

Investigating the Development Patterns of Agility Literature with Co-Word Analysis 1990-2023

Abstract

Due to the corrosive effects of changes in the environment on competitive advantage, businesses seek to be proactive in the face of change. Being proactive is about constantly monitoring the environment and adapting quickly to anticipated changes. This building of proactivity against uncertainty and fluctuations in the environment is linked to agility. Therefore, efforts to understand the concept of agility are intensifying both theoretically and practically. However, there is no study that addresses the change in the development patterns of the agility literature, which has a dynamic structure, over time. In this study, co-word analysis (henceforth CWA), one of the bibliometric analysis techniques, was conducted to examine the change in the development patterns of agility literature. For the CWA, a review of the internationally recognized Web of Science database was deemed appropriate. The findings show that the use of agile is expanding from the software industry to other sectors. It is also noted that with the spread of use, the concept has undergone various nomenclature and is defined as a competence. As the research area of agility continues to expand, it brings new areas of study to the fore in the light of the discussions in the literature.

Keywords: agile, agility, co-word analysis, bibliometric analysis, Web of Science

JEL Code: M-10, M-20

Introduction

Since the 1990s, when agility was first put forward, it is seen that the development of the literature has gained momentum and there has been a periodic leap (Kumkale, 2016). Within these periods, the agility literature has passed its infancy stage and has expanded with different sub-fields with various nomenclatures and definitions. Thus, instead of a single structure, the concept of agility emerges as a structure that is defined through different concepts and can be dimensioned in various ways (Ashrafi et al., 2005; Lee & Xia, 2010). Bibliometric studies have been conducted on these various nomenclatures and conceptualizations (such as agile leadership agile software development) (Lee and Xia, 2010; Putra et al., 2022). Recently, various bibliometric studies on co-citation, authors and studies have tried to identify the prominent aspects of the agility literature (Diego and Almodóvar, 2022; Franco et al., 2022; Nugroho et al., 2022; Pinho et al., 2022; Ragazou et al., 2022; Roblek et al., 2022; Sehitoglu et al., 2020; Tomomitsu and Moraes, 2021). However, it does not contain information on the

details of the evolutionary process of the developmental patterns of agility literature over time. The need to examine the development patterns stems from the fact that agility has evolved with a body of knowledge that has been enriched by theoretical discussions as well as the practical-based aspect of agility spreading towards different sectors. As there is no clear research systematics to investigate this evolutionary process (Singh et al., 2013), the concept of agility continues to be discussed in a general and vague way (Diego and Almodóvar, 2022). In order to contribute to this gap, this study aims to examine the change in the development patterns of agility writing over time through co-word analysis (CWA). While existing studies provide valuable insights into the literature, new information is needed through an additional analysis of the literature using rigorous bibliometric methods (Garcia-Buendia et al., 2022). Thus, the necessity to reveal the structure of change patterns that accommodate the changing agenda and dynamics of the agility literature emerges (Pinho vd., 2022; Uludağ vd., 2022).

CWA is emphasized as a bibliometric method that can reveal the structure of the change patterns of a field and the direction of development (Bağış, 2021; Hu ve Zhang, 2015; Schitoglu vd., 2020). Therefore, in this study, a CWA was conducted to reveal the structure formed by the development patterns of agility literature. In this study, the reason why it is thought that the field of agility can be put into CWA is the necessity of defining and explaining the relationship between them as various nomenclatures and concepts related to agility form sub-branches. In this way, it will contribute to filling the gap by providing an insight into the evolution and future of the concept (Eğilmez, 2022).

The Web of Science database was searched on agile using data filtering criteria and 12,300 studies were obtained between 1990 and 2023. Vosviewer software was used to analyze this data volume. The findings show that the use of agile is expanding from the software industry to other sectors. It is also noteworthy that the concept has been subjected to various nomenclatures and defined as a competence as its use has become widespread. As the intellectual structure of agility continues to expand, it highlights new areas of study in the light of the discussions in the literature. The findings of this study reveal the estimated links and orientations between agility and other concepts. However, it does not provide details on the direction, intensity, differences, etc. of these connections. Therefore, it reveals only the existing search for agility-related literature and a periodic review of the intellectual journey of agility.

Agility Literature

The agility has attracted attention for its contribution to sustaining competitive advantage and agility is considered to be an appropriate concept to explain differences in competition

(Darvishmotevali et al., 2020; Kumkale, 2016; Zhang and Sharifi, 2000). Increasing uncertainty and the need to respond quickly to sudden changes in the environment emphasize the need for agility (Diego and Almodóvar, 2022; Gangully et al., 2009; Sharifi and Zhang, 2001; Zhang and Sharifi, 2000). In this context, there has been a notable increase in interest in the concept of agility within the academic field related management and organization (Ashrafi et al., 2005; Pinho et al., 2022). Accordingly, the importance of agility has increased over time at the individual, strategic and organizational levels (Roblek et al., 2022). The concept of agility was first introduced in 1991 by the Iacocca Institute (1991) in the United States of America as an approach based on the principles of capability-based, flexible and agile production, with the objective of meeting the rapidly changing needs of the market (Kale et al., 2019). Despite the evident clarity regarding the origin of agility, there is not yet a consensus on how this concept should be handled (Dove, 1999; Sherehiy et al., 2007). Despite growing interest in agility research, a systematic review defining, measuring and analyzing it is still needed (Singh et al., 2013). This is because the concept of agility is not a fixed term; its definition and associated nomenclature vary over time (Kumkale, 2016). It can thus be argued that a synthesis approach, related to agility, is the most appropriate means of transferring the existing body of literature-based knowledge (Xing et al., 2020).

The growing importance of agility and its complex definitions cannot be attributed solely to the concept's dynamism. It is crucial to consider the evolving external environment and the shifts in competitive advantage it entails. In the literature, it is seen that agility is defined through perceiving and reacting to environmental changes (Ashrafi et al., 2005). Therefore, environmental orientation is often included in agility definitions (Sherehiy et al., 2007; Yusuf et al., 1999). In light of the growing emphasis on environmental issues, agility is increasingly regarded as a crucial capability. In the agility literature, there is a dual view of agility as a generic capability (flexible-based strategies) and a versatile capability (business process set) (Shin et al., 2015). The term "agility" is defined as a generic capability that enables flexibility in response to changes in the external environment (Sherehiy et al., 2007; Singh et al., 2013; Zhang and Sharifi, 2000).

