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The impact of co-creation and co-invention in supply chains: a bibliometric review

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Abstract

Purpose – Co-creation and co-invention are two diverse spheres in modern-day supply chains. Despite literature suggesting the existence of similar coherence between these concepts, the availability of published theory favoring these ideal lacks justification. This research aims to investigate the correlation and convergence of these well-known concepts to support a combined impact on research.

Design/methodology/approach – Comprehensive review of published literature using mathematical and statistical tools to measure inherent interrelationships and publication impacts in literature handling co-creation and co-invention.

Findings – An exploratory quantitative and qualitative analysis reveals the conundrums existing in distribution, keyword and adoption of research in the global and scientific community. The research favors a positive correlation existing between concepts such as co-ordination, collaboration, open-innovation, value creation with supply chain management and its development with rising importance of big data and block-chain technologies. Analysis reveals knowledge development with increased user-based interaction, better utilization of resources and enhanced productivity to support the mutual adaptation of co-creation and co-invention.

Research limitations/implications – Outcomes will be a beacon for researchers to develop models and frameworks. Results derived will aid in improving customer participation, enhance decision making in product development, augment value creation and knowledge and resource sharing leading toward innovation.

Originality/value – Results will provide a detailed outline of the development and implementation of concepts in both developed and developing countries. Outcomes will also serve as a framework for marketing heads, graphic designers, website designers, supplier management and customer management in the service industry, production supervisors and customer management personnel in manufacturing industries.

Keywords Co-creation, Co-invention, Bibliometric analysis, Supply chain

Paper type Literature review

1. Introduction

Since the Industrial Revolution's advent, supply chain management's efficiency and productivity have been of particular interest to researchers and industrialists, amplified several times with the establishment of lean manufacturing concepts (Martínez-Jurado & Moyano-Fuentes, 2014). The occurrence of Industry 5.0 concepts further urges the need for

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efficient, viable and succinct supply chains, with everyday decision-making requiring innovations. One needed strategy has been to include the concepts of co-creation and co-invention for the enhanced involvement of end-users in influencing the direction and outcomes of the production process (Candelo, Casalegno, Civera, & Mosca, 2018).

Co-creation focuses on shifting from the conventional firm and product-centric view to personal customer-centric statements implying more user-based involvement at every level of product development. Co-invention suggests the creation of knowledge-based networks for collaboration across geographies and localized centers to enhance creativity and innovative productivity (Lacoste, 2016). A real-life example of co-creation could be travel agencies offering customized holiday packages. On the other hand, co-invention can be a collaborative alliance of researchers across geographies, participants of MNCs for knowledge infusion and inclusion of supply chain decision-makers to alleviate shortcomings for productivity enhancement. A detailed understanding of these concepts is provided in the upcoming sections.

1.1 Co-creation

Coined by Prahalad and Venkat Ramaswamy (2004), this concept implies a shift from conventional and product-centric views to specific customer-centric ideas. Tseng and Piller (2003) analyzed the espousal of these concepts in several companies by implying mass customization for enhancing sales. Extrapolating this idea, Strappers and Sanders (2008) presented the future scope of co-creation by developing an innovative framework for firms by defining roles for product designers and researchers via enhanced participation of users leading to a new frontier such as open innovation. Explored by Piller, Ihl, and Vossen (2010), this involved assessing the evolving customer participation and proposing a typology based on recent trends and practices regarding co-creation. The research further presented the application concepts in different companies and their impacts [1].

The next phase of development came with the conceptualization of co-innovation, which involved top management taking decisions regarding product development involving supply chain members in lines of organizational elements such as convergence revolution, collaboration and co-creation in a comprehensive view through megatrends while stressing the importance of value creation (Lee, Olson, & Trimi, 2012; Almirall & Casadesus-Masanell, 2010). The concept of value co-creation gained immense momentum, fueling the need to understand and conceptualize this ideal. In 2016, Ranjan and Reed defined and conceptualized the boundaries and elements of value creation, developing a conceptual framework through a comprehensive literature review on two primary dimensions: co-production and value-in-use. Based on the current development of open innovation and value creation, Gao, Ding, and Wu (2020) conducted a study regarding the scope and future of open innovation to explore the potential limitations and to provide possible implications and ideas. However, the directionality and the interrelationship with other domains were not established appropriately, requiring further exploration.

1.2 Co-invention

The advent of sophisticated technologies and enhanced knowledge flows has diversified research scopes and networks, leading to collaborative networks on research and innovation known as co-invention. Breschi and Lissoni (2009) attempted to analyze and observe the inventor's network in knowledge dispersion across geographies forming co-invention networks. It was observed that the knowledge diffusion rate significantly impacted negatively, signifying the substantial importance of co-invention networks. This led to a new stream of research, further explored by Breschi and Lenzi (2016) to analyze the role of collaborative networks in enhancing creativity and innovative productivity in urban centers.

The study concluded that collaborative networks improved social proximity and interactions, leading to an enhanced influx of knowledge, causing more significant levels of trust and cooperation and encouraging higher creativity and inventive productivity (Breschi & Lenzi, 2016). This argument was further extrapolated by Chen, Jang, and Chang (2013) to identify and recognize the trends in support of international collaborative networks through a case study focusing on China.

However, shortcomings and concerns about the application co-invention from an international perspective are evident. Branstetter, Li, and Veloso (2013) focusing on India and China, illustrated that despite advancements in innovative collaborations and R&D, these countries lag in economic growth and per capita income. The reason cited is that most patents were granted to individuals employed in foreign firms, initiating localized co-invention networks. Huallacháin and Lee (2014) demonstrated the trends and development of localized networks through an analysis of American biotechnology firms. Outcomes revealed that while inter-metropolitan networks have deepened and intensified regarding knowledge contributions and distribution, most local and regional nodes have shown tremendous development. This was supported and quantitatively demonstrated by Lee (2016) to analyze co-invention networks from 1979–2009 through social network analysis. A notable feature observed was that collaboration networks became more prominent and valuable in knowledge distribution. This was stated as a concluding fact based on the research on the changing co-invention patterns in the US urban centers (van der Wouden, 2020). At present, the research trend focuses on knowledge creation in addition to knowledge distribution. Huo (2021) demonstrated through his empirical research that for better knowledge creation, the correlation of knowledge between the inventors in the networks should be low, implying that the research and technical areas of the inventors should be different.

A literature survey provides conclusive evidence on scientific research witnessing increased collaborative and impactful symbiosis of different streams, providing an extensive correlation in research. However, concepts of co-creation and co-invention have been independently researched and developed and the author percept that there is a high positive correlation between the two concepts. Our research suggests the mutual implementation of both these concepts in supply chain management can enhance efficiency and innovation. Table 1 represents author contributions to co-creation and co-invention. The authors highlight: 1) possible mutual implementation of both the concepts, 2) the role of economic factors determining the development of the concepts and 3) practical and research significance and role of technology in this domain.

Derived outcomes provide a detailed outline of the development and implementation of concepts in developed and developing countries focusing on India and its possible reasons. The authors also strongly feel that results can serve as a framework for marketing heads, graphic designers, website designers, supplier management and customer management in the service industry, production supervisors and customer management personnel in manufacturing industries and the research and academic fraternity involved. Furthermore, with the introduction of technological advancements such as Big Data, Blockchain and advanced analytics, literature surveys also reveal an expanding momentum in concepts of co-creation and co-invention over the last decade (Huo, 2021; Breschi & Lenzi, 2013). These scenarios present an essential need for quantifying the impact created and depicting the further research trend in terms of significant criteria and factors. An obligatory quantitative and comprehensive analysis is required rather than conclusive qualitative research to track these developments, to implement and streamline the various research trends. Hence, to satisfy this need in research, the authors adopt Bibliometric Analysis (BA) coupled with content analysis.

