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Performance of cold chain logistics service providers in the fast-moving consumer goods industry in Nigeria: a systematic review

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Performance of cold chain logistics service providers in the fast-moving consumer goods industry in Nigeria: a systematic review

Susanna Ibrahim Zego[1,2], Zuhra Junaida binti Mohamad Husny[1]

[1]Faculty of Built Environment and Surveying, Universiti Teknologi Malaysia

[2]Nigerian Institute of Transport Technology, Zaria.

E-mail: zego20@graduate.utm.my

Abstract. The operations of the fast-moving consumer goods (FMCGs) businesses in Nigeria rely on the efficiency and efficacy of cold chain service providers for quality storage and optimal safety of perishable goods. However, the sector faces obstacles such as inadequate technology, unskilled labour, insufficient funds, weak regulation, and a poor regulatory policy framework, all of which impede the business's growth and performance. The goal of this study is to systematically review the issues that restrict cold chain logistics service providers' performance in Nigeria's highly perishable food business. This study employs PRISMA procedure and the systematic literature review technique to extract articles and emphasize the importance of employing cold chain services to increase efficiency, quality service delivery, and consumer fulfilment. The study's findings demonstrate that achieving quality service delivery, service effectiveness, cost savings, and customer satisfaction is hampered by a lack of proper synergy between cold chain logistics service providers and cold chain major stakeholders such as regulators, as well as an absence of skilled personnel, policy, funding, infrastructure, and technologies for monitoring and tracking product movement and condition. By remedying these difficulties, Nigeria's FMCGS sectors could potentially improve their performance and contribute to the development of a robust, sustainable cold chain logistics industry. As a result, the quality and safety of FMCG goods would be enhanced, driving the expansion of the FMCG sector in Nigeria. Future research findings should focus on the cold chain logistics performance leverages on economic growth and development in Africa.

1. Introduction

The fast-moving consumer goods (FMCGs) industry is a very dynamic industry that provides household and industrial consumers on a daily basis with affordable varieties of products [1-2]. The category of these FMCGs varies from agricultural fresh food products such as vegetables, fruits, and dairy products to other products which include; cosmetics, pharmaceuticals products, electronic products, beverages, personal care, household goods, and pet supplies [3]. However, the supply of quality products in the fast-moving consumer goods industry is largely dependent on the services of cold chain logistics service providers [4–7]. The role of cold chain logistics service providers spans from the process of planning, implementing, and controlling the flow and storage of perishable goods, temperature control, information management to improve -customer value and ensure quality service delivery [8]. Cold chain logistics service providers play a major role in preserving product quality through cold storage and `distribution thereby facilitating products' seamless transshipment and flow from their source to the

consumers [5]. Cold chain perishable food products are mostly fast-moving consumer goods (FMCGs). However, according to [3] and [9] most of these FMCGs are highly temperature perishable products notable of which are the vegetables. These FMGCs industry is renowned for daily huge sales volumes and low prices of food products, especially perishable products [10]. Similarly, according to [10-11] the FMCG industry plays a crucial role in advancing economic progress and development globally. Thus, it is important to systematically review the performance of cold chain logistics service providers in the FMCGs industry in Nigeria.

The dynamics of the FMCGs industry also imply that significant criteria that boost service delivery must be available for cold chain products to be acceptable to consumers [12]. Products must have the right quality of freshness and be delivered at the right time in acceptable form based on customer requirement. Hence, the quality of perishable food in the FMCGs must also be maintained through proper temperature monitoring [13-14].

In Nigeria, the FMCGs industry has a lot of growth opportunity given that fruits and vegetable food chain continue to dominate consumer budgets. The Nigerian FMCGs perishable food chain has a sizable market to serve and have a sizable amount of opportunity to grow [10]. Hence, the role of cold chain service providers is very vital towards ensuring that cold chain products have safe quality handling, packaging, storage, and distribution through ambient controlled temperature required so as to offer consumers with quality products at all times in the FMCGs in Nigeria. Similarly, according to [5-7] cold chain logistics service providers are saddled with the responsibility of coordinating and responding to process requirements and customers' feedback in order to enhance operations and service efficiency and effectiveness. Furthermore, [15] argued that to achieve effective and efficient service delivery in today's contemporary market space cold chain logistics service providers have to be innovative in their service delivery in order to remain competitive.

Currently, food insecurity is a major problem confronting Nigeria which is ranked 96 out 113 of global food-insecure countries [16]. Nigeria is the 10th most malnourished country in the world, with 37% stunting, 29% underweight, 18 wasting, and 94% of food losses owing to inadequate cold chain logistics operations (GAIN, 2018). Similarly, according to [17], [16], [18-19], and [20], Nigeria experiences 40% losses of total food production which represents about 9.1% of Nigeria's gross domestic product (GDP), and 44% of Nigerians experience food insecurity. Furthermore, annually 40% -50% of fresh fruits and vegetables are lost as a result of cold chain logistics inefficiencies [19].This high ratio of perishable fresh food losses in Nigeria, has given rise to a national concern and focus on the operations of cold chain logistics industry and the roles cold chain logistics service providers play in providing quality products and services to customers and in eliminating food losses, waste and promoting food security in the cold value chains of the FMCGS industry in Nigeria [16], [21]. Hence a systematic literature review will encapsulate and assemble and synthesize all relevant literature on contemporary significant criteria that promote performance of cold chain logistics service providers in the FMCGs industry. The review will focus on the current state and limitation of cold chain logistics operations performance in Nigeria FMCGs, the significant criteria for enhancing cold chain logistics performance in Nigeria FMCGs, highlight sustainable cold chain logistics performance outcomes, and suggest future areas of research concern for cold chain logistics development in Nigeria. Thus, this systematic review paper focus will help cold chain logistics stakeholders understand the ways in which cold chain logistics operations can contribute immensely towards improving the performance of the FMCGs industry in Nigeria as well as in reducing the growing rate of food insecurity facing the country. in line with the sustainable development goals.