The concept of agility has been defined as environment-oriented and proactive, leading to the conceptualization of agility as a capability-based concept. A review of the literature on agility reveals that the concept was initially defined in terms of speed (Yusuf et al., 1999). An alternative generic perspective defines agility as the capability to manage and deploy knowledge in an effective manner (Dove, 1999). As the detrimental influence of environmental

shifts on competitive advantage became apparent, research defining agility as the capability to respond promptly to environmental changes emerged as a prominent area of study (Braunscheidel and Suresh, 2009; Dahmardeh and Pourshahabi, 2011). In addition to its definition as a generic capability, agility has also been characterized as a strategic concept, requiring the fulfilment of specific requirements that extend beyond the realm of operational activities. Thus, it can be said that agility has gained an emphasis on versatile ability. This strategic characterization has become a situation that directs agility studies as well as maintaining competitiveness against change and speed in the environment. Consequently, the common emphasis in agility definitions is on speed and flexibility (Dahmardeh and Pourshahabi, 2011).

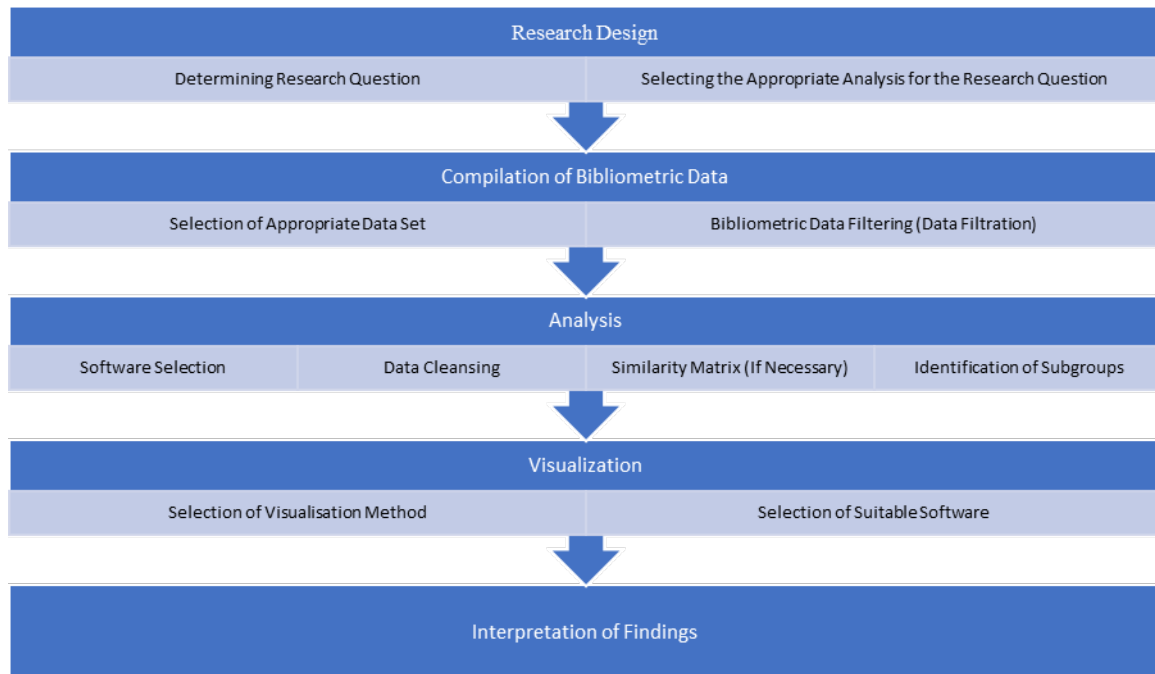
As previously stated, the concept of agility based on capabilities has undergone evolution over time. Initially, agility was perceived as a phenomenon exclusive to the organizational context. Subsequently, the notion of incorporating generic attributes was embraced, culminating in the integration of multiple capabilities within the conceptual framework of agility studies. The shift in perspective on agility as a capability is linked to environmental volatility and businesses that have shown they can develop agility across industries. Agility first entered the agenda of businesses in the field of software and the principles of what agility is were evaluated through the Agile Manifesto Principles (Agile Manifesto Principles, 2001). While there was an acceptance that it could be built specific to the business with software companies, with the widespread use in the manufacturing sector, the common aspects of successful companies in agility were emphasized by focusing on generic features. Then, as a result of the need for agility in the service sector and the increasing complexity of environmental changes, the focus is on how agility can be built as a multi-faceted business process set that can include multiple capabilities. It can be posited that the characteristics of flexibility, responsiveness, speed, a culture of change, integration, the mobilization of core capabilities and low complexity which are globally associated with agility (Sherehiy et al., 2007), indicate that agility is considered to be a multifaceted capability.

Method

In bibliometric studies based on CWA, it is asserted that analyses can be conducted by identifying word groups and addressing potential opportunities and challenges for future research questions on the referenced concept (Roblek et al., 2022: 120). Zupic and Čarter (2015: 433) put forth a five-step workflow for science mapping in bibliometric analyses. In this study,

which aims at a bibliometric analysis based on CWA on agility, it was thought that this workflow could draw a framework for both data filtering and the acquisition of findings.

Figure-1: Workflow Chart for Bibliometric Analysis



Source: Zupic ve Čarter (2015: 433)

As a research question in research design, which is the first stage, it was determined that CWA is appropriate to determine the structure of change patterns of agility writing. In the second stage of the process, the WoS dataset was searched with regard to the term "agility" and data filtering was carried out using filters based on management-organization and document type. The VosViewer software was used for analyzing the data set obtained second-stage, including cleaning and visualization. Because, VosViewer is a software tool that facilitates the creation of bibliometric maps and the visualization of data sets (Jan van Eck and Waltman, 2010). The data were visualized using network analysis and historical stratification mapping. Once the procedures had been completed, the relationship frequencies of words and subgroups (i.e. clusters) were determined. Thus, the third and fourth stages of the analysis were completed. At the last stage, the findings were interpreted in conjunction with bibliometric studies and research articles on agility.

CWA was conducted to ascertain the correlation between the keywords extracted through the aforementioned operations (Hu and Zhang, 2015). The fundamental premise of CWA is that when groups of keywords co-occur with high frequency in studies, the concepts or themes that underpin these words are closely related (Hu and Zhang, 2015; Zupic and Čarter, 2015). It is

observed that matching words evince an internal relationship between them and the quantity of such matching words is indicative of the strength of the relationship (Sehitoglu et al., 2020). CWA is conducted on the titles, summaries, and keywords of the studies in order to determine the relevant concepts and to form clusters of these (Sehitoglu et al., 2020: 418). Thus, sub-topics in the relevant research area can be identified (Bağış, 2021: 298). It is stated that the keywords belonging to the articles examined in the data filtering can express the main content of the related studies and the frequency of these keywords can measure the importance of the relevant themes in a certain area (Hu and Zhang, 2015: 332). This means that threshold values must be determined for word appearance in joint word analysis (Zupic and Čarter, 2015: 441). In data visualization, the criterion that keywords were repeated at least 3 times in the selected studies was used. Thus, the selection of concepts related to agility and the differentiation of subgroups were ensured.

