Application of Operations Research in Optimisation of Supply Chain Management

Author Name: Sameer Goel

NMIMS Anil Surendra Modi School of Commerce

Author Name: Ronit Billimoria

NMIMS Anil Surendra Modi School of Commerce

Abstract

Purpose: All processes that transform raw materials into finished goods are included in the management of the flow of goods and services, and "optimization" is the key to achieving the highest level of efficiency by adjusting supply chain operations. The incorporation of quality control into the entire production process, from the sourcing of raw materials to the distribution of goods to clients, is implicitly supported by the supply chain. Initiated by British logistician and consultant Keith Oliver in an interview in 1956, the terms "supply chain" and "SCM" today play a crucial role in many enterprises. By giving businesses greater flexibility and enabling them to impose restrictions further down to meet specific requirements, supply chain optimization ensures that the best quality product is always created. The simple application of an idea won't result in actual output unless and until its performance is thoroughly evaluated. The pace of technological progress is quick and dynamic. As a result, it becomes vital to comprehend where people stand in terms of supply chain study. The current paper's objective is to review significant supply chain research conducted by eminent researchers, including authors, journals, leading institutions and universities, and citation data.
Keywords: **Operations Research; Supply Chain Management; Optimization; Supply Chain**

1. INTRODUCTION

In this age of digitization and technology boom, the importance of the Supply Chain has increased drastically. Real-world commerce is incredibly dynamic and competitive. The nature of global market competitiveness has changed from historical supply chains to current innovative supply chains as a result of the high rate of innovation, technology, globalization, and customer expectations. (Movahedipour et al. 2016)". Having a competitive advantage is very essential. While many organizations focus on product development as a way of achieving competitive advantage, an organization can effectively save costs and make higher margins by optimizing the supply chain.

An organization's supply chain is crucial to the way its business is run. The supply chain affects an organization's productivity and performance traits, which are directly related to price. Therefore, it's essential to reduce costs while increasing supply chain efficiency. A manufacturing corporation must make important decisions about which warehouses to use, how the product should be transported between them, how to get the goods to customers affordably, etc. "Intel, one of the biggest producers of computer chips worldwide, requires little introduction. Consequently, after releasing its inexpensive "Atom" chip onto the market, the company found that it was necessary to dramatically cut supply chain expenses. For units selling for $100, supply chain costs of roughly $5.50 per chip were manageable; however, the cost of the new chip was only about $20.("Success with Supply Chain Cost Reduction: 7 Mini Case Studies" 2019)".

Globally, the SCM industry is anticipated to expand from $15.58 billion in 2020 to $30.91 billion in 2026. (Placek 2022).

Many Quantitative techniques have been used to achieve optimization in the supply chain. For example:

- Monte-Carlo simulation technique
- Closed-Loop supply chain network design
- Modern optimal program control (OPC) theory
- Linear programming model
- Genetic Algorithm (GA)
- Multi-Objective Optimization
- Rational Analysis method
- Cost-to-Serve (CSM) method
- General algebraic modeling system

These techniques have been observed in many of the research papers while studying them briefly.

OR is an analytical tool for problem-solving and these techniques and methods are a part of OR. It simplifies complicated business problems into well-defined mathematical constructs. One of the primary characteristics of OR is optimization and minimization. This scientific tool provides a powerful approach to decision-making and can greatly contribute to achieving optimization in Supply Chain. Supply Chain is highly underrated. This topic has been taken to show the importance of the SCM and how its optimization

can lead to a lot of benefits and give a company a competitive advantage. While many companies focus on profit maximization using an increased advertisement or a deep discounting model, we want these companies to focus on reducing their cost and giving value to the Supply Chain. SCM optimization solves the problem of transportation and logistics and all the costs associated with it.

There has been less coverage on this topic and how to achieve optimization is not common knowledge. We want to shed some light on this topic and help the manufacturers and suppliers reduce their costs which may indirectly benefit the consumers.

2. LITERATURE REVIEW

2.1 Conceptual Background

The terms "Supply Chain" and "Supply Chain Management" were coined by Keith Oliver. He is a British logistician and consultant. In an interview with Arnold Kransdorff of the Financial Times on June 4, 1982, he used these terms for the first time in public. (Heckmann, Shorten, and Engel, n.d.)."

There are two aspects to SCM Optimization.

i. Optimization of Supply Chain Management in a broader sense: it considers supply chain processes in general and makes these processes efficient. It applies to managerial approaches and focuses on improving supply chain performance.

ii. Optimization of Supply Chain Network: "achieving supply chain optimization through a quantitative approach. Large-scale data-intensive problems can be solved using this approach. (Malinovskaya 2021)"

2.2 Evidence from Literature

SCM essentially refers to the flow of products and services that is centrally managed and covers all the procedures that convert any raw materials into finished commodities. Businesses can save unnecessary expenditures to supply goods to their respective customers more quickly and effectively by adopting an effective SCM strategy. Planning, sourcing, manufacturing, and returning are all phases in SCM.(Ahumada and Villalobos 2009)

Today, practically all sectors use SCM in new directions that we had never considered. For instance, establishing and

3. OBJECTIVES OF THE STUDY

This paper aims to improve the economy and contribute to sustainability in Supply Chain using OR. The goal is to help manufacturers, suppliers, and consumers by reducing costs and increasing income. "People want to know if this was grown sustainably. From where did these oats originate? How much carbon is emitted by this box of cereal? After learning this, do I want to buy it? With the help of better supply chain monitoring systems, all of this customer-facing data plus various additional parameters of particular relevance to the product's maker can be quickly gathered and consistently displayed. (Lawson n.d.)". "That technology can be implemented online sooner than most people think with a little government assistance. (Lawson n.d.)". "Therefore, it is

managing supply chain partnerships can be challenging, similar to the manufacturing sector. Even the most basic things are today manufactured and acquired through procedures that are quite complex in terms of the technology that is used in manufacturing, the expertise needed to produce the commodities, and the number of stages required. The only way to solve this issue is for the companies working on the creation of a new product to collaborate and the other participants in the chain right from the beginning of the product's design and engineering process.

From talking about the various industries, the supply chain is being used everywhere in the world like in the Pan-European industrial properties; then it has been used for decades including in industries like humanitarian logistics and emergency management. (Thompson 2005) In a place like hospitals too, the materials and logistics, require SCM support challenges in the chemical-pharmaceutical industries. In the past ten years, it has also been used to make mathematical advancements in modelling methodologies. From managing the high-tech industry to designing a warehouse for operation optimization, a supply chain has been used(Sapry, Ali, and Ahmad 2020). Now let's talk about the use of SCM in the agriculture department. A few of the most interesting places where it is used in the green gas industry are biomass-for-bioenergy manufacturing, digestion of the biowaste component, etc(Bekkering, Broekhuis, and van Gemert 2010). The DREAM-based multi-objective efficient procedure of Jialing River's reservoir unit uses the SCM in one of the most intriguing ways possible(Diao et al. 2021). It has been widely used in the most fundamental things, such as food chains, forest ecosystems, and the mining industry.

Speaking of more recent times, SCM was also employed during the COVID era, which used operations management approaches to shed light on efficient utilization of resources, supply and demand instabilities, and transportation network optimization(Farooq et al. 2021). In the transport and logistics of medicines, food, and other essentials, the companies have used it extensively.

SCM is also applied for upcoming investigations. SCM is being used successfully in several ways, including using meta-heuristics for a sustainable supply chain and in the function of AIs in the operations environment (Faramarzi-Oghani et al. 2022)

crucial to develop new approaches and instruments to take into account the economic, environmental, and social pillars of sustainability in a multi-stakeholder chain. In this situation, operational research (OR) techniques are essential for assisting sustainable supply chain operations.(Barbosa-Póvoa, da Silva, and Carvalho 2018)."

The fundamental purpose of this research is the answers to the questions below:

RQ1: To understand what is SCM Optimization and why is it important.

RQ2: To analyse SCM Optimization tools and techniques and how can OR contribute to achieving SCM optimization.

RQ3: To learn how quantitative techniques can be used to provide a common solution for both aspects of Supply chain optimization (as mentioned above).

4. RESEARCH METHODOLOGY

4.1 Database, keywords and inclusion criteria

A statistical review of published scientific articles, books or book chapters is known as bibliometric analysis, and it is a useful method for assessing the impact of publications on the scientific community (Iftikhar et al. 2019). To arrive at the information pertinent to this study, data was collected from The COPUS database by Elsevier. Taken from the website, "Scopus integrates superior data quality and coverage, sophisticated analytics, and advanced technology in a single solution designed to combat predatory publishing, optimize analytic powers and researcher workflows, and enable better decision-making.

5. DATA ANALYSIS AND RESULTS

5.1 Summary of review papers

SCM essentially refers to the movement of products and services that is centrally managed and covers all the procedures that convert any raw materials into finished commodities. Companies can reduce unnecessary costs and deliver goods to their respective customers more quickly and effectively by adopting an effective SCM strategy. Planning, sourcing, manufacturing, and returning are all phases in SCM.

