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A Literature Review and Classification of Two-Echelon Sustainable Inventory Models in Supply Chains with Green Technology Investment

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Abstract

The inventory problem in the supply chain has significant implications for a company's financial performance, as inventory value accounts for approximately 25% of the total value of all assets owned. This paper provides a literature review and current classification of 51 articles on sustainable inventory models in supply chains with green technology investment. We evaluate 51 articles published between 2017 and 2025, focusing on key elements such as mapping existing research, identifying trends, and revealing future research opportunities in two-echelon sustainable inventory management. Mapping analysis aims to identify, visualize, and analyze the relationship between elements in a research field. The results of identifying publication trends or developments in the research field of inventory models in the supply chain, considering carbon emissions, show an increase in the publication of articles. Future research opportunities include developing a two-echelon sustainable inventory model in the supply chain that incorporates green technology investment.

Keywords:
Sustainable, Inventory Model, Supply Chain, Carbon Emissions, Two Echelon

1. Introduction
Along with the rapid development of the global economy and increasing environmental challenges, green technology and green investment have become essential components of a sustainable manufacturing industry development strategy. Green technology is a technology designed to minimize negative environmental impacts, enhance the efficiency of natural resource use, promote sustainable development, and reduce carbon emissions and pollution. Meanwhile, green investment is a type of investment focused on projects, technologies, or business activities that aim to mitigate negative environmental impacts, promote ecological sustainability, and facilitate the transition to a low-carbon economy.

Several literature review studies by researchers discuss inventory issues. For instance, Utama et al. (2025) Discuss the seller-buyer inventory model in a two-echelon supply chain, but do not consider emissions. Becerra et al. (2021) discuss a quantitative green supply chain model for sustainable inventory management. Ruggerio (2021) discusses the concept of sustainability and sustainable development in scientific research. Chotisarn & Phuthong (2025) conducted a systematic review to analyze the intellectual structure of research on the relationship between green production processes and consumer behavior. Bezerra et al. (2021) present a literature review on models for assessing corporate sustainability. Bendig et al. (2023) discuss how green manufacturing plays a vital role in the fight against climate change. Sebbe et al. (2022) discuss the two processes considered and hybrid manufacturing processes. René et al. (2022) discuss a systematic literature review on hybrid manufacturing process planning models with a predictive approach.

This research aims to fill the gap in previous literature reviews by reviewing articles published between 2017 and 2025. The results of the article review identify the latest research trends and developments in the two-echelon sustainable inventory model. Based on the description of several literature review studies, we review the problem of sustainable inventory models, especially two echelons with green technology investment, described as follows: (1) There has been no previous comprehensive review of the two-echelon sustainable inventory model between 2017-2025, and (2) Not many industries have implemented the two-echelon sustainable inventory model with green technology investment. Therefore, the research aims to review the two-echelon inventory model with green technology investment comprehensively. To provide a more focused review, this study sets out research questions (RQs), which are outlined as follows:

RQ1. What are the dominant trends in two-level sustainable inventory models?
RQ2. What procedures dominate the resolution of two-level sustainable inventory model problems in supply chains with green technology investments?
RQ3. What objective functions are frequently used by researchers to study the probability of two-level sustainable inventory models with green technology investments?
In addition, this article will review the shortcomings of previous literature review studies regarding the two-echelon inventory model with green technology investment. Research developments and directions related to sustainable inventory models are also outlined. This review contributes to the evaluation of articles on sustainable inventory models published between 2017 and 2025, focusing on emerging trends and identifying future research opportunities. This article consists of several sections. Section 1 provides an introduction and a literature review on sustainable inventory models. The data collection procedure for the sustainable inventory model, along with the keywords used, is presented in Section 2. Section 3 reviews the development of the sustainable inventory model. Section 4 reviews the classification scheme of the sustainable inventory model. Future research opportunities are presented in Section 5. The final section of this article presents the conclusion.

