International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

Vol. 43 No. 1 February 2024, pp. 166-178

Research Development In Sustainability And Optimization Model Of Supply Chain: A Systematic Literature Review

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Abstract— Rising sustainability concerns motivate the organization to be more cognizant of its supply chain decisions. In addition to focusing on minimizing operation costs and maximizing profits, the company must evaluate the environmental and social impacts of various supply chain activities, such as manufacturing, warehousing, and distribution, since the current customers expect low-cost, high-quality products or services, rapid, flexible, and consistent delivery services, as well as an optimal environment and social consideration, which necessitates the construction and planning of supply chains with great care. This article intends to examine the implementation and utilisation of a sustainability and optimisation model for the supply chain by addressing economic, environmental, and social components through a thorough literature review. This study comprises 111 evaluated publications on supply chain optimization and sustainability published between 2015 and 2021 from Science Direct, IEEE, and Emerald database. Using the PRISMA method, this study contributes to the evaluated works categorized based on descriptive statistics of review papers, supply chain optimization issues, optimization models, and research gaps for designing a better sustainable supply chain.

Keywords— supply chain, optimization, sustainability, model, systematic literature review

I. INTRODUCTION

Current and future supply chains for all businesses are significantly more complex than ever. Governments, customers, and society expert pressure and present obstacles regarding the operation of sustainable businesses. Researchers' interest in integrating sustainability and optimization practices into supply chain-related topics is highly relevant to the current state of affairs. However, these issues make this an arduous endeavor and hold all parties accountable.

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Since the focus of all stakeholders is on environmental and social dimensions, more than maximizing return on investment by emphasizing economic performance is required. The impacts on the environment and society of diverse supply chain activities, such as production, warehousing, and distribution, cannot be disregarded. Customers expect low-cost, high-quality products/services, speedy, flexible, consistent delivery services, and an ideal social and environmental footprint; therefore, it is essential to develop and plan supply chains carefully. Strategic decisions made by business actors using supply chain networks In the context of fluctuating economic cycles and increasing globalization, supply chain network design is a prominent topic of discussion, taking into account the location and capacity of facilities as well as strategic and policy decisions about the movement between these facilities[1]. Moreover, determining the ideal degree of capacity enables a business to meet client requests with the right amount of product at the right time [2]. Maximizing capacity utilization is essential for considerably boosting logistics network efficacy and reducing total facility costs [3].

However, supply chain sustainability has emerged as one of the most innovative and significant research disciplines in decision management. With the introduction of rising themes, new theoretical and model methods, and interdisciplinary viewpoints, the number of primary and secondary research papers has skyrocketed [4]. According to the Brundtland report, the rise of resilience is a significant social motor; therefore, from an international philosophical standpoint, this idea implies satisfying the global community's needs. This concept entails meeting "the needs of the present without compromising future generations." [5], [6]. Consequently, sustainable supply chain (SSC) considerations are now integrated into supply chains. These SCs are sophisticated network systems involving various entities that handle items from suppliers to buyers and the accompanying revenues, with consideration for social implications, the environment, and the economy [7], [8]. The presence of diverse objectives and, at times, conflicts with the already complicated matter of supply chain design and planning has established supply chain sustainability as a highly relevant field of study [9].

Some researchers have researched the optimization and sustainability of supply chains. Nevertheless, developing optimized and sustainable supply networks still needs to be improved [10]. Researchers may use Simulation, mathematical modeling, mathematical programming, or a combination of these techniques to optimize supply networks [11]. Optimization and sustainability are also utilized in process industries' supply networks [12]. Numerous academics have developed optimization models based on a single-criteria mathematical model [13], Multi-objective mathematical programming[14]–[21], and In planning supply chain optimization, some academics employ Simulation as a strategy [22]–[24].

SMEs are urged to undertake challenging growth strategies to boost their competitiveness and continue adjusting to brand-new social and technological settings [25]. Indonesia is a developing country strugglingneed help to satisfy global market standards [26]. The conventional SME model, defined by a relatively limited domestic market, low levels of digital innovation, and an emphasis on sustainability, is no longer feasible [27]. Despite the aforementioned flaws, it is anticipated that a mathematical model will be able to solve the problem.