This research, in total, attempts to address the following research questions (RQs). The RQs being:

Citation	Main research point	Originality
Co-creation		
Osborne (2018), Voorberg, Bekkers, and Tummers (2015)	Shift from firm-centric production to user-centric involvement	Mutual implementation in supply chain management for enhanced efficiency and innovation
Gummesson, Mele, Polese, Nenonen, and Storbacka (2010), Ranjan and Read (2016), Piller *et al.* (2010), Lee *et al.* (2012), Pitelis and Teece (2010)	Developing and enhancing frameworks for implementing co-creation	–
Osborne, Radnor, and Strokosch (2016), Dolan, Seo, and Kemper (2019), Prebensen, Vittersø, and Dahl (2013), Piller, Vossen, and Ihl (2012)	Application of co-creation in different sectors	Detailed outline of development and implementation of concepts in developed and developing countries with particular focus on India
Co-invention		
Breschi and Lissoni (2009), Branstetter *et al.* (2013), van der Wouden (2020)	Development and implementation of co-invention networks	Provide a development scope for concepts of co-invention in both research and practical fields
Chen *et al.* (2013), Huo (2021), Riikonen, Seitamaa-Hakkarainen, and Hakkarainen (2018)	Evaluating frameworks for co-invention collaborations	
Breschi and Lenzi (2016), Lee (2016)	Impact and application of co-invention	

Table 1.
Research contributions

RQ1. Understand interlinks of co-creation and co-invention in developed and developing countries?

RQ2. Identify existing trends linking co-creation and co-invention and forecast its future.

2. Research methodology

The authors espouse a comprehensive BA to scrutinize and correlate present and future scope concepts by signifying theoretical and practical importance. BA is defined as a quantitative assessment of academic journals based on statistical parameters such as citations, publication, author, countries sources and affiliations, assisting in analyzing the significance and research impacts of the research domain (Ellegaard & Wallin, 2015). Some criteria for data comprehension include pattern assessment of keyword, authorship, citation, sources and bibliographic coupling. This quantitative analysis method provides a good picture of the future trends based on historical results by providing valid correlations. Based on this rationale, BA is implemented for visual analysis collaborated with quantitative methods to investigate the impacts of co-creation and co-invention on a combined level with scrutiny of supply chains. This research article adopts a review method integrating quantitative bibliometric and qualitative analysis content analysis as proceeded by Du, Xu, Li, Liu, and Chu (2021). The procedure adopted in this research coincides research carried out by Jia and Jiang (2018), hence confirming its validity.

This task is primarily initiated by understanding qualitative information such as author, subject, country, publication, source and quantitative justifications such as network analysis, keyword burst and content analysis. The identification of various keywords initiates this entire task through extensive literature review and analysis. Using the Scopus database, articles derived are subjected to certain exclusion criteria (such as article type and publications in the English language). Scopus is chosen as a preferred source for data as it

provides better and more comprehensive scientific content (50%–230% more, conditional on the domain and region) than its competitors (Harzing & Alakangas, 2016). The proposed methodology is detailed in Figure 1. Data aggregated are further analyzed using VOS Viewer. This software provides a graphical interpretation of data forming clusters and assists in identifying and analyzing existing linkages within different categories (Tandon, Kaur, Mäntymäki, & Dhir, 2021; Li, Xu, Wang, & Wang, 2020). Even though VOS-viewer analyses keywords and bibliographic coupling, co-citation [2], co-authorship [3] and co-occurrence clusters, additional analyses such as keyword bursts and citation bursts, thematic map, authors' productivity, top countries in terms of productivity, annual scientific productivity, scientific productivity model in terms of authors, conceptual structure get undermined. Hence, additional software such as Cite Space and the bibliometric package (Rodríguez-Soler, Uribe-Toril, & Valenciano, 2020) are used. The outcomes from bibliometric package using R programming complements the results previously obtained by detailing the thematic map, author's productivity, top countries in terms of productivity, annual scientific productivity, scientific productivity model in terms of authors and a conceptual structure providing analytical depth. The outcomes are further strengthened via content analysis providing more depth to the research and trends pursued by including top cited articles and analyzing them comprehensively. Research is concluded by providing implications based on research conducted depicting the potential future scope of development that can be pursued by researchers as well as industry practitioners and supply chain members. Data retrieval uses designed keyword strings fed as both singular and plural versions. The search string is as follows: *"co-creation(s)" OR "co-design(s)" OR "co-production(s)" OR "co-invention(s)" OR "value creation(s)" OR "innovation(s)" OR "co-specialization(s)"AND "supply chain(s)"*.

Search results yielded a total of 953 articles with a set period from 1995-2021. This comprised of 931 documents in English language (97.7%) followed by Chinese (1.4%), Portuguese (0.7%) and French (0.2%). The documents assessed consisted of articles (71.2%), book (1.3%), book chapter (4.3%), conference paper (15.8%), conference review (0.1%), editorial (0.62%), note (0.52%), retracted (0.1%) and review (5.6%). After the segregation,

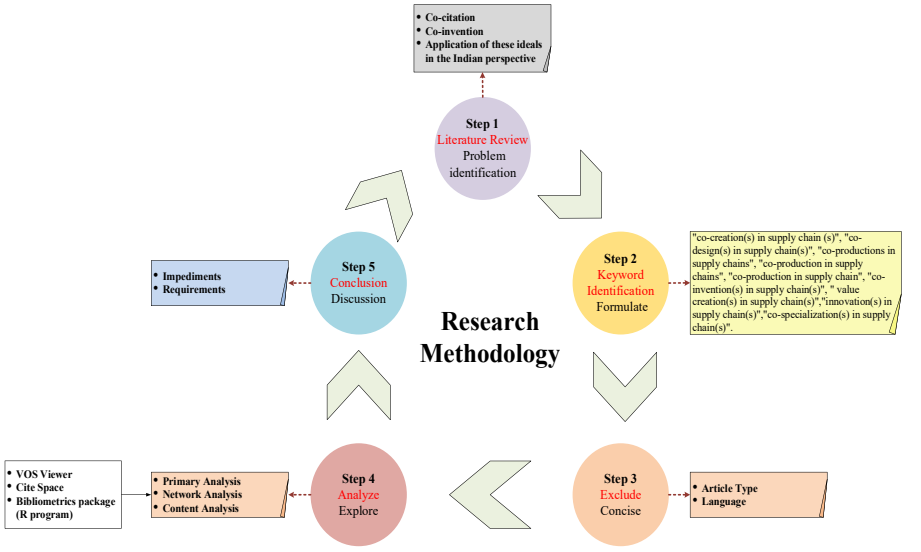


Figure 1.
Flowchart of proposed methodology

primary data analysis is performed based on the results depicted by Scopus to draw a preliminary conclusion. Network analysis is implemented to establish the conclusions and discover the correlation between the keywords. Finally, content analysis has been included to identify and highlight the current trend of research in this particular domain.

2.1 Research limitation

Despite the robust methodology adopted, this research succumb certain assumptions/ limitations adopted. The limitations of the adopted methodology have been numbered below:

(1) Only research papers (type of documents) in English language (language) were included as a source of information for analysis.

(2) While using VOS-viewer, implemented the limit of minimum five for keyword analysis and co-citation analysis, leading to a fraction of authors and papers being excluded, especially the recent ones.

(3) BA only provides a macro level idea based on networks and trends. It does not provide a detailed picture behind the trend.

(4) There is always a scope of better results with increased number of indicators and tests.

3. Results and discussion

3.1 Preliminary data analysis

This section comprises an initial analysis comprising of analyzing the subject, source and distribution of research. Table 2 reveals preliminary information about sources, database, growth rate and citations of documents. Outcomes also show an increasing trend with a growth rate of around 15% per year. Figure 2 indicates the evident rise in research over the years, with each year showing significant growth in article numbers. The nature of the graph is monotonous and increasing, implying that this particular domain is the trending topic in the research community.