The data set was constructed using the filtering criteria of the results obtained from the Web of Science (WoS) database. The process of creating this dataset started with the data filtering process through the keywords ‘Agile*(topic) or agile* (title) or agile* (author keywords)’ in WoS. The diverse usages of concepts can have a significant impact on the construction of a bibliometric data set (Zupic and Čarter, 2015). Considering the differences in the English usage of the concept of agility, the word search completion feature of the WoS was used. Then, **“Article or proceeding paper, early access or review article”** options were selected from the document types of the filtering criteria. Thus, publications without keywords were excluded from the data analysis (Bağış, 2021: 297). **“The Management or Business”** filter in the WoS was selected and 2,327 studies were accessed. The obtained data set was downloaded in ten-year periods. 89 results were obtained between 1994-2003, 730 results between 2004-2013 and 1508 results between 2014-2023. The data of each period was evaluated separately and the changes in the structure of the field were emphasized by making comparisons between them (Zupic and Čarter, 2015).

The Results

The findings are listed with the clusters belonging to the three periods and the interpretation of the connections between the concepts related to each cluster. Thus, *“it enabled the identification of existing and emerging research clusters in order to identify key research topics, interrelationships and collaboration models”* related to agility (Garcia-Buendia et al., 2022). Accordingly, an attempt was made to demonstrate the interconnections between the clusters by referencing the concepts that the respective clusters encompass. In addition, time-based

stratification maps were used to support the identification of links between clusters. In all three periods, agility is considered in relation to certain concepts. In particular, as expected in the literature, it is a research area linked to different fields such as management, logistics, marketing, computer science, information systems and digital transformation (Roblek et al., 2022). There is also an emphasis on clarifying the line between agility and similar concepts in the literature such as dynamic capabilities and strategic flexibility (Singh et al., 2013). In light of these considerations, predictions for the future have been tried to be put forward.

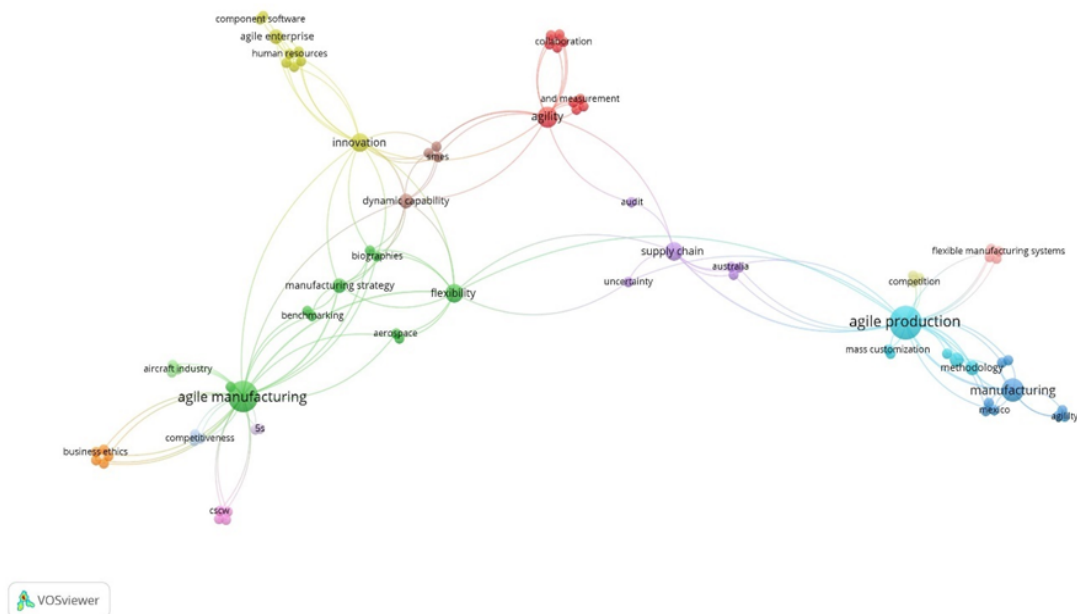
Prior to presenting the findings, it is beneficial to delineate a few key aspects pertaining to the methodology employed in their analysis, in alignment with the objectives of the study. First, the results are presented in three 10-year periods. The reason for the election of three terms is that there is a change in competition every ten years. Secondly, the concepts represented in the visuals presented in each period do not merely indicate a situation that begins and ends within that period. Each concept cluster represents the weight and frequency of agility-related studies in each period. Therefore, the same concepts in different clusters do not constitute a contrast. There may be a number of reasons why a given concept emerges concurrently in different clusters or periods. This indicates that the related concepts have been associated with and studied in relation to different concepts over time. In addition, the WosViwer program is able to provide network and density maps with links between clusters by creating clusters according to the agile-related parameters set in the method section. Another issue concerns the status of concepts that do not exist in the relevant time periods. The absence of a concept related to agility in a cluster does not indicate that the concept has been excluded from study in that period or that it is no longer a topic of interest within the agility literature. Each cluster formed by the concepts shows which concepts are concentrated and clustered in the studies on agility.

A-1994-2003 Period

A review of the network analysis visual (Figure 1) for the period 1994-2003 reveals that the primary concepts are those of agile manufacturing and agile production. These are embedded within 14 clusters, which collectively encompass 78 concepts. In Cluster 1, the concepts of agility, measurement, competence, capability, collaboration, fuzzy logic, global competitiveness and virtual entrepreneur are found to be interrelated. This situation demonstrates that agility is regarded as a capability. A review of the literature on agility reveals that definitions of this term treat agility as either a capability or a capacity, or indeed both (Singh et al., 2013). Cluster-2 encompassed the following domains: agile manufacturing, benchmarking, flexibility, global market, manufacturing strategy, organizational development

and performance measurement. In this cluster, manufacturing-based agility is considered in conjunction with the growth of the organization. In the literature section of this study, it was pointed out that agility became widespread in the manufacturing sector in the early periods and it is seen that this situation is reflected in the first period studies. Agile manufacturing is a common methodology in these studies, as shown by Sharifi and Zhang (2001).

