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Energy Issues in Sustainable Retailing: A Systematic Literature Review

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ABSTRACT

In addition to playing a very important role as an intermediary between producers and end consumers, retail has an economic role, for example in terms of providing employment opportunities and contributing to GDP (gross domestic product). However, retail also faces several issues related to sustainability, such as consumerism, food waste, energy efficiency and carbon emissions in retail transportation activities. These issues are always related to energy. For example, carbon emissions from transportation activities are closely related to fuel consumption, and storing goods in cold storage is related to energy efficiency. This fact makes research on energy issues in the context of retail operations that support sustainability important. Therefore, in this paper, we comprehensively review and synthesize the literature on sustainable retailing by focusing on energy issues. The articles were collected from the Scopus database and filtered using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) framework. The analysis continued by applying k-means text mining to form research topic groups in a retail sustainability context. After that, the characteristics of the papers in each group are analyzed. The results show that articles related to sustainable retailing can be grouped into four clusters, with the following characteristics: 1) energy issues related to food waste; 2) energy issues related to cooled storage; 3) energy issues related to general energy issues and energy efficiency, including green models in retail buildings; and 4) energy issues related to transportation in retail. Finally, the research gap and potential research directions related to sustainable retailing issues are explained.

Keywords: *energy issues, literature review, research topic groups, retail operations, sustainable retailing*

1. INTRODUCTION

Currently, increasing awareness of environmental impacts and social responsibility involves various sectors, including education, government, and industry. The retail industry is a sector that faces ongoing challenges (Erez, 2019; Widlitz, 2020; Anderson *et al.*, 2020). In a supply chain, the role of retail is very important because retail is the party that acts as an intermediary between manufacturers and end customers. In addition, the retail sector is also important because it comprises a large workforce and creates new jobs. This is understandable because retail requires many human resources to maintain intense interaction between retailers and their end customers. In the European Union, the retail sector employs almost 30 million people (https://single-marketeconomy.ec.europa.eu/singlemarket/services/retail_en) in 5.5 million companies, 99% of which are SMEs. Additionally, according to the National Retail Federation (2024) report, retail is the largest private employer in the United States. In addition, Thangavelu (2019) reported that there is a positive relationship between retail sector productivity and economic growth and development in Singapore.

In addition to its contributions to the economic sector, retail also faces issues related to sustainability. Sustainability is a series of ideas, attitudes, intentions, and behaviors that involve strategic considerations regarding the economy, environment, and society for the success of current and future generations (Vadakkepatt *et al.*, 2021). There are several issues related to sustainability in retail, such as excessive consumption by customers, energy efficiency, water consumption, packaging, transportation, and carbon emissions (Jones *et al.*, 2005). Also, excessive consumption by customers can occur when retailers have sales targets. Sellers attempt to reach these targets by such strategies as implementing massive promotions to attract buyers. These massive promotions often trigger consumerism among consumers. The customer might decide to buy something based on their wants rather than their needs, resulting in excessive consumption in certain

situations. Excessive consumption leads to waste, which in turn is linked to sustainability issues. In addition to these issues, the use of the Internet of Things in the retail industry (de Vass *et al.*, 2021b; Khayyam *et al.*, 2022) has been discussed, and this type of technology also supports sustainable retailing (Caboni & Bruni, 2022).

The issue related to sustainability in the retail sector has gained much attention from researchers working in this area. Searching the Scopus database via the keywords "sustainable" and "retailing," 834 documents were found, with a distribution per year as shown in **Figure 1.** Various scientific journals, including the leading ones, published these articles.

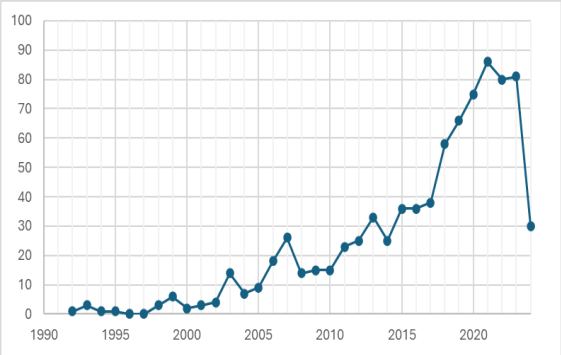

Figure 1 The number of research documents published between 1992 and 2024 with the keywords "sustainable" and "retailing" indexed by Scopus.

Figure 1 also reveals an increase in the number of publications related to the "sustainable retailing" keyword, from approximately 20 papers per year in the 2010s to approximately 80 papers per year in the 2020s. This trend proves that there is increasing attention in this area.