In order to achieve these goals, this paper is organized into four sections as; thus, section 1, will introduce the topic and give details of the structure, section 2 will give details of the PRISMA methodology used in the paper. Section 3 will focus on the systematic literature review regarding performance of cold chain logistics service providers in the fast-moving goods consumer industry by focusing on the significant criteria, limitation, and the veritable outcome for sustainable cold chain operations in Nigeria. Section four will present the paper conclusion, limitations and recommendation drawn from this paper findings.

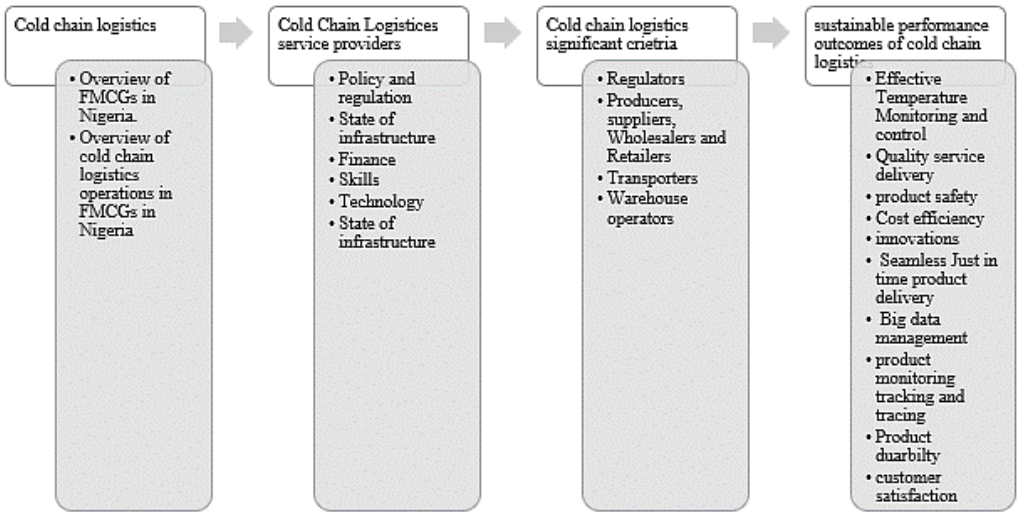

Figure 1. Research Conceptual Framework

The above Figure 1 shows the conceptual framework adopted for the study. The framework shows the flow structure of the paper discussion and focuses on the activities of cold chain logistics operation in Nigerian fast-moving consumer goods industry. The review will discuss cold chain significant criteria, cold chain logistics service providers and the sustainable performance outcome of cold chain logistics practices.

2. Research Methodology

2.1. Four Stage Methodology

A four-stage methodology was used for this study. This methodology shows a clear flow and connection of the research process followed. The current paper was established using a four-stage methodology, with the first stage being the search for publications, the second stage being the application of exclusion criteria, the third stage being the selection of inclusion criteria and the fourth stage being the execution of the systematic literature review with highlights of future research area of interest. The entire procedure is depicted in Figure 2 which shows the four-stage methodology structure and the flow of the paper. It starts with the search for literature using keywords then utilizes the exclusion criteria to eliminate irrelevant literatures and the inclusion criteria to gather literature relevant for the review then synthesizes this literature through the systematic review.

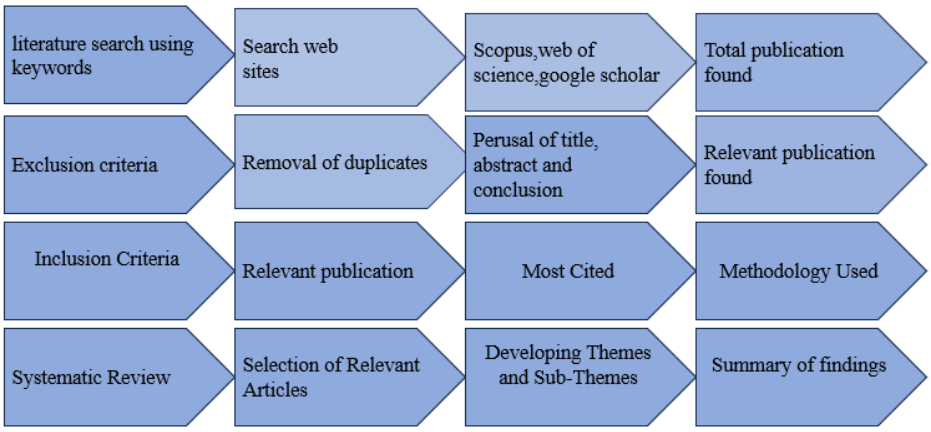

Figure 2. Four stage methodology

The study will also utilize the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), inclusion and extraction procedure to select the relevant publications utilized for this study. A set of criteria was set to actualize this requirement. These criteria include; search through data base, year of publication, relevant topic, accessibility to article, Most cited, country of origin, source of publication and type of publication. These are further highlighted in four stages. Figure 3 below shows the PRISMA exclusion and inclusion procedure used in extracting, eliminating, and including publications in the study. It shows the different stages filter criteria.