3.1.1 Subject-wise analysis. Subject-wise analysis (Figure 3) reveals research focus on Business, Management and Accounting (30.7%), Computer Science (16%), Engineering (14.9%) and Decision Science (14.8%), constituting almost 77% of the total research carried. The "Others" category includes the subjects with less than 5% contribution and comprises 16 subjects such as mathematics, environment, energy, agriculture, etc. Although the presence

Criteria	Value	Criteria inclusion/exclusion
Retrieval distribution	5th April, 2021	N/A
Database selected	Scopus	N/A
Time stamp	5th April, 00:22 am	N/A
Bibliographic criteria	January 1995 - April 2021	N/A
No. of articles identified	953	N/A
Articles in English	931	Inclusion (97.7%) of research articles based on language
Annual percentage growth rate	15.24383	N/A
Sources (Journals, Books, etc.)	492	N/A
Average years from publication	5.93	N/A
Average citations per document	19.99	N/A
Average citations per year per doc	2.761	N/A

Table 2.
Preliminary statistics

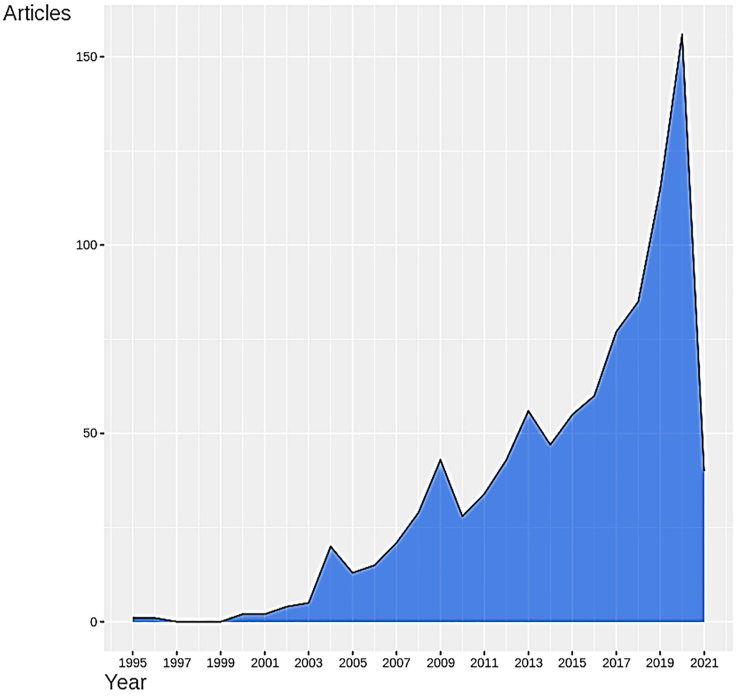


Figure 2.
Annual scientific publications per year

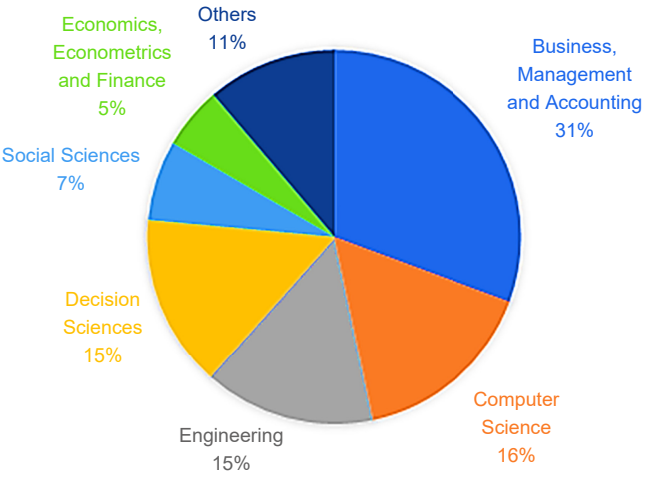


Figure 3.
Subject-wise distribution of documents

of business, management and accounting and engineering in the top domain was expected by the authors owing to its technical similarities to the field of management sciences, the presence of Computer Science as a trailing domain was unexpected. This might be due to the rising trend in the application and incorporations of data science, big data and blockchain technology in the field of supply chain management for developing knowledge creation and

exchange networks (Huo, 2021; Breschi & Lenzi, 2013), enhancing the scope of co-invention. Another reason can be the rise in the development of interactive platforms, an example of co-creation, for users regarding open collaboration and value creation of products and services, at any stage of its development and mass customization of products (Pacauskas, 2016). Concepts of co-creation and co-invention have impacted the domain of decision sciences, which is an interdisciplinary application of mathematics, economics, statistics and engineering for robust decision-making at different levels of an organization. This can be attributed to the fact that enhanced knowledge-based interaction between customers and the organization and the formation of knowledge and collaboration networks due to co-creation and co-invention have influenced decision-making factors, thereby leading to a rise in research trends (Acharya, Singh, Pereira, & Singh, 2018).

3.1.2 Source-wise analysis. To understand the contribution of publishing sources toward the discussed concepts, the top 10 journals were selected based on the number of publications (Table 3). Preliminary analysis reveals that substantial research has occurred since the 21st century correlating with the literature review. Journals such as "International journal of supply chain management" and "Sustainability" have maximum contributions from 2009–12. A citation analysis till 2021 w.r.t publishing sources revealed Journal of Cleaner Production (693744 citations) and Sustainability Switzerland (642115 citations), implies that the focus is majorly on the implementation of principles of green and sustainable production.

3.1.3 Distribution analysis. Distribution of research articles based on country; citation; author impacts and affiliations; an analysis is preceded in this section. A country-wise contribution analysis carried out toward co-creation and co-invention (Figures 4 and 5) revealed that China provided the maximum number of publications (177), followed by the USA (163) and the UK (103). India stands fourth in position (73). Table 4 reveals that publications are dominated by countries with a succinct GDP, implying that growth and development influence research rates. Another notable aspect observed is the maximum contributions by developed countries (USA, UK, Germany and others) irrespective of most publications being from a developing nation like China. This can be attributed to the fact that, since the 2018 trade war with the US, about 80% of the Chinese companies have revolutionized their supply chain by incorporating user and research-based interactions

Source title	Publisher	Articles	SJR 2019	*H*-index	JCR Quartile
Supply chain management	Emerald	36	1.68	107	Q1
International journal of production economics	Elsevier	25	2.38	172	Q1
International journal of production research	Taylor and Francis	23	1.78	125	Q1
International journal of supply chain management	Exceling Tech	22	0.19	13	Q3
Sustainability	MDPI	15	0.58	68	Q2
International journal of information management	Elsevier	14	2.88	99	Q1
International journal of logistics management	Emerald	13	1.06	72	Q1
International journal of operations and production management	Emerald	12	2.19	129	Q1
Journal of cleaner production	Elsevier	11	1.89	173	Q1
Benchmarking	Emerald	10	0.55	57	Q2