Figure-1: Co-Word Network Visualization for the Period 1994-2003

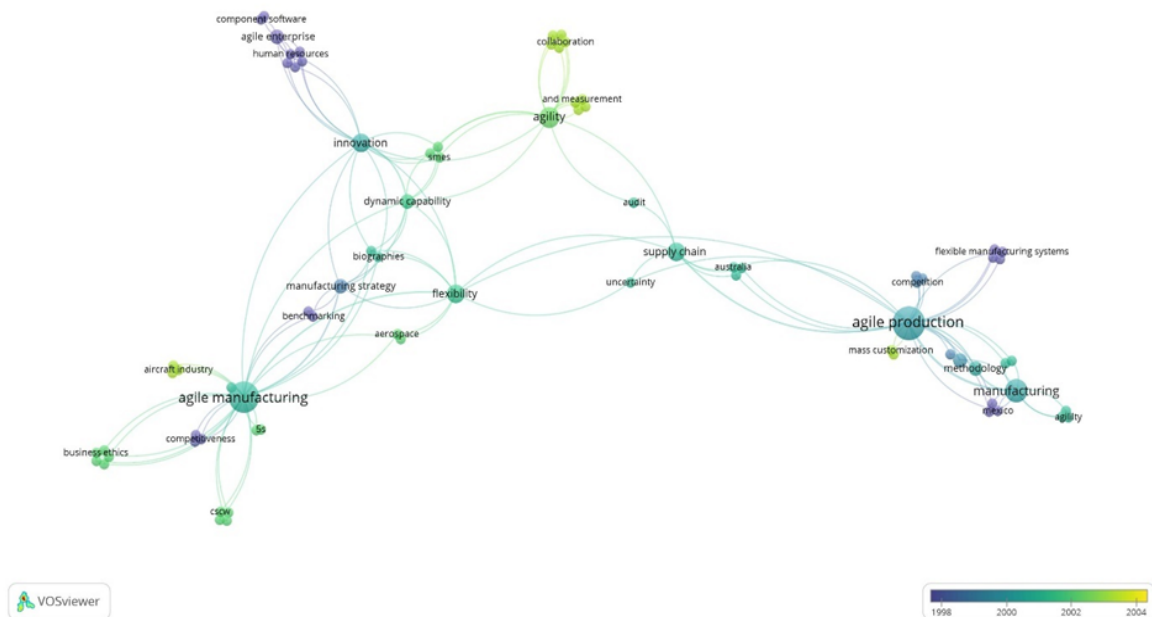


Cluster 3 is characterised by agility, cost, IT, manufacturing, organizational structure and process control. Cluster 4 is about agile enterprise, content software, human resources, knowledge sharing, innovation, organizational models and virtual businesses. Cluster 5 encompasses audit, case analysis, response flexibility, supply chain management and uncertainty. In cluster 6, agile production, manufacturing engineering, mass customization, method, organizational change, strategic planning are concepts related to agility through production processes. Cluster 7 comprised business ethics, environmental law, environmental protection, flexible manufacturing and lean manufacturing. Cluster 8 encompasses the notions of continuous development, dynamic capabilities and organizational development. The commonality among the aforementioned clusters is the incorporation of production-oriented concepts and the centrality of organizational structure for agility in production. From an organizational perspective, agility characteristics are mentioned globally and it is emphasized that the elements associated with agility are based on organizational behavior theory (Sherehiy

et al., 2007). Consequently, in the pursuit of agility, attention is frequently directed towards the internal elements of the organization, including the role of employees (Sherehiy et al., 2007), process management (Artun, 2021) and the flexibility of production (Yusuf et al., 1999).

Cluster 9 decision support, neural network, production design; Cluster 10 flexible manufacturing systems, history, mass production, paradigms; Cluster 11 aircraft industry, economic development, international technology transfer; Cluster 12 competitiveness, virtual company, win-win agreements; Cluster 13 competitiveness, operations strategy, resources. The formation of disparate concepts into small clusters during this period demonstrates that the initial phase of the agility literature was largely influenced by the production axis. Cluster 14 is related to the concepts of 5S and total productive maintenance and shows that agility is considered in connection with Total Quality Management. In examining the concepts associated with the aforementioned clusters, it can be posited that the role of agility in conferring competitive advantage is being elucidated through its interconnections with manufacturing, production, organizational structure and TQM on the production axis. It is seen that studies on agile manufacturing and agile production are concentrated between 1998-2000, and then there are small concentrations on different concepts between 2000-2003. Since the 2000s, there has been a notable increase in the number of studies conducted in this field.

Figure 2: Visualization of the Historical Layering for the Period 1994-2003

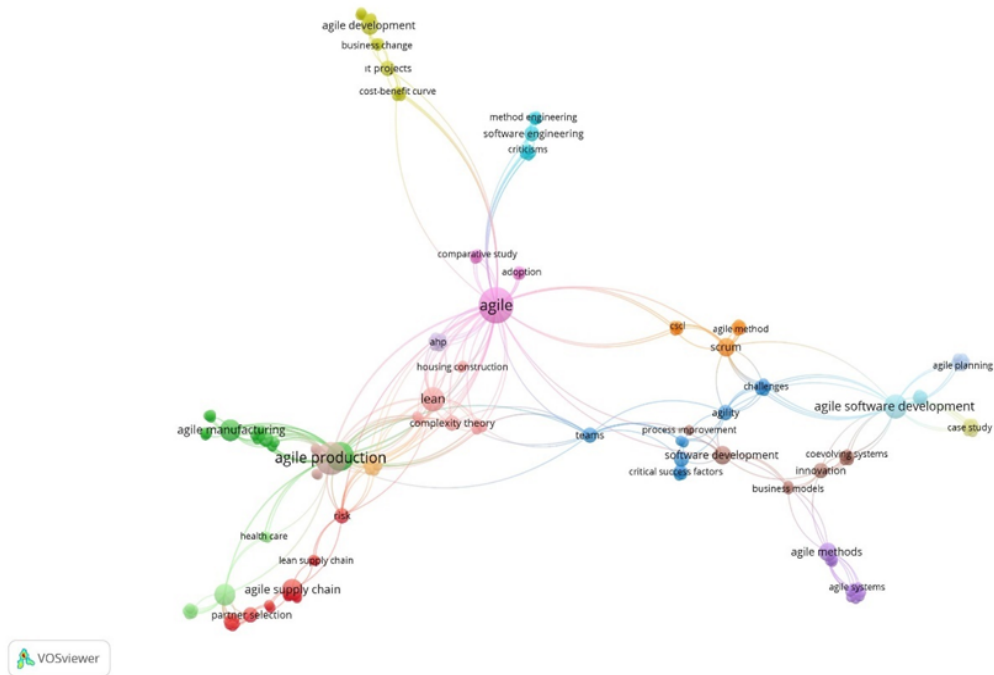


An examination of the time-based visualization (Figure 2) reveals a correlation between the concepts of innovation, dynamic capabilities and flexibility and the principles of agile manufacturing. Conversely, the concepts of supply chain, uncertainty and flexibility appear to be more closely associated with the tenets of agile production. It can be observed that the concept of flexibility serves to establish a connection between the principles of agile manufacturing and agile production. In addition, it is seen in Figure-2 that the concept of agility was first focused on software, human resources and agile companies and then evolved towards flexible manufacturing systems, content software, benchmarking agile manufacturing and agile production respectively. Afterwards, it is noteworthy that in the agile production cluster, while the transition towards customer-oriented production is made, the concepts of measurement and cooperation are on the agenda in the agility cluster. As it is understood from here, while the concept of agility created its own field based on production, after 2000s the measurement of agility started to be emphasized.