Today, practically all sectors use SCM in novel ways that we never would have considered. For instance, establishing and managing supply chain partnerships can be challenging in the manufacturing sector. Even the most basic things are today manufactured and acquired through procedures that are extremely complicated in terms of the technology used for production, the expertise needed to produce the commodities, and the number of steps required. The only way to solve this issue is for the companies working on the development of a new product to collaborate with one another and the other participants in the chain right from the beginning of the product's design and engineering process.

From talking about the various industries, the supply chain is being used everywhere in the world like in the Pan-European industrial properties; then it has been used for decades including in industries like humanitarian logistics and emergency management. In a place like hospitals too, the materials and logistics, require SCM and support challenges in the chemical-pharmaceutical industries. In the past ten years, it has also been used to make mathematical advancements in modeling methodologies. From managing the high-tech industry to designing warehouses for operation optimization, a supply chain has been used. Now let's talk about the use of SCM in the agriculture department. A few of the most interesting places where it is used in the green gas industry are biomass-for-bioenergy manufacturing, digestion of the biowaste component, etc. The multi-objective efficient procedure of the reservoir unit in Jialing River, which was based on the DREAM algorithm, is one of the most intriguing applications of the SCM. In the most basic things like food chains, forest ecosystems, mining industry, it has been commonly used.

("Scopus | The Largest Database of Peer-Reviewed Literature | Elsevier" n.d.)".We surveyed stage 3 which was filtering the record based on.

Stage 1: Only those publications were analyzed which contained the keywords, "OR" AND "Supply Chain Management" AND (optimization OR optimisation). This search yielded 638 results.

Stage 2: Then the source type that is article and review in the English language have been included which resulted in 358 papers.

Stage 3: Included the exclusion of duplicate articles. Duplicate articles were identified using Excel and were removed thus reaching a result of 357 papers.

To talk about recent times, SCM was also used in the times of COVID. In the transport and logistics of medicines, food, and other essentials, the companies have used it extensively. Lastly, SCM is also being used for future research. By learning from past mistakes made in SCM to modify future plans, using meta-heuristics for a sustainable supply chain, and in the role of AIs in the operations environment, SCM is being used successfully.

5.2 Trends seen in the publications

5.2.1 Year-wise publications

The average growth rate of production of articles is 14.64%. This is a good sign as there is a good increase in the popularity of this topic.

Figure 2 shows the number of research papers written on the supply chain from 1995 to 2022.

It can be seen that in the late 20th century almost little to no papers were being written on this particular topic but at the beginning of the 21st century globalization started to peak along with increasing supply chains.

Figure 3 shows the number of research papers published on SCM in 5 different countries over 27 years ranging from 1995 to 2022.

We can see that the USA and UK have consistent growth in the number of research papers published because of their stable and developed economy. On the other hand, China has seen a sudden growth of these articles being published because of their rapid industrialization in the late 20th and early 21st century because of which many big corporates have started maintaining their supply chains in China. Table 2 shows the number of research articles published by different countries on SCM. As we can see China tops this list followed by the USA and India. Iran maintains the fourth spot followed by the UK and other European nations like France, Germany, and the Netherlands.

5.3 Publication outlets

The 357 publications analyzed are dispersed over 201 journals. The top 15 journals which have published these articles represent 34.73% of total publications. The European Journal of Operational Research is the top publisher with 30

papers, followed by Sustainability (Switzerland) which has published 12 papers. The International Journal of Production Economies stands third with 9 papers. The following table shows the journals' ratings as per the "Australian Business Deans Council (ABDC)" and "Chartered Association of Business Schools (CABS)".

As visible from Tables 3 & 4, the top 5 sources which represent 18.77% of total articles published, are top highly rated journals and show original and high-impact factors except for the Sustainability (Switzerland) journal. This proves the credibility of the Bibliometric review and how further analysis would be helpful.

What is interesting in the above chart is the rapid increase in the number of articles published by the European Journal of Operational Research between the years 2005 and 2007. The journals Sustainability (Switzerland) and Journal of Cleaner Production published articles on this topic for the first time in 2016. The Journal of Modelling in Management published its first article in 2018.

5.4 Author influence and their associated institution and country

Based on our data set, 1007 authors have published articles on optimizing SCM. These authors are spread across 546 organizations in 44 countries. Considering the number of publications in this research area Table 5 shows the top contributors, Dmitry Ivanov at the top of the list with 8 publications. Boris Vladimirovich Sokolov and Anish Kumar are next with 7 and 5 publications respectively. Dmitry Ivanov and Boris Vladimirovich are the two authors who are regarded as authorities in this field. They have written extensively on SCM, optimization, and supply chain. The authors with the most citations are Dmitry Ivanov and Alexandre Dolgui with 848 and 761 citations respectively. Tayur comes in third with 741 citations.

The top organizations associated with the writers of SCM are listed in the Table. Islamic Azad University, located in Dubai, with 12 publications is the organization that has published the greatest number of articles on multi-objective optimization and supply chain. Purdue University and Nanyang Technological University are ranked second and third on the list with 7 and 6 publications respectively. China (62 articles), the United States (49 articles), and the United Kingdom (16 articles) are the top three nations linked with the publication of supply chain-related articles.

5.4. Citation network analysis

Citation count determines the number of citations a given document has received over a period of time. A more frequently cited document is considered more influential and productive than those which are less frequently cited. Citation analysis is the best method to map the influence of a research publication (Goyal and Kumar 2021).

5.4.1 Average Citation per year

Figure 5 shows the average citations from the year 1995 to the year 2021. According to Figure 5, for the Year 2019, the average number of citations was 5, for the year 2020, the average number of citations was 9.4 and for the year 2021, the average citation per year: was 5.3. Essentially, average citations over 5 are considered to be good. Here, in the past 3 years, they are over 5, which means that there has been progress over the years.

5.4.2 Most Global Documents

According to Figure 6, evidently for globally cited documents, De Koster R and Eur J Oper Res (2007) is at highest with 1142 citations, followed by Linton Jd and J Oper Manage (2007), with 1115 citations and followed by Linton Jd and J Oper Manage (2007), with 1115 citations and followed by Gavirneni S, (1999), Manage Sci with 642 citations.

5.4.3 Most Local Cited Documents

'Locally Cited' means "the count of times a certain author (or piece of content) in this collection has been cited by other writers who have also written works in this collection." Whereas for local cited documents, De Meyer A, (2014), with Renewable Sustainable Energy Rev has the highest local cited documents of 5. There are various other authors like Linton Jd, (2007), J Oper Manage; Gavirneni S, (1999), Manage Sci; Ahumada O, (2009), Eur J Oper Res and Flisberg P, (2012), J Oper Res Soc with the local citations of 4. There is a significant and observable gap between the global and local cited documents which means that the global citation topics are still developing at a very good pace.

5.4.5 Most Cited Countries

According to Table 8, the most cited documents are from the country of USA with a total citations of 3198, followed by the Netherlands which has 1622 total citations. India here stands 8th in the rank with a total citation of 488. This means that the topics chosen by the country are still developing and will gradually become the most used ones. There is a theory building on these isolated papers.

5.5 Keyword analysis

The themes of the research articles are represented by the keywords employed by different authors. A keyword analysis was carried out in RStudio to investigate the most popular SCM themes. A total of 2171 keywords were identified in 358 research papers from 1995 to 2022. Figure 9 shows the top 10 keywords applied in SCM research.

"SCM" is the most frequently used keyword with 160 occurrences. The other two most frequently used words are

"optimization" (135 occurrences) and "supply chains" (89 occurrences).

There is harmony in the conceptualization of SCM, which indicates that there is a standardized meaning, which is a significant finding from this research, and because of this most authors are compelled to use "SCM" as their keyword. Keywords have been excluded from the Word cloud for analysis. Decision Making was the most applied word in 14.53% of the sample size. The next major words are Inventory Control, Mathematical models, and sustainable development.

5.6 Thematic map

For the evaluation of the titles under the topic, we have used the thematic map. The four major typologies of themes—niche themes, motor themes, emerging or declining themes, and basic themes—can be seen using thematic mapping as shown in Figure 9. Under that, we have taken trigram for the SCM.

In the first quadrant, it identifies the motor themes, which means that the titles are well-developed and important themes for the structuring of a research area. This quadrant is characterized by both high centrality and density.

Now in the second quadrant, it identifies the niche themes, which are that the titles and the keywords are highly developed and isolated which also means that these themes are of limited importance and limited words in the research paper. They have a high density which means that have developed internal links but also are unimportant external links that are low centrality.

According to our thematic map, in the niche and the motor themes, integer linear programming, linear programming model, mixed integer linear, chain network design, decision support system, etc are included. It means that these words and titles are of restricted and limited importance. In our thematic map, there are no such items are included in only one of either motor or niche themes. It means that all the titles are both extremely important and highly developed.

In our thematic map, the titles are between the motor themes and basic themes which means that these words are general as well as well-developed topics.

Now in the third quadrant, we have emerging or declining themes which means that the titles are weak and still under development. It also means that these topics are marginal in the particular research papers. both low centrality and low density. All the titles of the emerging and declining themes.