Table 3. Top 10 contributing sources

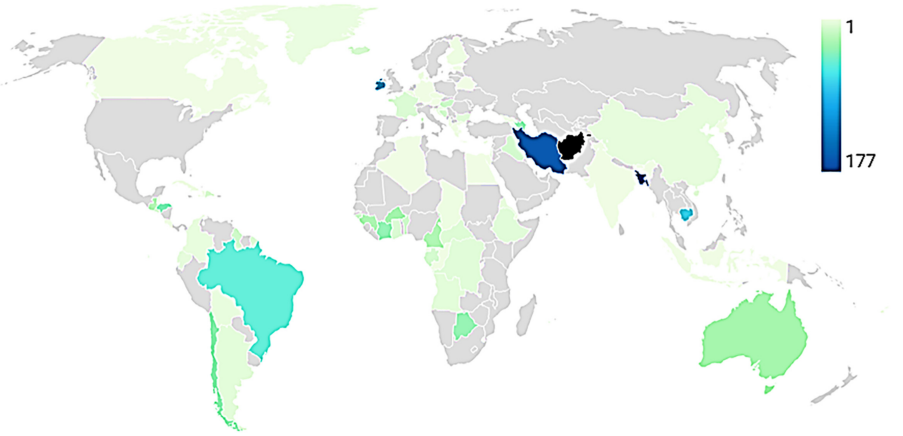


Figure 4.
Distribution of articles

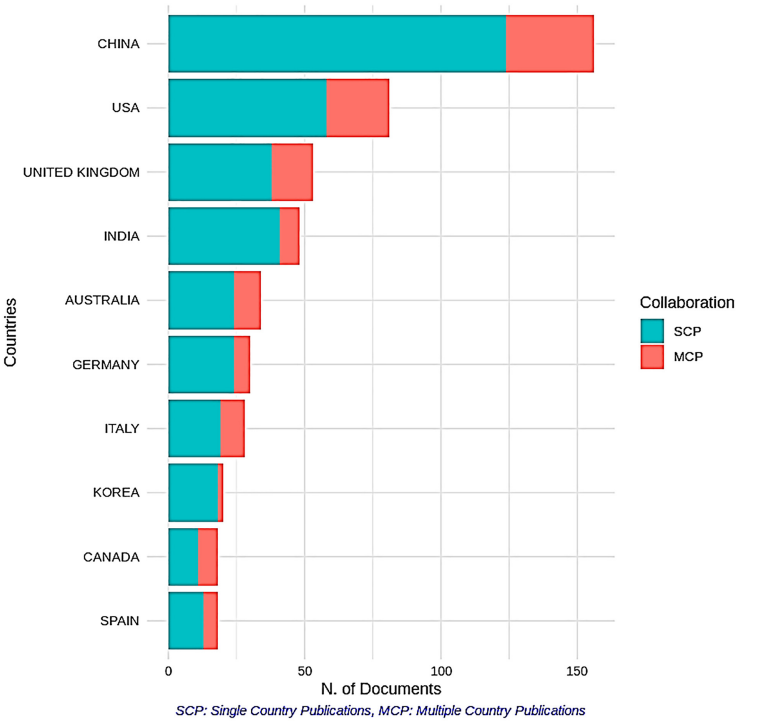


Figure 5.
Country-wise distribution of articles

and technological advancements in their supply chain network (Lee, Zhang, Suthiwartnarueput, Zhang, & Yang, 2020). The adaptability of published literature is understood by studying the pattern of citations via conducting a citation analysis. Outcomes reveal that developed countries have an average citation of 209.67 and developing countries have a value of 70.86, varying by almost three times. This can imply

Country	Publications	Frequency	SCP	MCP	MCP ratio	Total citations	Average citations
China	156	0.2235	124	32	0.205	1756	11.26
USA	81	0.116	58	23	0.284	3768	46.52
UK	53	0.0759	38	15	0.283	2046	38.6
India	48	0.0688	41	7	0.146	1380	28.75
Australia	34	0.0487	24	10	0.294	1195	35.15
Germany	30	0.043	24	6	0.2	328	23.67
Italy	28	0.0401	19	9	0.321	294	17.46
Korea	20	0.0287	18	2	0.1	617	30.85
Canada	18	0.0258	11	7	0.389	350	19.44
Spain	18	0.0258	13	5	0.278	519	28.83

Note(s): SCP- Single Country Publications
MCP- Multiple Country Publications

Table 4.
Top 10 countries statistics: publication wise

that researchers prefer research in developed nations over developing countries. This probably can be due to better research facilities.

Author analysis (Table 5) denotes the top 10 author contributions accounting for more than 7% of the total publications analyzed. Of this, the top three authors contribute 40% of the publications. For the qualitative assessment, the h-index metric analyzed provides the impact an author's publication has w.r.t the citations achieved. Outcomes indicate a clear distinction existing between the quality and quantity of publications. Based on this, it can be concluded that Xande Zhao's works are more referred to as Maryam Ghasemaghaei, despite the latter having more than twice the number of publications. Figure 6 highlights the productivity of the top authors with citations over the years. Table 6 represents an additional form of measurement referred to as the degree of centrality measurement, which is a criterion to measure the prominence of a particular author relative to other authors. It depicts the extent of connectivity of an author (denoted by a node) with other nodes in a network by measuring the number of connections of a particular node concerning the total number of links in a network. The higher the degree of centrality, the higher the significance of that author (Golbeck, 2015). This measure showed that Zhao depicted greater value when compared to other authors such as Ghasemaghaei in published research.

Authors	Organization	Publications	*H*-index
Maryam Ghasemaghaei	DeGroote School of Business, Hamilton, Canada	12	11
Angappa Gunasekaran	California State University, Bakersfield, Bakersfield, the United States	9	81
Luca Cagnazzo	Università degli Studi di Perugia, Perugia, Italy	7	8
Bowon Kim	Korea Advanced Institute of Science and Technology, Yusong, South Korea	7	16
Xiande Zhao	China Europe International School of Business, Shanghai, China	7	45
Wei Dai	Victoria University, Footscray, Australia	6	9
Baofeng Huo	Tianjin University, Tianjin, China	6	31
Paul Moynihan	Victoria University, Footscray, Australia	6	3
Rosane Alcantra	Universidade Federal de Sao Carlos, Sao Carlos, Brazil	5	7
Guangming Cao	Ajman University, Ajman, the United Arab Emirates	5	15

Table 5.
Top authors and organizations

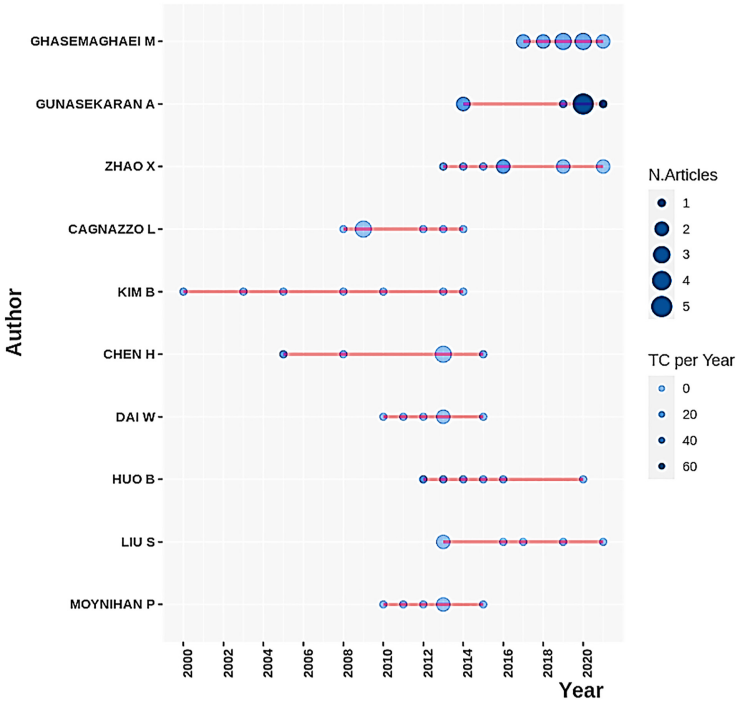


Figure 6.
Year-wise publications and citations of top 10 authors

Vertex id	Degree centrality
Zhao X	0.01033
Gunasekaran A	0.00935
Wang Y	0.00885
Foropon C	0.00885
Chen H	0.00787
Liu S	0.00738
Dubey R	0.00738
Wang Z	0.00639
Cagnazzo L	0.00590
Shou Y	0.00590

Table 6.
Degree centrality of top authors

Affiliation-wise analysis (Table 7) revealed that the top 10 affiliations account for over 11% of the documents published, with McMohan University leading the list. Among the assessed, the top five account for over 55% and 6% overall. In qualitative aspects, The University of Queensland has the most citations, almost double the number compared to McMohan University. This depicts that the former is preferred and has been conducting excessive and valuable research in co-invention and co-creation.

3.2 Network analysis

This section tries to understand the intricacies between literature using keyword analysis, citation bursts, thematic analysis and bibliographic coupling, including citation network, co-citation analysis and co-authorship analysis.

Affiliation	Region	Publications	Citations
McMaster University	Canada	14	237
Hong Kong Polytechnic University	Hong Kong	12	276
DeGroote School of Business	Canada	11	231
Montpellier Business School	France	11	383
Zhejiang University	China	10	360
The University of Queensland	Australia	10	457
Korea Advanced Institute of Science & Technology	South Korea	10	314
Universiti Sains Malaysia	Malaysia	9	61
Universiti Utara Malaysia	Malaysia	9	43
Chinese University of Hong Kong	Hong Kong	9	167

Table 7.
Top 10 affiliations

3.2.1 Keyword analysis. Keywords are segregated by applying a minimum frequency threshold of 5, with 169 words meeting the threshold. Analysis revealed (Figures 7 and 8) that extensive work has been carried out since 2018 in the domain of "Big data", "information systems", "firm performance", "decision-making process", and "top management support". The graphical network has been further divided into small clusters and assessed individually (Table 8).