B-2004-2013 Period

In this period, it can be said that the concepts in the clusters are closer to each other compared to the previous period. This is due to the fact that, during this period, a certain level of knowledge has been reached with regard to the methodology and literature of agility research, with a greater focus on the interconnections between concepts. A review of the network analysis visual (Figure 3) for this period reveals that the primary concepts are agility, agile manufacturing and agile production, with 169 concepts included in 17 clusters.

Figure-3: Co-Word Network Visualization for the Period 2004-2013



Cluster 1 can be called agile supply chain and is a cluster of concepts based on management model and systems thinking. This cluster includes 17 concepts such as agile supply chains, artificial neural networks, decision making, dempster-shafer theory for reasoning with uncertainty, dynamic feedback model, evaluation system, fuzzy comprehensive evaluation, lean supply chain, literature review, partner selection, risk, supplier selection, supplier evaluation and supply chain risk management. These concepts constitute the elements required for the creation of an agile supply chain and show that the interaction between the links in the agile supply chain is considered. At this point, the combination of agility and supply chain indicates that they jointly share the agenda of achieving competitive advantage. It is already established in the literature that businesses engage in competition as supply chains (Christopher, 2000).

The second cluster, which may be designated the "agile manufacturing cluster," encompasses 16 concepts, including agile manufacturing, full-time systems, lean manufacturing, lean production, Lagrangian heuristic, learning organizations, manufacturing management, multi-stage technique, operations and production, organizational strategy, organizational performance, organizational structure, R&D programmes, research and development, structural equation modeling, and supply chain network design. In the previous period, there was an agile manufacturing cluster, but it is seen that the intensity of studies on this concept has decreased in this period. In contrast to the preceding period, the concepts

associated with agile manufacturing have diversified, and it is evident that lean thinking is also a prominent feature, with the exception of organizational results. When the concepts are considered together, it can be stated that there is a relationship between agile manufacturing and lean thinking. Furthermore, the strategy, organizational structure and performance are evaluated for operationally agile manufacturing. While leanness may be a component of agility in certain scenarios, it is imperative to refrain from equating agility with leanness (Christopher, 2000).

Cluster 3 may be associated with the concept of agility and includes 15 underlying concepts: Agile methods, agility, challenges, control theory, critical success factors, iterativity, management system, project teams, requirements uncertainty, rational unified processing, scrum method, software project management, success enablers, teams, traditional management concepts. These concepts show that agility is considered team-based and associated with challenges that can enable optimization in the face of uncertainty. Cluster 4 refers to agile development. The cluster included the concepts of adaptive construction theory, agile development, ambidexterity, business change, cost-benefit curve, distributed development, governance, IT funding, IT projects, bid analysis, qualitative case analysis, roc curve, waterfall and request for proposal. It can be said that agile development depends on the ability to carry out progress both on the IT side and on the production side with a cost-indexed balance, and this is theorized with ambidexterity. Ragazou et al. (2022) also stated in their findings that agility offers a new business model with ambidexterity and open innovation capabilities. Moreover, agile development is not monolithic (Ashrafi et al., 2005) and may involve conflicting capabilities (Lee and Xia, 2010). It is notable that the cluster encompasses equilibrium-oriented concepts, such as the cost-benefit curve and adaptive structure. In addition, in the existing agility literature, agility can be evaluated through the combination of various capabilities corresponding to different dimensions. In the literature section of this study, it is stated that agility can also be defined as a combination of capabilities (Shin et al., 2015). In light of the conflicting capabilities highlighted by Lee and Xia (2010), agility may exert opposing influences on organizational outcomes in the short and long term. Although it is concluded that it supports innovation in the long term, it may have a negative impact on productivity or performance in the short term. Although it is argued that these negative effects may be due to the environmental perceptions of decision makers in enterprises and sectoral differences (see Artun, 2023), Lee and Xia (2010) maintain that different effects of agility are not an acceptable issue. While Lee and Xia (2010) posit that agility is a desirable phenomenon,

Artun (2023) asserts that it is context-dependent. This lack of acceptance may be related to the tendency to ignore the negative effects, as well as the failure to address the impact of agility in different names, contexts, and on non-financial performance. There are already studies indicating that agility should be handled on the basis of contingency theory (Darvishmotevali et al., 2020; Sherehiy et al., 2007).

Cluster 5 encompasses a range of concepts related to agile methods, including agile project management, agile systems, mental shortcuts, comfort with change, habit, information systems time, innovative products, bias-based omissions, personal innovativeness, product development process, status quo bias, and the composite theory of technology acceptance and utilization. The sixth cluster encompasses a range of software-related disciplines, including agile methodology, critique, development, evaluation, method engineering, principles, software engineering, and web development. Cluster 7 can be called agile methodology. In this cluster, computer supported collaborative learning (cscl), experiential learning, iterative development, key performance indicator (KPI), marketing performance, marketing systems, project management, scrum, agile knowledge management software (wikis) were included. Concepts related to organizational outputs were frequently included in the cluster and it is seen that learning is considered as an agile method in this cluster. In the literature, it was put forward by Artun (2021) that agility can be defined through learning. While agility was associated with flexibility in the development periods of literature and the main feature was stated to be flexibility in production systems (Christopher, 2000), the feature of fast learning has also been added to the present day (Artun, 2021). The evolution of agility to include different concepts or characteristics in this way is related to the process of building its core values, supported by practice-based arguments as stated by Lee and Xia (2010). The term 'rapid learning' is used to describe a learning process that is able to respond rapidly to customer needs by developing new technologies (Nugroho et al., 2022).

It can be posited that the concepts of business models, co-evolving systems, complex adaptive systems, innovation, and mindfulness, the theory of gainful practice, process development, rhythm, software development, and time progression are associated with the establishment of agility in the way of thinking, particularly within cluster 8. Cluster 9 demonstrates that the concepts of adaptation, agility, comparative study, measurement, organizational culture, small software companies, web applications and research teams are collectively aligned with the utilization of agility applications for small businesses. The extant literature on the organizational characteristics of agility tends to focus on organizational culture.

Figure 4 illustrates that the concepts of agile, agile production and agile software development are closely interrelated during this period. It can be observed that the concepts associated with the terms 'agile' and 'agile production' experienced a notable increase in prevalence during the year 2012. It is noteworthy that the concepts related to the agile software development phrase started before 2010. The number of studies on agile method, scrum, complexity theory, leanness, agile production concepts, which are on the agility agenda in the recent period, increased between 2011 and 2012.