1.1 Objectives
This paper aims to identify, visualize, and analyze the relationship between elements, analyze publication trends on inventory models in the supply chain considering carbon emissions and waste, and help researchers to identify relevant information from the vast amount of literature more easily. This paper also aims to assess the research published in reputable international journals by considering the current research developments and classifying the articles published from 2017 to 2025

2. Methods

The method used to conduct the review involves the use of keywords, citations, author collaboration, trends, and research developments over time related to the theme. Based on a Scopus database search, 55 articles published between 2017 and 2025 were identified. This methodology is based on the article by Utama et al. (2022). The stages of the literature review are presented in Figure 1 below:

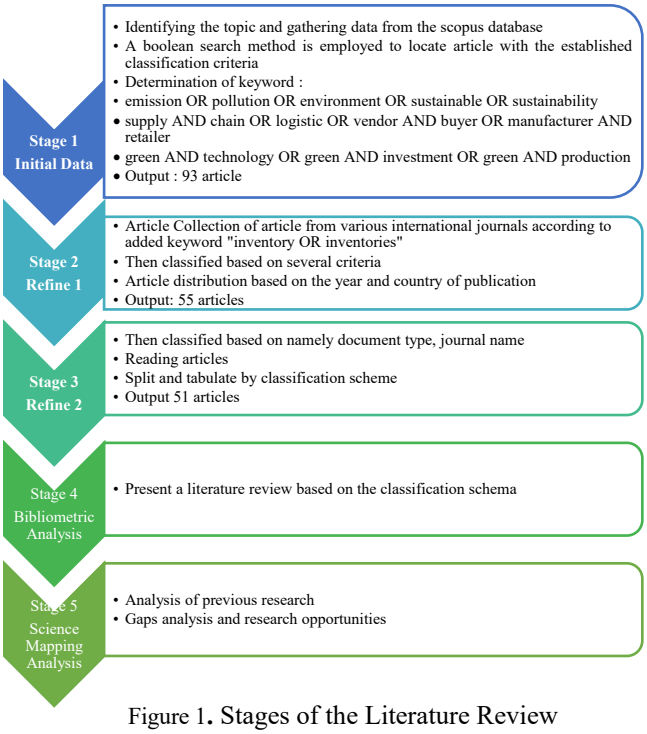

Figure 1. Stages of the Literature Review

Based on Figure 1 above, the stages in the literature review can be described as follows:
In the initial stage, the focus is on identifying the topic and gathering data from the Scopus database. A Boolean search method is employed to locate articles that align with the established classification criteria. The search utilizes specific keywords relevant to the research topic, which are as follows:

(TITLE-ABS-KEY (emission OR pollution OR environment OR sustainable OR sustainability) AND TITLE-ABS-KEY (supply AND chain OR logistics OR vendor AND buyer OR manufacturer AND retailer) AND TITLE-ABS-KEY (green AND technology OR green AND investment OR green AND production).

A search of the Scopus database from 2017 to 2025 yielded 93 relevant articles, with a focus on emerging trends and identifying critical areas for future research (Table 1).

Table 1. Rules and Keywords

Rule	Keywords
1	Emission OR Pollution OR Environment OR Sustainable OR Sustainability
2	Supply AND Chain OR Logistics OR Vendor AND Buyer OR Manufacturer AND Retailer
3	Green AND Technology OR Green AND Investment OR Green AND Production

At the refine 1 Stage, we select papers based on the theme of inventory management. The selection results show that there are 55 papers that are relevant to the topic of inventory management. At the refining 2 Stage, then classified them based on document type and journal name. We found 4 articles from the proceedings and then removed them from the review. We read the 51 articles and separated and tabulated them based on the scheme classification. At the bibliometric analysis Stage, the literature review is presented based on the classification scheme at the initial stage of searching for articles. At the science mapping analysis stage, a science mapping analysis is carried out, which includes an analysis of several previous studies and an analysis of gaps and research opportunities.

3. Data Collection

This section presents a literature review based on a classification scheme for sustainable inventory models in supply chains, based on demand rate, supply chain structure, inventory policy, investment, carbon regulation, and emission sources, are shown in Figure 2.