3.2.2 Citation burst. This section identifies the rise in citations associated with a single keyword. Figure 9 represents the top 25 keywords with a strong citation burst along with the period mentioned, with "Big Data" having the highest strength (20.89). This indicates its relevance in co-creation and co-invention during 2018–2021. The analysis is further carried out by dividing keywords into phases based on time and then selectively assessing the most relevant keywords based on strength. The first phase (2001–2007) deals with "mathematical model" and "industrial management". Supply chain management and related issues were found to gain attention from practitioners, which can be cited as the reason for this burst (Faisal *et al.*, 2007). This amplified focus on the supply chain further emphasized the need to

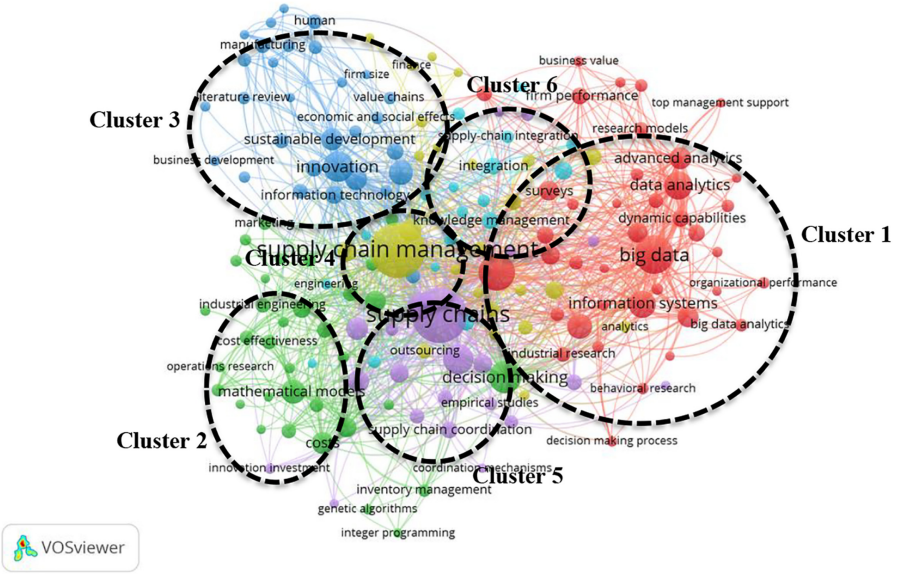


Figure 7.
Network visualization of index keywords

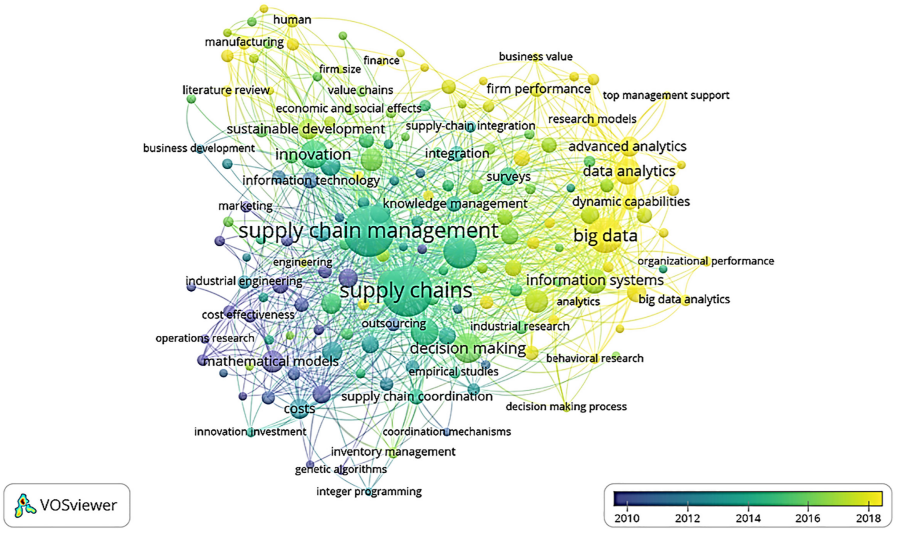


Figure 8.
Overlay visualization of index keywords

optimize customer demands and quantify performance using mathematical models. The second phase (2004–2016) includes keywords such as "supply chain co-ordination", "supply chain collaboration" and "profitability". Collaborative planning and partnership among the retailers and manufacturers have been instrumental in providing enhanced quality of products, thereby increasing productivity and profitability (Ramanathan & Muyldermans, 2010). The third phase includes keywords such as "big data" and "data analytics". These concepts have provided solutions to constraints such as amplified customer necessities involving enhanced lead time and reduced services, product accessibility and reliability, leading to increased value creation and knowledge dispersion (Witkowski, 2017).

3.2.3 Thematic map analysis. This section uses thematic maps to highlight research insights through conceptual networks represented in Figure 10. This analysis qualitatively and quantitatively illustrates the significance of each keyword based on the size. It classifies them into different themes such as niche, motor, basic, emerging and declining themes. Each node or bubble in the map demonstrates a collective network of keywords with a substantial frequency of occurrence proportionate to the node's size. The map's position depends upon the network's criticality and density (Rincón-Moreno, Ormazábal, Álvarez, & Jaca, 2021). Results conclude that supply chain is a key and basic term around which fundamental research related to co-creation and co-invention revolves. Another notable aspect is the presence of "big data" which is a motor theme and highly developed, indicating the extent of importance to the supply chain relative to other terms. In addition, "innovation" and "mathematical models" are depicted as niche themes and require further research to attain more relevance and development.

3.2.4 Co-citation analysis. Based on a minimum threshold of 5,571 cited references, 1566 cited sources and 6758 cited authors were considered. Results are analyzed based on highly cited references and authors detailed in Tables 9 and 10. The most cited author is Michael E Porter and the highly cited reference is Cohen and Levinthal (1990). Deeper explorations reveal that no important links/correlations are present between most cited authors and references. This implies that both these factors are moving independently. Tabulations are highlighted using citation counts and total link strength (TLS). TLS represents the degree of

Cluster	Title	Description
1	Big Data Analytics	Keywords in this linkage include "Big Data", "data analytics" and "information systems". The emergence of collaborative business networks has led to the increase in the distribution of information and knowledge giving, rise to big data analytics. This technique implements methods to analyze and segregate helpful information required for functioning and decision-making (Grover & Kar, 2017; Yu, Zhao, Liu, & Song, 2021). Assisting in the creation of new strategic routines considering market dynamics and value creation corresponding to customers' demand through efficient information management increases flexibility and quality production of a firm providing a competitive advantage to the organization (Chen, Preston, & Swink, 2015)
2	Inventory Management and Production Control	Keywords in this cluster include "inventory management", "mathematical models" and "cost effectiveness" (Moharana, Murty, Senapati, & Khuntia, 2012; Abd Karim, Nawawi, & Salin, 2018; Jugend, Fiorini, Armellini, & Ferrari, 2020). Inventory management and production control are two prime objectives in any supply chain. Proper inventory assists in the reduction of unnecessary costs and maximizes profit. Similarly, production control enhances the quality of the product and reduces the effective time (Ben-Daya & Hariga, 2003) using mathematical models which are either deterministic or probabilistic (Vijayashree & Uthayakumar, 2016)
3	Sustainability and Innovation	Covering sustainability and open innovation, this domain provides new dimensions to product development (Isaksson, Johansson, & Fischer, 2010; Kusi-Sarpong, Gupta, & Sarkis, 2019). fv, and Bstieler (2016) attempted to merge these concepts as sustainability catered to complex and diverse demands followed by product requirements such as customer-specific, cost-specific and environment-driven specifics. Open innovation provides knowledge-based external sources enhancing value creation (Krishnan, Yen, Agarwal, Arshinder, & Bajada, 2021)
4	Information and Resource Handling	This cluster covers domains of information sharing, facilitates an increase in prediction accuracy, coordinates manufacturing processes and supplies, implements proper inventory utilization processes and inculcates a symbiotic relationship for maximum impact (Wu, Chuang, & Hsu, 2014; Faisal, Banwet, & Shankar, 2007; Neubert, Ouzrout, & Bouras, 2004). Collaborations provide coordination between different supply chain members, minimizing cost and maximizing revenue, providing quality customer service while adapting to demands and developing innovative marketing strategies. (Lusiantoro, Yates, Mena, & Varga, 2018; Maskey, Fei, & Nguyen, 2020)
5	Application and Impact of Coordination	This cluster links to "value creation" and "dynamic capabilities" (Garrido-Moreno, García-Morales, King, & Lockett, 2020; Ambrosini & Bowman, 2009). This impact was first exploited and analyzed by Nagarajan and Sošić (2008) in a two-stage assessment using cooperative game theory to examine and improve profit allocation and stability of supply chains, followed by incorporating coordination to enhance supply chain performance
6	Impact of Managerial Implications	The prominent keyword in this cluster is "managerial implication". Managerial implications have been one of the significant impacts on supply chain performance and play vital roles in decision making and responsiveness (Chen *et al.*, 2015). Illustrated by Ibrahim and Hamid (2014), a survey and model-based analysis of Sudanese manufacturing companies reflected that supply chain management practices are instrumental for effective performance and enhancing supply chain coordination