C-2014-2023 Period

The most prominent clusters in the 2014-2023 period are project management, agile, agility, agile supply management, agile project management, digital transformation, leanness, resilience, digitalization and software development. Cluster 1 contains 45 concepts and can be considered as an agile manufacturing cluster. The concepts in this cluster exhibited considerable diversity. Firstly, the inclusion of modern approaches shows that agility is related to current approaches. Second, this cluster also includes concepts related to organizational outcomes. It can be said that the relationship between agility and effectiveness and performance is particularly emphasized. Thirdly, it is seen that the relationship between supply chain and agility is frequently addressed. Furthermore, this period addresses the performance of the supply chain in relation to agility (Braunscheidel and Suresh, 2009; Christopher, 2000). In addition, the agile manifesto has been another prominent concept. It is noteworthy that although the Agile Manifesto was announced in 2001, it gained importance in academic studies at a late stage. The prominence of the Agile Manifesto during this period may be attributed to the growing interest in the concept of agility, which in turn led to a heightened focus on identifying its fundamental principles.

characteristics considered necessary in the process of seeking excellence in quality management, is linked to concepts such as kanban, learning agility and quality in this cluster.

In cluster 5, 30 concepts are clustered and it is seen that they are related to market orientation. There are concepts for rapid response to changing customer demands and the creation of product / service designs based on customer feedback. In the context of various issues such as market orientation and strategic alignment, agility comes to the fore in interpreting organizational responses (Roblek et al., 2022). Consequently, agility can be defined as the speed of reaction or flexibility (Yusuf et al., 1999). However, agility is different from flexibility. Agile production and flexible production are sometimes used in the same sense, but while flexible production is characterized as reactive, agile production is known as proactive (Flumerfelt et al., 2012). Agility definitions include the concept of flexibility within themselves (Ganguly et al., 2009) and flexibility is an internally orientated competence that is a precursor to agility (Braunscheidel and Suresh, 2009). Market orientation is related to the pursuit of environmental change or uncertainty. Therefore, market orientation means sensing the changes and responding to changes in demand, and agility is seen as a solution to environmental uncertainty (Christopher, 2000; Darvishmotevali et al., 2020; Singh et al., 2013).

The 30 concepts in cluster 6 can be divided into those related to adaptation and those related to lean thinking. Firstly, the concepts associated with adaptation can be interpreted as being oriented towards the development of agile capabilities. Secondly, concepts related to lean thinking are oriented towards sustainable development through both the production model, such as design thinking, and the business model, such as lean entrepreneurship. The objective of lean thinking is to eliminate superfluous elements in both the production process and the products or services offered, in order to align with the needs of the customer. In particular, studies on lean supply chain management are continuing (Garcia-Buendia et al., 2022).

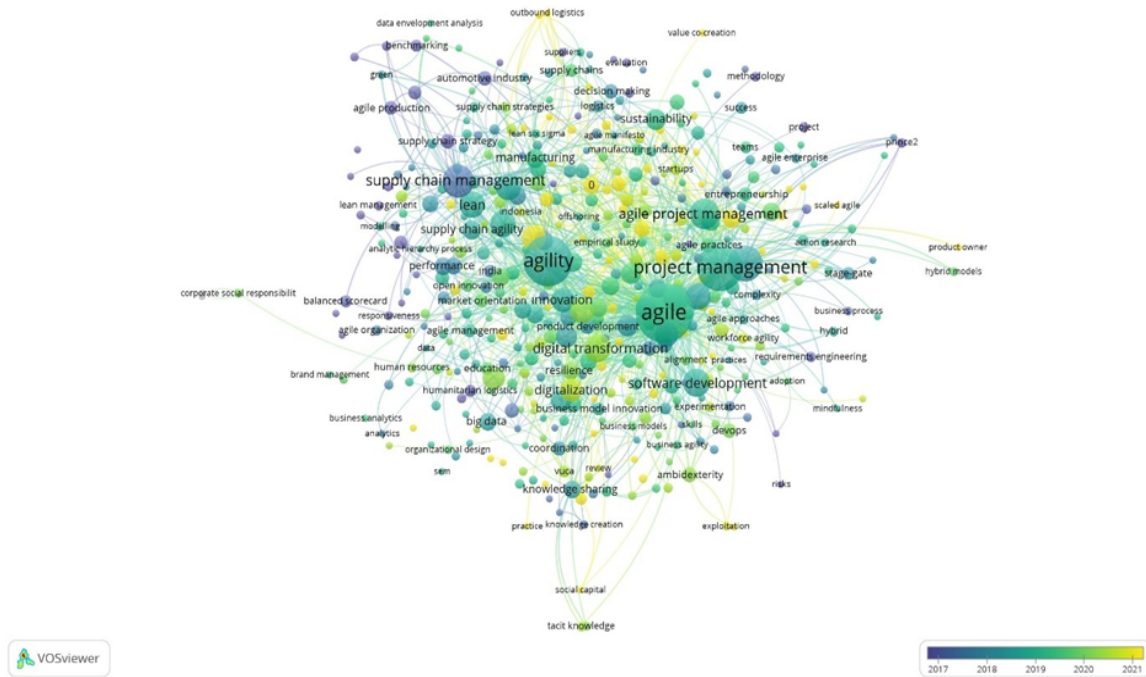
Cluster 7 consists of 28 concepts related to service development. The cluster is characterized by a focus on the human factor, which is identified as a critical resource for service development, and a particular emphasis on the digitalization of services. In cluster 8, agile capabilities and agile leadership stand out among 27 concepts. In cluster 9, the agile organization and related concepts such as employee participation, organizational transformation, talent management, which can be included in organizational results, are dominant. Lee and Xia (2010) point out that although agility development approaches emphasize self-organizing autonomous teams, the empirical evidence supporting this principle is limited and contradictory. Although different characteristics of autonomous teams in terms

of agility are emphasized in the literature, the universally prominent feature is the provision of autonomy to teams (Lee and Xia, 2010). Therefore, the finding of their study shows the need to manage team autonomy and diversity (Lee and Xia, 2010). There are 24 concepts in the 10th cluster. Agile methods, agile practices, agile teams come to the fore. It is seen that these three concepts are handled with sprint, start up and project management. These concepts are related to lean thinking. Given that agility is addressed on a project-by-project basis, it can be asserted that agile methodologies are conducted through digital processes. Furthermore, the incorporation of project and performance concepts indicates that project-based and performance-based assessments have been conducted in studies on agility over time.

