# Analyzing and Extending Research Phenomena in Supply Chain Management to Advance Scientific Impact – An Extensive Bibliometric Analysis

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## Abstract

*The discipline of Supply Chain Management (SCM) has undergone several disruptions in recent years. In 2021, Wieland wrote a seminal article on transformative SCM and proposed three levels for describing and advancing the discipline. However, the author states their insufficiency and the need for an extension. Therefore, the purpose of this study is to identify the phenomena that affect SCM and to extend the levels. In doing so, we help to identify a research framework and to advance the impact of SCM research. We examined all articles from 1976 to 2022 that contained "supply chain*" in title, abstract, or keywords. A co-occurrence analysis of the publications revealed seven main phenomena to be regarded in the SCM context. Further, we revealed research implications for each cluster and derived additional levels for describing and advancing SCM research. In sum, our findings extend existing research and provide valuable insights into the SCM discipline.*

**Keywords:** Supply Chain Management, Panarchy Theory, Research Phenomena, Bibliometric Analysis, VOSviewer.

## 1. Introduction

The field of Supply Chain Management (SCM) has traditionally relied on borrowed, reductionist, and static theories (Richey et al., 2022; Wieland, 2021). As a result, many supply chains (SC) are operated without considering their wider environment. This viewpoint disregards the fact that supply chains have become both fragile and vulnerable systems. In addition, supply chains have faced major disruptions and experienced several changes in the past few years (Centobelli et al., 2018; Flynn et al., 2021; Richey et al., 2022). That is, events like the Covid-19 pandemic have upended existing supply chains (Sodhi & Tang, 2021; Wieland, 2021). Further, alongside emerging discussions on digitalization along the SC, the social relevance and impact of SCM is increasingly coming into focus (Schniederjans et al., 2020; Bubicz et al., 2019; Wieland, 2021). Particularly in the last few years, there has been a significant increase in the amount of research into sustainability and circular economy (Angelis et al., 2018; Bubicz et al., 2019; Centobelli et al., 2018; Liu et al., 2022), as well as an intensification of the efforts of practitioners to improve their environmental footprint. Therefore, SCM necessitates a dynamic perspective that considers the broader contextual environment.

In this sense, Wieland (2021) recommends moving away from a static view and design of SCM to a dynamic and interconnected consideration of SCM that embraces the environment as well as interrelations between SC actors and phenomena and can adapt to newly evolving circumstances. Drawing on panarchy theory (Gunderson & Holling, 2001), a new understanding of SCM is developed (Wieland, 2021) which applies the idea of levels and adaptive cycles (Holling 1968; 2001) to SCM research. According to panarchy theory, SC can be embedded in a dynamic structure that consists of three levels, which are interconnected (Wieland, 2021): (1) Supply Chain Level, (2) Political-Economic Level, and a (3) Planetary Level. However, this theoretical view shows some limitations and insufficiency in the levels when it comes to the study of SCM phenomena (e.g. Allen et al., 2014; Wieland, 2021). Thus, we argue that additional levels must be taken into account to further develop this theoretical perspective for research in SCM.

In our interpretive study (Cornelissen et al., 2021), we aim to address this argument, in order to enrich the three proposed levels and to question the selected panarchy dimensions. Here we further refer to Allen et al. (2014) who state that the number of levels for describing phenomena according to the panarchy theory can vary. These considerations lead us to the following research questions: RQ1: *What phenomena already exist in the academic literature on SCM?* RQ2: *What impetus for future research exists that can help expand the existing levels for describing and analyzing SCM?*

URI: https://hdl.handle.net/10125/106982
978-0-9981331-7-1

Since our first research question is ex-post in nature, we formulated RQ2 to clearly address our research objective.

Therefore, the purpose of our interpretive study is to identify affecting phenomena and to extend the existing levels for an appropriate and holistic consideration of SCM. That is, our study aims to advance the renewed understanding of SCM (Wieland, 2021) and to point out directions or opportunities for further knowledge development (Cornelissen et al., 2021). Therefore, the level of abstraction in our research study is medium to high. To answer the research questions, we performed an extensive search of the entire SCM-literature since the first publications in 1976 and conducted a bibliometric co-occurrence analysis. In sum, 73,439 scientific publications were included in the analysis. In addition, complementing this comprehensive ex-post examination, we further discuss our findings with additional literature to elaborate impetus for future research phenomena in SCM.