Table 8.
Cluster analysis

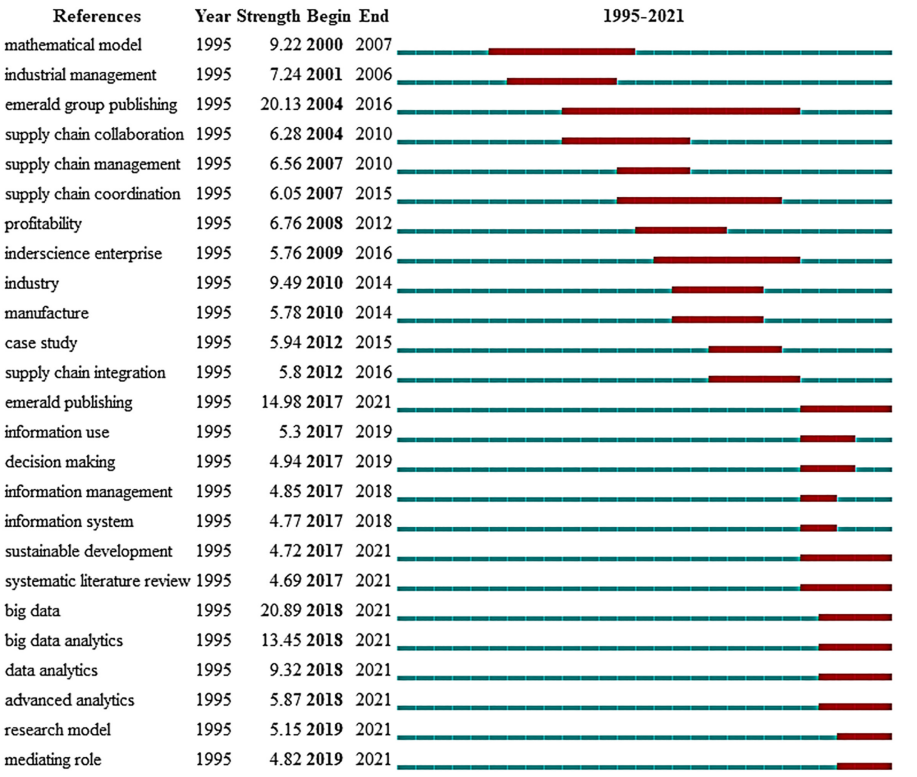


Figure 9.
Keyword Burst of top 25 keywords

correlation and significance of the keywords, authors or countries. This analysis reveals that authors from developed countries are cited more as the initial works were dominated by authors from developed countries, possibly suggesting that supply chain innovation and enhanced participation of all supply chain participants play a pivotal role in economic development and stability.

3.2.5 Co-authorship analysis. A minimum threshold of 1 per document and citation revealed 1884 authors, 1611 organizations and 70 countries contributed to this domain. Analysis revealed major nodes in each link corresponding to authors (X Zhao, Y Wang, S. Liu, H. Chen and many others) of South Asian descent, majorly from China. Further analysis also revealed China to be one of the largest nodes depicted in the country-wise co-authorship analysis (Figure 11). Organization about that School of Management, Zhejiang and School of Management, Hangzhou, both situated in China are the central nodes in this network, clearly indicating the dominance of China in this domain. A plausible cause can be attributed to the ever-evolving and adaptable nature of Chinese companies supply chains that have shown a growing trend of foreign research and development investment in the country.

It is also found that features such as service-dominant logic describing supply chains as value creation and resource/knowledge integration networks, provide a viewpoint for assessing and evaluating the roles of significant supply chain participants in innovation. This was found to be incorporated in the supply chains of the Chinese companies, as highlighted by Hallikas, Immonen, Pynnönen, and Mikkonen (2014). Further research has

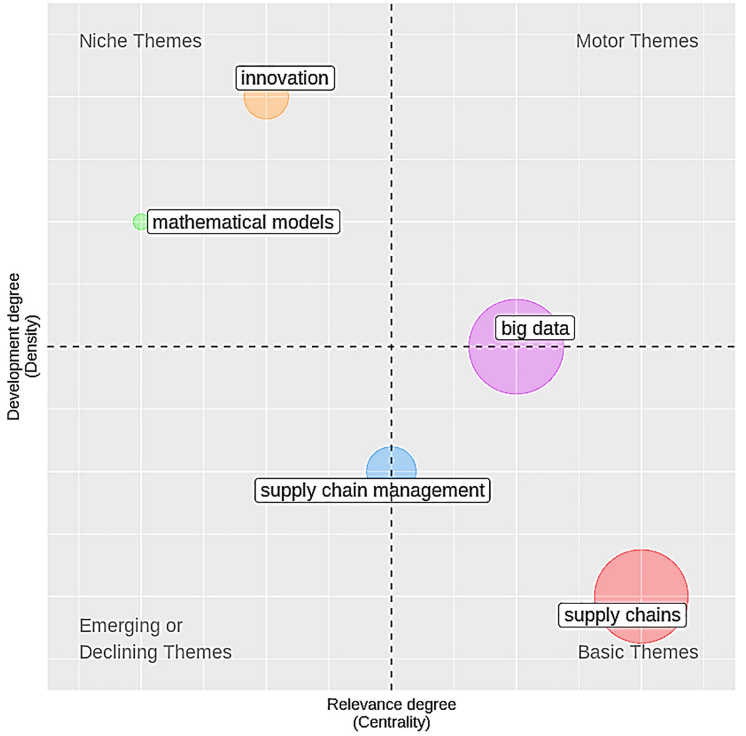


Figure 10.
Thematic map

Cited reference	Citations	TLS
Cohen and Levinthal (1990)	71	177
Teece, Pisano, and Shuen (1997)	49	161
Zahra and George (2002)	38	117
Nonaka (1994)	34	57
Kogut and Zander (1992)	33	86
Ahuja (2000)	28	53
Uzzi (1997)	28	41

Table 9.
Top cited references

resulted in improved customer information acquisition and higher value creation with supplier integration (Zhang, Zhao, Voss, & Zhu, 2016). This as a result has made China gain a strong foothold in global markets leading to an increase in research and development.

4. Content analysis

Content analysis has been carried out using the top 3 cited papers from each year based on similarities found in Nagariya, Kumar, and Kumar (2020) and Almeida-Filho, Kawachi, Filho, and Dachs (2003). This methodology has been adopted to indicate the importance and trend of research further segregated into clusters. Table 11 provides a snapshot regarding the various ideals and papers discussed under each cluster and have been detailed below.

