations) in the context of bibliometric analysis. The main problem is that this can lead to the elimination of potentially interesting articles.

In the context of the results, based on the overarching visualisation and analysis, we can state that over the years, researchers have found that there is no standard equation that would determine the evolution of an agile company. A company can become increasingly agile, but it will never be concretely agile. Bibliographic coupling analysis shows that agility is an endless process that never ends and should be understood as a continuous improvement of organisational processes and operations. The main assumptions that have evolved over the years and are now among the most important substantive assumptions that help us understand organisational agility are core competencies, competitive advantages and differences based on strategic thinking, innovative approaches, the promotion of change and the constant need to adapt and proactivity of organisations. In doing so, companies are considering the awareness of consumers and competitors, introducing shorter product life cycles, ensuring a faster supply of new products to markets and reducing operating costs. Therefore, it can be concluded that agility enables a company to survive in a changing environment, provided it introduces organisational changes that include changes in leadership, systems adoptions and culture changes (Vrontis *et al.*, 2021; Warner and Wäger, 2019). From the bibliographic coupling analysis, it can be concluded that digital transformation is between the hottest research in the current period and a key factor for the firm's performance and success. Moreover, digitalisation, in conjunction with the increasingly important informatisation, is an important field of research for the future, involving not only technological changes in finished products (e.g. electric cars) and the robotisation of manufacturing processes (both implications for the supply and value chain and future workforce structures, etc.) but also the issue of creating a new corporate culture and knowledge management through increased collaboration between people and machines, as well as the importance of process virtualisation, BDA, cloud computing and artificial intelligence (Holbeche, 2018; Jede and Teuteberg, 2016; Warner and Wäger, 2019).

Future research and development in artificial intelligence, together with CPS, is expected to accelerate the replacement of people in most enterprises (from

Table 4.
Bibliographic coupling: number/citations/total link strength per author (first ten authors

Author	Documents	Citations	Total link strength
Gunasekaran, A.	9	1,141	26,439
Dubey, R.	9	1,141	25,600
Childe, S.J.	6	970	16,018
Blome, C.	4	297	14,263
Fayezi, S.	4	125	12,809
Akter, S.	4	779	12,415
Gligor, D.M.	5	236	11,762
Liu, H.	7	231	10,496
O'Loughlin, A.	3	106	10,222
Zutsi, A.	3	106	10,222

Source(s): Created by author, based on the VOSviewer analysis

manufacturing, quality control and logistics to strategic decision making). COVID-19 also raises questions about a complex SC, which in many cases is unsustainable and geographically distant from headquarters and subsidiaries. Distance leads to a shortage of materials needed for ongoing production and food supplies in the event of a crisis (El Baz and Ruel, 2021).

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About the authors

Vasja Roblek is a Ph.D. student at the Faculty of Organization Studies in Novo Mesto. He earned his M.Sc. from the University of Primorska; his research interests include management, knowledge management, information management and sustainability.

Vlado Dimovski is a full professor in management and organisation studies at the University of Ljubljana School of Economics and Business. He earned his Ph.D. from Cleveland State University; his research interests include multiple intelligences, knowledge management and age management.

Maja Mesko is a full professor in management at the University of Primorska, Faculty of Management. Koper and full professor in human resource management at the University of Maribor, Faculty of Organization Science, Kranj. She earned her Ph.D. from the University of Ljubljana; her research interests include psychology in management, occupational health and management.

Judita Peterlin is an associate professor in management and organisation studies at the University of Ljubljana School of Economics and Business. She earned her Ph.D. from the University of Ljubljana; her research interests include multiple intelligences, social innovation and sustainable leadership. Judita Peterlin is the corresponding author and can be contacted at: judita.peterlin@ef.uni-lj.si