We provide the following contributions to academia and our understanding on SCM. First, our findings of the bibliometric analysis reveal seven clusters that represent the main research phenomena on SCM from an ex-post perspective. These are: (1) Supply Chain and Value Creation, (2) Supply Chain Sustainability and Circular Economy, (3) Covid-19, Resilience and Risk Management, (4) Game Theory and Coordination, (5) Logistics and Optimization, (6) Supplier Selection and Sustainable Sourcing, as well as (7) Digitalization. In our consideration, each *cluster* depicts a *main research phenomenon*. We denote each individual item within such a main phenomenon/cluster as a *phenomenon* in the following. In addition, there are *levels* as referred to by Wieland (2021), which can consist of several different *main phenomena*.

Second, we discuss our findings from the bibliometric analysis and elaborate on clusters could be extended by further trends that we have derived. Our analyses led to two additional levels complementing Wieland's (2021) research. We name these levels *digital service level* as well as *sociocultural* level.

## 2. Theoretical Foundations

### 2.1. Supply Chain Management

In the academic literature, there is a plethora of different thoughts on the term "*supply chain management*". Over the past 30 years, a wide variety of approaches to defining SCM has emerged. One of the very first elaborations on SCM goes back to Stevens in 1989. The author describes an effective SC as fundamental for any company and sees the goal of SCM as synchronizing customers' requirements with suppliers' material flow and delivery (Stevens, 1989). Ellram and Cooper in 1990 also choose a rather broad definitional approach, denoting SCM as an approach aimed at managing the entire distribution flow from supplier to customer (Ellram & Cooper, 1990). In 2001, Mentzer et al. published what is to date the most frequently cited definition of SCs. The authors define these as "… *a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a to a customer, (and return).*" (Mentzer et al., 2001, p.4). The point of the *return* loop is also taken up by Christopher, who refers to SCM as the management of *"...upstream and downstream relationships..."* (Christopher, 2016, p.3). What is particularly remarkable in the more recent publications on SCM definitions is the emphasis on network thinking rather than a linear chain. For example, Carter et al. (2015) describe a SC as a network consisting of multiple nodes and edges that does not just refer to one focal actor or product. According to the authors, the success of a SC is determined by how well the actor is aware of the nodes in the process of creating a product or service Carter et al., 2015). Similarly, Stock & Boyer (2009) mention the need to manage a network of relationships between different actors. What is consistent across the various established definitions of SCM are its goals. These can be summarized as the creation of superior customer value, with the lowest possible cost, the matching of the demand side and the supply side, with the least possible inventory in the chain (e.g. Christopher, 2016; Ellram, 1991; Ellram & Cooper, 1990; Stevens, 1989).

However, given the growing instabilities and uncertainty that affect SCs, considerations and initial publications are emerging that reflect the need to rethink the established SCM concept. For example, Christopher & Holweg (2017) state that a mindset shift is required away from static viewpoints on SCM to one that reflects the volatility and uncertainty that influence all aspects of current corporate situations. A seminal article on the reorientation of SCM was authored by Wieland in 2021. In line with Christopher & Holweg (2017), he criticizes a predominantly static and reductionist view of SCs and SCM that does not consider environmental concerns (Wieland, 2021). Since SCM has long been designed for control, rationality, and optimization, there have been little scope and flexibility for dealing with complex challenges and rapid change. Indeed, Wieland (2021) challenges traditional assumptions about SC and stresses the need of reinterpreting the SC as a dynamic construct that is capable of coping with the changing and scarcely predictable business reality. Therefore, it is necessary to create a transformative character of SCs, so that SCM is not perceived in isolation from its

environment. Rather, SCM should be prepared for and able to deal with future challenges and crises. Wieland (2021) summarizes these considerations in the metaphor of "*dancing*", which allows formerly rigid systems to transform and to be perceived as an entity embedded in the environment. In order to realize the needed dynamism, the author suggests adapted and integrated approaches to describe SCM as these can enhance capabilities regarding the management of processes and structures. Specifically, Wieland (2021) draws on the so-called *Panarchy Theory* that was significantly shaped by Gunderson & Holling (2001).

### 2.2. Panarchy Theory

The panarchy theory is rooted in ecology and describes how natural ecosystems adapt to changing environmental conditions as drought or flood over time (Garmestani et al., 2009; Gunderson & Holling, 2001; Holling, 2001). A panarchy describes how socio-ecological systems can evolve and experiment while being protected from destabilizing developments (Holling, 2001). Through the focus on socio-ecological systems, not only the evolution of natural phenomena is considered in the theory, but also their interaction with humans (Allen et al, 2014). Thus, panarchy theory can be understood as a model that dynamically organizes complex systems of humans and nature across temporal and spatial dimensions (Gunderson & Holling, 2001). A central claim of the theory is that dynamic forces of complex natural and social systems can only be successfully harnessed if their management is active and adaptive, turning away from stability-seeking optimization efforts (Gunderson & Holling, 2001; Ruhl, 2012).