The dominant topic in the 11th cluster is flexibility, in the 12th cluster is agile development, in the 13th cluster is agile project management. These three clusters show how agility efforts in new product development are connected. The 15 concepts are grouped together in the 14th cluster. These ones are pertinent to the field of IT sector. The concepts of project governance, risk management, scrum methodology, project management knowledge base demonstrate that agility studies in the IT sector are project-based. The notable expansion of research on IT and agility since the beginning of 2014 may be an indication that this topic has begun to mature within the relevant academic literature and is attracting the attention of an increasing number of researchers (Tomomitsu and Moraes, 2021). However, without appropriate investments in IT, it can hinder agility efforts (Franco et al., 2022).

There are 15 concepts in the 15th cluster and agile management stands out. In addition to facilitating agile management, this cluster encompasses monitoring organizational progress, including tracking results. This situation is related to the handling of agility on a generic basis. It was mentioned above that the generic-based approach is common in the agility literature. According to the generic-based perspective, agility is able to sustain competitive advantage against environmental uncertainty. The common theme here is that agility can often be defined in terms of embracing and responding to change (Lee and Xia, 2010). Thus, agility is generally evaluated in four dimensions created by Sharifi and Zhang (1999): responsiveness, competence, flexibility, speed. Cluster 16 can be labeled as a set of bilateral capabilities. This nomenclature has two aspects and the concepts related to these aspects are included in the cluster. The first is exploit capability, which refers to the utilization of existing capabilities, and the other is explorer capability, which represents the development of new capabilities. In the last three clusters (17, 18 and 19), the concepts of management theory, big data and product ownership were included, showing that agility is studied in different fields.

Figure-6: Visualization of the Historical Layering for the Period 2014-2023



The Figure-6 shows that more recent studies are listed as intermediate studies next to the main clusters. While the figure shows that the main phrases such as agile-agility were formed before 2019, it indicates that new studies started to grow after 2021. The increase in these new studies after 2021 may have been caused by the widespread idea that agility has proven its worth in surviving sudden changes during the global pandemic caused by Covid-19. It is seen that recent studies are largely linked to earlier concepts such as agile, agility, digitalization, project management, supply chain management. This illustrates that the agile literature facilitates both the pursuit of clarity and the autonomy of the field by adding to the previous knowledge.

Discussion

The agility literature exhibits a dynamic structure due to the fact that agility can be defined theoretically within the framework of different disciplines and differences in practice between companies. In order to investigate the phenomena that feed the dynamism in the literature that previous bibliometric studies on agility have not addressed, this study tried to reveal the structure of the development patterns of agility by CWA. The findings obtained within the scope of the study were not compared with the findings of previous bibliometric studies on agility. The reason is that previous studies only addressed the prominent aspects of the literature by using citation, co-author, keywords for bibliometric analysis (Diego and Almodóvar, 2022;

Franco et al., 2022; Nugroho et al., 2022; Pinho et al., 2022; Roblek et al., 2022; Tomomitsu and Moraes, 2021; Uludağ et al., 2022). These bibliometric studies generally focus on the similarity relations between two publications (Garcia-Buendia et al., 2022). This study employs CWA to examine the relationship between bibliographic matching and publications (Hu and Zhang, 2015; Zupic and Čarter, 2015). Thus, in this study, since the dynamics and development of the agility literature were tried to be revealed, the interpretation of the findings obtained was carried out by focusing on the research question.

In the studies conducted in the first decade covering the period between 1994-2003, it is seen that agility is seen as a capability and handled on the basis of the manufacturing sector. Although the studies in this period focus heavily on a single sector type, these studies draw a widespread image by addressing agility with various concepts that seem to be independent of each other. In the second decade between 2004 and 2013, team-based approach to agility, IT, learning, agile methodology come to the fore. In this period, studies on agility continued to deal with its relationship with different concepts, but it can be said that the concepts in the clusters are closer to each other. This is due to the fact that, during this period, a certain level of knowledge has been reached with regard to the methodology and literature of agility research, with a greater focus on the interconnections between concepts. In addition, similar to the previous period, the agile manufacturing cluster continues to exist. However, it is observed that the intensity of studies on this concept decreased in this period. Unlike the previous period, the concepts associated with agile manufacturing have diversified and it is seen that lean thinking is also prominent, except for organizational results. When the concepts are considered together, it can be stated that lean thinking is related to agile manufacturing and strategy. Furthermore, the evaluation of organizational structure and performance is conducted for the purpose of operational agility in manufacturing.

In the studies between 2014-2023, organizational outcomes in agile manufacturing have started to take place more frequently. The most prominent clusters in the 2014-2023 period are project management, agile, agility, agile supply management, agile project management, digital transformation, leanness, resilience, digitalization and software development. In the last ten-year period, in contrast to the preceding two periods, the most frequently mentioned concepts are agile and agility. This situation can be said that the studies in the field of agility are directed to the service sector as well as the manufacturing sector and the concept has expanded towards the real sector. The shift in focus of the literature from manufacturing and production to the generic concepts of agile and agility has resulted in this outcome. This change is a result of

agility being seen as an important approach to gaining competitive advantage against environmental uncertainty (Darvishmotevali et al., 2020; Singh et al., 2013). The process, which initially started with agility being considered as a capability in software development, has opened a different lane with generic-based efforts to maintain competitive advantage against environmental uncertainty. Recent bibliometric studies on agility indicate that the field is shaped on the basis of two different perspectives (Shin et al., 2015; Singh et al., 2013). Shin et al. (2015) mention two features of the agility literature. The first is a generic view of agility. This perspective specifies the basic components or characteristics required for agility. Secondly, agility constitutes an integrated form of practice, founded upon a multitude of capabilities. Singh et al. (2013) state that these efforts form the basis of the agility literature. In addition to the disparate elements of the three historical periods under examination, the study also encompassed a number of shared concepts.

According to the findings, the listed concepts were able to take place in different clusters by showing a permeable feature between clusters. The fact that the concept of agility is handled in different fields, its relationship with various concepts and the ongoing research of its impact on organizational results may have caused the concepts related to agility to show permeability between clusters. The appearance of similar concepts following the principal concepts in the three periods indicates that the impact of the principal concepts on organizational outcomes was examined. The examination of organizational outcomes aims for greater clarity. Because organizational results are related to whether the goals of the organization are achieved or not, and agility does not make sense when it does not support organizational goals (Asharifi et al., 2005). In addition, the literature discusses various metrics applicable to both manufacturing and service sectors (Ganguly et al., 2009). Secondly, the permeability of various concepts demonstrates that agility is regarded as a pivotal concept. The existence of studies examining both the agility of enterprises and the agility of supply chains indicates the importance of this key concept.

Conclusion

After the periodic differences of the results revealed by the findings of this study, an evaluation of the agility literature can be made by focusing on the key concept role mentioned above to support the findings of other studies in the literature. Because the way the concept of agility is handled determines the framework of the studies and shapes the differences and similarities with other studies. Therefore, based on the findings of this study, five points can be stated for the changing pattern structure of the agility literature over time.