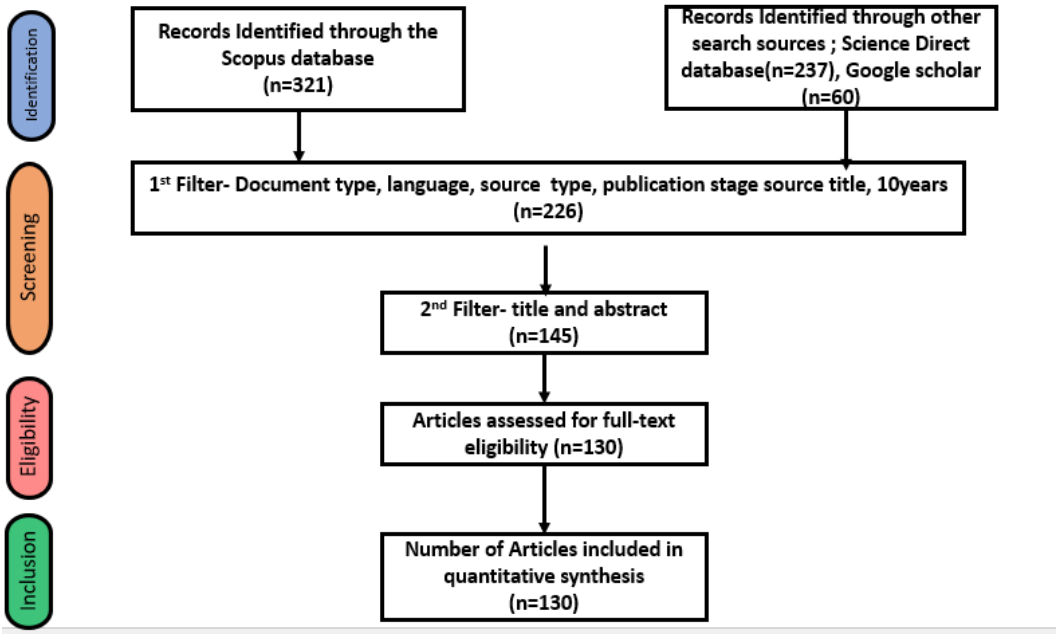

Figure 3. PRISMA Procedure

2.2. Stage One: Search for Publications

The search criteria were defined as keywords in order to acquire the most relevant journals on the performance of cold chain service providers in the fast-moving consumer goods industry in Nigeria. The search criteria are thus.

i. "Performance" OR "Growth" OR "Development" OR "Enhancement" AND "Cold" AND "Chain" AND "Logistics" OR "Stakeholders" AND "Food".

The systematic search for literature was based on the set of keywords used to select the publications. At the initial stage 321 documents were found from Scopus, 237documents were found from science direct and 60 documents were found from other sources such as google scholar and web of science. Thus, a total of 618 documents were found at the initial search from data search sources such as Scopus, Science Direct and Google Scholar. Furthermore, a ten (10) year's literature mapping from 2013 to 2023 was carried out and documents were found from the Scopus, science direct, google scholar search. Furthermore, the subject area documents search included; Engineering, Computer Science, Agricultural and Biological Science, Business Management and Accounting, Decision Science, Environmental Science, Energy, Supply chain management. The document types include journal articles and conference papers, language selected was English, and the publication stage selected was final after this filter from all data bases. Scopus data bases, had 145, Science Direct data base had 52 and Google Scholar data base 29. This means that a total of 226 documents were found. Similarly, using these databases and with the specified search terms, at the search, 226 publications were gathered and stored in the library manager software Mendeley. An additional 64 publications were added to the library through snowball searching from other journal sources making a total of documents found 290, these being gathered from the reference lists of publications considered of major relevance to the subject of this paper.

2.3. Stage two: Publications Elimination Criteria

The duplicates of 90 were first taken out from 290 references were removed from the library during this stage. Thus, the documents were limited to 200. Following this, an additional 55 records were eliminated from the database after titles and abstracts were read leaving a total of 145 documents. The third and last stage was a thorough review of the remaining 145 documents, with an additional 15 references being eliminated. Hence, 130 publications were used in the following portions of this paper, corresponding to references. The primary themes of information were discovered and categorized into key categories of information during this phase.

2.4. Stage Three: Inclusion Criteria

In this section, all gathered papers were analyzed, with the goal of exposing the current state and progression of knowledge on the topics of performance of cold chain logistics service providers in the fast-moving consumer goods industry (FMCGs) a total of 20 number articles out of the 130 number of publications and their varying citations were used to show the evolution of the number and type of publications evaluated over the period of years between 2013 and 2023.

2.5. Progression of Publications

The Figure 4 below shows the progression of cited publications per year and their respective authors in the field of Cold Chain Logistics Studies. The figure further shows that there is a downward trend in the research associated with the performance cold chain logistics service providers in the fresh food value chain. Starting from 2018, a non- linear downward decline in publications was identified to the year 2022. However, the maximum number of publications was identified in 2018, with 117 publications while the least was identified in the year 2022 with 10 publications. It can therefore be said that the subjects under analysis in the current paper is currently having low direct impact on the Operations in

FMCGs industry and attracts less interest in the scientific community as highlighted between the years 2018 and 2022.

Furthermore, out of the 130 publications used for this review 110 were journal articles while (13) were conference papers. This indicates that a great portion of the information generated is reliable, increasing the quality of cold chain logistics performance analysis done in this paper. Similarly, a clear fluctuation in the number of citations is visible between 2013 and 2023. In the publication cited the review showed the year that had the maximum number of citations within the 10 period is the year 2018 with 117 citations, the least being 2021 with 11 citation this corroborates the previous hypothesis that research on the divergent systems performance of cold chain logistics in promoting food safety and security.

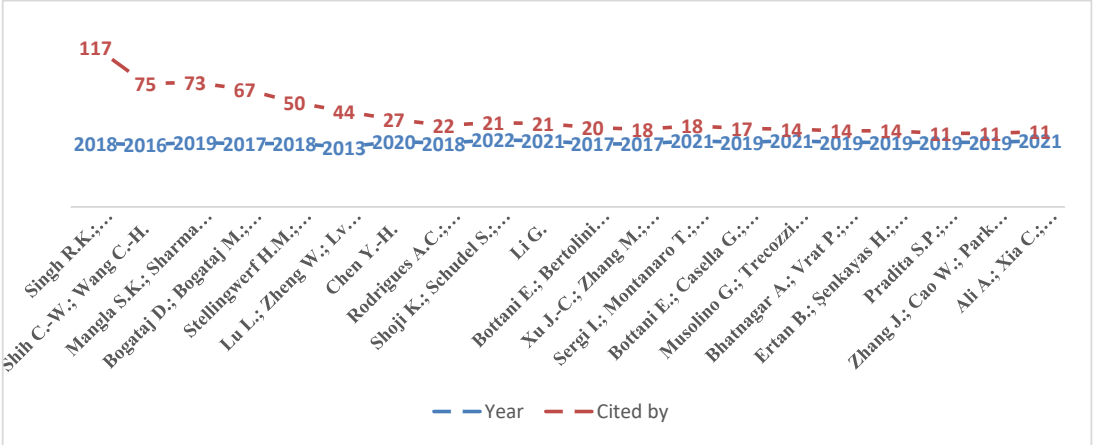

Figure 4. The progression of cited publications per year and their respective authors

2.6. Publication Data

The Figure 5 below shows the different sources of journal publications, the year of the publications and the number of times this journal articles publications. These publications came from different journal sources showing diverse interest by journal sources on the performance of cold chain logistics service providers in FMCGs industry subject area.