The Integration of several factors simultaneously considers three conflicting objectives: The objectives are to minimize the overall expenses of transportation and fixed costs, minimize the total CO2 emissions resulting from transportation, and maximize the utilization of capacity in each level of the network. The proposed model can be implemented to determine the optimal quantities of products to be transported, the optimal number and locations of wholesalers and retailers, and the optimal connections between them. Mujkić (2018) argues that social sustainability is significantly underrepresented in quantitative research and that there are fewer papers on the social aspect than the economic and environmental aspects. Sustainable supply chain management emphasizes economic and environmental performance [28], [29]. Because most social indicators are challenging to quantify and convert to mathematical models, A mathematical model is used to achieve sustainability by answering the objectives.

This research question is concise, well-defined, and has an appropriate scope. By defining terminology and locating existing reviews on a related topic to inform the development of the research question, identify gaps, and confirm that previous reviews have yet to be duplicated, the researcher can avoid duplicating efforts. (1) What descriptive statistic applies to review articles? Distribution and quantity of articles published in various journals, writer's country of origin, and distribution of publishing years from 2015 to May 2021 Linked to supply chain optimization design and sustainability? (2) What type of research topic is selected by most researchers interested in the optimization and sustainability of supply chain design? (3) What optimization model is most frequently employed by researchers in designing sustainable and optimized supply chains? (4) What

research gaps can guide future studies on the sustainability and optimization of supply chain design? Which type of proposed model is most recommended for the design of supply chain optimization and sustainability?

The structure of this work is as follows: it begins with a literature review and methodology section, which presents the findings of the descriptive analysis. Analysis and potential areas for further investigation are presented. Ultimately, the conclusion ensues.

II. LITERATURE REVIEW

2.1. Introduction to supply chains

A supply chain comprises all activities associated with the transformation and flow of raw materials into finished goods, as well as the exchange of information [29]. These processes and activities must be well-aligned to boost the efficacy and efficiency of internal and external operations and produce better results in delivering products to customers [30]. Efficient supply chain management (SCM) ensures that client demands are aligned with the flow of materials from suppliers, leading to a harmonious achievement of company goals, including excellent customer service, cost-effective products, and minimal inventory levels.[30]. SCM's core aims are reducing SC-related expenses, improving customer satisfaction through enhanced relationship management, enhancing profitability, and preserving competitive advantage for all SC-based firms [29]–[31].

2.2. Sustainability

Consumers, the government, the media, investors, and other stakeholders now require that all organizations demonstrate sustainable development in their operations [32]–[35]. Traditional operations systems are not sustainable; therefore, organizations must modify their processes to comply with regulations and achieve sustainability [36]. The consequence is that the organization must implement sustainable practices [37], [38], [39].

2.3. Sustainability supply chain

In their study, Sánchez-Flores et al. (2020) found that 50 percent of the analyzed articles focused on three dimensions, with 17.9 percent discussing environmental and 16.1 percent discussing social aspects. Additionally, 12.5 percent of the articles addressed environmental and social components, while just 1.8 percent focused on the economic and environmental components.

Table 1. Previous research

Authors and year	Optimization model used	Eco 1Min 2 Max	Env 1Min 2 Max	Soc 1Min 2 Max	Research focus
[20]	multi-objective mathematical programming model	1	1	-	network
[41]	three-objective mixed-integer linear mathematical model	2	2	2	network
[42]	mixed-integer linear programming model	2	1	-	distribution
[43]	multi-objective mathematical model	1	1	-	network
[44]	multi-objective optimization model	1	1	-	All SC Process
[45]	multi-objective optimization model	2	2	2	network
[46]	Robust Optimization and Mixed Integer Linear Programming (ROMILP)	2	1	-	network
[17]	multi-objective robust optimization model	2	1	2	network
[47]	robust supply chain network design optimization model	2	1	2	network