Firstly, it has been observed that various conceptual features related to agility are reflected in the literature. This is because there is no typology or theory about agility that is agreed upon both theoretically and practically (Singh et al., 2013), so the characteristics specified in agility definitions are utilized. Although its source is mostly considered as digital products, software and technological content, agility is mostly defined through certain characteristics (Cicerali, 2019). Therefore, it is tried to determine the changes in agility definitions over time and the common points formed by adhering to the literature. It is seen that agility has different definitions at different times and has developed over time (Kumkale, 2016). Therefore, there is no homogenous view of agility in the agility-related literature and furthermore, the search for clarification has shaped the development of the literature (Ambrose and Morello, 2004). It is seen that the common concepts related to agility in the time stratification maps in the three periods are firstly software, human resources and agile companies, then agile, agile production, transition to agile software and finally agile-agility concepts constitute the main clusters.

Secondly, an examination of the findings of the study reveals a notable increase in the number and variety of concepts to which agility is seen to be linked across the three periods. The investigation of the connections between these diverse concepts with agility, initiated from the aforementioned agility characteristics, may have resulted in the observed diversity of concepts and phrases in the study findings. Given the dynamism inherent in agility (Singh et al., 2013), the concepts associated with it have evolved over time. Consequently, the process of developing a body of knowledge in this field entails building upon the insights gleaned from prior research. As the knowledge of these concepts matures, breaks are experienced. Depending on these breaks, sub-layers of agility literature (such as agile production, strategic agility, agile manufacturing) are formed and as a result, agility has been able to form an independent literature. The recent network visualization (Figure-5) points to this. This illustrates that agile literature facilitates both the pursuit of clarity and the autonomy of the field by articulating prior knowledge. In addition, it has been observed that agility is associated with current issues such as knowledge management, innovation and digitalization in the literature. In addition, it can be stated that agility is associated with current new approaches such as flexibility, dynamic capabilities, leanness, resilience, and that agility is addressed together with changing paradigms in maintaining competitive advantage. However, these concepts are frequently conflated with agility. In order to avoid confusing agility with such environment-based approaches (Singh et al., 2013), the focus is on how agility can be structured in organizations (Artun, 2021; Lee and Xia, 2010).

Thirdly, it is observed that the existence of the various concepts mentioned above is located in different clusters in different periods. In other words, the observation that the same concepts are situated in disparate clusters across three distinct periods indicates that their associations with agility are addressed in disparate ways across different studies. The reason for this difference is that different links can be established between these various concepts in the analyzed studies and that they have different weights depending on the number of studies in each period. Furthermore, permeability exists between different periods. The reason is that the weighting of concepts in the literature is addressed by CWA. In addition, agility is conceptually named differently and forms different phrases in each period. As seen in the findings of the study, there is no common concept usage in the literature. The appearance of phrases and clusters such as "agile," "agility," "organizational agility," and "manufacturing agility" in all three periods is indicative of this issue. The relative importance of such uses may vary across the three periods, and different concepts may be considered together with agility in different periods. For example, while the agile manufacturing cluster had a larger volume in the period 1994-2003, there is a decrease in its volume in the period 2004-2013.

Fourthly, agility is addressed at various levels (individual, organizational, supply chain, etc.) with differing definitions and measurement criteria, making the literature on it complex. Because there is no single agile organizations design on both academic and sectoral basis (Ambrose and Morello, 2004). This situation is founded upon the contingency theory, as evidenced by numerous studies on agility (Darvishmotevali et al., 2020; Sherehiy et al., 2007). Thus, instead of a common set of ideas in the agility literature, it is seen that efforts and searches for clarification have shaped the literature. Therefore, a review of the literature on agility reveals that a systematic research program has yet to be established (Singh et al., 2013). The absence of a systematic research program has resulted in an emphasis on clarification efforts. In the absence of a systematic research program, the research findings indicate that efforts to clarify the field have shaped the literature.

Fifth, the relationship between agility and organizational outcomes is present in all three periods. A review of the literature reveals that the role of agility in achieving organizational results is a recurring theme (Darvishmotevali et al., 2020). The extent to which agility affects organizational outcomes is contingent upon temporal considerations, both immediate and extended (Artun, 2023). In particular, the investigation of mediating and moderating effects has started to gain weight. The investigation of agility is typically conducted in relation to organizational outcomes, with a focus on its mediating or moderating effects on the relationship

between the two. The occurrence of concepts denoting organizational outcomes in disparate clusters across all three periods is indicative of this conclusion.

Limitations

While the study offers insights into the development of agility literature, it is not without limitations. It should be noted that the method, database, and the nature of the study are subject to certain limitations. As a first limitation, the findings of this study do not include the concept of agile leadership and strategic agility, which has been frequently emphasized recently. Agile leadership and strategic agility is linked to the concept of agility, but the word strategic agility, leadership or agile leadership was not searched in the WoS database when the findings of this study were obtained. The link between strategic agility, agile and leadership was included separately only in some clusters. Secondly, the study did not provide a detailed examination of the interrelationships between agility and other concepts. These connections could be interpreted through the clusters they formed by coming together. Therefore, the interpretations of these connections also include an intuitive aspect (Hu and Zhang, 2015). Third, the data analyzed within the scope of the study were collected only from the WoS database. Therefore, it is based on a single database. Fourthly, the pattern of the literature on agility was analyzed by going through themes and research topics, and only CWA was used, not co-citation, bibliography matching and co-author analyses (Bağış, 2021). Fifth, given the potential limitations of CWA in clustering smaller niche specializations in the related literature (Zupic and Čarter, 2015), it was assumed that niche areas in agile literature could not be clustered in this study. As previously indicated, the strategic agility and agile leadership discussed above are indicative of this phenomenon.

The Further Research

As a recommendation for future research, it would be beneficial to investigate the convergence of the agility field. Because both the need for clarity is felt in the agility literature and the agility field follows the changing paradigms in the field of management and organization. Despite the difference between them, the fact that agility is mentioned together with concepts such as dynamic capabilities, resilience, flexibility and leanness is due to their environmental orientation. Therefore, it has been observed in the findings of these studies that their relations with these concepts are subject to academic discussion. These concepts have formed important clusters in the agility literature. Whether it will converge with these concepts will be an important research question. Because competition is becoming increasingly intense and it makes businesses think about multi-capability strategies. A significant point of contention

is the concept of "leangile," which is a combination of the terms "lean" and "agile." As a second suggestion, a CWA on agility based on different databases can be performed and compared with the findings of this study. Third, bibliometric studies can be carried out on different nomenclatures or sub-categories of agility. Bibliometric studies on these sub-categories or different nomenclatures will allow us to consider the difference between product-based and project-based study of agility. Thus, it is thought that it can provide important findings regarding agility.

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