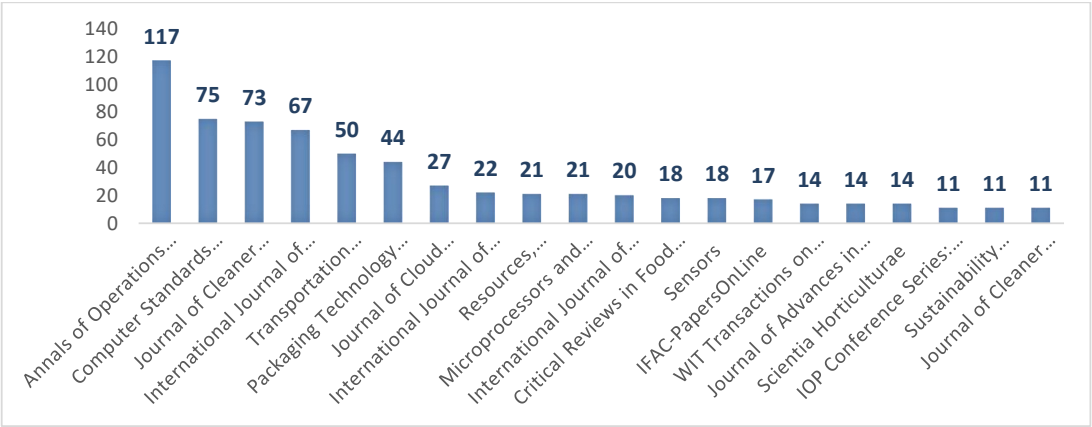

Figure 5. The sources of publications the year and the number of times cited.

2.7. Major Keywords and co-occurrence

Ten (10) Major keywords with their co-occurrence were used for this review and are based on Scopus search. These keywords further convey the key focus of the paper. The keywords used also interlinked networks of research ideas that was arrived at. These keywords represent processes capable of improving cold chain operations performance especially in FMCGs industry. Thus, these secondary keywords represent relevant fields of study, representing some of the main topics of information identified and reviewed in Sections.

The Figure 6 below shows 10 of the major keywords used for this review and their relatability with topic of the paper. These keywords and their co-occurrences are as follows; ‘‘Cold Chain Logistics”85, “Cold Chain” 57, “Food Supply”32, “Food Storage”32, Supply Chain Management” 31, “Logistics service providers” 22, “Sustainable Development” 20, “Food Safety” 18, “Refrigeration” 7 and “Economics” 7.” These keywords reveal that the research into performance cold chain logistics operations may influence the sustainability levels in the FMCGs industry.

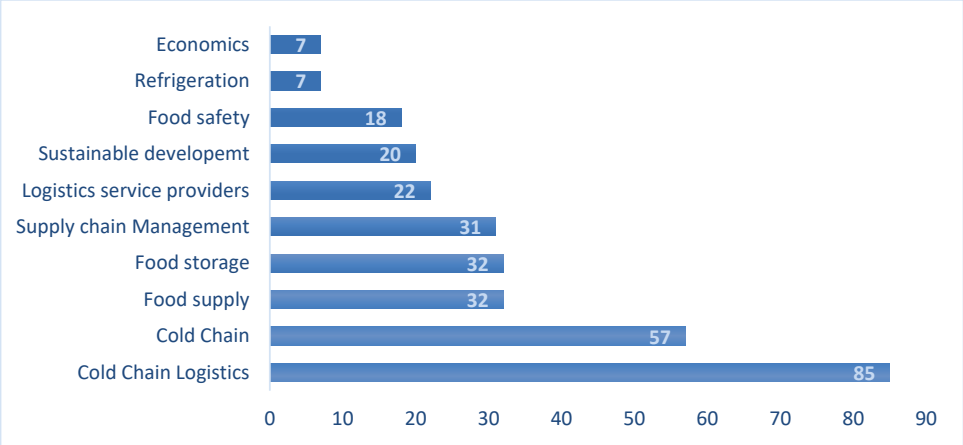

Figure 6. Major keywords and their co-occurrences

2.8. Country of Origin of Publications

The review assigned each publication to their country of origin. A total of 5 countries were identified to have the most publications as shown in figure 7 below of these, 5 had two or more publications, as shown in Figure 7. These countries publications indicate that they are the research leaders in terms of number of publications that originate from their countries.

The Figure 7 below shows different countries and their percentage of publication. These countries and their publication percentages are China 66%, India 13%, the United Kingdom 7%, Thailand 7%, and South Korea 7%. These demonstrates the interest of Asian countries in reducing the environmental impacts in fresh food losses. It can therefore be stated that the higher the technological development of each country, the greater amount of research on these fields, in view of the technology development. This is corroborated by the lack of sufficient research in less developed countries.

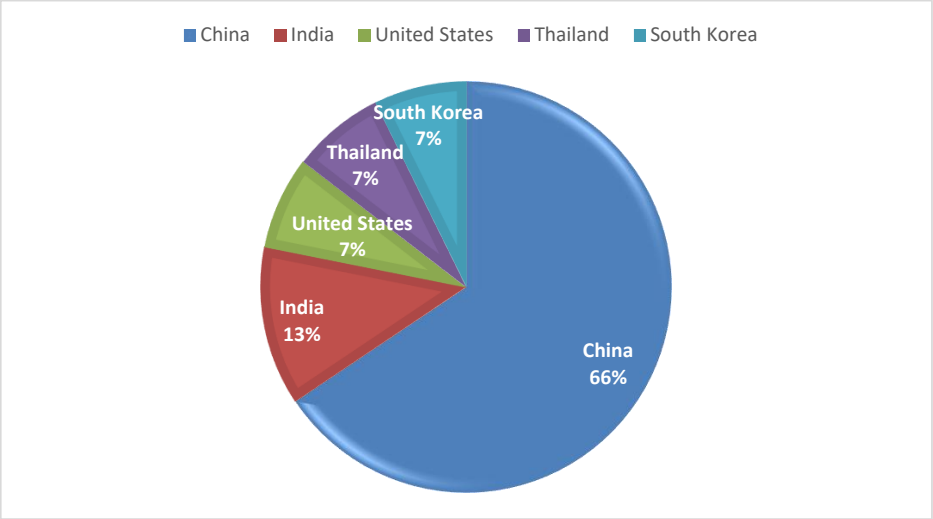

Figure 7. Percentage (%) of publication by country

The Figure 8 below shows the absolute number for publication used for this analysis. The two major publications used are presented in figure 8 and includes 117 journal articles and 13 conference papers with general focus on performance of cold chain logistics, as well as specific publications about service providers. The review only considered two highest types of publications, these being journal articles and conference papers. A total of 117 scientific journals articles and 13 Conferences papers were identified. Considering the high number of journals, Figure. 8 includes only the journal articles and conference paper published and the total number cited in the study.