Table 10.
Top cited authors

Author	Citations	TLS
Michael E. Porter	502	104997
David J. Teece	457	72868
Eric von Hippel	431	58438
Richard R. Nelson	366	63057
James G. March	361	92553
Kakuro Amasaka	358	46523
Kathleen M. Eisenhardt	344	65822
Henry Chesbrough	327	29086
Oliver E. Williamson	317	87861
Daniel A. Levinthal	313	51376

4.1 Cluster 1 – supply chain integration (SCI)

SCI was introduced by Stevens in 1989 (Stevens & Johnson, 2016). This concept purposes to align and incorporate all supply chain flows and functionalities to increase efficiency and performance. The evolution of e-integration in this century involves integration of supply chain functionalities using information systems (Vijayasarathy, 2010). Integration being a complex, multi-functionality process pertains inputs from different disciplines demonstrating trust and commitments. Despite SCI enhancing firm's performance, the associated supply chain risks often get undermined. Zhao *et al.* (2013) commented on the various risk involved stating supply delivery risk pertaining to supply/conveyance failures, incompetence in fulfilling requirements and misaligned schedule of delivery/demand variability caused due to high volatility in markets. Presently, concept of SCI has evolved to give rise to collaborative networks, which are more flexible and transient in nature, due to evolving demands and requirements (Stevens & Johnson, 2016).

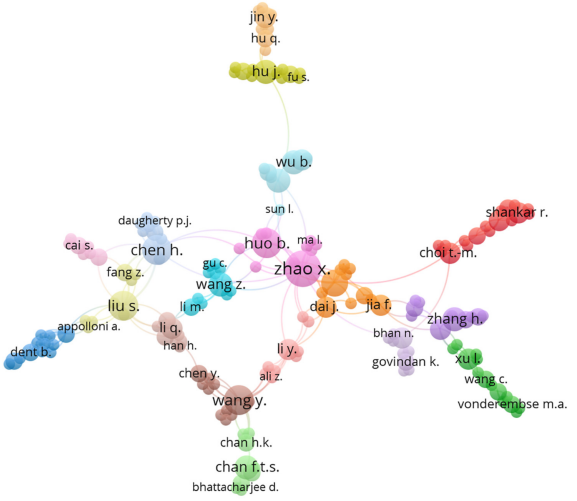
4.2 Cluster 2 – supply chain collaboration

Depicting the idea and development of supply chain collaboration, this cluster focuses on working jointly with entities sharing similar goals and objectives. Cao *et al.* (2010) stated that collaboration comprises of seven major principles namely knowledge distribution, objective similarity, combined decision making, oriented motivation, inventory management, clear viewpoint expression and value creation. Wiengarten *et al.* (2010) further stated that though information sharing and decision synchronization led to performance improvements, weak correlations were evident between information sharing and in aspects of operational efficiency such as inventory management. For improved information sharing, Wu *et al.* (2014) attempted to demonstrate the impact of social exchange theory (SET), based on reward biased interactions with the help of a model-based framework. The observations depicted that SET consisted of trust, commitment, mutuality and authority having significant influence on information sharing and except mutuality others have significant effect on collaboration. The successful impact of collaborative partnership of organizations and supply chains have positive impacts on supply chain participants which lead to long term collaborations subsequently enhancing benefits and reducing burden (Ramanathan & Gunasekaran, 2014).

4.3 Cluster 3 – supply chain innovation

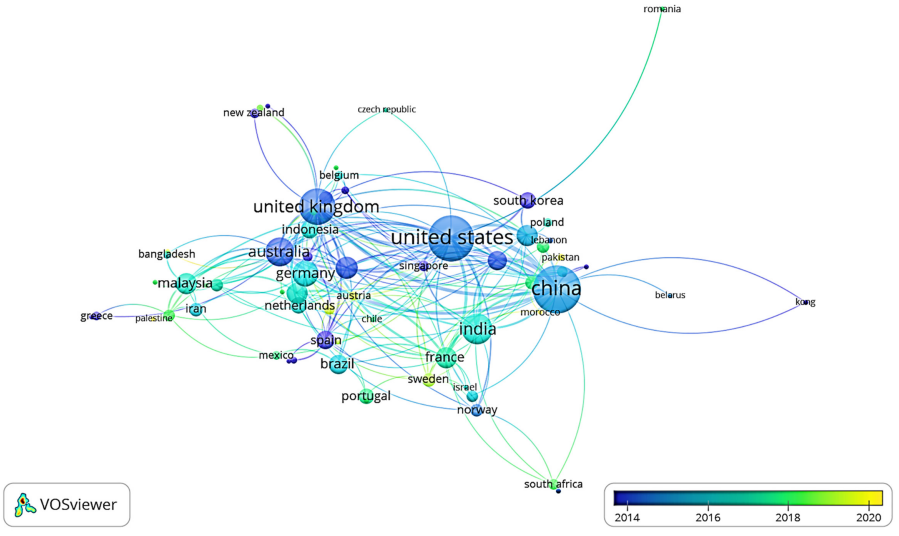
This cluster deals to the continuously evolving customer demand and subsequently enhancing organizational effectiveness using new technologies. Lee *et al.* (2011) attempted to implement this ideal in the healthcare industry in South Korea and observed that the adoption

of innovative measures impacted supply chain performance increasing efficiency. One such innovation included the concept of open innovation involving user participation focusing a shift toward improved quality and innovation gaining competitive advantage (Inauen & Schenker-Wicki, 2011). Outcomes also denoted positive correlations existing between open innovation and efficiency when stakeholders were integrated. One such example is the Indian FMCG sector that involves the incorporation of small retailers as supply chain collaborators



Author Wise

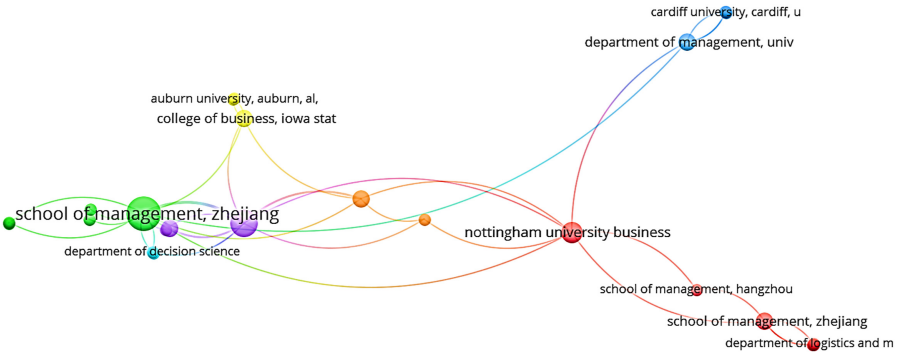
(a)



Country wise

(b)

Figure 11.
Co-authorship analysis



Organization wise
(c)

Figure 11.

Group	Ideal	Reference
Cluster 1	Supply Chain Integration	Vijayasarathy (2010) Zhao, Huo, Sun, and Zhao (2013) Stevens and Johnson (2016)
Cluster 2	Supply Chain Collaboration	Cao, Vonderembse, Zhang, and Ragu-Nathan (2010) Wiengarten, Humphreys, Cao, Fynes, and McKittrick (2010) Wu *et al.* (2014) Ramanathan and Gunasekaran, (2014)
Cluster 3	Supply Chain Innovation	Inauen and Schenker-Wicki (2011) Lee, Lee, and Schniederjans (2011) Khare and Khare. (2012) Fearne, Martinez, and Dent (2012) Wuttke, Blome, Foerstl, and Henke (2013) More and Basu (2013) Dong and Wu (2015)
Cluster 4	Big Data and its Applications in Supply Chains	Chen *et al.*, 2015 Sheng, Amankwah-Amoah, and Wang (2017) Grover and Kar (2017) Tiwari, Wee, and Daryanto (2018) Lehrer, Wieneke, Vom Brocke, Jung, and Seidel (2018) Batistic and van der Laken (2019) Dubey *et al.* (2020) Ciampi, Demi, Magrini, Marzi, and Papa (2021)

Table 11.
Cluster wise categorization of conceptual

to form information linkages providing stakeholders with information at much lower costs (Khare & Khare, 2012). Despite showing promising outcomes, inadequacies ought to be addressed was the lack of sustainability in terms of social and environmental aspects. The social aspects were discussed by Fearne *et al.* (2012) who stated the incorporation of sustainable tools whereas the economic aspects were discussed by More and Basu (2013). They stated that economic issues persisted owing to irregular cash flows, insufficient financial management knowledge, improper inventory management, over reduction of selling prices of goods to gain competitive advantage. These issues were addressed by

Wuttke *et al.* (2013) who attempted to implement a supply chain finance framework based on a case study conducted on European firms. The factors included involved restructuring, redefining, clarifying and disseminating.