Another central idea of panarchy theory is the aspect of adaptive cycles, in which the nature and humans are interlinked (Holling, 1986; Holling, 2001). These cycles can be understood as levels with different phases through which a system needs to pass, when intending to change (Holling, 1986). The levels are sequential and each level includes the four aspects of growth, conservation, release and reorganization (Holling, 1986). While the higher levels are described as slower, larger and inert, the lower innovation cycles are faster and smaller (Holling, 2001). A panarchy differs from traditional hierarchies in that it provides a framework that describes the complex systems of nature and humans across all levels in a dynamically structured way (Allen et al., 2014).

The dissemination of the theory in the management literature has been scarce (Wieland, 2021). Wieland (2021) draws on this gap and transfers the panarchial idea of adaptive cycles with its different levels to the SCM research field. According to panarchy theory, Wieland (2021) conceptualizes the SC as being embedded in a structure that consists of three interconnected levels: A (1) Supply Chain Level that depicts the adaptive cycles of the individual product SC, a (2) Political-Economic Level that considers questions regarding globalization and growth versus regionalization, and a (3) Planetary Level that takes considerations concerning the design of sustainable SCs into account (Wieland, 2021). Since panarchy theory recognizes the need of systems to adapt, it stands out for application in the SCM context.

The levels provide a framework for our study, illustrating which phenomena should initially be considered in transformative SCM. Our study aims to expand upon these three levels. Based on the findings of our bibliometric analysis and a comparison with the levels, we therefore propose a content-based extension.

## 3. Research Design and Methodology

In order to identify the main phenomena affecting SCM and therefore to answer RQ1, we conducted a bibliometric analysis. This method provides a tool for analyzing the results of several years of research (Merigó & Yang, 2017; Moral-Muñoz et al., 2020). The advantage of a bibliometric analysis lies in its capacity to provide comprehensive information on a distinct research field (He et al., 2022; Wang et al., 2017) and to process large volumes of scientific data (Donthu et al., 2021). This allows identifying research clusters and main research areas as well as understanding the connections between authors, keywords or journals in their evolvement over time (Waltmann et al., 2010; Wang et al., 2017). Bibliometric analyses are capable to examine the relationships between publications, citations and keywords (He et al. 2022). Furthermore, a bibliometric analysis allows for objective identification of relevant literature without biased expert selection of publications (Ali & Gölgeci, 2019; Wang et al., 2017).

We followed the insights of Ali & Gölgeci (2019), Wang et al. (2017), and van Eck & Waltman (2010). We used VOSviewer as a software tool because of its conclusive visualization capabilities of bibliometric networks (Ali & Gölgeci, 2019; van Eck & Waltman, 2010). In particular, VOSviewer is characterized by its ability to handle very large datasets from different sources (Moral-Muñoz et al., 2020). We conducted a co-occurrence analysis that examines connections and similarities between keywords (Ali & Gölgeci, 2019; van Eck & Waltman, 2010). By considering the number of co-occurrences and calculating the Euclidian distance, the software is able to cluster related keywords (Ali & Gölgeci, 2019). That results in a comprehensive overview of clusters that depict the distinct research phenomena influencing SCM.

This bibliometric analysis is based on an extensive search of SCM literature in the Scopus database, one of the major and leading sources for scientific articles (Calatayud et al., 2019). Since the aim of this analysis is to obtain a holistic overview of the research area, the entire literature on SCM will be covered. Therefore, the following search term was applied: *TITLE-ABS-KEY ( "supply chain management" OR "supply chain*") AND DOCTYPE ( "ar" ) AND ( LIMIT-TO ( LANGUAGE,"English" ) ).*

Our search of the term in the Title, Keywords, and Abstract fields, considering the inclusion criteria *articles* written in *English*, resulted in 73,439 papers. As the search period was not restricted, we examined all articles, covering the entire range of publications from 1976 to the end of 2022 until we stopped collecting data.

Based on these 73,439 results, we then conducted an analysis using VOSviewer for carrying out network analyses algorithmically and objectively (Ali & Gölgeci, 2019). For the sake of clarity, not all keywords from the total amount of publications were included in the analysis. The VOSviewer software includes the function for setting thresholds regarding the minimum number of occurrences of a keyword. For ensuring significance of the content of the keyword, we considered all keywords of the 73,439 articles that occur at least twice. Furthermore, among all the keywords that were included twice or more, we selected the 500 terms that appeared the most. Before applying these settings for the final analysis, we conducted several tests with different thresholds of minimum occurrences and various amounts of considered keywords. Through this analysis, we found out that the number of clusters and their most frequently appearing keywords have not changed much. Therefore, we assumed that with the setting 2/500 we have identified the main clusters and keywords. Under these conditions, the co-occurrence analysis of the keywords of the papers allowed us to uncover seven main SCM-related phenomena.