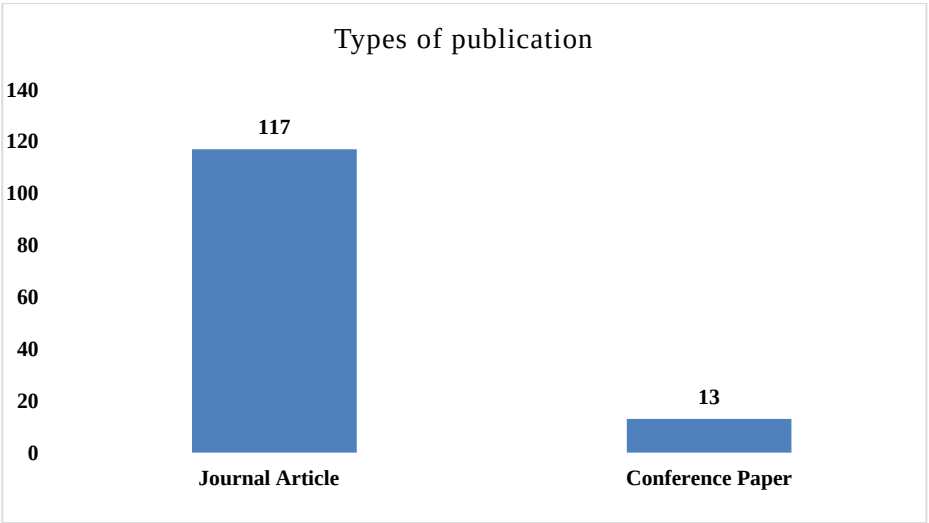

Figure 8. Types publications used and frequency

2.9. Prominent Publications

Table 1 below shows twenty (20) of the most cited publication from the list of articles used for this study. The table further highlights the diverse methodology and approaches used by the different authors

and studies in solving the different cold chain logistics operational challenges. Thus, from the table it can be seen that most authors used SMART technology, internet of things, and mathematical modelling to proffer solutions to cold chain logistics operational challenges.

Table 1. Twenty (20) most cited publications by the authors, methodology and publication cited times.

Authors	Methodology	Cited
[22]	Fuzzy AHP is used to rank different criteria for 3PL selection, then Fuzzy TOPSIS is used to select the best 3 PL based of performance.	117
[23]	Internet-of-Things (IoT) architecture as well as international food standards named ISO 22,000.	75
[24]	Graph theory and matrix approach has been applied to select the most significant challenge.	72
[25]	Internet of Things (IoT) infrastructure, where there is a smart device that tracks ambient conditions like temperature, humidity, and gas concentrations	67
[26]	Use of the extended Load-Dependent Vehicle Routing Problem (LDVRP) Model is applied in a case study in the Dutch frozen food industry.	50
[26]	Mathematical modeling and time window constraint analysis	27
[27]	The parallel design and analysis of a coarse-grained genetic algorithm are used to solve the simulation model of the established optimization model in cloud computing and big data technology.	27
[28]	Used Data Envelopment Analysis (DEA) and robust regression approach in secondary data from the annual study published by Revista Tecnologística (years 2008–2016) to determine the variables that significantly affect the efficiency of third-party logistics (3PL) providers of refrigeration services	22
[29]	Use of physics-based digital twins, namely virtual representations of the food products	21
[30]	An Internet of Things analysis framework for assessing overall performance. Simulation results confirm the performance of this method	21
[31]	RFID logistics pilot III (RLP3) project, which has dealt with the deployment of the radio frequency identification (RFID) technology and the development of an IT infrastructure for the management of the real-time data collected in a fresh food supply chain	20
[32]	SMART freezing technology includes new and intelligent technologies and concepts applied to the pretreatment of the frozen product, freezing processes, cold chain logistics as well as warehouse management	18
[33]	Internet of Things (IoT)-enabling technologies and its specific branch called edge computing is bringing different enhancements (Azure Sphere platform)	17
[34]	Use of a detailed equation in an analytic model to carry out the computation of the economic and environmental sustainability,	17
[35]	Set of planned interventions for the realization of the agri-food logistics scenario	14

Authors	Methodology	Cited
[36]	An agglomerative hierarchical clustering algorithm is used to build a cluster hierarchy that is commonly displayed as a tree diagram called dendrogram	14
[37]	SPSS package programme with many types of Randomised Split Parcel Trial Pattern so where the harvest time is the main parcel and the storage term is the sub-parcel.	
[38]	Conducted an in-depth interview and analysed the business process using Integration Definition for Function Modelling (IDEF0)	11
[39]	Analyzed the uncertain factors affecting the cold chain distribution system based on fault tree model, and then transform it into Bayesian network to evaluate the reliability of the cold chain distribution system for fresh agricultural product and identify the key factors affecting the reliability of the cold chain distribution system through calculated probability importance of each node.	11
[40]	Adopted the life cycle assessment approach and the category method (C-Method) to estimate the percentage of postharvest losses (PHL) and their economic and environmental impacts	11

3. Overview of The FMCGs Industry in Nigeria

3.1. Performance of FMCGs in Nigeria

The FMCG industry although vital and contributes significantly to employment and economic growth, development in Nigeria faces several challenges such as low innovative practices including inadequate infrastructure, limited technology adoption, innovative practices, professional skills requirement and a challenging regulatory environment according studies of [2], [41], [42], [43], and [44]. These authors further argued that FMCGs are faced with different types of environmental and industrial challenges that affect their daily performance. However, despite all the challenges experienced, the sector has continued to experience significant growth due to the country's large population, migration as a result economic opportunity, insecurity challenges and urbanization. Cold chain logistics plays a crucial role in the FMCG industry in Nigeria according to studies of [16] and [19] particularly in the transportation and storage of perishable goods such as fruits, vegetables, dairy products, and frozen foods.