	to				
[48]	multi-objective mixed integer linear programming model	2	0	-	network
[14]	multi-objective	1	1	-	network
[49]	Multi-objective	1	1	2	network
[50]	MINMAX goal programming method.	1	1	-	network
[51]	bi-objective decision support model	1	1	-	network
[21]	multi-period single objective mathematical model	2	-	-	network
[52]	multi-objective mixed-integer linear programming	1	1	-	network
[53]	multi-objective mixed-integer	2	-	-	All SC Process
[54]	bi-objective mathematical model	1	1	-	network
[55]	multi-objective mixed integer linear programming (MILP) problem	1	-	-	network
[56]	multi-objective optimization model	2	1	-	network
[57]	mixed-integer programming model	1	1	2	network
[58]	multi-objective optimization problem that can be solved using Pareto optimal solution	1	1	2	network
[59]	multi-Objective Optimization	3	1	1	network

2.4. Supply chain optimization

Supply chain operations are interconnected with supply chain optimization subjects, which are essential for formulating strategic, tactical, and operational choices. Some examples encompass supply chain network optimization, strategic positioning of facilities/depots, forecasting and planning for supplies, scheduling and planning for production, optimizing inventory levels, capacity planning, determining optimal lot sizes, and selecting suppliers and carriers. Supply chain operations and cost efficiency can be determined using a mathematical model. By employing linear programming, mixed integer programming, multi-objective linear programming, multi-objective mixed integer programming, fuzzy mathematical programming, stochastic programming, heuristics, and hybrid models, intricate supply chain issues can be effectively resolved.

III. RESEARCH METHOD

In order to address the research gap noted earlier, a systematic literature review approach was employed to identify the utilization of the Preferred reporting Items for systematic reviews and Meta-Analyses (PRISMA) criteria for data screening and selection [60]. Many researchers use this PRISMA method to find the gap, trend, research opportunity, and the position of research, particularly for supply chain optimization and sustainability [61]–[65]. The phase that must be completed to respond to the research question posed in this paper.

3.1. Define criteria for inclusion and exclusion

We chose Science Direct, IEEE, and Emerald Insight to search for target articles in digital databases. Each article that met the stated requirements was included. We restrict the criteria for this topic by selecting English-language literature, peer-reviewed articles, research articles, and conferences published between 2015 and May 2021.

In order to be considered for this evaluation, the seleected articles must meet all of the following criteria: 1) The article should be written in English and published in a peer-reviewed journal. 2) The paper should utilize mathematical modeling (specifically optimization) as a research methodology for decision-making. 3) The objective functions or constraints of the models should explicitly consider the economic, environmental, or social aspects of sustainable supply chains [10].

3.2. Search for studies

The study selection process comprised a literature search followed by three screening and filtering rounds. First, by examining the paper's title and abstract and downloading each article, *"sustainable OR sustainability OR "triple bottom line" OR green) AND (optimize* OR optimization OR "mathematical modeling") AND ("supply chain" OR "supply chain management")* second filter after extraction the articles from the first filter, we remove duplicate articles, and we focus on the design of the model. In addition to that, we read the full text for each article to get vital information to support the research.

3.3 Select studies for inclusion based on pre-defined criteria.

The search was started in the middle week of May 17, 2021. For the first time, we used the keywords sustainable supply chain and optimization—the number of articles needed to be more. Then, the following keywords were used in the search process. These keywords were used in a Boolean search in combination with the following terms: mathematical modeling, green supply chain, sustainability, environmental sustainability, and social sustainability. We used mixed keywords that include *sustainable* OR *sustainability* OR *"triple-bottom-line" OR* green). Moreover, (optimize* OR optimization OR *"mathematical-modeling"*) AND (*"supply chain"* OR *"supply chain management"*) AND (*design*)." We exclude books, conferences, and reports. Backtracking is used to seek previous sources, and forward-tracking is used to find relevant sources that were not found through keyword searches.