## 4. Descriptive Results

In sum, the publications originated from 49 different conferences and 7,005 distinct journals. Table 1 shows the 10 journals that contain the highest number of individual contributions as well as their ranking according to the Academic Journal Guide. The journal with the most publications (1,921 single articles) is the *Journal of International Production Economics*, followed by *Sustainability* (1,896) and the *Journal of Cleaner Production* (1,784). The table further shows, that the TOP 10 journals are highly ranked, with 4 or 3 being the best ranking according to the ABS journal guide. An overview of the top 20 journals and all journals considered is available in the online appendix: https://figshare.com/s/fd35198ae0f54e43c344.

Calculating the cumulative proportion of articles published in the 10 journals in relation to the 73,439 papers, it becomes apparent that nearly 17% of the papers come from the TOP 10 journals. Approximately 25% of the studies included in the analysis come from the 20 most frequent journals.

**Table 1: Top 10 Journals sorted by the highest number of individual articles**

| Journal Name | Number of Publications | Ranking ABS |
|---|---|---|
| International Journal of Production Economics | 1,921 | 3 |
| Sustainability | 1,896 | n.a. |
| Journal of Cleaner Production | 1,784 | 2 |
| International Journal of Production Research | 1,593 | 3 |
| International Journal of Supply Chain Management | 1,395 | n.a. |
| European Journal of Operational Research | 1,228 | 4 |
| Computers and Industrial Engineering | 1,052 | 2 |
| Supply Chain Management | 691 | 3 |
| Annals of Operations Research | 594 | 3 |
| Transportation Research Part E: Logistics and Transportation Review | 556 | 3 |

An analysis of the publication dates of the articles, as displayed in Figure 1, shows a significant increase of SCM research from the 2000s onward. Especially in the past ten years, at least 3,000 articles were published per year, evolving to around 8,000 in 2021 and to the so-far maximum of almost 10,000 in 2022. Based on this exponential growth, an increased interest of academia into this research field can be concluded.

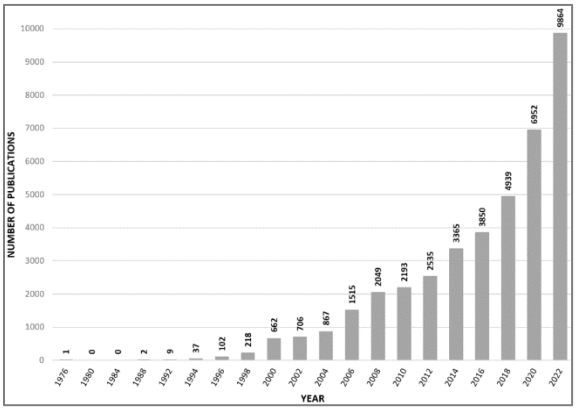


**Figure 1: Yearly distribution of publications.**

## 5. Results of the Bibliometric Analysis

Performing the co-occurrence analysis resulted in seven major clusters that represent the main research phenomena in the SCM discipline. Figure 2 presents an overview of the clusters (see online appendix for higher

resolution). An analysis including the main articles per cluster revealed the following findings: cluster 1 (red color) depicts elaborations on *Value Creation Management* within a SC; cluster 2 (green color) addresses the phenomena of *Sustainability and Circular Economy*; cluster 3 (light blue color) uncovers *Covid-19, Resilience and Risk Management*; cluster 4 (purple color) points out *Game Theory and Coordination*; cluster 5 (dark blue color) focuses on *Logistics and Optimization* topics; cluster 6 (yellow color) ascertains *Supplier Selection and Sustainable Sourcing*; and cluster 7 (orange color) elaborates on *Digitalization*. In addition, The online appendix shows the TOP 5 keywords that occur most frequently per cluster.