The importance of the research issue related to sustainability in the retail sector is also demonstrated by the number of review papers on this issue. Among the 834 documents included in **Figure 1**, 29 articles were review papers. After reviewing these articles, selected titles are presented in **Table 1**, some of which will be highlighted here. Zogg (2003) was the first review article to explicitly mention and use the term "sustainable retailing". Some of these articles focus only on single types of products, such as renewable energy (Gossling *et al.*, 2005), food (Jones *et al.*, 2008; Tian & Kamran, 2021), and fashion (Yang *et al.*, 2017; Sinha *et al.*, 2023). Moreover, some of these articles focus on the organizational structure of retail, for example, Coop (Zogg, 2003) and digital omnichannel (Vhatkar *et al.*, 2024). Some articles have focused on issues in specific regions (Zogg, 2003; Jones *et al.*, 2007; Alexander & Doherty, 2017; Chattopadhyay & Jain, 2018; Jones & Comfort, 2021), whereas other articles have focused on the consumer point of view (Gossling *et al.*, 2005; Bălan, 2021; Yusoff *et al.*, 2023). The review of Yang *et al.* (2017) in this area should be highlighted since they also explicitly used the term "sustainable retailing." They conducted a review of sustainable retailing, specifically focusing on the fashion industry. They noted that this industry, due to the short lifespan of its products and their frequent consumption, faces sustainability issues. They also noted that sustainable retailing refers to retailing practices whereby retailers minimize emissions, efficiency, and waste through continuous improvement in their internal operations.

Table 1 Selected review papers on sustainable retailing

No	Title	Authors
1	Switzerland's Coop: Working closely with suppliers	Zogg (2003)
2	A target group-specific approach to green power retailing: Students as consumers of renewable energy	Gossling *et al.* (2005)
3	Sustainable development and the UK's major retailers	Jones *et al.* (2007)
4	Moving towards sustainable food retailing?	Jones *et al.* (2008)
5	The Origins of American International Retailing: Tiffany of New York in London and Paris, 1837-1914	Alexander & Doherty (2017)
6	A study on organized retail infrastructure development and its various implications in Indian context: Literature review	Chattopadhyay & Jain (2018)
7	Sustainable retailing in the fashion industry: A systematic literature review	Yang *et al.* (2017)
8	A review of antecedents and effects of loyalty on food retailers toward sustainability	Tian & Kamran (2021)
9	Leading European Retailers and the Sustainable Development Goals	Jones & Comfort (2021)
10	How does retail engage consumers in sustainable consumption? A systematic literature review	Bălan (2021)
11	A systematic review and future research agenda for sustainable fashion in the apparel industry	Sinha *et al.* (2023)
12	Drivers of green purchasing behaviour: a systematic review and a research agenda	Yusoff *et al.* (2023)
13	A glimpse of the future sustainable digital omnichannel retailing emerges - A systematic literature review	Vhatkar *et al.* (2024)

Pramudika *et al.* (2023) reported four groups of topics that are often discussed in the context of sustainable retailing: (1) a supply chain and retail management oriented towards a green model; (2) a sustainable business strategy in the retail industry; (3) reducing food waste in the retail industry; and (4) corporate social responsibility (CSR) in the retail industry. The classification can be summarized in **Table 2.**

Table 2 Topics that are often discussed in sustainable retailing concept

Topics	Authors
Supply chain and retail management oriented towards a green model	Adivar *et al.* (2019), Álvarez-Rodríguez *et al.*, (2020), Chkanikova & Sroufe (2021), de Vass *et al.* (2021a), Gong *et al.* (2019), Nayak *et al.* (2019), Pérez-Mesa *et al.* (2019)
Sustainable business strategy in the retail industry	Jin & Shin (2020), Kumar & Polonsky (2019), Mukonza & Swarts (2020), Nilssen *et al.* (2019), Okwu & Tartibu (2020), Wei *et al.* (2020)
Reducing food waste in the retail industry	Albizzati *et al.* (2019), Broekmeulen & van Donselaar (2019), Kayikci *et al.* (2022), Riesenegger & Hübner (2022)
Corporate social responsibility (CSR) in the retail industry	Dal Mas *et al.* (2022), Mayorova (2019), Nyame-Asiamah & Ghulam (2020), Rahdari *et al.* (2020), Swaen *et al.* (2021), Vo & Arato (2020)

Yang *et al.* (2017) stated that sustainable retailing involves two important aspects: (1) green transportation, which refers to efficiency in goods moving activities to minimize the carbon emissions produced; and (2) green store operations, which refers to retailing operations that help converse energy through waste reduction or recycling. These two important aspects are closely related to the energy issue.

Energy is an indispensable factor for sustainable development and economic growth (Rogner & Popescu, 2001). However, energy use can increase pollutants, potential dangers, and the risk of accidents while also harming the environment and natural ecosystems (Dincer, 1998). Compared with other industrial sectors, the retail industrial sector has much higher level of energy consumption (British Retail Consortium, 2016). The retail industrial sector consumes at least 500 to 1000 kWh/m^2/year of energy (Schönberger *et al.*, 2013). The largest sources of energy use in the retail sector are energy consumption caused by cooling, lighting, cooling, or space heating systems (NACS, 2020; National Business Initiative, 2014).

Sustainability practices are beginning to be widely implemented in the retail industry. This is because more than half of the customers from Generation Z, millennials, Generation X, and baby boomers have stated that when making shopping decisions, sustainability factors are more important than brands. Customers prioritize personal, social, and environmental values over low prices and good quality (First Insight, Inc., 2021).