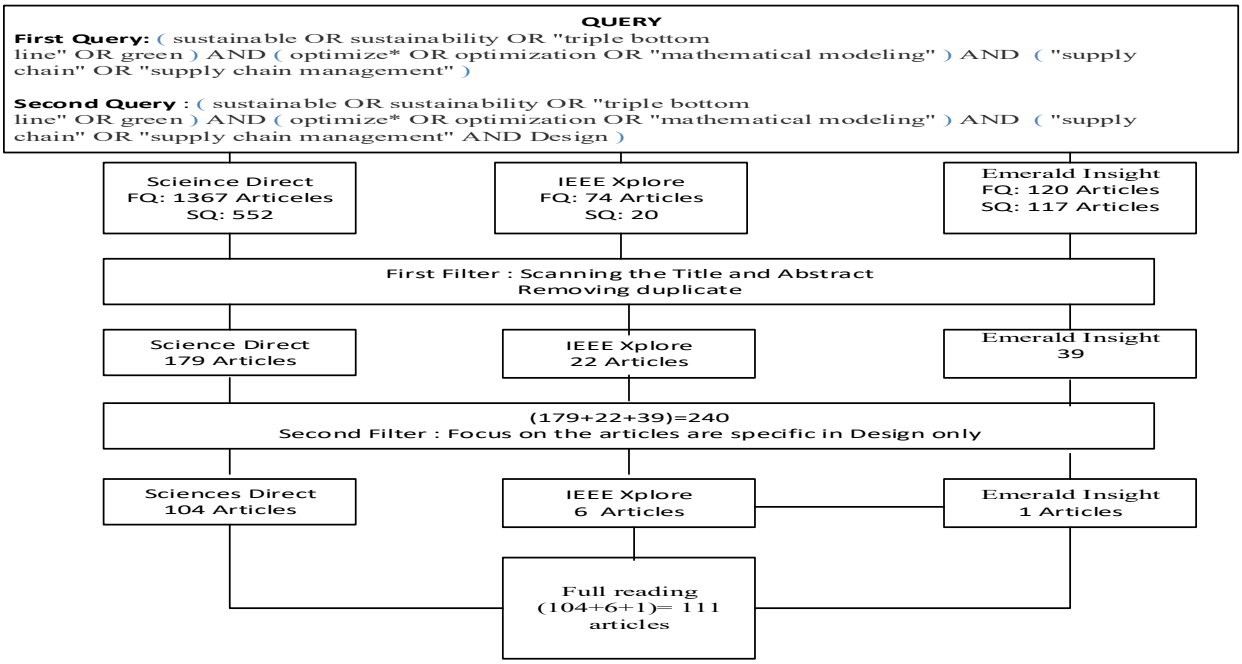

Fig. 1. Study selection flowchart, including search query and inclusion criteria

3.4. Extract data from included studies

A complete list of all included articles, with their corresponding initial categories, was compiled from the various sources into Excel files to simplify further steps. Several full-text readings were performed by the authors, as well as in running the Classification of the articles into a refined taxonomy. All comments were saved in the body of the text. The process of summarization, tabulation, and description of the main findings followed this. Sets of relevant information were saved in Word and Excel files and also exported to Mendeley, including the whole list of articles, their respective source databases, summary and description tables, and categorization tables based on the sustainability and optimization of supply chain design.

IV. Result and Discussion

4.1. Descriptive statistics

This section examines the selected papers in depth regarding year-by-year publication frequency, journal name, and writer's country of origin.