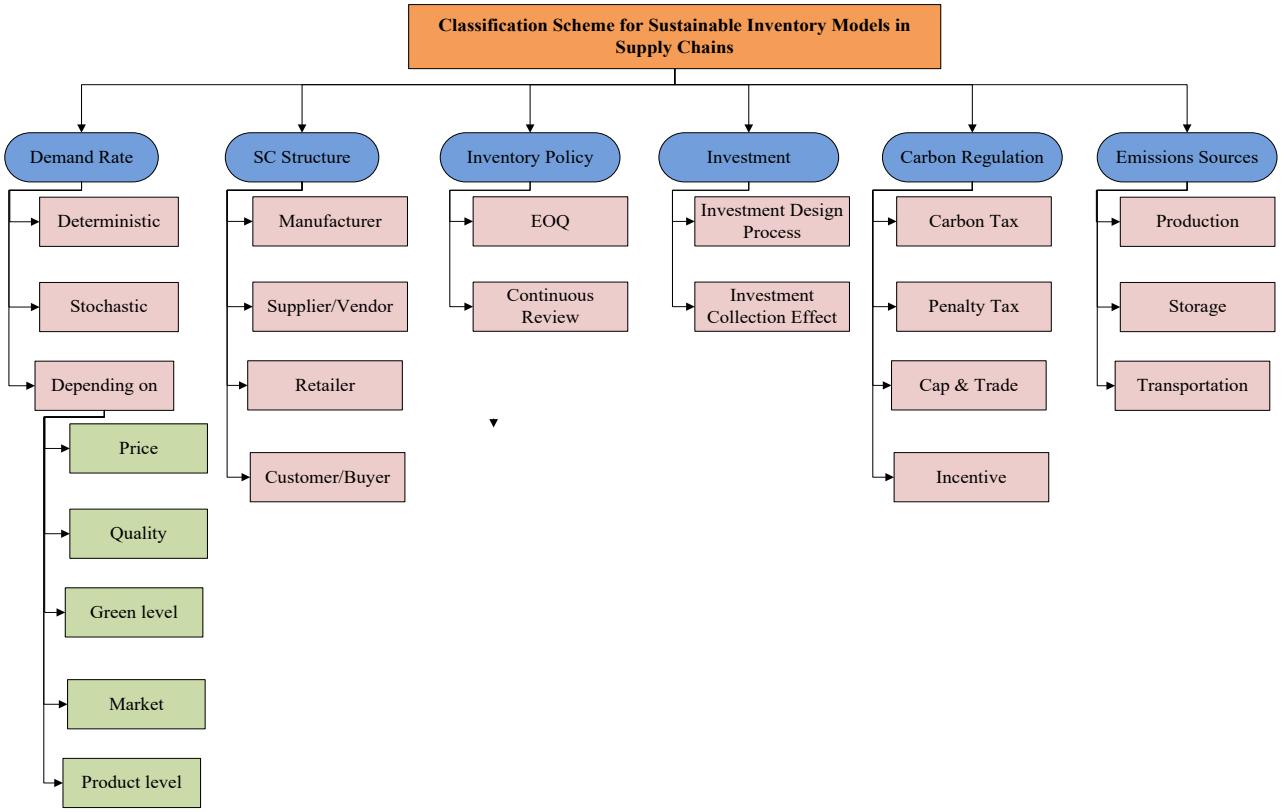

Figure 2. Literature Review Classification Scheme

Based on stage 3, we evaluated 51 articles and separated and tabulated them based on the scheme classification, which is presented in Table 2.

4. Results and Discussion

4.1 Results Review of Sustainable Inventory Model in Supply Chain

Articles reviewing sustainable inventory models are shown in Table 2.