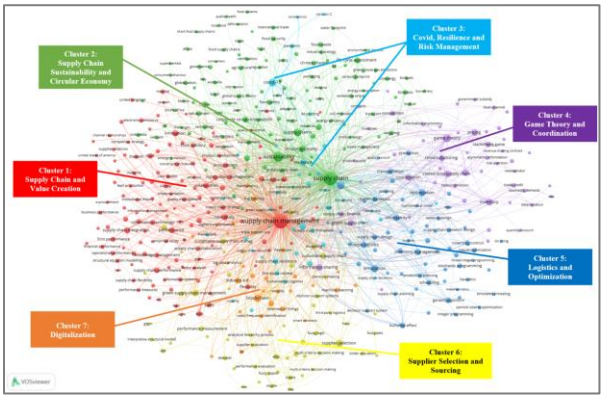


**Figure 2: Bibliographic map with 7 clusters**

**Cluster 1: Supply Chain and Value Creation.** The first cluster includes in sum 134 different keywords and depicts rather management-oriented aspects on SCM. The most frequent key terms that determine this cluster are supply chain integration, performance, collaboration, trust and innovation. A detailed look into the cluster further reveals basic SC concepts and relevant SC capacities like responsiveness, flexibility or agility. Key theories in the SCM discipline such as the Resource-Based View and Dynamic Capabilities also appear in this cluster. The cluster shows that SCM relies on these basic concepts and strategic considerations like performance, integration or collaboration questions for an effective management of the value chain.

**Cluster 2: Supply Chain Sustainability and Circular Economy.** Cluster 2 displays the phenomenon of sustainability and circular economy, two recent developments that are heavily influencing SCM. As it can be seen in figure 2, the nodes of these both keywords are –besides supply chain management and supply chain– relatively big what shows their frequent occurrence in current research. This can also be seen in Table 1 that depicts the journals containing the most articles. The journal Sustainability and the Journal of Cleaner Production contain the second- and third-most articles in the entire research area. Further considerations in this thematic area with in sum 124 key terms include the importance of *corporate social responsibility* as well as an adequate *governance*. The occurrence of terms like *climate change, life-cycle assessment* and *greenhouse emissions* in the cluster show the need and the relevance of these topics also in a SCM context. In sum, this cluster demonstrates the importance of sustainable and circularly designed SCs to address the arising environmental challenges.

**Cluster 3: Covid, Resilience and Risk Management.** Another phenomenon that is influencing SCM, is the Covid-19 pandemic that has kept the world and SCs respectively in a tight hold. From one moment to the next, country borders were closed and cities and ports were locked down, causing a collapse in production, transport routes and available employees. These phenomena and their impact on SCM are expressed in cluster 3 that comprises 41 keywords. As such, besides *covid-19* other frequent key words are *(SC) resilience*, *risk management* as well as *supply chain disruption*. In sum, this cluster shows the emergence of a global crisis craving for the need of resilient and *robust* SCs and adequate risk management processes in order to deal with the disruptions.

**Cluster 4: Game Theory and Coordination.** The co-occurrence analysis revealed a research focus on game theory and coordination that includes in sum 52 items. This cluster also includes competition and the Stackelberg game. This shows that existing research in this cluster has focused on interactions in SCs and possible strategies of SC actors. Such findings can help to develop efficient and effective strategies for SCM. Specifically, the cluster further emphasizes topics related to pricing, incentives, contracts, or vendor-managed inventory. These topics substantially advance research toward game-theoretic approaches, coordination, and interactions in SCM."

**Cluster 5: Logistics and Optimization.** The fifth cluster expounds 62 keywords and summarizes research on the topic of logistics and optimization. Regarding the keywords that occur here, such as reverse logistics or inventory management, it becomes apparent that this cluster is focused on established concepts and techniques that keep SCs alive. Terms as production planning and bullwhip effect emphasize the need of SC managers for planning efforts in order to realize efficient operations. The keywords simulation, uncertainty and supply chain design indicate the necessity for permanent optimization of daily tasks and therefore the direct SC in order to be prepared for exceptions or disruptive shocks.

**Cluster 6: Supplier Selection and Sourcing.** A further emerging phenomenon affecting SCM lies in the supplier selection according to predefined criteria. This

is intended in order to realize sustainable sourcing as well as the overarching goal of green and sustainable supply chain management. This cluster with its 55 items is clearly related to cluster 2 that focuses sustainability questions. Customers are increasingly requiring companies to report on their sustainability efforts along the entire SC. This is why organizations increasingly demand sustainability reports from their suppliers and even select the providers according to their life cycle assessments. In order to evaluate suppliers' efforts for an adequate performance measurement, decision support systems and data envelopment analyses are applied. In summary, this cluster deals with companies' efforts on realizing a sustainable SC involving all actors.

**Cluster 7: Digitalization.** A last cluster and a phenomenon lies in *digitization*, *digital transformation* and *industry 4.0* and herewith in the application of digital technologies in the SC context. As such, this cluster mentions several important innovative technologies such as *blockchain*, *internet of things*, *cloud computing*, *big data* or *radio frequency identification*. Further, the keywords *machine learning*, *artificial intelligence* as well as data mining are displayed, describing significant phenomena for improving SCs and to create a *digital supply chain*. This cluster with its 32 items not only comprises technologies but also their benefits. As such, the key terms *security* and *traceability* as well as *demand forecasting* are mentioned as well. *Digital twins* occur in the cluster in order to drive the idea of a virtualization of the SC. In sum, this cluster contains digital technologies and describes their benefits to be harnessed for creating a *digital supply chain*.