Lastly, the fourth quadrant has basic themes. These basic themes generally specify that they are some general topics that are very parallel/similar/transversal to different research areas of a particular field. As we have noticed earlier also, some titles are a part of two themes. For example, biofuel supply chain, sustainable supply chain, OR perspective, logistic supply chain, supply chain system, etc mix with the basic theme as well, which means that they are declining and also, they are some general topics that are parallel or transversal in different topics of different fields. It means that even though being basic, they are under development and in the future will make great success in particular research fields. These are characterized by high centrality and low density.

In the basic themes, we have SCM, systematic literature revision, and humanitarian supply chain. These titles are only a part of the basic themes which means that they are very parallel words.

5.7 Thematic Evolution

For the analysis of thematic evolution from Figure 10, we have divided the map into two time quadrants, one being from the years 1995-2016 and the other being from the years 2017-2022. To explain thematic evolution, it is the type of approach which mixes and compares performance analysis and science mapping for keywords that are used in the particular research paper. For this particular research paper, we have noticed that keywords like forestry, optimization, production control, supply chain optimization, SCM, and business process are part of the time slice 1 which are the keywords prevalent from the years 1995-2016. Now coming to time slice 2 which includes keywords like optimization, SCM, optimizations, life cycle, and heuristic methods. As we talk about the fact that SCM is a part of both the time slices, we also notice the importance of these keywords which has been in the trend since the year 1997. To talk about optimization and supply chain optimization both have similarities from the past to the current years. There are themes in the last period like life cycle and heuristic methods which are nowhere to be seen in the first half of the period. Usually, the thematic evolution represents a structural growing pattern. Now from the table, we understand the top 4 highest occurrences with their respective keywords. We have noticed that the word optimization has been extremely important in almost 3 of the contents which means that the papers have been building on this for a long time and are still building.

5.8 Three-Field Plot

Three Field Figures or Sankey Diagrams are used to visualize the relationship between the authors, keywords, and journals. From Figure 11 we can see that the authors who have contributed to the study in this area are Dolgui A, Kaeschel J, and Puigjaner L. We can see that the top and most relevant authors like Ivanov D and Sokolov B are present in Table 6. The authors and publications, including those not included in our dataset but cited by authors in our dataset, are displayed in the left field of the Figure. Our dataset includes authors like "Ivanov D", "Sokolov B", and "Dolgui A" who have cited their previous work in the articles that are present in our data set. Other writers include Beamon B.M., "Perea E.", "Grossmann I.", "Ydstie E.", "Tahmassebi T.", "Sarimveis H.", "Patrinos P.", "Tarintellis C.D.", and "Kiranoudis C.T.", who has the most outflows of all the authors from earlier years (4). The majority of the publications that the authors cite were most recently published in the early 2000s as well as in the late 2000s. Despite this, Beamon B.M., an author who published a paper on Supply Chain Design and Analysis in 1989, is most frequently cited (as mentioned above), demonstrating the relevance of this ancient paper in the present.

Our study's primary topics are "optimization of SCM" and "OR", it is obvious that the authors primarily focus on these fields in their writings. However, the authors also included

other concepts like "simulation," "genetic algorithm," "modelling," "logistics," and "inventory" as keywords in their research.

5.9 Co-Occurrence Network Analysis

Clustering is a popular and effective approach to meaningfully grouping a mass of information and data. A cluster is a group of objects that are distinct from the objects in other clusters but comparable to one another. The positioning of the diagram's nodes and edges demonstrates how cluster analysis works. A cluster mostly comprises articles that address the same field of study, and these clusters are briefly connected. A specific cluster is represented by nodes having strong connectivity. The structural characteristic known as modularity measures the extent to which a system's strongly connected compartments can be divided into autonomous communities or clusters that engage more with one another than with other communities. An effective basis for clusters has been obtained using the Louvain Algorithm. The study area exhibits two distinct clusters. These clusters made it feasible to see connections between various studies and improve our understanding of the relationship between the studies and the dataset.

The papers from the Scopus database are grouped into two groups (Cluster 2: Optimization and OR and Cluster 1: SCM and Supply Chain) and are explained in the paragraphs that follow. The supply chain subject is explained by each cluster being different (Refer to <u>Figure 12</u>). The interconnection of several clusters is another topic covered in this paper, which is an intriguing phenomenon.

Decision-making-related SCM is the focus of Cluster 1. In SCM, selecting between a specific good or service involves multiple steps or decision phases. For effective SCM, three decision steps are required to determine how knowledge, goods, and liquidity will be handled. Also, the academic research on supply chain collaboration and sustainability has increased as a result of the worldwide movement toward sustainable development which links sustainable development with the supply chain.

Cluster 1 focuses on optimization and OR because these disciplines deal with issues like designing advanced control systems, solving and analyzing difficult problems involving the efficient distribution of limited resources while utilizing insufficient information, and creating long-term strategies to deal with conflict and cooperation. These issues have always been important and difficult for people, organizations, and economies. Additionally, inventory control can be seen explicitly accounting for multistage and fluctuating demand in the cluster illustrating production-inventory issues for the firm.

Cluster 2 focuses on OR and optimization. The disciplines of research and optimization deal with issues like complex system control design, challenging resource allocation problems involving incomplete data, and the creation of long-term strategies to deal with conflict and cooperation, all of which have always been important and difficult for people, organizations, and economies. The cluster that depicts the manufacturer's production-inventory conundrum by explicitly accounting for multistage and changing demand can also be understood as stock control.

6   DISCUSSION AND IMPLICATIONS

6.1 Findings

Despite the collaborative nature of our investigations, the top 5 categories received the majority of attention: "OR", "SCM", "supply chain" and "optimization".

Researchers and prominent managers started writing on this topic and before the 2008 financial crash these researches were beginning to catch pace after the crash, there was a fall in the number of these research but these papers once again saw a sharp increase during the pandemic when all the major supply chains emerging from far eastern countries like China, Japan, and Taiwan failed people of the western world again started researching on how to manage supply chains and diversify them from these cheap labor countries sustainably. Similar to China, India has seen rapid growth after the first decade of the 21st century as the 2010s was the time when the internet along with its resources became available in India in abundance. China has been concentrating on the supply chain because of its involvement in the last phases of global chain assembly. Effective SCM gives businesses a competitive edge over rivals, aids in the elimination of waste, and lowers inherent risks thus giving the topic international significance. Sustainability is a fairly new concept introduced in the 19th century that didn't gain importance until the end of the 20th century (Pisani 2007).

Based on our dataset, we discovered that the works of our top 10 most relevant authors, including D. Ivanov, and B. Sokolov, have undergone a significant degree of change. Ivanov D. started developing a particular multi-disciplinary technique for CN modeling in 2007 with a total of 14 citations, referencing authors like Beamon B.M. and Grossman I. to allow flexible application of various modeling frameworks. But over time, he narrowed his attention by demonstrating how epidemics and pandemics like the coronavirus (COVID-19) can substantially disrupt supply chains (SC) around the world in 2020. A total of 305 citations attest to the fact that his work was helpful in a variety of supply chain-related fields.

The Journal of Modelling in Management published its first article in 2018. This shows how this topic has gained popularity in recent years and not many journals were focusing on SCM Optimization. This also shows how digitalization has a role to play in SCM as the technology boom that started in the 2000s had its effect on SCM later on. This statement is also supported by the European Journal of OR as the number of articles published increased by 250% from 2005 to 2007. Mathematical models have been used in all research papers to solve SCM problems and achieve optimization in different industries and fields. Sustainable development is a very immerging topic in the recent economy and all organizations should focus on achieving sustainability in their supply chain.

From the analysis of the thematic map, we feel that the SCM has been in the talks for decades and has been developing for years. The fact that it is a part of the basic theme makes it even more relevant in almost all research fields. From the thematic evolution where we divided all papers into 2 time slices namely 1995-2016 and 2017-2022. As we can see, the

keywords in the first time slice were supply chain, forestry, optimization, SCM, and so on. However, in the second time slice, we say the keywords change/evolve to SCM, life cycle and heuristic methods, optimization, etc. When we excluded the keywords from the word cloud, we came up with popular words like decision-making, sustainability, inventory control, production control, etc. Therefore, we can safely say that our analysis is in line with the emerging trends

6.2 Discussions

The present article offers a distinctive contribution to the body of research on SCM and its associated fields based on the qualitative and quantitative analyses presented in the study. All factors that increase the effectiveness and performance of a supply network, such as blockchain, AI, and IoT, are never consistent in nature. Therefore, it is crucial to investigate, comprehend, and talk about the supply chain's current state and potential future work scope. The combination of the chosen keywords (supply chain, OR, scheduling, optimization, and SCM), followed by the analysis format (Biblioshiny), has not been found in the articles consulted, even though this paper was able to locate literature related to SCM. In light of the results, this work makes some understandings and suggestions for related future research investigations. First, it is advised across a wide range of industrial setups for researchers to frequently evaluate the same subjects to spot any alterations that might happen over time. The long-term study will enable experts and other interested parties to conduct critical analysis, allowing them to weigh the pros and cons of SCM. Everything appears to be consistent with the studies in the short term, but there is always an opportunity for improvement over the long term. Secondly, genetic algorithm is the buzzword. It is important to note that only a small number of sectors and industries have adopted this phenomenon.