Even though energy issues in retail are important, this topic has not been extensively studied, as shown in **Table 2**. Moreover, the articles related to this topic have not yet been comprehensively reviewed, as the list mentioned in **Table 1** shows. Therefore, this situation motivates the work presented in this paper to provide an overview of the research-related energy issue in managing retail operations to support sustainable retailing. The review presented in the paper aims to evaluate the current state of research related to sustainable retailing and provide further direction for doing research in this area. We aim to answer the following research questions:

RQ1. What is the development and distribution of topics related to energy issues in sustainable retailing?

RQ2. What potential topics could be used for further research?

The remainder of this paper is organized as follows: Section 1 presents the introduction and is followed by the research methodology in Section 2. Section 3 discusses the results of the research findings and answers to the research questions while Section 4 contains the conclusions.

2. RESEARCH METHODOLOGY

The literature review presented in this paper is conducted via the steps outlined in **Figure 2**. The methodology used, in addition to the systematic literature review (SLR) approach, which is the approach used in compiling an objective literature review to answer research questions (Tranfield *et al.*, 2003; Durach *et al.*, 2015), also adopted the use of data mining techniques, namely k-means clustering and text mining.

The SLR method can support consistency, reduce bias, and provide a reliable basis for analysis (Kitchenham *et al.*, 2010; Ummi *et al.*, 2023). The SLR method adheres to the preferred reporting items for systematic reviews and meta-analysis (PRISMA) framework (Page *et al.*, 2021). The SLR steps include (1) identifying the research questions; (2) selecting research sources; (3) defining search terms; (4) appraising (applying inclusion and exclusion criteria); (5) performing reviews; and (6) synthesizing studies (Tranfield *et al.*, 2003).

The goal of using text mining in the research methodology presented in **Figure 2** is to conduct reviews and synthesize studies in steps 5 and 6 of the SLR framework. Grouping text documents into several research topic groups can accomplish this. Text mining, also called text analysis, is a multidisciplinary activity that combines elements of data mining, linguistics, computational statistics, and computer science (Feinerer *et al.*, 2008). The main difference between data mining and text mining is that data mining usually involves structured data, whereas text mining involves with unstructured or semi structured data (Carracedo *et al.*, 2021). This study employs a text mining technique known as text clustering (Bafna *et al.*, 2016) and uses the k-means algorithm to map extensively researched topics. This research employs text mining techniques to map extensively researched topics related to energy issues in sustainable retailing.

The use of text mining to help map the research topics was adapted from previous research (Abdelaziz *et al.*, 2021; Ranjbari *et al.*, 2021; Ranjbari *et al.*, 2022; Ranjbari *et al.*, 2023) via a text mining module in VOSviewer software. VOSviewer performs text mining via the term co-occurrence algorithm and displays the results in two-dimensional term maps. Distance describes the relationship between terms in term maps. The smaller the distance between two terms, the stronger the relationship between them (van Eck & Waltman, 2011). This paper employs the k-means algorithm for clustering. The k-means algorithm for processing text data has been widely used for various purposes, for example, to identify work needs (Debao *et al.*, 2021), group news topics (Hasan *et al.*, 2022; Zhou *et al.*, 2020), and group research articles (Petrus*al.*, 2019; Wibawa *et al.*, 2022). Text clustering via k-means was conducted on

the titles, abstracts, and keywords of the research articles collected in the previous stage. The results of article clustering via the k-means algorithm are reviewed to ensure that the research articles are placed in the correct group.