Table 2. Review of Sustainable Inventory Model in Supply Chain

No.	Author	Demand Rate							SC Structure				Inventory Policy		Investment		Carbon regulation				Emissions Sources		
		Deterministic	Stokastic	Depending On					Manufacturer	Supplier/ Vendor	Retailer	Customer/buyer	EOQ	Continuous Review	Investment on design process	Investment on collection effect	Carbon Tax	Penalty Tax	Cap & Trade	Incentive	Production	Storage	Transportation
				Price	Quality	Green level	Market	Production level															
1	Karimi & Niknamfar (2017)	√		√					√		√		common replenishment		√		√				√		√
2	Khatua et al. (2017)	√							√	√	√		√		√						√		√
3	Bazan et al. (2017)	√							√		√		√		√		√	√			√		√
4	Taleizadeh et al. (2018)		√	√		√			√		√		√		√				√		√	√	√
5	Niknamfar et al.(2018)	√							√		√		√		√		√				√		√
6	Bai et al. (2019)		√	√		√			√		√		√		√				√		√	√	√
7	Rabta (2020)	√				√			√				√		√		√			√	√		√
8	Darzi Ramandi & Khakzar Bafruei (2020)	√		√		√			√		√					√	√		√		√		√
9	Huang et al. (2020)	√								√	√		√		√		√		√	& offset	√	√	√
10	Motla et al. (2021)		√						√		√			√		√					√		√
11	Jauhari et al. (2022)		√						√		√			√		√	√			√	√	√	√
12	Karim & Nakade (2021)		√						√		√			√	√			√			√		√
13	Paul et al. (2021)	√		√		√							√		√		√				√	√	√
14	Gautam et al. (2021)	√								√		√	√			√					√		√
15	Dey et al. (2021)		√	√					√		√		Planned Backordering dan			√					√		
16	Giri & Dash (2021)	√		√		√			√		√		√			√	√		√		√	√	√
17	Lu et al. (2022)	√							√		√		√		√		√		√		√	√	√
18	Wei & Huang (2022)		√						√		√		√			√	√				√		
19	Jauhari et al. (2024)		√							√		√		√	√		√				√	√	√
20	Jauhari (2022)		√						√		√			√		√	√				√	√	√
21	Jauhari et al. (2022)		√						√		√			√		√	√				√	√	√
22	Zokaee et al. (2022)	√							√		√	√	√		√	√					√	√	√
23	Wu (2021)	√							√	√	√	√	√			√	√				√	√	√
24	Sarkar & Bhuniya (2022)		√	√	√				√		√			√	√						√		√
25	Sarkar et al. (2022)		√	√	√	√			√		√	√	√				√						√
26	Öztürk (2022)	√		√	√					√		√		√	√		√	√					√

Table 2. Review of Sustainable Inventory Model in Supply Chain (Continued)

No.	Author	Demand Rate							SC Structure				Inventory Policy		Investment		Carbon regulation				Emissions Sources		
		Deterministic	Stokastic	Depending On					Manufacturer	Supplier/ Vendor	Retailer	Customer/buyer	EOQ	Continuous Review	Investment on design process	Investment on collection effect	Carbon Tax	Penalty Tax	Cap & Trade	Incentive	Production	Storage	Transportation
				Price	Quality	Green level	Market	Production level															
27	Sarkar, Debnath, et al. (2022)	√				√			√	√	√			√		√				√	√		√
28	Dash et al. (2023)		√	√					√		√			√	√					√	√		√
29	Thomas & Mishra (2022)	√							√		√		√			√	√				√	√	
30	Gautam et al. (2022)	√		√		√			√				√		√		√				√	√	
31	Das Roy & Sana (2023)		√	return rate dan remanufacturing rate					√	√		√			Ordering cost reduction				√	√	√		√
32	Bhavani et al. (2023)		√		√				√	√	√			√		√	√		√		√	√	√
33	Panja & Mondal (2023)		√	√		√			√	√	√		√		√		√				√	√	√
34	Bhavani et al. (2023b)		√	√					√		√					√	√				√		√
35	Heydari et al. (2023)		√	√		√			√		√			√		√				√	√		√
36	Alamri (2023)	√								√		√	√			√	√		√		√	√	√
37	Khatun et al. (2023)	√								√		√		√		√			√		√	√	√
38	Wang et al. (2023)		√		√				√	regulator			√			√	√			√	√		√
39	Jauhari et al. (2024)		√	√	√	√	√	√	√		√			√	√		√				√	√	√
40	Arora et al. (2023)								√		√				√				√		√		
41	Muthusamy et al. (2024)		√	√		√			√		√		√		√		√		√		√	√	√
42	Sahadevan & Mishra (2024)	√							√		√			√	√				√		√		√
43	Singh & Zaidi (2024)	√							√		√			√	√		√				√	√	√
44	Sahadevan & Mishra (2024b)	√							√	√	√		√			√	√		√		√		√
45	Modares; et al. (2023)		√	√						√	√		√			√				√	√	√	√
46	Guchhait & Sarkar (2024)	√	√	√	√				√		√		√		√		√				√	√	√
47	Tolgari & Zarrinpoor (2024)		√						√	√	√	√		√	√						√		√
48	Pan et al. (2024)	√		√					√		√		√			√	√					√	√
49	Thomas & Mishra (2025)	√		√		√			√		√		√		√		√		√		√		√
50	Sebatjane (2025)	√								√	√		√			√			√			√	√
51	Mahapatra et al. (2025)	√		√	iklan	√			√		√		Multi channel inventory		√				√		√	√	√