SCM is currently viewed as one of the top concerns across various corporate entities, and mathematical modelling offers a foundation for scheduling and planning. The current research, however, leans more toward using various SCM strategies in various industries. Thirdly, today's success is rooted in operational excellence. As every project revolves around sustainability, this article begins by attempting to comprehend the ideas of operational efficiency using sustainability to benefit the economy. To put it another way, a sustainable setup is more widely accepted. But in addition to supply chain operations, sustainability is reliant on a wide range of other elements. Quantitative approaches are not being used effectively, which hurts society as a whole and certain industries (Dhamija and Bag 2020). Real progress and development are being thrown to the wind in the quest to accomplish enormous goals. Sincere demand exists for the adoption of simulation with accurate mathematical programming, but implementers lack the necessary expertise. As a result, this study proposes to consult with and evaluate SCM optimization from the perspective of 1007 different authors who reviewed 18746 references from 202 different sources between 1995 and 2022. A significant concern that needs to be addressed is how supply chain networks and management optimization are influencing both decreased and increased costs when pursuing sustainable development.

Fifth, adopting the appropriate procedures needed for optimization is not difficult; picking the appropriate approach for its implementation is. The findings of this study point to the use of heuristic and combinatorial optimization techniques in green SCM. Future studies can concentrate on determining whether the use of stochastic systems and information technology is advancing multi-objective optimization. The combination of production control and waste management is a highly intriguing contribution made by this research. The optimization of the supply chain is no exception. Any effort is only worthwhile if it can lead to economic improvement. The idea of the circular economy will be introduced in this paper together with strategic linear programming and reverse logistics. The circular economy has a great chance of addressing this characteristic, which is why waste management is the talk of the town.

6.3 Implications

A thorough and structured review was provided by this paper on the Optimization of SCM. Our findings have shown how the total number of articles published has been concentrated in hands of a few authors. The top 15 authors' production account for 16.53% of all publications. Another point is that even though productions start in 1995, these authors started writing more about this topic from 2010 onwards. A paper is more influential if it has more citations. The more influential papers have been written in the later years by the relevant authors. For reference, tables 5 and 6 have proven this statement and show how after 2015 the citations of these papers are more than those earlier than 2015.

Monitoring the authors and co-authors can provide guidelines for future research. Wang H, an author wrote a paper in 2004 on analyzing a supply chain composed of one supplier and n retailers. However, in 2020, he wrote a paper on water saving service supply chain, showing how there has been a change in personal beliefs to achieve a sustainable environment. This is just an example showing how sustainability has gained importance, similarly, more topics have gained importance in recent years.

SCM is a dynamic topic and keeps evolving with technology. With the introduction of AI and other technological developments, the importance of this topic will become even more evident.

China has the highest number of published articles whereas the USA has the highest number of citations. This is due to the importance given to the supply chain in the country. Even though India is the 5th highest producer of papers, it stands 8th with 488 citations only. This means that there is a lot of scope for this topic in India and must be given greater importance.

India being a developing economy can adopt new measures to improve its economy. "Supply Chain" plays a key role in building the economy as all products and services are supplied from one place to other. From medicines to food to furniture, all products are supplied across the country. Collaboration of authors from different countries is advised. The collaborations between developing and developed economies will help both economies, helping the developing economies with recognition and gaining popularity and incentivizing more people to start writing and researching. It also helps the developed economies by tapping into the

growing minds of the developing economies and developing relations with them for trade.

The non-keyword keyword word cloud given in Figure 8 contains Sustainable Development. This along with the author's production over time proves the importance given to sustainability. As a managerial implication, it is also suggested for the decision-makers instill confidence in the customers regarding their supply chain and how it is sustainable and doesn't harm the economy. These decision-makers should provide more information to the general public about their supply chain.

This article will be useful to all the researchers who want to research this topic and want a brief of what all earlier authors have talked about in their papers. This paper will help these researchers to understand which topics they can research and which topics are emerging and have gained importance in the eyes of the general public. This research proposes a quantitative approach to supply chain network and management optimization for future research.

7. CONCLUSION AND LIMITATION

Altogether, the article makes a major contribution to the body of supply chain knowledge that already exists. This study focused on data in the form of journals that were published between 1995 and 2022. The conclusions are based on articles that were taken from the Scopus database. Findings from the previous part have been thoroughly examined in this article. It provides academics, businesspeople, managers, policymakers, and other such organizations with some thought about how to use this knowledge for the good of the community.

Suppliers attempt to design and operate supply chains that are cost-effective and feasible through SCM. This article highlighted how Production, product development, and the data management required to manage these activities are all covered by supply chains. Supply chains cover all of the following: manufacturing, product innovation, and the information management necessary to manage these activities. The goal guiding all activities in a supply chain is viewed as raising the level of competition. Because there is no longer a single organizational unit, is exclusively in charge of ensuring that its goods and services are competitive not just from the perspective of the final consumer, but also the entire supply chain. This study examines the body of knowledge on SCM and its evolution along two distinct routes that eventually converged to give rise to the present era of a comprehensive and integrated approach to operations, resources, and inventory control. Additionally, since the research is rife with terminologies that address components or stages of this new management philosophy, this article makes an effort to define SCM in plain terms.

Firstly, Before the 2008 economic collapse, researchers and prominent managers were beginning to write on this topic, but after the crash, the number of this research got declined. However, during the pandemic, when all the major supply chains emerging from far-eastern nations like China, Japan, and Taiwan failed, people in the western world once again started researching how to manage supply chains. Secondly, With a total of 14 citations, several scholars, including Ivanov D., began developing a multi-disciplinary method for CN modeling in 2007. His work was beneficial in numerous sectors, as evidenced by the 305 citations that he has received. The technology boom that began in the 2000s had an impact on supply chain management later on, which is another example of how our research demonstrates how digitalization has a role to play in supply chain management. Also, the analysis of the thematics and clusters helped us to get a better understanding of the emerging trends. Thematic development uses both inductive and deductive reasoning to assess the text's data which is beneficial for future research studies that are related to the current analysis. This research offers a very exciting combination of production control and waste management. Choosing the best strategy for execution is more challenging than adopting the proper procedures required for optimization. The results of this study suggest that green supply chain management makes use of heuristic and combinatorial optimization strategies.

There were restrictions in the way we organized and displayed our findings. The field may be reviewed more thoroughly if the keywords were expanded to include sustainability, reverse logistics, scheduling, decision-making, and a range of other terms. There was a lack of knowledge in the initial stages about the field of SCM which was overcome in the later stages.

REFERENCES

Ahumada, O, and J R Villalobos. 2009. "Application of Planning Models in the Agri-Food Supply Chain: A Review." European Journal of Operational Research 196 (1): 1–20. https://doi.org/10.1016/j.ejor.2008.02.014.

Barbosa-Póvoa, A P, C da Silva, and A Carvalho. 2018. "Opportunities and Challenges in Sustainable Supply Chain: An Operations Research Perspective." European Journal of Operational Research 268 (2): 399–431. https://doi.org/10.1016/j.ejor.2017.10.036.

Bekkering, J, A A Broekhuis, and W J T van Gemert. 2010. "Optimisation of a Green Gas Supply Chain - A Review." Bioresource Technology 101 (2): 450–56. https://doi.org/10.1016/j.biortech.2009.08.106.

Dhamija, P, and S Bag. 2020. "Role of Artificial Intelligence in Operations Environment: A Review and Bibliometric Analysis." TQM Journal 32 (4): 869–96. https://doi.org/10.1108/TQM-10-2019-0243.

Diao, W, P Peng, C Zhang, S Yang, and X Zhang. 2021. "Multi-Objective Optimal Operation of Reservoir Group in Jialing River Based on DREAM Algorithm." Water Supply 21 (5): 2518–31. https://doi.org/10.2166/ws.2021.064.

Faramarzi-Oghani, S, P Dolati Neghabadi, E.-G. Talbi, and R Tavakkoli-Moghaddam. 2022. "Meta-Heuristics for Sustainable Supply Chain Management: A Review." International Journal of Production Research. https://doi.org/10.1080/00207543.2022.2045377.

Farooq, M U, A Hussain, T Masood, and M S Habib. 2021. "Supply Chain Operations Management in Pandemics: A State-of-the-Art Review Inspired by Covid-19." Sustainability (Switzerland) 13 (5): 1–33. https://doi.org/10.3390/su13052504.

Goyal, Kirti, and Satish Kumar. 2021. "Financial Literacy: A Systematic Review and Bibliometric Analysis." International Journal of Consumer Studies 45 (1): 80–105. https://doi.org/10.1111/IJCS.12605.

Heckmann, Peter, Dermot Shorten, and Harriet Engel. n.d. "Supply Chain Management at 21 The Hard Road to Adulthood."

Iftikhar, Pulwasha M, Fatima Ali, Mohammed Faisaluddin, Azadeh Khayyat, Maribel De Gouvia De Sa, and Tanushree Rao. 2019. "A Bibliometric Analysis of the Top 30 Most-Cited Articles in Gestational Diabetes Mellitus Literature (1946-2019)." Cureus 11

(2): 4131. https://doi.org/10.7759/CUREUS.4131.