4.1.1. Year-wise frequency of publications

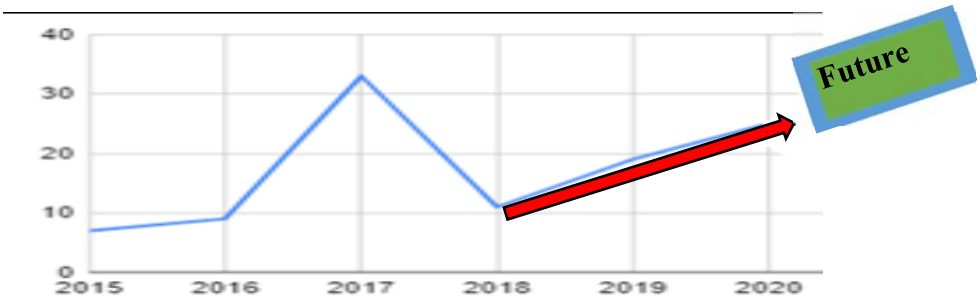

Fig. 2. Year-wise frequency of publications

Figure 2 illustrates the frequency of publications from 2015 to 2021, demonstrating variations in the quantity of published papers throughout the years. Starting in 2015, there has been a noticeable and consistent increase in the number of publications that specifically address sustainability and the optimization of supply chains. This trend is expected to persist, with a projected rise in publications in the upcoming years.

4.1.2. Name of publisher

Table 2 presents the distribution of papers reviewed. 94% of papers were sourced from Science Direct, followed by IEEE and Emerald.

Table 2. Name of publisher

Name of publisher	No of paper	Percentage
Emerald	1	1%
IEEE	6	5%
Science Direct	104	94%
Total	111	100%

4.1.3. Name of country origin of writer

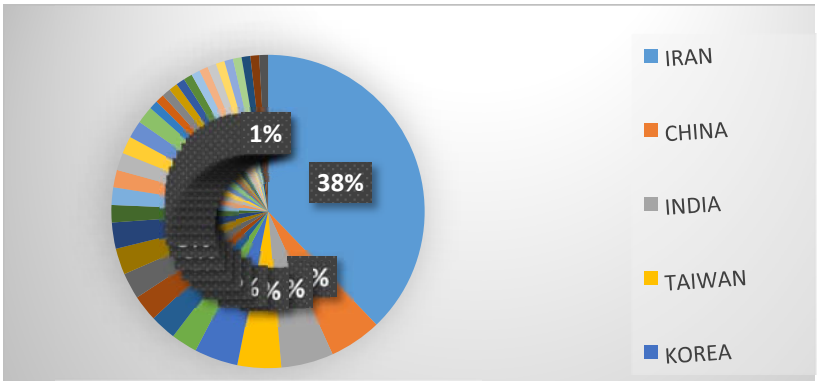

Fig. 3. The top country of origin of the writer

According to Figure 3, most papers (38%) were published in Iran, with China, India, Taiwan, and Korea each accounting for 5% of the publications. The remaining countries contributed less than 5% each. Indonesia especially still requires more attention from reseachcers, academision and all others stakeholders.

4.1.4. Classification of literature paper from the perspective of sustainability criteria

Table 3. Classification literature paper

Research on	Number of paper	Percentage
Eco	6	5.41%
Eco and Env	68	61.26%
Eco and Soc	0	0
Env and Soc	0	0
Eco, Env, and Soc	37	33.33%
Total	111	100%