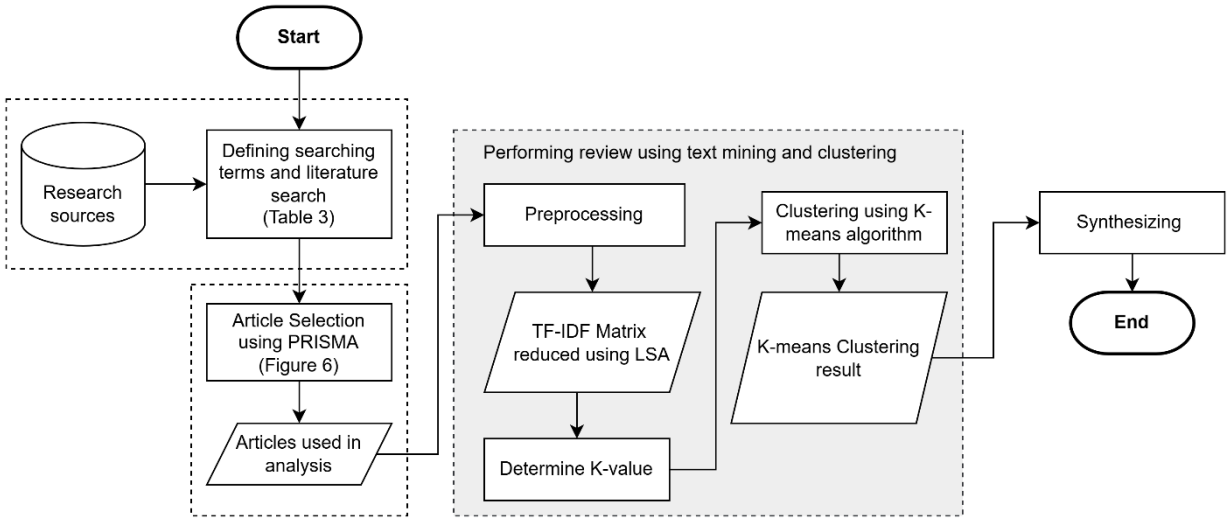

Figure 2 Research methodology

Table 3 Searching term

Searching Term	Database	Total
("retail* industry" OR "retail* strategy" OR "retail* sector" OR "retail* operation") AND (energy OR carbon OR co2 OR emission OR ghg OR "greenhouse gas") AND (reduction OR minimize* OR efficient*)	Scopus	154

2.1 Research Resources. Defining the Search Term and Literature Search

In this step, articles were collected from the Scopus database via the search terms presented in **Table 3.**

2.2 Article Selection via the PRISMA Framework

The PRISMA framework includes steps for collecting and filtering articles (Page *et al.*, 2021), as shown in **Figure 3.**

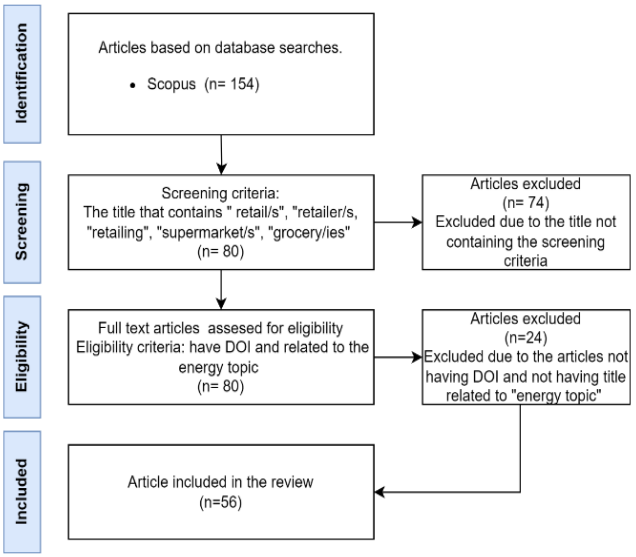

Figure 3 Steps for collecting and filtering articles via the PRISMA framework

2.3 Text Mining

Text mining is carried out via the Python programming language and Google Colab. The following are the steps for carrying out text mining:

a. Preprocessing

Preprocessing is carried out to clean text data, such as irrelevant characters, remove conjunctions or pronouns, and change words into their basic forms. Articles that have been cleaned are then weighted via term frequency-inverse document frequency (TF-IDF). TF-IDF is used to convert documents into a more structured format (Bafna *et al.*, 2016). After obtaining the TF-IDF matrix, the next step is to carry out the latent semantic analysis (LSA) algorithm to increase the accuracy of the text classification, which will be carried out next. LSA can measure the semantic similarity between two words, making it superior to TF-IDF, and the singular value decomposition (SVD) algorithm in LSA can break down matrices that have many empty elements from the TF-IDF algorithm to increase efficiency in the text classification process (Y. Li & Shen, 2017).

b. Text clustering

In this step, the articles were grouped via the k-means algorithm. The differentiating variables used in the k-means algorithm are the matrices produced in the TF-IDF and LSA weighting steps in the previous stage. Grouping begins with determining the k value, which is found via the elbow method (Yuan & Yang, 2019), and by examining the resulting groups. Grouping with the k-means algorithm was carried out via the scikit-learn library in Python. The grouping results were then plotted in the form of a scatter plot via the matplotlib library.

3. RESULT AND DISCUSSION

The number of clusters in the k-means algorithm is determined via the elbow method, as shown in **Figure 4,** and the results of the clustering can be seen in **Figure 5.**

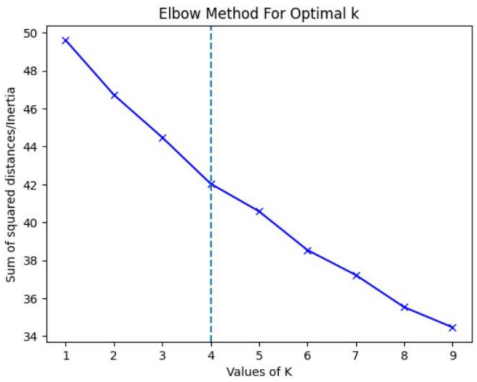

Figure 4 The number of clusters using Elbow method

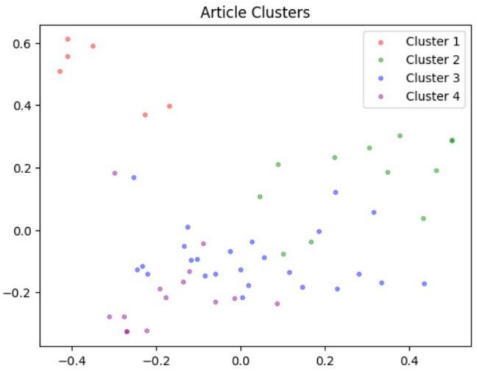

Figure 5 Articles by clusters

The k-means algorithm provides the most frequent words that appear in every cluster. Therefore, each cluster has several of the most frequent words that can be used to help analyze the main topic in that cluster. The result from the k-means text mining algorithm in the literature review.