Although the clusters appear separated in Figure 2, there exist interrelationships, which underline the interconnectedness and complexity of the diverse phenomena affecting SCM (see also Wieland 2021). For example, tight connections in the form of edges exist between cluster 2 (Sustainability and Circular Economy) and Cluster 7 (Digitalization). From many of the keywords that display digital technologies, edges are going to terms like "sustainability", "circular economy". This demonstrates not only their common consideration in academia, but also the importance and indispensability of digital technologies for the realization of sustainability. In a similar vein, links also exist between some digital technologies, the keywords *traceability* and *transparency* from cluster 7 and the terms of *sustainability*, *food supply chain* and *food safety* from cluster 2. This further underlines the impact of digitalization on sustainability and on compliance with legal regulations. Other examples of interrelations include the keywords *circular economy* (Cluster 2), *closed-loop supply chain*, *coordination* and *game theory* (Cluster 4) with *uncertainty*, *reverse logistics* and *robust optimization* (Cluster 5). A last example presented here demonstrates the interrelations between *covid-19*, *disruption*, *resilience* and *risk management* (Cluster 3), *sustainability*, *supply chain*, *public health*, *china*, *global value chains* (Cluster 2) as well as *e-commerce* (Cluster 1) and *blockchain* (Cluster 7).

## 6. Discussion

Our findings reveal in total 7 clusters addressing main phenomena that affect SCM. Cluster 1 addresses the Value Creation Management, including basic concepts, strategic considerations for designing SCs as well as key theories in SCM research. Cluster 2 demonstrates the importance of designing sustainable and circularly SCs to cope with arising environmental challenges. Cluster 3 shows the emergence of a global crisis craving for the need of resilient and robust SCs and adequate risk management processes in order to deal with the disruptions. Cluster 4 includes research toward game-theoretic approaches, coordination, and interactions in SCM. Cluster 5 indicates the relevance of logistic processes as well as the necessity for permanent optimization of daily tasks in order to be prepared for exceptions or disruptive shocks. Cluster 6 summarizes considerations regarding the selection and evaluation of appropriate suppliers. Finally, Cluster 7 depicts the use of digital technologies and describes their benefits to be harnessed for creating a digital SC.

These identified main phenomena can be enriched and deepened by recent studies. As such, regarding the first cluster, further strategic considerations could focus on customer-centricity or personalization as the expectations of customers are increasingly evolving (Pedersen et al., 2020). Organizations will need to adopt demand-driven approaches, leverage customer data and analytics to anticipate needs, and enhance the responsiveness and flexibility of their SCs (Richey et al., 2022). Further, organizations will need to foster collaborative relationships, share information, and co-create value with suppliers, customers, logistics providers, and other stakeholders (Andrews, 2023). This includes exploring new models of collaboration, such as the ecosystem approach (e.g., Papert and Pflaum, 2017; Rong et al., 2015), and data sharing. To be responsive in this context, the dynamic capability theory (Teece et al., 1997) might be an important concept as it provides a theoretical framework able to explain and guide organizations in managing and adapting to dynamic and uncertain environments (Masteika & Čepinskis, 2015). As the theory emphasizes the alignment of goals and resource allocation within SCs, it guides organizations in making decisions about resource allocation or investment priorities. By understanding their core competencies and aligning their capabilities with

objectives, organizations can effectively allocate resources to support their SC strategies (Canhoto et al., 2021; Yeow et al., 2018). Based on the phenomena described in here, this Cluster can be assigned to Wieland's (2021) supply chain level.

Regarding the second cluster, sustainability and circular economy are becoming increasingly influential factors in shaping SCs. For example, efforts regarding green logistics and transportation like the optimization and assessment of transport routes become important. Further important aspects on this topic will be efforts on reduction of waste and carbon emissions, recycling as well as reporting according to upcoming sustainability policies. Here, tracking systems and databases will gain significant importance for measuring the environmental and social impact of firms. Research potential on this cluster can lie in the design and the optimization of circular and closed-loop-SCs, the development of metrics and measurement tools for assessing the sustainability performance using digital technologies (Angelis et al., 2018; Bubicz et al., 2019). In addition, developments towards resource positive supply chains could be vital interest for our planet. Another particularly important aspect are social responsibility and ethical practices in SCs. This can include exploring approaches for ensuring fair labor practices or human rights along the SC and their impact on SC performance and stakeholder relationships. It is important for SCM to generate social impact, regarding fair production environments or the overcoming of the climate crisis together (Toesca, 2022). Additionally, organizations will need to ensure and monitor fair treatment of workers, respect for human rights and adherence to social and environmental standards (Alinaghian, 2023; Kippenberg, 2021). Based on the phenomena described in here, this Cluster can be assigned to Wieland's (2021) planetary level.