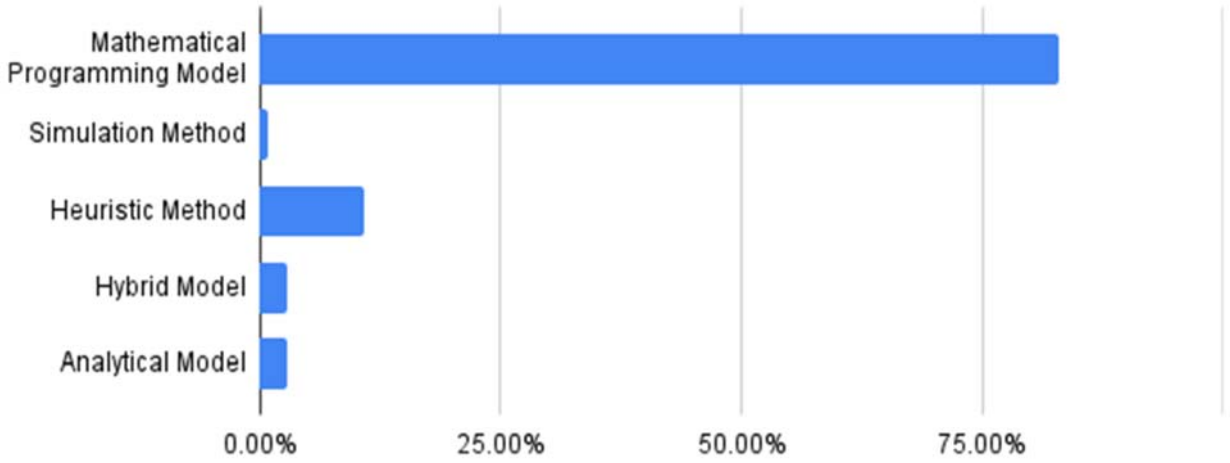

Fig. 4. Optimization model used by researchers

Of the 111 publications examined, 33.3% concentrate on three specific dimensions: economic, environmental, and social. Additionally, 61.26% of the papers address economic and environmental dimensions. There are still prospects for future research that can focus on the three characteristics.

4.1.5. Journal distribution

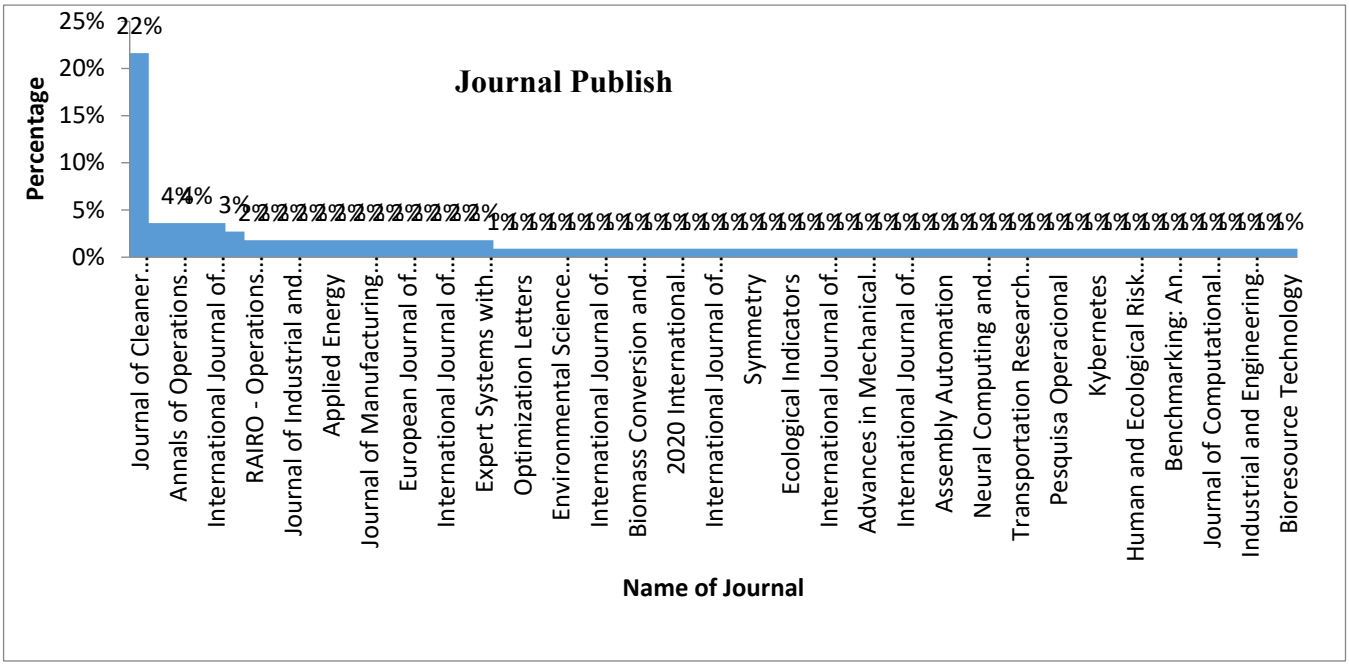

Fig. 5. Publication of papers over time

Fig. 5. depicts the Name of the Journal publication. Journal of Cleaner Production is the leading publication (22%), followed by Annals of operation research (4%) and the International Journal of Production Research (4%).