The efficient and effective management of cold chain logistics ensures the quality and safety of perishable products and reduces waste and spoilage, which can lead to significant economic losses in FMCGs industry. Thus, without adequate cold chain logistics services, FMCG business in Nigeria according to studies of [45], [46] and [47] will struggle to meet consumer demand and maintain product quality, which can lead to lost sales, decreased profitability, and damage to brand reputation. This will also limit the reach of FMCGs and prevent them from expanding their operations in Nigeria. Therefore, the importance of cold chain logistics in the FMCGs industry in Nigeria cannot be overstated. The successful management of cold chain logistics is critical to the growth and sustainability of the FMCGs industry, as it ensures the availability of safe and high-quality products for consumers while reducing waste and increasing profitability for companies [19], [48].

3.2. Current State of Cold Chain Logistics in Nigeria

The practices of cold chain logistics in Nigeria is insufficient in meeting the ever growing demand of the consumers of cold chain services [49].Thus, there so many risk associated with practices of cold chain logistics in Nigeria where on annual basis 50% of tomatoes waste is recorded and 94% of the risk occur as a result of the broken cold chain logistics practices in country and lack of proper synergy between cold chain logistics service providers and cold chain logistics major stakeholders such as regulators [19]. Many studies have linked inadequate knowledge of the cold chain logistics management as the major reason why there is poor performance of cold chain logistics especially in the health sector and rural areas of Nigeria [45], [46], [48], [50–53]. These studies further show that the cold chain

logistics personnel lack the professional skill expertise required for the discharge of their duties in Nigeria.

Studies conducted by [16], [48], and [19] argued that despite the importance of cold chain logistics in the FMCG industry in Nigeria, the current state of cold chain logistics in the country is suboptimal. The is because infrastructure for cold chain logistics is inadequate, and there are limited technology and equipment available for temperature control and in order to support the transportation and storage of perishable goods, limited skills, poor regulation, and limited access to sufficient finances required to support the cold chain logistics system. This has resulted in significant supply chain disruptions, leading to increased costs, product spoilage, and waste. Thus, [45], [48], [50] argued that the lack of infrastructure and technology, policy regulations, professional skill has also limited the reach of FMCG businesses, particularly those operating in remote and rural areas of the country. As a result, many consumers in these areas do not have access to safe and high-quality perishable products and this has limited the growth potential of the industry. The regulatory framework is complex and often unclear, leading to non-compliance and cold chain logistics disruptions. This has resulted in a lack of trust and coordination among stakeholders and personnel lack of competence which further compounds the challenges faced by the industry [48], [50], [54]. Hence, the insufficiency of cold chain logistics operations has led to high product spoilage and waste, increased costs operating cost, decreased profitability, and damage to brand reputation and have limited the access to safe and high-quality perishable products hinder the growth potential of the tomatoes value chain, particularly in remote and rural areas of the country.

3.3. Cold Chain Logistics Service Providers

The nature of cold chain logistics operations is akin to different categories of service providers and stakeholders who play various roles in ensuring the seamless operational flow in the cold chain logistics operations stages. The study conducted by [5] stipulates that the selection process for cold chain logistics service providers is a complex multi-criteria decision making (MCDM) process which involves consideration of numerous factors based on the requirements and specifications of the type outsourced services. However, using a third-party logistics (3PL) cold chain logistics service providers to handle the transportation and distribution of operation of a business is a viable option for reducing transportation costs and losses [5], [28], [55], [56]. The categories of service providers in the cold chain logistics cycle are numerous. However, based on their roles and responsibilities they can be broadly categorized into three (3) namely, the service regulators who represent government (public) and private sector, logistics service providers who are transporters and warehouse operators, and the distribution channel members who are the product producers or suppliers, wholesalers, retailers and middlemen.

3.3.1. Cold Chain Logistics Service Providers Categories. Cold chain service providers can be categorized into three namely.

- The regulators are responsible for coordinating cold chain logistics operations by providing the right policy, standards and policy direction. Cold chain logistics service regulators' tasks and responsibilities are critical for safeguarding cold chain's integrity and the integrity of the temperature sensitive products [15], [43], [57–60].
- The distribution channel members act as facilitators and mediums for cold chain products distribution and delivery to the desired customers. The distribution channel for cold chain logistics involves several key service providers who play essential roles of facilitating ensuring the seamless distribution, transfer and delivery of the temperature-sensitive products [23]. They are categorized into; product suppliers, products wholesalers and retailers [16], [61], [62].
- The logistics service providers who represent logistics vendors and 3PLs saddled with the provision of unique logistics services such as refrigerated services for storage of products through warehousing, product packaging, haulage, distribution and delivery to consumers in order to make the cold chain logistics operations more competitive and effective [22], [28]. These service providers also include; warehouse operators and transporters who facilitate cold chain logistics product distribution to

consumers [63]. The warehouse operator is expected to provide refrigerated warehouses, to store temperature-sensitive products at specified temperatures while the transporters or carriers are responsible for physically transhipment of temperature-sensitive products from the supply origin to the desired destinations, including distribution centres, retailers, and end consumers. The logistics service providers also play a critical role in ensuring the safe and efficient transportation, storage, and handling of temperature-sensitive products throughout the cold value chain [5–7], [60], [63–66].