Based on stage 4, we evaluate 51 articles and present literature review based on a classification scheme, it can be seen that the inventory model in the supply chain is classified into six categories, namely based on demand rate, supply chain structure, inventory policy, investment, carbon regulation, and emission sources. There are 3 types of classification based on demand rate, namely deterministic, stochastic, and demand rates that depend on price, quality, green level, market, and product level. Some researchers Giri & Dash (2021); Lu et al. (2022); Zokaee et al., (2022); Thomas & Mishra (2025) have considered deterministic demand rates, where demand is constant over time. Researchers Bai et al. (2019); Affifah et al. (2023); Jauhari et al. (2024) have considered the stochastic demand rate. This is based on the fact that consumer demand will always change over time. In addition to these 2 types of demand rates, price-dependent demand rates are also considered by researchers Karimi & Niknamfar (2017); Dey et al. (2021); Modares et al. (2023). Some researchers consider the demand rate that depends on price and green level Taleizadeh et al. (2018); Heydari et al. (2023); Muthusamy et al. (2024). Some factors are considered in the model, such as price and quality (Sarkar & Bhuniya; Öztürk; Guchhait & Sarkar), price, quality**,** and green level (Sarkar, Ganguly et al., Zaidi et al.), quality (Bhavani et al.; Wang et al.), market (Sarkar, Debnath, et al.), price, quality, green level, market, and production level (Jauhari et al.), price and market (Mahapatra et al.).

Classification based on the supply chain structure is divided into 4 types, namely Manufacturer, Supplier/Vendor, Retailer, and Customer or Buyer. Several researchers conducted research with a supply chain structure consisting of manufacturers and retailers (Bazan et al., 2017; Jauhari et al., 2021; Affifah et al., 2023; Jauhari et al., 2024; Muthusamy et al., 2024).

Several researchers conducted research with a supply chain structure consisting of a supplier/vendor and a customer/buyer (Gautam et al., 2021; Jauhari & Wangsa, 2022 ; Khatun et al., 2023). Some researchers conducted research with a supply chain structure consisting of suppliers/vendors and retailers (Huang et al., 2020; Modares et al., 2023; Tolgari & Zarrinpoor, 2024). Some researchers conducted research with a supply chain structure consisting of manufacturers, suppliers/vendors, and retailers (Khatua et al., 2017; Bhavani et al., 2023; Jauhari et al., 2022). Some researchers conducted research with a supply chain structure consisting of manufacturers, retailers, and customers/buyers (Zokaee et al., 2022 ; Sarkar, Debnath, et al., 2022). Several researchers conducted research with a supply chain structure consisting of manufacturers (Rabta, 2020; Gautam et al., 2022 ; Wang et al., 2023). Researchers conducted research with a supply chain structure consisting of manufacturers, retailers, and customers/buyers (Azhar, 2019). Researchers conducted research with a supply chain structure consisting of a manufacturer, a supplier/vendor, a retailer, and a customer/buyer (Wu et al., 2022; Tolgari & Zarrinpoor, 2024). Some researchers conducted research with a supply chain structure consisting of a manufacturer, a supplier/vendor, and a customer/buyer (Das Roy & Sana, 2023). Researchers conducted research with a supply chain structure consisting of retailers (Affifah et al., 2023). Researchers conducted research with a supply chain structure consisting of suppliers/vendors and customers/buyers (Alamri, 2023 ; Khatun et al., 2023).