Lawson, Doug. n.d. "Optimizing Your Supply Chain Tracking Improves Consumer Trust." Accessed August 30, 2022. https://www.forbes.com/sites/forbestechcouncil/2021/09/02/optimizing-your-supply-chain-tracking-improves-consumer-trust/?sh=110dd35a243f.

Malinovskaya, Anastasiya. 2021. "Supply Chain Optimization Explained – with an Example – AnyLogistix Supply Chain Optimization Software." 2021. https://www.anylogistix.com/resources/blog/supply-chain-optimization-explained-with-example/.

Movahedipour, Mahmood, Mengke Yang, Jianqiu Zeng, Xiankang Wu, and Shafaq Salam. 2016. "Optimization in Supply Chain Management, the Current State and Future Directions: A Systematic Review and Bibliometric Analysis." Journal of Industrial Engineering and Management (JIEM) 9 (4): 933–63. https://doi.org/10.3926/JIEM.2035.

Pisani, Jacobus A Du. 2007. "Environmental Sciences Sustainable Development-Historical Roots of the Concept Sustainable Development-Historical Roots of the Concept." https://doi.org/10.1080/15693430600688831.

Placek, Martin. 2022. "• Global Supply Chain Management Market Size 2020-2026 | Statista." GlobeNewswire. 2022. https://www.statista.com/statistics/1181996/supply-chain-management-market-size-worldwide/.

Sapry, H R M, N A Ali, and A R Ahmad. 2020. "Warehouse Design and Operation Optimization." Journal of Critical Reviews 7 (8): 76–83. https://doi.org/10.31838/jcr.07.08.16.

"Scopus | The Largest Database of Peer-Reviewed Literature | Elsevier." n.d. Accessed September 18, 2022. https://www.elsevier.com/en-in/solutions/scopus.

"Success with Supply Chain Cost Reduction: 7 Mini Case Studies." 2019. May 2019.

Thompson, B. 2005. "Pan-European Industrial Property." Journal of Property Investment and Finance 23 (4): 379–85. https://doi.org/10.1108/14635780510602435.

Tables
Table 1: Summary of Review Papers

Farooq mu;hussain a;masood t;habib ms	Supply chain operations management in pandemics: a state-of-the-art review inspired by covid-19	Review	1-33	23
Gruner rl;power d	Mimicking natural ecosystems to develop sustainable supply chains: a theory of socio-ecological intergradation	Review	251-264	23
Memari a;rahim ara;ahmad r;hassan a	A literature review on green supply chain modelling for optimising co2 emission	Review	509-525	21
Marques cm;moniz s;de sousa jp;barbosa-povoa ap;reklaitis g	Decision-support challenges in the chemical-pharmaceutical industry: findings and future research directions	Review		18
Jayasinghe rs;chileshe n;rameezdeen r	Information-based quality management in reverse logistics supply chain: a systematic literature review	Review	2146-2187	18
Jayasinghe rs;rameezdeen r;chileshe n	Exploring sustainable post-end-of-life of building operations: a systematic literature review	Review	689-722	14
Kemmerer j;labelle er	Using harvester data from on-board computers: a review of key findings, opportunities and challenges	Review		13
Romero-silva r;de leeuw s	Learning from the past to shape the future: a comprehensive text mining analysis of or/ms reviews	Review		12
Kühmaier m;erber g	Research trends in european forest fuel supply chains: a review of the last ten years (2007–2016) – part two: comminution, transport & logistics	Review	139-152	10
Romero-silva r;marsillac e	Trends and topics in ijpr from 1961 to 2017: a statistical history	Review	4692-4718	9
Yáñez-sandivari l;cortés ce;rey pa	Humanitarian logistics and emergencies management: new perspectives to a sociotechnical problem and its optimization approach management	Review		7
Faramarzi-oghani s;dolati neghabadi p;talbi eg;tavakkoli-moghaddam r	Meta-heuristics for sustainable supply chain management: a review	Review		2
Thompson b	Pan-european industrial property	Review	379-385	2
Mahmoudi m;shirzad k;verter v	Decision support models for managing food aid supply chains: a systematic literature review	Review		1
Sadeghi asl r;bagherzadeh khajeh m;pasban m;rostamzadeh r	A systematic literature review on supply chain approaches	Review		1
Tóth sf	The 17th symposium on systems analysis in forest resources: an introduction and synthesis	Review	424-427	1
Sapry hrm;ali na;ahmad ar	Warehouse design and operation optimization	Review	76-83	1
Meshalkin vp;dovì vg;bobkov vi;belyakov av;butusov ob;garabadzhiu av;burukhina tf;khodchenko sm	State of the art and research development prospects of energy and resource-efficient environmentally safe chemical process systems engineering	Review	593-604	0
Diao w;peng p;zhang c;yang s;zhang x	Multi-objective optimal operation of reservoir group in jialing river based on dream algorithm	Review	2518-2531	0

Table 2: Production of Scientific Papers by Countries

AUTHOR	TITLE OF PAPERS	DATA TYPE	SAMPLE SIZE	NO OF CITATIONS
Huan sh;sheoran sk;wan g	A review and analysis of supply chain operations reference (scor) model	Review	23-29	337
De meyer a;cattrysse d;rasinmäki j;van orshoven j	Methods to optimise the design and management of biomass-for-bioenergy supply chains: a review	Review	657-670	220
Barbosa-póvoa ap;da silva c;carvalho a	Opportunities and challenges in sustainable supply chain: an operations research perspective	Review	399-431	188
Bloemhof-ruwaard jm;van beek p;hordijk l;van wassenhove ln	Interactions between operational research and environmental management	Review	229-243	170
Tsolakis nk;keramydas ca;toka ak;aidonis da;iakovou et	Agrifood supply chain management: a comprehensive hierarchical decision-making framework and a critical taxonomy	Review	47-64	155
Wu sd;erkoc m;karabuk s	Managing capacity in the high-tech industry: a review of literature	Review	125-158	134
Bastas a;liyanage k	Sustainable supply chain quality management: a systematic review	Review	726-744	122
Bilgen b;ozkarahan i	Strategic tactical and operational production-distribution models: a review	Review	151-171	111
Lowe tj;preckel pv	Decision technologies for agribusiness problems: a brief review of selected literature and a call for research	Review	201-208	105
Bekkering j;broekhuis aa;van gemert wjt	Optimisation of a green gas supply chain - a review	Review	450-456	102
Volland j;fügener a;schoenfelder j;brunner jo	Material logistics in hospitals: a literature review	Review	82-101	99
Ivanov d;sethi s;dolgui a;sokolov b	A survey on control theory applications to operational systems, supply chain management, and industry 4.0	Review	134-147	89
Habib ms;lee yh;memon ms	Mathematical models in humanitarian supply chain management: a systematic literature review	Review		75
Pimentel bs;gonzalez es;barbosa gno	Decision-support models for sustainable mining networks: fundamentals and challenges	Review	2145-2157	66
Chopra s;lovejoy w;yano c	50th anniversary article five decades of operations management and the prospects ahead	Review	8-14	56
Dhamija p;bag s	Role of artificial intelligence in operations environment: a review and bibliometric analysis	Review	869-896	54
Vargas-vasquez sm;romero-zerón lb	A review of the partly hydrolyzed polyacrylamide cr(iii) acetate polymer gels	Review	481-498	48
Pourhejazy p;kwon ok	The new generation of operations research methods in supply chain optimization: a review	Review		45
Mišić vv;perakis g	Data analytics in operations management: a review	Review	158-169	41
Breitenmoser l;gross t;huesch r;rau j;dhar h;kumar s;hugi c;wintgens t	Anaerobic digestion of biowastes in india: opportunities, challenges and research needs	Review	396-412	41
Zahraee sm;shiwakoti n;stasinopoulos p	Biomass supply chain environmental and socio-economic analysis: 40-years comprehensive review of methods, decision issues, sustainability challenges, and the way forward	Review		38
Ivanov d;sokolov b	The inter-disciplinary modelling of supply chains in the context of collaborative multi-structural cyber-physical networks	Review	976-997	32

region	Freq
CHINA	148
USA	140
INDIA	48
IRAN	43
UK	40
FRANCE	31
CANADA	23
GERMANY	20
NETHERLANDS	19
GREECE	18

Table 3: Rating of the top Journals

Journal Name	ABDC Ranking	CABS Ranking	Total Publications
European Journal of Operations Research	A*	4	30
Sustainability (Switzerland)	NR	NR	12
International Journal of Production Research	A	3	9
International Journal of Production Economics	A	3	8
Journal of Cleaner Production	A	2	8
Journal of Modelling in Management	C	1	8
Computers and Industrial Engineering	NR	NR	7
Interfaces	NR	NR	7
Journal of Manufacturing Technology Management	B	1	7
Annals of Operations Research	A	3	6
Journal of Operational Research Society	A	3	5
Omega (United Kingdom)	A	3	5
Production Planning and Control	A	3	5
Computers and Chemical Engineering	NR	NR	4
Computers and Operations Research	A	3	3

Table 4: Meaning of Ratings given in table 3

Notes:

Ratings	Meaning
A* (ABDC)	Highest quality. Top 5%-7% journals
A (ABDC)	Top 15%-25% of journals
B (ABDC)	35%-40%
C (ABDC)	Rest of the Journals
NR	Not Ranked
4* (CABS)	Highest Impact Factor and Most Original Research
4 (CABS)	Second Highest Impact Factor and Original Research
3 (CABS)	Original Research but not necessarily a high-impact factor
2 (CABS)	Acceptable Standard Research
1 (CABS)	Standard Research

Table 4: Meaning of Ratings given in table 3

Tables 5 & 6: Author's Production over time

Author	year	TI	SO	TC	TCpY
CHENG CY	2010	THE SERVICISATION OF THE CUTTING TOOL SUPPLY CHAIN	INTERNATIONAL JOURNAL OF PRODUCTION RESEARCH	17	1.308
CHOI TM	2010	OPTIMAL SCHEDULING OF A SINGLE-SUPPLIER SINGLE-MANUFACTURER SUPPLY CHAIN WITH COMMON DUE WINDOWS	IEEE TRANSACTIONS ON AUTOMATIC CONTROL	44	3.385
DOLGUI A	2012	APPLICABILITY OF OPTIMAL CONTROL THEORY TO ADAPTIVE SUPPLY CHAIN PLANNING AND SCHEDULING	ANNUAL REVIEWS IN CONTROL	94	8.545
GAVIRNENI S	1999	MANAGING A CUSTOMER FOLLOWING A TARGET REVERTING POLICY	MANUFACTURING AND SERVICE OPERATIONS MANAGEMENT	3	0.125
IVANOV D	2007	INTEGRATED MODELLING OF AGILE ENTERPRISE NETWORKS	INTERNATIONAL JOURNAL OF AGILE SYSTEMS AND MANAGE	14	0.875
KUMAR A	2020	EVALUATION OF MACHINE TOOL SUBSTITUTE UNDER DATA-DRIVEN QUALITY MANAGEMENT SYSTEM: A HYBRID DECISION-MAKING APPROACH	TQM JOURNAL	1	0.333
MESHALKIN V	2017	MATHEMATICAL METHODS FOR THE MULTI-CRITERIA OPTIMIZATION OF STRUCTURE AND MANAGEMENT OF ENERGY EFFICIENT GAS SUPPLY CHAINS	THEORETICAL FOUNDATIONS OF CHEMICAL ENGINEERING	4	0.667
SOKOLOV B	2007	INTEGRATED MODELLING OF AGILE ENTERPRISE NETWORKS	INTERNATIONAL JOURNAL OF AGILE SYSTEMS AND MANAGE	14	0.875
TAYUR S	1999	MANAGING A CUSTOMER FOLLOWING A TARGET REVERTING POLICY	MANUFACTURING AND SERVICE OPERATIONS MANAGEMENT	3	0.125
WANG H	2004	A GAME-THEORETICAL COOPERATIVE MECHANISM DESIGN FOR A TWO-ECHELON DECENTRALIZED SUPPLY CHAIN	EUROPEAN JOURNAL OF OPERATIONAL RESEARCH	69	3.632

Table 7: Most Relevant Authors

Author	year	TI	SO	TC	TCpY
CHENG CY	2021	SUPPLY CHAIN-ORIENTED TWO-STAGE ASSEMBLY FLOWSHOPS WITH SEQUENCE-DEPENDENT SETUP TIMES	JOURNAL OF MANUFACTURING SYSTEMS	1	0.5
CHOI TM	2018	BIG DATA ANALYTICS IN OPERATIONS MANAGEMENT	PRODUCTION AND OPERATIONS MANAGEMENT	269	53.8
DOLGUI A	2020	IMPACTS OF EPIDEMIC OUTBREAKS ON SUPPLY CHAINS: MAPPING A RESEARCH AGENDA AMID THE COVID-19 PANDEMIC THROUGH A STRUCTURED LITER	ANNALS OF OPERATIONS RESEARCH	305	101.667
GAVIRNENI S	2001	AN EFFICIENT HEURISTIC FOR INVENTORY CONTROL WHEN THE CUSTOMER IS USING A (S,S) POLICY	OPERATIONS RESEARCH LETTERS	18	0.818
IVANOV D	2020	IMPACTS OF EPIDEMIC OUTBREAKS ON SUPPLY CHAINS: MAPPING A RESEARCH AGENDA AMID THE COVID-19 PANDEMIC THROUGH A STRUCTURED LITER	ANNALS OF OPERATIONS RESEARCH	305	101.667
KUMAR A	2022	AN INTEGRATED LITERATURE REVIEW ON SUSTAINABLE FOOD SUPPLY CHAINS: EXPLORING RESEARCH THEMES AND FUTURE DIRECTIONS	SCIENCE OF THE TOTAL ENVIRONMENT	3	3
MESHALKIN V	2021	CURRENT THEORETICAL AND APPLIED RESEARCH ON ENERGY- AND RESOURCE-SAVING HIGHLY RELIABLE CHEMICAL PROCESS SYSTEMS ENGINEERING	THEORETICAL FOUNDATIONS OF CHEMICAL ENGINEERING	1	0.5
SOKOLOV B	2018	A SURVEY ON CONTROL THEORY APPLICATIONS TO OPERATIONAL SYSTEMS, SUPPLY CHAIN MANAGEMENT, AND INDUSTRY 4.0	ANNUAL REVIEWS IN CONTROL	89	17.8
TAYUR S	2003	ENTERPRISE-WIDE OPTIMIZATION OF TOTAL LANDED COST AT A GROCERY RETAILER	OPERATIONS RESEARCH	30	1.5
WANG H	2022	MODELLING, SIMULATION AND OPTIMISATION OF MEDICAL ENTERPRISE WAREHOUSING PROCESS BASED ON FLEXSIM MODEL AND GREEDY ALGORITHM	INTERNATIONAL JOURNAL OF BIO-INSPIRED COMPUTATION	0	0

Authors	Articles	Articles Fractionalized
Ivanov D	8	2.83
Sokolov B	7	2.58
Kumar A	5	1.14
Meshalkin VP	4	2.63
Tayur S	4	1.67
Wang H	4	2.08
Cheng CY	3	1.08
Choi TM	3	1.00
Dolgui A	3	0.83
Gavirneni S	3	1.83

Table 8: Number of citations in different countries

Country	TC	Average Article Citations
USA	3198	65.27
NETHERLANDS	1622	180.22
CANADA	1293	143.67
GERMANY	1094	72.93
CHINA	825	13.31
FRANCE	812	62.46
UNITED KINGDOM	604	37.75
INDIA	488	32.53
IRAN	366	24.40
GREECE	351	43.88
BELGIUM	255	85.00
PORTUGAL	218	36.33
KOREA	212	30.29
TURKEY	198	66.00
HONG KONG	196	28.00
ITALY	194	48.50
SPAIN	180	25.71
DENMARK	174	87.00
SWEDEN	145	72.50
SINGAPORE	138	69.00
AUSTRALIA	121	17.29
NORWAY	116	23.20
SAUDI ARABIA	109	36.33
JAPAN	89	44.50
AUSTRIA	63	21.00
SOUTH AFRICA	54	27.00
COLOMBIA	52	17.33
BRAZIL	48	12.00
SWITZERLAND	41	41.00
MALAYSIA	31	7.75
PHILIPPINES	28	28.00
EGYPT	25	25.00
MOROCCO	16	5.33
FINLAND	15	7.50
MEXICO	9	9.00
CHILE	7	7.00
NEW ZEALAND	5	5.00
POLAND	4	4.00
THAILAND	4	2.00
JORDAN	3	1.50
SLOVENIA	2	2.00
CROATIA	0	0.00
INDONESIA	0	0.00

Table 9: Occurrences of Keywords in all research articles

Words	Occurrences
SCM	160
Optimization	135
Supply chains	89
OR	86
Decision making	52
Inventory control	40
Mathematical models	34
Sustainable development	32
Logistics	28
Scheduling	25

Table 10: Thematic Evolution Table

From	To	Words	Weighted Inclusion Index	Inclusion Index	Occurrences
optimization --1995-2016	optimization --2017-2022	Optimization; resource allocation; decision theory; food supply	0.22	0.02	86
optimization --1995-2016	optimizations--2017-2022	OR	0.07	0.04	74
optimization --1995-2016	SCM--2017-2022	inventory control; decision-making; cost-effectiveness; genetic algorithms; benchmarking; heuristic algorithms	0.12	0.02	30
production control--1995-2016	heuristic methods--2017-2022	customer satisfaction; sensitivity analysis; nonlinear programming; public policy; reverse logistics; environmental protection; profitability; robust optimization	0.20	0.03	8

Figures

Figure 1: Data Retrieval Process

Stage 1
- Documents retrieved from SCOPUS
- (Keywords: "operations", "research", "supply", "chain", "management", "optimization", optimisation")
- **n = 638**

Stage 2
- Articles and Review refined through languages with the specifications of English and journal source
- **n = 358**