Analysis clearly reveals a supply chain level transformation toward incorporating and exploiting of IT services and its business value, positively leading toward an enhanced value creation with improved knowledge creation and distribution networks. One such example is strategic implementation of social media technologies for crowdsourcing, which has increased the innovative capabilities of the firm due to increase in the level of interactions between the consumers and firms (Dong & Wu, 2015).

4.4 Cluster 4 – big data and its applications in supply chains

This cluster relates to the advancements in Big Data Analytics recently for value creation caused by the incremental rise in application of IT services in supply chains. The processing and handling of large volumes of data have revolutionized the application of value co-creation by providing interactive and user-friendly digitized platforms (Ma, Yan, Kang, & Wei, 2016). The capability to process large volumes of data within a short span of time can assist in better decision making and increasing value hence differentiating between high performing and low performing firms (Batistic & van der Laken, 2019). Sheng *et al.* (2017) suggested that big data analytics had an impact on the organization, operational, marketing, accounting and financial perspective of an organization. Acharya *et al.* (2018) implemented this technique in the fashion industry and revealed the existence of correlation between big data implementation and enhancement of knowledge co-creation. A supply chain-oriented application of Big Data concepts has witnessed a rise in usage such as consumer-supplier analytics, tech supported innovations and efficient management of complex information where user collaboration is suited (Grover & Kar, 2017). The usage of this concept has also increased in the domain of descriptive analysis such a predictive analysis and prescriptive analysis (Tiwari *et al.*, 2018). To explore further, a comprehensive industrial case study was carried out by Lehrer *et al.* (2018). The observations demonstrated that all sectors relied on development of data warehouses, automation of customer services, application visualization, mobile analytics, etc. The advancement in supply chains can be instrumental in implementing co-creation and co-invention due to enhanced knowledge dispersion and virtual user interactions overcoming geographical barriers. Also, Big Data can have a substantial impact on incorporation of green supply chains and sustainable development by reducing unnecessary carbon emissions and improve performances on social, environmental and economic aspects. Regardless of its unbound potential there have been supply chain irregularities to incorporate data analysis into their systems (Dubey *et al.*, 2020). While Big Data is a tool utilized for value creation, it is actually the top management who regulates it (Chen *et al.*, 2015). In similar lines the implementation of entrepreneurial orientation which is the management's attitude toward implementing new ideas and technologies also play a crucial role in innovation having substantial impact on implementation (Ciampi *et al.*, 2021). Centralization in decision making can be attributed toward the lack of standardized procedures, lack of flexibility and unnecessary complexity in supply chain management or use of inaccurate data (Tiwari *et al.*, 2018).

5. Implications

The results obtained from this study demonstrate the new avenues of research possible in this field. Although both co-creation and co-invention have made significant progress independently, in terms of research done, the presence of positive correlations as depicted by the analysis have opened the possibility of joint implementation of both these concepts.

Being a marketing perspective, the concepts of co-creation and co-invention form an extensive relation between the company and the consumer (Janteng, Tan, & Fernando, 2017). This, however, envisages the conjoint implementation of digital competence, digitalization and customer experience. This can effectively make use of digital technologies available such as cloud databases eventually creating a consumer base having vast experience and brand performance. Incorporating these ideals in a giant firm will require preliminary customer trust, advanced analytics of data, improvised promotion strategies, etc. effectively transforming firms following the conventional supply chain model (Ma *et al.*, 2016). This as a result will require a structured synergetic conversion framework toward co-creation and co-invention involving consumer experience and distinctive capability (Stevens & Johnson, 2016). Though consumer experience plays the pivotal role in this discussion (Mihardjo, Sasmoko, Alamsyah, & Elidjen, 2020), the authors of this manuscript however feel that advanced IT systems will play a major role in the effective collaborative implementation of both co-creation and co-invention (Ciampi *et al.*, 2021). Besides, it is also necessary to note that improvements must overcome localized developments and must be at a holistic supply chain level. The major advantage of these technological innovations is the focused improvements bringing in segmented customer developments aiding a business to focus on satisfying real-time customer needs. The involvement of external knowledge from the customer is pivotal for decision making entailing technologies such as ERP's. Such advancements will directly influence purchasing intentions. Notions in collaborations apart from the literary connotation will be the improved knowledge sharing developed influencing skill development, employee training and improved R&D/client-client/producer relationship.

6. Conclusion and future scope

This research adopts a novel attempt to track and evaluate the combined development of co-creation and co-invention in supply chain management using the BA tool. The research is amplified further by conducting an exploratory analysis to capture research trends and analyze research networks consisting of co-occurrence and citation networks and bibliographic coupling. The conclusions derived from this research are enlisted as follows:

(1) Research outcomes clearly indicate the requirement to implement technology for enhanced robustness and flexibility in handling and analyzing large volumes of data considering the evolving and complicated nature of modern-day supply chains. Analysis also illustrates encouraging outcomes in the combination of concepts through creation of better centralized knowledge networks and subsequently increasing user-based value addition and participation in product formation enhancing productivity. Content analysis details the description of methods employed and subsequent development in supply chains showing the evolution of supply chains from integration, collaboration till recent trends of big data applications and its future scope.

(2) Distribution analysis reveals that economic stability plays a major role as majority of research is from developed countries. This theory is backed by affiliation wise analysis as universities from developed countries lead. However, China leads the table implying that innovation in supply chain is the primary focus. This same trend is reflected in the author wise analysis and degree centrality which imply that works of authors from developing countries have more significance.

(3) A keyword analysis demonstrates positive correlation between coordination, collaboration, open innovation, value creation with supply chain management and its development with rising importance of big data and blockchain technologies.

(4) Citation burst and keyword analysis depict the trend and development of themes, respectively. Big Data is found to be a significant theme pertaining to both the concepts suggesting the progressiveness and inclination of research and practical players of supply chain toward it.

(5) Co-citation analysis reveals that authors from developed countries are cited more as the initial works were dominated by authors from developed countries, possibly suggesting that supply chain innovation and enhanced participation of all supply chain participants play a pivotal role in economic development.

(6) Co-authorship analysis revealed major nodes in each link corresponding to authors are of South Asian descent, majorly from China. Further analysis also revealed China to be one of the largest nodes depicted in the country wise co-authorship analysis. Organization analysis show that School of Management, Zhejiang and School of Management, Hangzhou, both situated in China are the major nodes in this network, clearly indicating dominance of China in this domain.

(7) Content analysis details the description of methods employed and subsequent development in supply chains showing the evolution of supply chains from integration, collaboration till recent trends of big data applications and its future scope.

Since the research work corresponding to this concept is relatively new and less developed, future studies can incorporate the implementation of this concept in different industries. Future research can also focus on providing insights on firm types willing to collaborate and the parameters used to assess collaboration and impacts especially in developing countries. It should also incorporate the extent and purpose of participation of each supply chain participant in a well-defined manner and proper management of resources and information systems using latest technological advancements. Lastly, focus must be placed on the organizational structure and decision making process implemented by the firm is aligned accordingly.

Notes

1. The mentioned companies include Fujitsu Siemens Computers. They organized community based competition to develop ideas for the new data center applicable in the future, organized summer camps and developed digital platform (muji) to understand and analyze customer behavior and perspective through improved interactions), LEGO (launched LEGO factory, a highly advanced but user friendly toolkit for the children to co-design and innovate), and Quirky (launched an initiative to enhance the proximity between user developed products and the market place).
2. It assists in detecting the frequency of two documents being referred individually by other publications (Shiau, Dwivedi, & Yang, 2017). It is basically implemented to mitigate the major discrepancies and issues for a specific domain (Small, 1973). It provides a better quantitative analysis of identifying semantic connections among the scrutinized documents (Shiau *et al.*, 2017; Van Oorschot, Hofman, & Halman, 2018).
3. It provides an assessment of the best dynamic collection of documents and classifies units with the maximum threshold of mutual or collaborative publications among authors, organizations and countries. It provides a measure of joint productivity to the research fraternity or scholars pursuing research in a particular domain (Martínez-López, Merigó, Valenzuela-Fernández, & Nicolás, 2018).

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