Classification based on inventory policy is divided into two types, namely EOQ and Continuous review. Researchers (Zokaee et al., 2022; Alamri, 2023; Pan et al., 2024). Consider the inventory policy with EOQ. Under the continuous review policy, product orders will be placed in the same quantities with different intervals between orders. Several researchers researched inventory policies with continuous review (Karim & Nakade, 2021; Heydari et al., 2023; Jauhari et al., 2024). Classification based on investment is divided into two types, namely investment in the design process and investment in the collection effect. Researchers (Taleizadeh et al., 2018; Bai et al., 2019; Huang et al., 2020; Panja & Mondal, 2023; Jauhari et al., 2024). Conducted research by considering investment in the design process. Several researchers have conducted studies considering the investment in the collection effect (Ramandi & Bafruei, 2020; Jauhari, 2022; Affifah et al., 2023;). Classification based on carbon regulation is divided into four types, namely carbon tax, penalty tax, cap & trade, and incentive. Several researchers have investigated carbon regulation, including the carbon tax (Karimi & Niknamfar, 2017; Jauhari et al., 2022). Several researchers have investigated carbon regulation, including the penalty tax (Bazan et al., 2017; Karim & Nakade, 2021; Öztürk, 2022). Several researchers researched carbon regulation, consisting of cap & trade (Taleizadeh et al., 2018; Asadkhani et al., 2022; Muthusamy et al., 2024). Several researchers researched carbon regulation, consisting of incentives (Rabta, 2020; Jauhari et al., 2022; (Das Roy & Sana, 2023). Classification based on emission sources is divided into three types, namely production, storage, and transportation. Several researchers researched emission sources, consisting of production (Jauhari et al., 2022; Thomas & Mishra, 2022; Modares; et al., 2023; Guchhait & Sarkar, 2024). Several researchers researched emission sources, consisting of storage (Taleizadeh et al., 2018; Jauhari, 2022; Wu et al., 2022). Several researchers researched emission sources, consisting of transportation ((Bai et al., 2019; Paleta et al., 2023; Zaidi et al., 2024)

4.2 Graphical Results Review of Sustainable Inventory Model in Supply Chain

4.2.1. Classification of Articles by Year

Based on the classification results of 55 articles based on the year of publication of the article during the period from 2017-2025, in 2022 showed that the highest number of articles was 16 articles, in 2024 (11 articles), in 2023 (10 articles), 2021 (7 articles), in 2019 (3 articles), in 2017 (3 articles), in 2025 (2 articles), in 2018 (2 articles), and in 2020 (1 article) published (Figure 3) .