Stage 3
- Removal of Duplicate Values
- **n = 357**
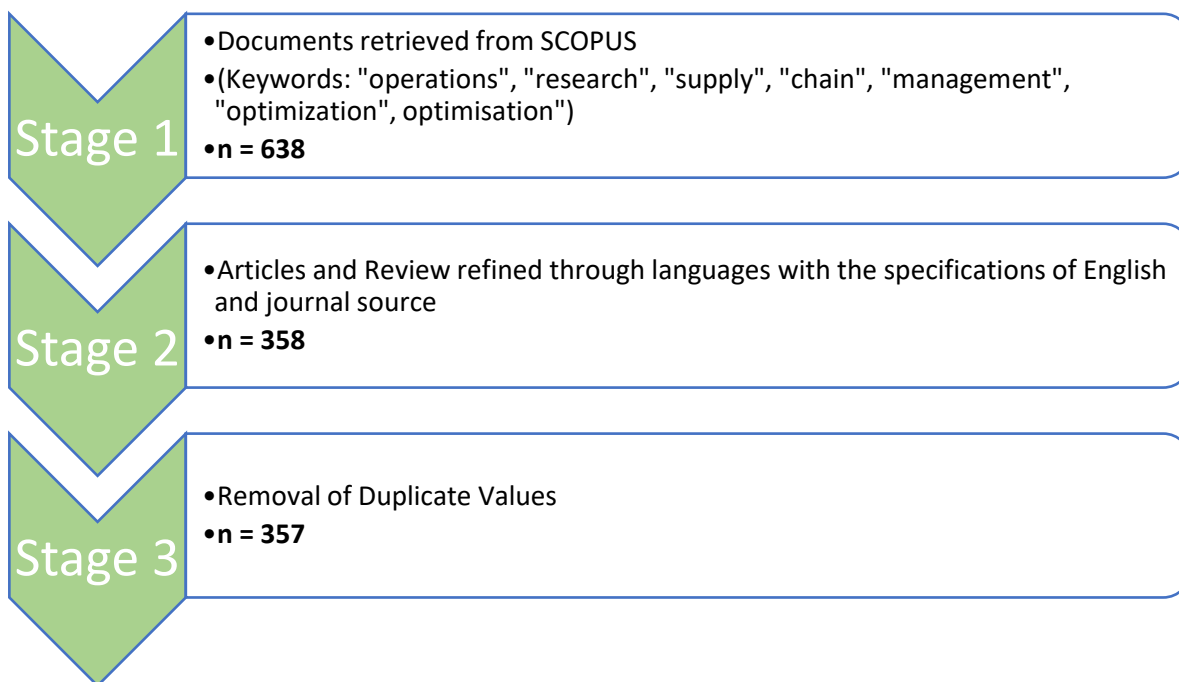
Figure 2: Production of Scientific papers over 26 years
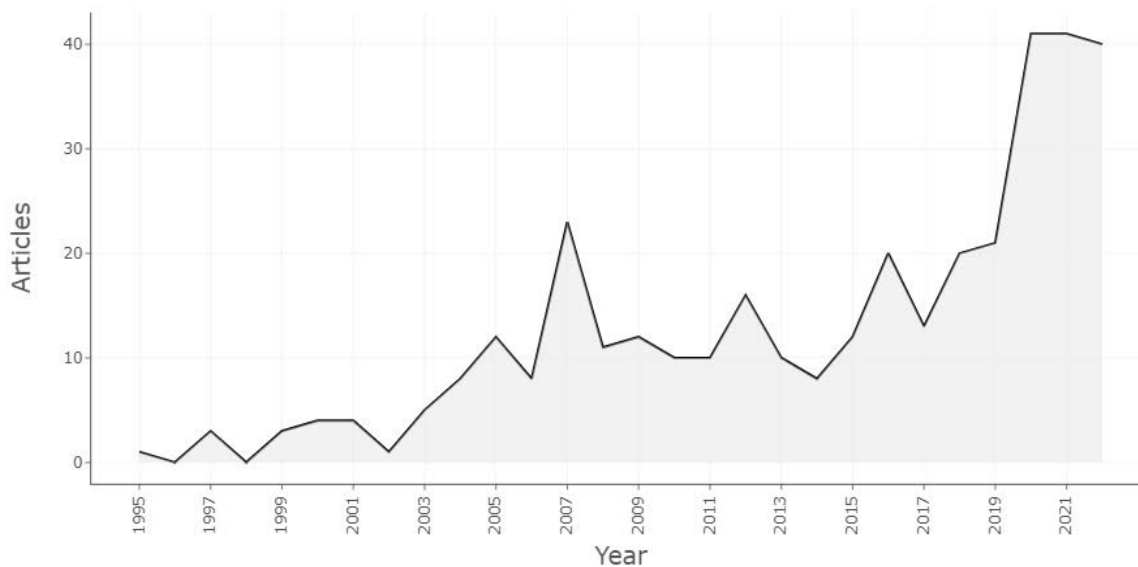
Figure 3: Production of Countries over 26 years
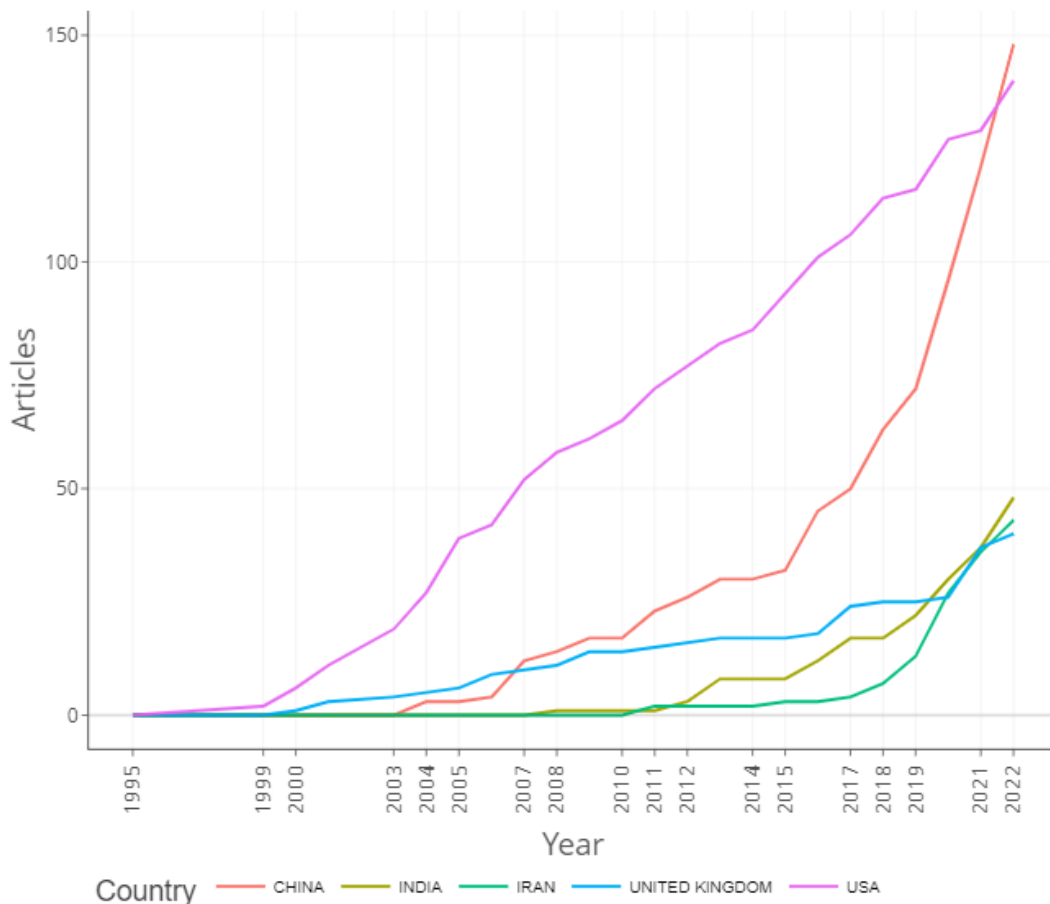
Figure 4: Number of Articles published by different papers over 26 years
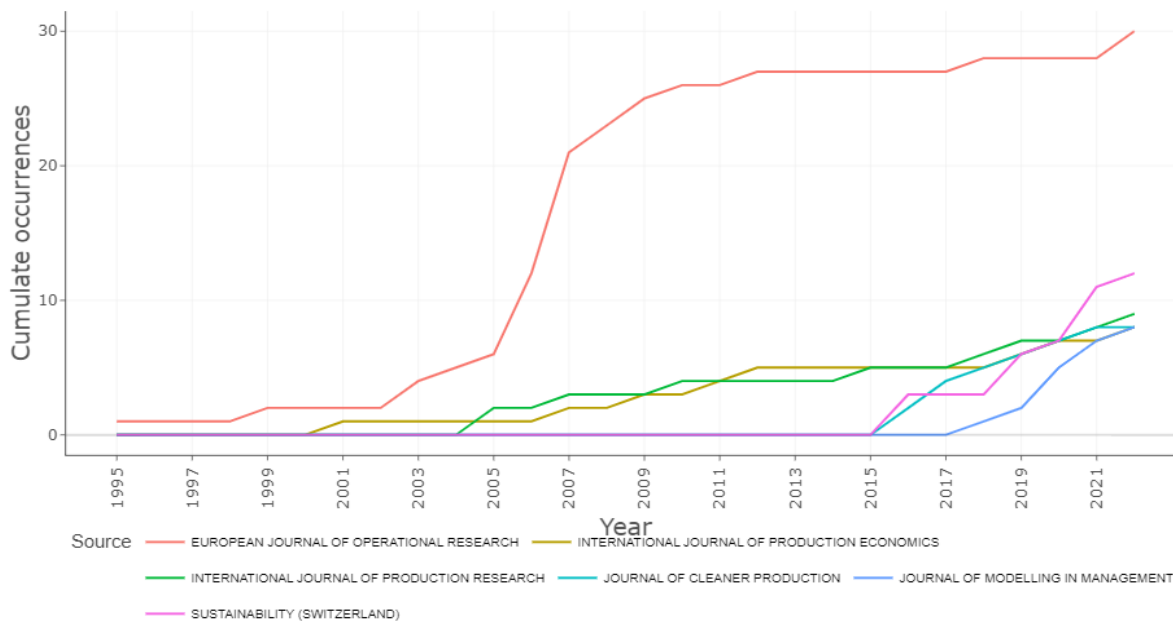
Figure 5: Average Citations over 26 years
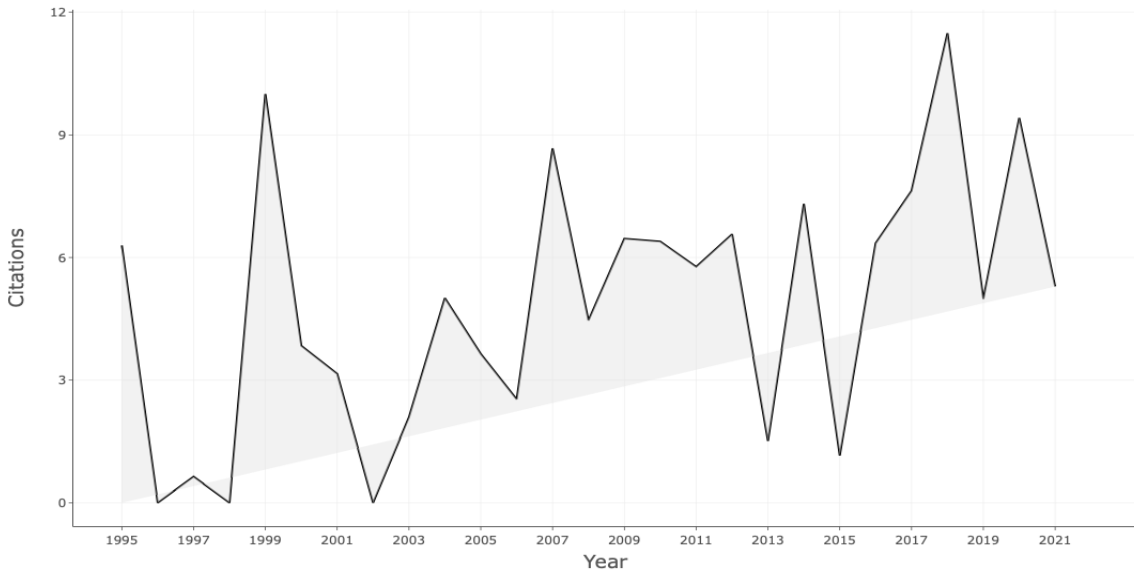
Figure 6: Global Citations by different authors