Table 4 Cluster keywords and cluster size.

Cluster	Most Frequent Words	Number of Articles
1	waste food anaerobic digestion environmental incineration management footprint retailers meat	6
2	refrigeration energy food systems heat electricity technologies cooling efficiency retail	12
3	energy retail efficiency sustainability retailers' management green policy buildings industry	24
4	delivery electric vehicle transport emissions routing distribution carbon freight urban	14

The results presented in **Table 4** indicate that each cluster has the following characteristics:

1. Cluster 1 consists of articles that discuss energy issues related to food waste.
2. Cluster 2 consists of articles that discuss energy issues related to cooled storage.
3. Cluster 3 consists of articles that discuss energy issues related to general energy issues and energy efficiency, including green models in retail buildings.
4. Cluster 4 consists of articles that discuss energy issues related to transportation in the retail sector.

After determining that a certain article belongs to a specific group, each article is reviewed manually to check whether it fits the characteristics of a certain cluster. This step is important for verifying whether the result from the k-means clustering technique is accurate. The results from this step are presented in **Table 5.**

Table 5 The number of papers per cluster after verification

Cluster	Number of Articles	Number of Articles after Verification
1	6	6
2	12	10
3	24	28
4	14	12

Three articles initially belong to Cluster 2, but upon manual verification, they transition to Cluster 3. In addition, one article initially belongs to Cluster 3, but after it is verified manually, it becomes a member of Cluster 2. Moreover, two papers initially belonged to Cluster 4, but upon verification, they transitioned to Cluster 3. **Figure 6** presents the distribution of articles by topic per cluster.

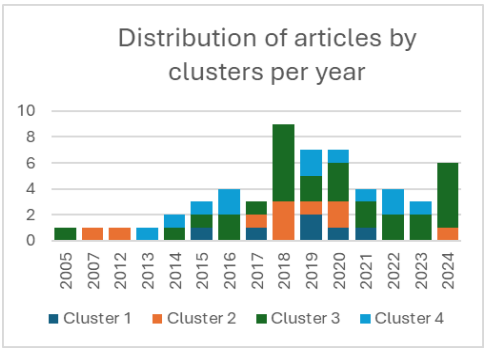

Figure 6 Distribution of articles by clusters per year

Detailed explanations of each cluster are explained in the following sub-sections.

3.1 Cluster 1: Energy issues related to food waste

Cluster 1 consists of articles related to retail sustainability from the perspective of food waste, as presented in **Table 6.**

The research in Cluster 1 focuses on reducing food waste due to customer consumption patterns. This is interesting because the main activity in the retail sector is selling goods to end customers. Retailers profit from the difference between buying and selling prices. Therefore, retailers tend to persuade consumers to buy a product with marketing efforts such as discounts and promotions to achieve sales targets. This action sometimes causes

overconsumption, which may result in waste. In line with Sustainable Development Goals Number 12 (SDG 12), namely sustainable production and consumption, waste due to overconsumption must be reduced. Therefore, retailers need to strike a balance between these two objectives.

Table 6 Issues related to food waste.

Authors	Topics
Tjärnemo & Södahl (2015)	How food retailers assist consumers that support sustainability, such as by consuming organic products and avoiding food waste.
Mondello *et al.* (2017)	The life cycle assessment (LCA) method for assessing the environmental impact of the disposal and treatment of food waste.
Carpio-Aguilar *et al.* (2019)	There are different alternatives to food waste management to reduce the environmental footprint.
Albizzati *et al.* (2019)	Food waste management using the circular economy concept, for example, by using food waste for the livestock industry.
Marrucci *et al.* (2020)	The use of DMAIC (Define Measure Analyze Improve Control) to improve the waste management system of a supermarket.
Grosu (2024)	Best practices for greener activity in the Romanian food retail sector.

Research on the ability of retail businesses to manage retail food waste was conducted by Albizzati *et al*. (2019), Carpio-Aguilar *et al*. (2019), and Marrucci *et al*. (2020). In addition, research on sustainable consumption has been carried out by Tjärnemo & Södahl (2015). An LCA was applied to identify energy consumption in food waste management by Mondello *et al.* (2017). Grosu (2024) conducted an analysis of sustainability reports on food retailers and reported that the greener activities that were carried out by food retailers included, among other things, waste management, reducing food waste, and energy efficiency and savings.