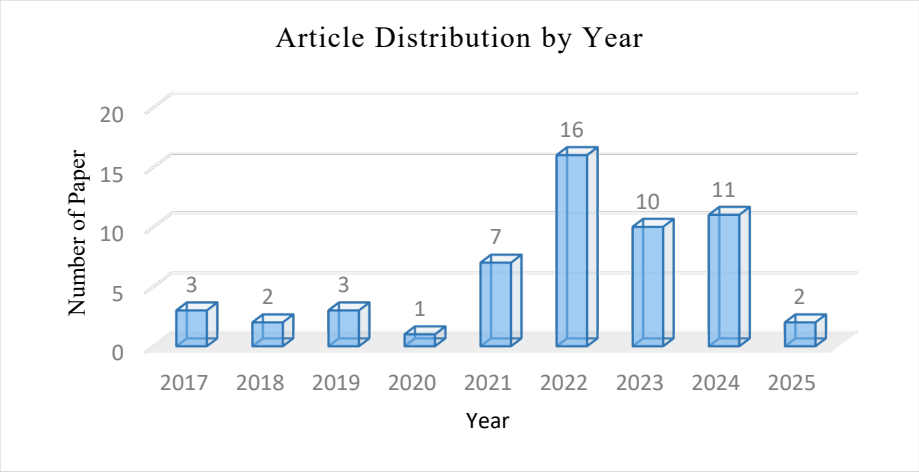

Figure 3. Graph of Article Classification Based on Year Published

4.2.1. Classification of Researcher Country of Origin

While the classification results of 55 articles based on the country of origin of the researchers who published articles show that India has the highest number, with 21 articles published by researchers. Furthermore, various countries contributed significantly, including Indonesia (8 articles), Iran (8 articles), China and South Korea (4 articles), Taiwan (2 articles), Canada, Japan, Hong Kong, Austria, Saudi Arabia, Turkey, and South Africa (1 article). The following graph shows the classification of articles based on the researcher's country (Figure 4):

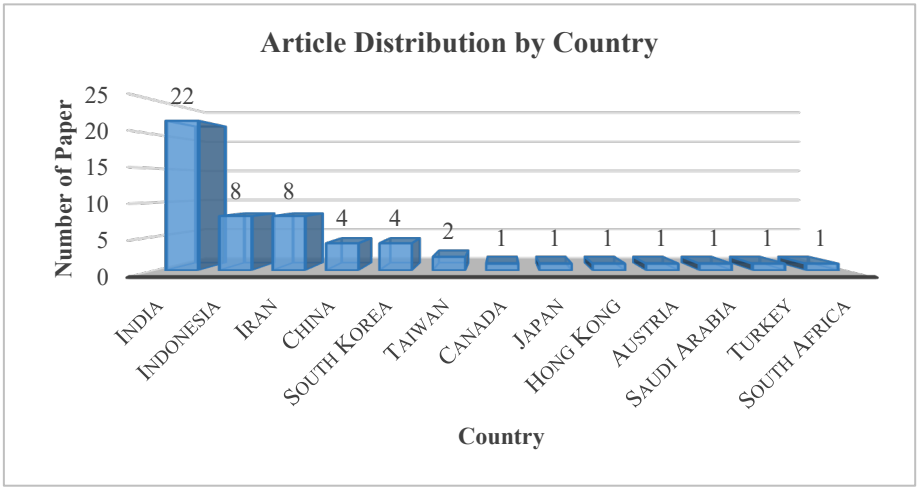

Figure 4. Graph of Article Classification Based on Researcher Country

4.3 Proposed Improvements

The development of sustainable inventory management across two tiers in the supply chain, which integrates green technology investments, currently demonstrates an increasingly complex and adaptive approach to environmental

regulations and market dynamics. Several studies in the literature review sustainable inventory management across two tiers in the supply chain that integrate green technology investments. These include Sebatjane (2025), who researched sustainable inventory models in the cold chain supply chain with green technology investments and demand dependent on stock under carbon emission tax regulations. Isnayana et al. (2024) have studied a closed-loop supply chain inventory model with carbon emissions and green technology investments. Ghosh et al. (2020) presented the impact of green technology investments on a two-tier supply chain under strict carbon cap policies. Wangsa et al. (2023) proposed a sustainable supply chain coordination model with green technology investment and electric equipment.

Based on the analysis of previous studies, the next step is to analyze research gaps. We note that current research only considers supply models in supply chains with green technology. Therefore, research focusing on sustainable two-tier supply models that integrate green technology investment presents a valuable research opportunity for the future.

5. Conclusion

Inventory issues in the supply chain have a significant impact on a company's financial performance, as inventory value accounts for approximately 25% of total asset value. We present the latest classification and literature review of 51 articles on sustainable inventory models in the supply chain published between 2017 and 2025. Based on a systematic approach, articles were selected from the Scopus database by applying specific inclusion and exclusion criteria. The articles were classified and tabulated based on a classification scheme for sustainable inventory models in supply chains, divided into six categories: demand level, supply chain structure, inventory policy, investment, carbon regulation, and emission sources. The literature review is presented to contribute to the classification scheme for sustainable inventory models, extend previous research, identify trends, and outline future research opportunities in sustainable inventory models within supply chains. This article contributes to the expansion of knowledge, consolidates fragmented literature, and adds a new classification framework for sustainable supply models.

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