What kind of optimization model is the most used by the researcher on the design of supply chain sustainability and optimization of the supply chain?

Fig. 5. shows that the mathematical programming model is the most used, followed by the heuristic's method, analytical model, hybrid model, and Simulation.

What kind of research topic area related to the design of supply chain sustainability and optimization is selected by most researchers?

From 111 papers reviewed, 93 papers, or 83.78 %, discussed network design and the rest discussed all stages along the supply chain.

4.2. Discussion

This study attempted to systematically review the existing literature on the optimization and sustainability of supply chains. A systematic search of the existing literature from three databases, Science Direct, IEEE, and Emerald, identified 111 articles from 2015 to 2021.

Based on the analysis of 111 papers, most indicate a consistent rise in articles focused on sustainability and optimization from 2018 to 2020. Among the three databases used as sources for the articles, most papers were published on Science Direct, followed by IEEE and Emeralds. Based on the papers analyzed, the writer's nationality may be traced back to five countries: Iran, China, India, Taiwan, and Korea. The proportion of papers focused on the economy and environment is 61.2%, while research that examines the economic, environmental, and social aspects accounts for 33.3%. Economics, social sciences, and environmental studies still need more research and scope. The utilization of optimization models in response analysis is commonly observed among previous researchers. Mathematical modeling is the predominant approach, followed by the utilization of heuristics and analytical models. Additionally, hybrid models have been employed, and a few researchers have

utilized simulation methods. The frequency of papers considering the Integration of environmental and economic aspects is higher. Only a limited number of studies incorporated three dimensions into their investigation.

Regarding the predominant research topic, prior scholars had a significant interest in network design, accounting for 83.78% of the studies. The remaining content pertains to all phases within the supply chain. The discoveries may result in multiple suggestions for future investigations. Currently, the sustainability and optimisation approach research is at its preliminary phase and has certain limitations. Prior researchers have mainly concentrated on examining the sustainability method and only focused on the design of the network. However, the Simulation of the intended network currently needs to be improved.

V. CONCLUSIONS

The systematic review elucidates the Integration of sustainability and supply chain optimization, specifically within the Indonesian environment. Although earlier studies have examined these topics, there needs to be more literature that primarily focuses on developing sustainable and efficient supply chains customized to Indonesia's unique characteristics, which can vary greatly. The findings highlight the possibility of future research efforts, especially in utilizing a combination of approaches. It is essential to give more consideration to small and medium-sized firms (SMEs) in Indonesia, as they have a significant impact on the country's economy. Starting from 2020, there has been a significant trend toward scrutinizing the environmental and social sustainability factors in supply chain management. In the future, the incorporation of operations research methodologies, such as mathematical modeling and optimization, shows potential for improving decision-making accuracy. An example of how mathematical modeling and simulation techniques can be used in Sustainable Supply Chain Management (SSCM) is to improve decision-making processes by making them more optimal and accurate.

Moreover, creating standardised problems for evaluation purposes and doing comparative analyses across different sustainable supply chain management (SSCM) methodologies would enhance the comprehension of the area and offer significant insights for both practitioners and researchers. Examining the differences in sustainability results in supply chains between developed and emerging economies provides an exciting opportunity for investigation, providing a significant understanding of the dynamics of sustainable supply chain practices in various socio-economic settings. To summarise, this study emphasizes the present state of sustainable supply chain research and delineates prospective directions for future exploration. Researchers can contribute to improving sustainable supply chain methods that are successful and contextually appropriate by adopting interdisciplinary approaches and prioritizing practical applications.

VI. ACKNOWLEDGMENTS

The authors would also like to thank the Universiti Tun Hussein Onn Malaysia and the University of Ibnu Sina.

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