3.2 Cluster 2: Energy issues related to cooled storage

Cluster 2 consists of articles related to energy issues in cooled storage systems at retail, as presented in **Table 7.**

Some products, such as product diaries, food, and medicine, require special treatment for storage. When storing and displaying goods in a store, cold storage is necessary to preserve their quality. The use of cold storage for this purpose is one of the largest energy-consuming activities in the retail sector.

According to **Table 7**, this cluster research focuses primarily on the technological and economic analysis of retail cooling systems (Pather-Elias *et al.*, 2012; Tassou *et al.*, 2017; Gullo *et al.*, 2018a; Torben, 2020). One of the problems with the cooling system, which is a source of carbon emissions, is a leak in the cooling system with a high global warming potential (GWP). To resolve this issue, the use of new refrigeration systems, which are more energy-efficient and environmentally friendly, is encouraged (Gullo *et al.*, 2017; Gullo *et al.*, 2018b; Minetto *et al.*, 2018; Tashtoush *et al.*, 2024). Hart *et al.* (2020) conducted research to develop optimal investment strategies that encourage the food retail industry to move from hydrofluorocarbon (HFC) refrigeration systems to systems that have low GWP. The research states that a retrofitting strategy can reduce annual carbon emissions through the end of 2030, but this strategy carries the risk of failure in the cooling system.

Cooling system performance that is not optimal can also cause energy waste, so Efstratiadi *et al.* (2019) analyzed the effectiveness of using water-based cooling instead of air cooling in a refrigeration system. The research results show that water-based coolers have the potential to reduce electricity consumption by 3% when outside temperatures are high, whereas the use of hybrid coolers can reduce electricity consumption by 6%. In contrast, previous studies have attempted to minimize heat from the cooling system.

Table 7 Issues related to cooled storage

Authors	Topics
Pather-Elias *et al.* (2012)	Discuss the techno-economic analysis of energy efficient technologies to recommend to the food retail sector for use in supermarkets.
Tassou *et al.* (2017)	Discuss tri-generation technology and the feasibility of its application to the food retail industry.
Gullo *et al.* (2017)	Compare R744 refrigeration with conventional HFC-units in terms of energy savings.
Gullo *et al.* (2018a)	Discuss technologies that are the most efficient and climate-friendly for the European food retail sector.
Minetto *et al.* (2018)	Discuss energy-efficient refrigeration, heating, and cooling solutions for Europe's food retail sector.
Gullo *et al.* (2018b)	Compare various technologies that support low-global warming refrigerant in European cities.
Efstratiadi *et al.* (2019)	Discuss the effectiveness of using water-based cooling compared to air cooling in a refrigeration system.
Torben (2020)	Examine storage cooling that supports a sustainable cold chain with less energy consumption.
Hart *et al.* (2020)	Examine the source of carbon emissions in the refrigerator.
Tashtoush *et al.* (2024)	Examine a new CO2 refrigeration system with a two-phase ejector and parallel compression for supermarkets.

2.3 Cluster 3: Energy issues related to general energy issues and energy efficiency, including green models in retail buildings.

Cluster 3 consists of articles related to energy issues and energy efficiency in retail operations, which exclude transportation and logistics. **Table 8** presents the articles in his cluster, which also includes articles on green models in retail buildings.

2014; Tidy *et al.*, 2015; Tsaur & Huang, 2016; Dey & Seok, 2024; Si, 2024). Research has also attempted to identify the factors that support the retail sector in

achieving energy efficiency through several strategies, such as Li & Sha (2014), Dixon-O'Mara & Ryan (2018), and Naidoo & Gasparatos (2018). In addition, there is research on the development of a framework for certification as an energy consultant in the retail sector (Lindberg & Borgqvist, 2018).

Table 8 Issues related to energy issues and energy efficiency, including green models in retail buildings.