Concerning cluster 3, further research on resilience and risk management could include diversifying supplier networks, developing contingency plans and implementing technologies to monitor and mitigate risks effectively. This could involve identifying key performance indicators and developing quantitative and qualitative methods for evaluating and managing both resilience and risk. For this, conducting in-depth case studies and examining best practices of resilient SC across different industries and contexts can provide valuable insights (McKinsey, 2022). Based on the phenomena described, this cluster can be assigned to Wieland's (2021) political-economic level.

Cluster 4 underscores the crucial role of game theory in understanding interactions and strategies within SCM. The prominence of themes such as pricing, incentives, and contracts denotes a nuanced comprehension of how SCM players optimize shared benefits while minimizing risks. As supply chains continue to evolve, there is a pressing need to explore dynamic game-theoretic models that address uncertainties, particularly in digital and globalized environments. Moreover, bridging the gap between theory and real-world SCM practices will be crucial to guarantee practical relevance and impactful strategies.

Cluster 5 highlights the ongoing focus on core logistics principles, emphasizing the continuous requirement for effective supply chain operations. When these foundational elements intersect with terms like "simulation" and "uncertainty", it showcases the evolving and adaptive nature of supply chain strategies to address emerging challenges. The emergence of new disruptions calls for research into adaptive and predictive optimization techniques. There's also an imperative to delve deeper into integrating real-time data analytics, AI, and robotic process automation in logistics, ensuring resilience and agility in the face of unforeseen supply chain disruptions.

Further research in Cluster 6 can focus on green procurement and sustainable supplier management. This includes the exploration of criteria and practices for selecting and evaluating suppliers based on their sustainability performance, realizing ethical and sustainable sourcing. As globalization and trade dynamics are a current phenomenon, companies will need to navigate evolving trade policies, geopolitical tensions, as well as reshoring and regionalization trends. This includes diversifying sourcing and manufacturing locations, building resilience against trade disruptions, and ensuring compliance with changing regulations (Villena & Gioia, 2020; Uthayakumar, 2022). In addition, the existing trend of outsourcing value creation activities should be reconsidered. Extensive outsourcing activities increase the dependence of companies on the business environment and can also affect sustainability, for example through long transport routes.

Regarding Cluster 7, SCs should deal with the rapid advancement of digital technologies. Companies must embrace digital transformation and leveraging technologies such as machine learning or AI. This requires investments in data analytics capabilities. Research could further focus on examining the adoption and implementation of digital technologies, exploring their impact on SC visibility. In a similar vein, research can investigate the impact of these technologies on promoting circular economy practices and sustainable innovation. That is, the realization of a closed-loop SC in different industries or the realization of several closed-loop sub-SCs in one SC could be examined. Also, developing performance measurement frameworks and metrics for assessing the impact of digital technologies on SC performance is an ongoing research area. This includes exploring approaches for

measuring and advancing the responsiveness of SCs (see Richey et al., 2022). The investigation of cybersecurity risks for SCs and governance for data sharing among SC actors is also crucial. A further promising research area lie in SC collaboration, integration, and value creation with the help of digital platforms. These foster connectivity and information sharing between SC actors, improved visibility and enable data-driven decision-making. As they eliminate geographical barriers and enable businesses to connect with suppliers and customers worldwide, these present promising area (Anderson et al., 2022; Berger, 2022; Ellis et al., 2023; Gartner, 2023).

Another phenomenon increasingly influencing SCs could lie in servitization that refers to the transformation of a product-centric business model into a service-oriented one. As companies pursuing servitization shift away from primarily delivering physical products to providing a combination of products and services, the nature of SCs in terms of design, processes and capabilities has to change. It involves aligning the SC to meet service-level agreements, managing service parts and inventory, and developing service-oriented logistics and distribution channels. Regarding value creation, servitization fosters customization and blurs the lines between manufacturing, distribution, and service functions. The SC must be integrated across these domains. Therefore, new capabilities are necessary and need to be acquired. Collaboration and coordination among various stakeholders from the ecosystem become critical for ensuring service delivery. Further, servitization can lead to new revenue streams and business models. By offering services alongside products, companies can generate recurring revenue. This shift requires SCs to adapt to revenue models that are based on service performance, usage, or outcomes rather than solely on product sales. Moreover, research can focus on understanding the unique characteristics and challenges of managing service SCs. This includes exploring the coordination and integration of service activities, resource allocation, service network design, and revenue distribution among supply chain partners. A relevant research area is also exploring the intersection of servitization and digital technologies. This focuses on examining how different technologies enable and enhance service strategies (KPMG, 2021; Porsche Consulting, 2021; Rathmann, 2019; Verhoef, 2021).