3.3.2. Challenges Faced by Logistics Service Providers in Nigeria: Logistics service providers face numerous challenges in delivering quality, effective, efficient and reliable services [47], [67–69] these challenges range from infrastructure problems, technological problems, product temperature monitoring, tracking, and tracing, information management, coordinating real time information and energy efficiency problems. A study by [70] suggests that improving the cold-chain logistics system through use of intelligent methods. Furthermore, the studies of [71], [24], [72], [7], [73], and [74]. examined the challenges of logistics service providers in providing effective services to consumers and suggested that meeting regulatory requirements, demands, proactive compliance strategies, continuous training programs, and having effective communication with service stakeholders will alleviate these challenges. Studies of [16] argue that cold chain logistics service providers in Nigeria, are faced with problems ranging from poor infrastructure connectivity between product sources and destination market, lack of sufficient cold storage technology for product preservation and lack of standard policy for regulating operational norms and a lack of proper synergy between the cold chain logistics service providers and cold chain major stakeholders such as regulators. According to studies conducted by [25] distribution challenge is a key challenge that occur when carrying out product distribution. This challenge are temperature control issues, greenhouse gas emissions (GHG) during product distribution. Similarly, studies of [75], [76] argued that road transportation is responsible for a considerable part of global emissions. Thus, in order to reduce greenhouse gas emissions, reduce wastage, decrease financial losses and solve environmental pollution issues there is need for the provision of more efficient and dependable logistics infrastructure [26], [77–80]. Furthermore, overcoming the distribution challenges will require investments in temperature-controlled technology, implementation of robust information monitoring systems like the Geographical information system (GIS), Radio Frequency Identification Device (RFID), adaptation of SMART emission control technologies , frameworks and models and adherence to best practices in temperature management [33], [75], [81–84].

3.4. Performance of Cold Chain Logistics in the Tomatoes Value Chains in Nigeria

Cold chain logistics performance in the tomatoes value chain in Nigeria is very low and poor, annually about 50% of fresh Tomatoes products get wasted in Nigeria due to poor cold chain logistics service providers performance [46], [52]. The tomatoes value chain, logistics service providers are the farmers, wholesalers, retailers, middlemen, transporters, warehouse operators and government and private sector regulators. Although cold chain logistics operations are highly desired to preserve tomatoes at an optimal temperature range of −9 °C to2 °C frozen, ambient temperature is 15 °C to20 °C; and cool temperature of 2°C to 15 °C; safely from the effect of global warming [85]. Cold chain logistics operations play a critical role of ensuring the ambient temperature levels are maintained, safe, efficient transportation and storage of tomatoes products. However, the performance of cold chain logistics service providers in the Nigeria tomatoes value chain is impeded by inadequate Infrastructure development, poor technology adoption, absence of regulatory frameworks and non-compliance with established forms of regulatory norms, limited industry collaboration, financial constraint and professional skills deficiencies in the industry [16], [17], [19], [20], [85], [86]. Thus, improving the state of chain logistics infrastructure and technological limitations, implementing innovative solutions and adapting best practices from developed economies such as the G20 with highly advanced technologies such as the G5 Technologies, SMART technologies, Radio frequency identification device(RFID), from internet of things (IoT), internet of everything (IoE) ,with the development of cloud computing and big data technology is very important for the enhancement of cold chain logistics operations and performance in Nigeria [33], [67],

[87]. Thus, the study of [46] argued that the expected solutions to solving cold chain logistics service providers problems in Nigeria would require adoption of local approach technology development, skill development, competence building, provision of standard infrastructure needs, financial assistance and policy development in line with indigenous needs and requirement.

3.5. Significant Criteria for Improving Cold Chain Logistics Performance

These are the independent variable that service providers have to rely on in order to deliver quality service to cold chain product consumers. This criterion also presents several connections for cold chain logistics quality service delivery with enhanced performance. Thus, service providers must ensure that the cold chain logistics significant criteria are provided to ensure long-term safety, sufficiency, effectiveness, and efficiency. Hence, studies by [45], [46], [88], [55], [73], and [89] argued that a tremendous investment of resources, effort, and political will be required to achieve this.

3.5.1. Regulation and Policy: Government policies create easy access for regulation, capital and support for cold chain logistics development [7], [16]. A public policy approach entails decisions that would be made by decision-makers after estimating projected impact and taking costs and benefits into [90]. Furthermore, according to [91] politics and administration are crossing boundaries through policy thus, Public organizations have adopted a policy in response to the issues facing society. However, studies conducted by [52], [92], and [7] Legal obligations and various regulatory requirements of the organizations will clearly cause efficient harvesting, storage, transportation and processing. Weather condition is also one of the important threats for food quality. Perishables should not be stored where sun light is intensive such as a balcony or patio.

3.5.2. Specialized Skills: Cold chain logistics operations require specialized skills for effective material handling. Similarly, according to [93] skill development is built on academic abilities, leadership abilities, personal qualities and research, development, and innovation which promotes the attainment of skill competence. Similarly, [7] argued that engaging personnel with poor cold chain logistics skills will promote the use of unsuitable operational procedures, bad management, and expensive costs in the service environment. [92] opined that there is need to understand the effect of temperature on foods and receive comprehensive training regarding correct loading and unloading practices, proper storage and handling practices, quality assurance and a general knowledge of refrigeration system. Thus, [45] and [47] argued there should be an adequate number of qualified and skilled staff at each location of cold chain logistics and they should take necessary precautions including hygiene requirements and protective clothes in their discharge of cold chain operations.

3.5.3. State of Technology: The state of cold chain logistics technology is crucial in protecting the integrity of cold chain fresh and perishable products like tomatoes that are highly temperature sensitive [15]. Cold chain technologies boost operations performance through effective product storage and tracking and tracing, temperature monitoring and distribution management. The benefits derived from use of wireless sensor network (WSN) and the Radio frequency identification device (RFID), cloud computing and 5G technologies are enormous [4], [30], [92], [94]. These technologies are applied in areas of storage, transportation to promote product precooling, cooling for the elongation of product shelf life.

3.5.4. State of Infrastructure: The state of cold chain logistics infrastructure determines the performance. In order to achieve effective and efficient cold chain logistics operations the right cold chain infrastructure must be provided and operational. Typical cold chain logistics infrastructure consists of pre-cooling facilities, cold storages, refrigerated carriers, packaging, warehouses, and distribution facilities, road, rail network, good roads, air mode, sea mode, and equipment's [16], [47], [95]. Cold chain logistics infrastructure provides refrigeration systems that keeps perishable goods from spoiling, extending their shelf lives and enhancing food safety [96].