Authors	Topics
Li *et al.* (2023)	Discuss the decision rule in inventory policy to reduce energy consumption by minimizing dead stock items.
Ferreira *et al.* (2022)	Discuss sustainable business operation practices that enable retailers to increase the environmental performance of their stores by maximizing energy efficiency and carbon neutrality.
Mukonza & Swarts (2020)	Discuss green marketing strategies in the South Africa retail sector.
Barchi *et al.* (2019)	Discuss predictive energy control strategies through the combination of production and demand forecasting.
Ferreira *et al.* (2019)	Examine the energy-related building solutions of the top 27 global retailers.
Dey & Seok (2024)	Discuss carbon emission policy and credit financing.
Saadatian & Olbina (2024)	Discuss barriers to the implementation of energy efficiencies in facility management among US retailers.
Bhunia *et al.* (2024)	Examine the optimization of closed-loop supply chains by considering carbon caps and trade policies.
Mridha *et al.* (2023)	Examine dual-channel retailing (online retailing and offline retailing) to improve energy efficiency.
Si (2024)	Discuss green circulation efficiency (GCE) in China's Network Retail (NR) 2024.
Yao & Kao (2023)	Investigate the feasibility of implementing the demand-side management (DSM) aggregator model in the retail industry to achieve energy savings.
Zheng *et al.* (2022)	Discuss the mechanisms of logistics service quality, energy efficiency, and customer loyalty to the internet store to reduce energy consumption.
Liu *et al.* (2020)	Discuss the development of the energy electricity retail market.
Stavrou & Papakyriakopoulos (2020)	Develop Bluetooth Low Energy (BLE) beacon-based services for detecting customer location-based services.
Ferreira *et al.* (2018)	Examine the link between the highest carbon (CI) and energy intensities (EI) to assess retail buildings.
Dixon-O'Mara & Ryan (2018)	Empirically examine the drivers and barriers to energy efficiency measures in the food retail sector to decide effective energy efficiency policies in the retail sector.
Chen *et al.* (2018)	Discuss the design of the retailer's optimal contract with asymmetric information.
Naidoo & Gasparatos (2018)	Examine the key drivers for the adoption of CES (Corporate Environmental Sustainability) strategies in the retail sector, as well as the most common strategies and measures of progress.
Tamaș *et al.* (2017)	Examine the energy efficiency status in the retail industry in Romania to be implemented in commercial buildings.
Tsaur & Huang (2016)	Discuss the performance of sustainable environmental practices among ten selected retailers in Taiwan and design the green performance of those retailers.
Tidy *et al.* (2015)	Examine sustainable supply chain management of food supply chain operations to reduce greenhouse gas emissions in supermarkets in the United Kingdom (UK).
Christina *et al.* (2014)	Examine environmental sustainability from a systems perspective in the UK retail sector.
Li & Sha (2014)	Examine the factors that support retail sustainability using the analytic hierarchy process (AHP).
Accurso *et al.* (2021)	Examine energy efficiency in buildings such as hotels using SFOC cogeneration technology.
Lindberg & Borgqvist (2018)	Examine the framework for a proposed certification for energy consultants in the grocery sector.
Saabit *et al.* (2021)	Discuss green energy on retail sites by setting up a virtual power plant.
Wu *et al.* (2018)	Propose optimal scheduling to integrate distributed energy resources into community systems by coordinating distribution and retail operations.

Efforts that can be made to realize retail operations that save energy or use green energy include synchronizing retail operations with other operations related to retail (Ferreira *et al.*, 2022; Zheng *et al.*, 2022). Several other studies have shown that other operations that can be synchronized are marketing operations (Mukonza & Swarts, 2020; Liu *et al.*, 2020), production (Barchi *et al.*, 2019), and demand management (Barchi *et al.*, 2019; Yao & Kao, 2023). Moreover, other studies have focused on reducing energy consumption in retail through the development of various optimization models related to retail, including inventory policy (Li *et al.*, 2023), contracts (Chen *et al.*, 2018), distribution (Wu *et al.*, 2018), offline and online channels (Mridha *et al.*, 2023), and supply chains (Bhunia *et al.*, 2024). In addition, other research has developed technology for reducing energy consumption (Stavrou & Papakyriakopoulos, 2020).

A research subgroup found in this cluster includes some studies related to energy efficiency or green models in retail buildings. To reduce energy use in retail buildings, which is in line with green energy and decarbonization issues, various building solutions and technologies have been proposed, including those by Ferreira *et al.* (2019) and Saabit *et al.* (2021). Other research in this subgroup focuses on developing methodologies and technologies to assess and examine the energy efficiency of retail buildings (Tamaș *et al.*, 2017; Ferreira *et al.*, 2019; Accurso *et al.*, 2021). Moreover, a study conducted by Saadatian & Olbina (2024) discussed the implementation of barriers to energy efficiency in retail buildings.

3.4 Cluster 4: Energy issues related to transportation in retail.

One of the activities that supports retail operations is logistics transportation from one place to another. Cluster 4 consists of 11 articles that discuss carbon emissions related to transportation activity in retail, as presented in **Table 9.**

Transport activities, including those in the retail sector, have an impact on the environment and must be minimized. Therefore, how organizations measure performance related to transportation and how to improve it has been addressed in the past (Li *et al.* 2016; Proff *et al.*, 2019, Martins-Turner *et al.*, 2020). Many optimization efforts have been proposed to optimize transportation activities in retail organizations, including selecting particular delivery systems (Zhang & Zhang, 2013), setting up consolidation centers (Triantafyllou *et al.*, 2014), determining distribution routes (Sullivan & Gouldson, 2016), and utilizing technology (Wang *et al.*, 2015).