Figure 7: Local Citations by different authors
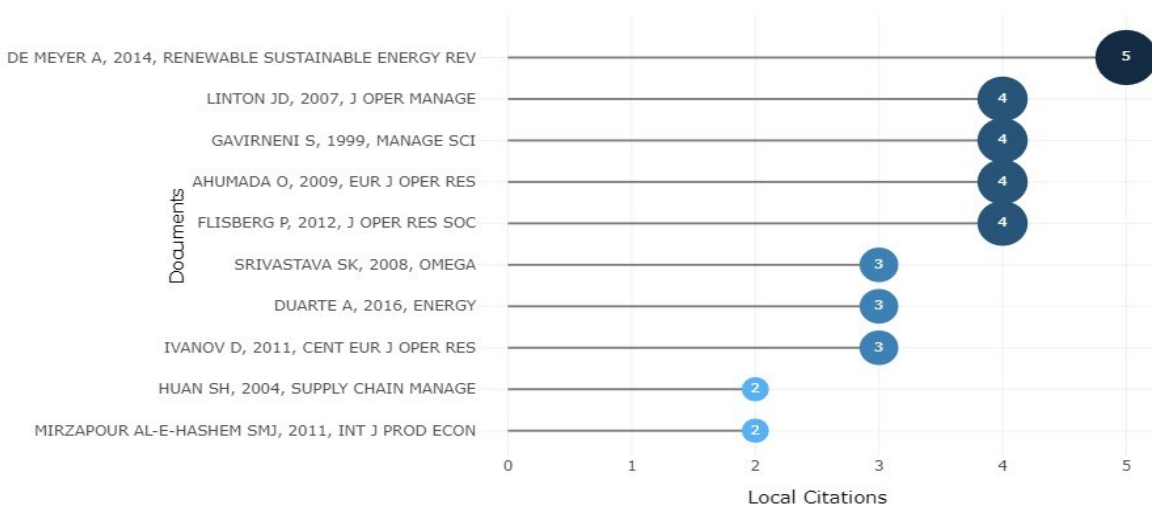
Figure 8: Word Cloud excluding Keywords

Figure 9: Thematic Map

Figure 10: Thematic Evolution
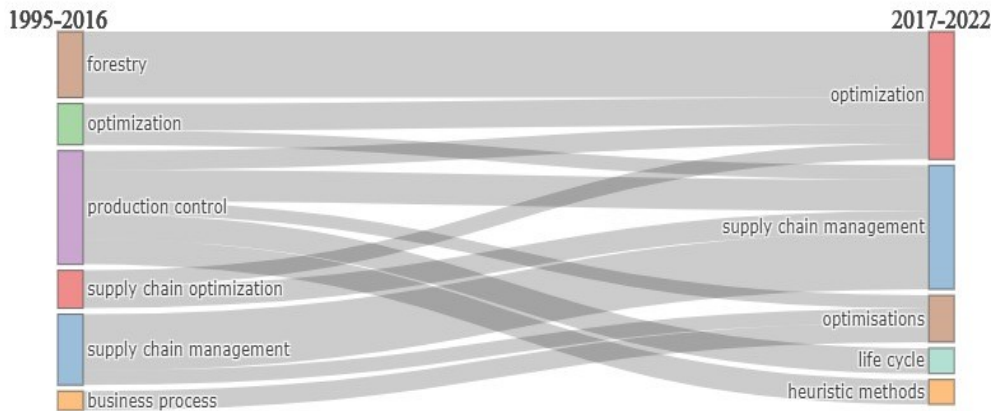
Figure 11: Three-Field Figure
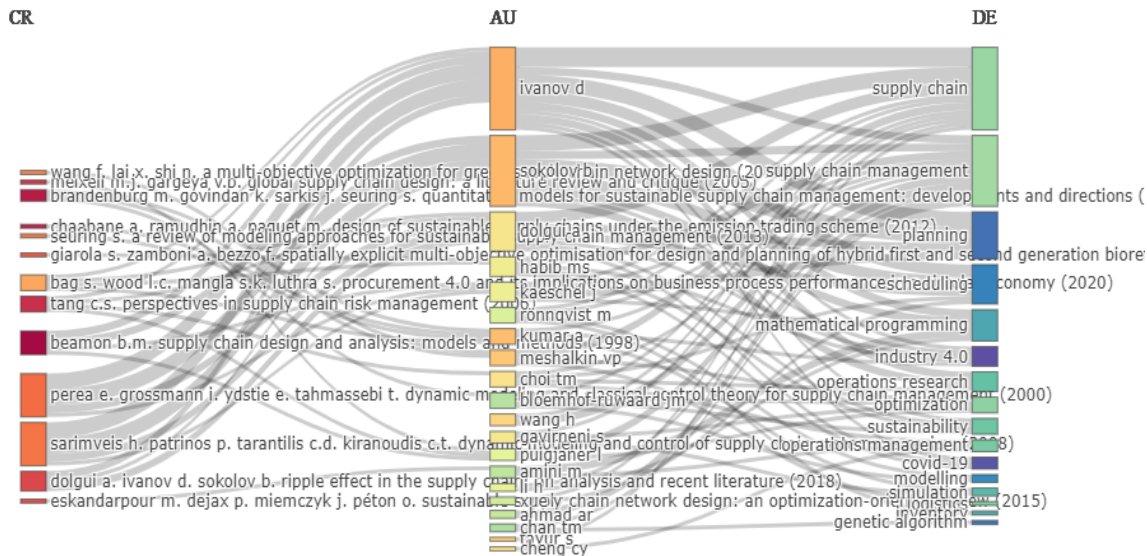
Figure 12: Co-occurrence Network