Regarding the discussion of our clusters and a comparison with the presented levels in section 2.2, we propose two further levels as possible unit of analysis for transformative SCM. These include on the one hand a *digital service level* that comprises our findings concerning Cluster 7 on the theme of digitalization as this is not reflected in Wieland's (2021) work yet. Further, this level includes the research potential and thoughts towards service SCs as well as digital platforms from the paragraph above. We argue here that digital technologies are the foundation for the realization of service SCs and especially servitization. This level includes analyses whose unit of analysis focuses on technologies such as the use of artificial intelligence in SCM processes. The impact of the use of artificial intelligence on SCM would then be the unit of analysis at the supply chain level. On the other hand, we propose a *sociocultural level* that reflects and encourages the essential societal impact of SC including the elaborations on efforts for climate change, ethical sourcing, and the monitoring of labor conditions and human rights in all cultures along SCs. For example, in the case of regenerative supply chains, a study might consider a triple bottom line framework to evaluate supply chain performance. Here, people analysis fits into the sociocultural level.

## 7. Conclusion

The purpose of this interpretive study (Cornelissen et al., 2021) was to identify the main phenomena affecting SCM and to extend the existing levels for an appropriate and holistic consideration of the research field. Drawing on SCM and the panarchy theory, we intended to advance the scientific impact of SCM. Therefore, we performed an extensive search of the entire SCM-literature since the first publications in 1976 and conducted a bibliometric co-occurrence analysis with 73,439 publications. The findings of the analysis reveal seven clusters that represent the research phenomena on SCM from an ex-post perspective. These are: (1) Supply Chain and Value Creation, (2) Supply Chain Sustainability and Circular Economy, (3) Covid-19, Resilience and Risk Management, (4) Game Theory and Coordination, (5) Logistics and Optimization, (6) Supplier Selection and Sustainable Sourcing, as well as (7) Digitalization. To deepen these clusters, we analyzed additional literature and enriched our findings.

Considering the identified clusters as well as current additional phenomena we propose two new levels, complementing the research of Wieland (2021). These include a digital service level as well as a sociocultural level. As such, there now in sum five levels that describe SCM: a Supply chain level, comprising the phenomena from Clusters 1 and 5, a political-economic level, comprising the phenomena from Cluster 3, a planetary level, comprising the phenomena from cluster 2, a digital service level, comprising the phenomena from Cluster 7 as well as the additional phenomenon of servitization, and finally, a sociocultural level, comprising the phenomena from Clusters 4 and 6.

Our research provides some theoretical contributions. By considering the existing literature on SCM, our results provide valuable insights into the main phenomena of a whole research area. Through a bibliometric analysis, we synthesized, structured, and interpreted existing research on an entire discipline holistically. The results should help to advance our understanding of SCM. In line with an interpretative study, the proposed ideas for further research should also create opportunities for knowledge development.

As practitioners often struggle with a dynamic environment, we provide an overview on the main phenomena affecting SCs that managers have to deal with in the future. That is, practitioners gain an overview of existing and emerging SCM issues that can influence business development, strategic decision making, resource allocation, and the management of value creation activities in the wider environment. In addition, we provide initial recommendations for action to achieve social impact in SCs, which can, for example, help address the climate crisis.

However, our study suffers from limitations. First, our theoretical and interpretive study focuses on panarchy theory. Secondly, relying solely on a co-occurrence analysis with all the journals considered to identify phenomena could lead to overlooking important research that may not be well-cited or published in leading SCM journals, but that is nonetheless relevant. Third, our co-occurrence analysis and clustering results are reliant on the keywords that authors have selected. Fourth, due to the number of articles, we were not able to verify the quality of the articles analyzed, leading to potential inaccuracies in the results. Fifth, we set a threshold in the VOSviewer program, regarding the 500 most important keywords that occur at least twice. Although more broad settings have led to a similar map, interesting keywords may have been excluded. Sixth, we did not analyze the co-citation of the articles in the research field in order to identify the most influential authors. However, capturing the landscape of SCM research offers interesting potential for further research. We have outlined potential research directions in section 6, which can be further explored through an examination of leading SCM journals.

## 8. Acknowledgements

The research project has been funded by the Fraunhofer Institute for Integrated Circuits IIS, Department for Supply Chain Services, Nuremberg/Germany.

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