One method for minimizing the environmental impact of transportation activities is the iterative method for the Linear Fractional Vehicle Routing Problem (LFVRP), developed by Bas & Ozkok (2023). The method provides the ability to consider dual objectives (cost and load) in one model, as well as a green-based approach to minimize fuel consumption while maintaining the maximum load. Currently, the rapid development of electronic commerce (e-commerce) has increased the number of home deliveries. One example is a food delivery service. Wang *et al.* (2021) revealed that carbon emissions from food purchased via delivery are lower than those from food purchased from supermarkets. E-commerce is considered to have lower environmental costs than conventional retail does. To increase the benefits of e-commerce development, there are various methods to reduce the negative impact of transportation and delivery services. Muñoz-Villamizar *et al.* (2022) developed a Mixed-Integer-Linear Programming (MILP) method to evaluate the impact of adding home delivery slots and reported that extending delivery times can reduce mileage, total costs, and fuel consumption and emissions. Heshmati *et al.* (2019) also reported that changes in delivery times play a role in increasing efficiency and reducing carbon emissions from e-commerce deliveries, among other factors such as integrated collection points and product bundling, as well as the use of green technology (bikes and electric cars). Decarbonization efforts in the transportation fleet are also carried out by considering other types of energy sources, such as battery electric vehicles (BEVs) and fuel cell electric vehicles (FCEVs). Winkler *et al.* (2022) conducted transportation simulations on BEVs, FCEVs, and internal combustion engine vehicles (ICEVs) and reported that FCEVs had the highest operational costs among BEVs and ICEVs. On the other hand, FCEVs have greater greenhouse gas emission reduction potential than BEVs do, but BEVs are still the preferred technology for urban transportation fleets from an economic and ecological point of view.

Table 9 Issues related to transportation in retail.

Authors	Topics
Zhang & Zhang (2013)	Compare delivery systems in the book retail sector.
Triantafyllou *et al.* (2014)	Examines urban freight consolidation centers in the UK retail sector.
Wang *et al.* (2015)	Examine the use of ICT for possible CO2 reduction in the UK's grocery retail sector.
Li *et al.* (2016)	Examine the actions, targets, and performance of UK and US retailers.
Sullivan & Gouldson (2016)	Discuss the problem of determining the optimal distribution route for the minimum carbon footprint of the retail industry.
Heshmati *et al.* (2019)	Discuss alternative e-commerce delivery policies to reduce carbon emissions.
Proff *et al.* (2019)	From electric cars to energy-efficient houses, the automotive retail sector is at the crossroads.
Martins-Turner *et al.* (2020)	Urban freight transport in the food retailing industry.
Winkler *et al.* (2022)	Urban freight transport in the food retailing industry.
Wang *et al.* (2021)	Evaluate the carbon emissions of alternative food provision systems.
Muñoz-Villamizar *et al.* (2022)	Examine the impact of shipment consolidation strategies for home delivery on a Mexican retail company.
Bas & Ozkok (2023)	Discuss green vehicle routing problem in a retail Türkiye.

4. CONCLUSION, RESEARCH GAP, AND SUGGESTION FOR FUTURE RESEARCH

Research in the form of a systematic literature review that has been carried out has succeeded in presenting a distribution of topics related to sustainability issues in the retail sector. Based on a literature review of 56 research articles from the Scopus database, these articles can be grouped into four research clusters via k-means text mining clustering. These issues include (1) energy issues related to food waste; (2) energy issues related to cooled storage; (3) energy issues related to general energy issues and energy efficiency, including green models in retail buildings; and (4) energy issues related to transportation in retail.

In Cluster 1, the research that has been carried out is related to how retail businesses manage retail food waste through sustainable consumption and use LCA techniques to identify energy consumption in food waste management. Grosu (2024) concluded that reducing and managing food waste in the retail industry is one of the key activities that support sustainable retailing. However, compared with other research clusters, the number of studies in this cluster is relatively small. Therefore, many gaps remain in this cluster, such as research exploring other techniques for

managing food waste, research on elements and factors for establishing sustainable consumption, and research related to energy optimization in food waste management.

In Cluster 2, in which the number of articles is approximately twice that of the first cluster, most of the research carried out is related to the technological and economic aspects of cooling systems used in retail businesses. The trend is to develop new technologies that are energy-efficient and environmentally friendly, as well as economically acceptable to retail businesses. This trend is, of course, still a wide-open research gap, considering that the price of new technology is usually more expensive than that of previous technology. Another area of research that merits further pursuit is the economic analysis of the new cooling system technology in the retail sector, for example, regarding the comparison of savings in terms of operational costs to the investment costs incurred.

In Cluster 3, which has the largest number of articles, there are three major research directions: 1) developing a framework and methodology related to energy efficiency and measurement in the retail sector; 2) optimizing retail operations and synchronizing them with other related operations for energy savings; and 3) developing energy efficiency models in retail buildings. Research in these three directions is still lacking, especially in the second and third directions. With respect to the second direction, considering that retail activities are the end activities of the supply chain, synchronization with various other activities along the supply chain and other related activities has great potential to achieve overall energy efficiency. Moreover, in the third research direction, research that can be developed in the future should not only focus on proposing various building solutions and technologies but also integrate them with other activities in retail operations, which is in line with the second direction.

In Cluster 4, the research carried out was concerned with carbon emissions related to transportation. The optimization of transportation-related activities was performed in previous studies in this cluster. However, considering that there are currently changes in the way people shop in retail, for example, through e-commerce and home delivery, more appropriate transportation methods and mechanisms, which also need to be optimized, should be anticipated. This is expected to remain the direction of research in this cluster.

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