3.5.5. Financial Support: The major challenge facing cold chain logistics performance in developing countries today is funding. A lot of cold chain are operating ineffective systems as a result poor financial support [46]. Cold chain logistics operations stability is dependent on financial stability which can be achieved through access to credit and loan scheme support from stakeholders' support [97]. Cold chain businesses should also provide significant support to help increase farmer income and thereby promote the revitalization of rural industry [68].

3.5.6. Innovations: Innovation affects organizational performance [98]. Innovation in small and medium-scale enterprises (SMEs) entails the use of internal knowledge sharing practices and external information and research collaborations for products to stay competitive in their market. Open innovation depends on knowledge sharing culture, which is significantly boosted when top management implements, supports, and nurtures knowledge sharing and innovation of businesses operating in dynamic markets.

3.6. Veritable attributes for Sustainable Cold Chain Logistics Performance

The Table 2 below shows the performance attributes for sustainable cold chain logistics operations. These outcomes are; maintaining product shelf life and freshness, effective temperature control, quality service delivery, safety, cost efficiency, innovations, just in time service delivery, proper product monitoring and traceability, reliability of product deliveries, big data management, having regulations and policies, professional skill, competence are in place and ensuring customer satisfaction.

Table 2. The Performance attributes for Cold Chain Logistics Operations

S/n	Performance outcome	Characteristics	Authors
1.	Maintaining product shelf life and freshness	Quality assurance	[22]
2.	Effective Temperature control	Temperature monitoring and control, preservation of product shelf life	[26], [80], [85]
3.	Quality service delivery	State of service delivery, Value, Product freshness, hygiene and free from contamination	[99], [100]
4.	Safety	Free of danger, hazard, and risk	[57], [59], [85], [101], [102]
5.	Cost efficiency	Service expenditures; operations cost, storage cost, refrigeration cost, packaging cost, inventory cost, technology cost, distribution cost, cost of product loss	[27], [38], [59], [73], [103], [104]
6.	Innovations	Improvements, dynamic change infrastructure	[33], [35], [73], [105]
7.	Just-in-time delivery	On time service delivery to customers, timeliness of service, service without delay	[106], [107]
8.	Product Monitoring and Traceability	Information management, freight tracking and tracing	[31], [100], [108]
9.	Reliability of product deliveries	State of Readiness without errors	[5], [85], [109]
10.	Big data management	Information control	[4], [76], [109]
11.	Regulations and policies	standards	[7], [57], [59]
12.	Professional skills and competence	Work ethics, capability, capacity, service providers competence	[5], [7], [105]
13.	Customer satisfaction	Customer satisfaction	[105]

3.6.1. Maintaining product shelf life and freshness in cold chain logistics: Maintaining optimal temperature conditions, rapid order fulfilment, and implementing effective rotation practices are crucial aspects of cold chain logistics operations for perishable fast-moving consumer goods (FMCG) to ensure product shelf life and freshness.

3.6.2. Temperature monitoring and control in cold chain logistics for perishable products: Temperature monitoring and control are critical aspects of cold chain logistics for perishable FMCGs according to studies of [110], [111], [85], [112], and [26]. These studies reveal that exposure to low temperatures can cause physical harm to the fresh tomato produce, a condition known as chilling or freezing injury. Furthermore, according to [23] continuous temperature monitoring is essential to maintain the quality and safety of perishable FMCG products throughout the supply chain. A study conducted by [23] emphasized that contemporary cold-chain logistics development in temperature control focuses more on single logistic chain rather than serving multiple channels. Thus, order to overcome this deficiency, a time-temperature indicator (TTI) based cold-chain logistics system with wireless sensors for collecting temperature data and formulation of Critical Control Point (CCP) criteria throughout the entire delivery process is needed. Similarly, studies of [67], [68], [113], and [114] reveal that the use temperature monitoring technologies such as wireless sensors, IoT (Internet of Things), and cloud-based platforms enables early real time detection of temperature deviations and execution of timely corrective actions to maintain product quality. Furthermore, studies by [31], [115], and [116] focused on temperature monitoring in cold storage facilities. The studies emphasized the importance of employing advanced monitoring systems, such as remote temperature sensors and data loggers, to ensure continuous temperature monitoring in cold storage facilities this helps in identifying issues, such as equipment malfunctions or temperature fluctuations. Thus, Temperature predictive alert systems and prompt corrective actions are crucial to mitigate the risks associated with temperature deviations in cold chain logistics [87], [117], [118]. Furthermore, [46] argued that maintaining temperature compliance during loading, unloading, and transportation is vital to preserve the quality and safety of perishable FMCG products and to minimizes temperature fluctuations while reducing the risk of product spoilage.

3.6.3. Quality Service Delivery: Quality service is a critical component of cold chain logistics services, as it directly impacts the integrity and safety of temperature-sensitive products throughout the cold chain and customer satisfaction [101], [119]. The attraction for cold chain logistics services is dependent on quality of service delivery through cold chain technology innovation [20]. This creates avenue for sustainable and value oriented cold chain logistics practices. However, weak policy can impede quality through ineffective cold chain logistics practices [50]. Thus, there need for cold chain logistics service providers to strengthen cold chain logistics service policies in order to enhance service delivery and satisfy customer needs [50]. Several factors contribute to the quality of service delivery in cold chain logistic operations these factors include; reliability, responsiveness, quality assurance, empathy, and tangibility.

3.6.4. Services Efficiency: Cold chain logistics services are constantly seeking ways to increase efficiency in order to reduce operating cost and enhance the quality, safety, and timeliness of delivering temperature-sensitive products. According to [15] cold chain logistics service providers to improve efficiency through the use of; Advanced Temperature Monitoring and Control Systems. ii, Optimal Route Planning and Load Optimization iii, Collaboration and Information Sharing, Automation and Robotics, Continuous Training and Skill Development for personnel.

3.6.5. Just-In-Time (JIT) Delivery: This is a strategy widely employed in perishable FMCGs industry to ensure timely arrival of distributed product while minimizing the inventory holding costs and improving cold chain logistics efficiency. A study by [22] explored the application of JIT principles in perishable supply chains. The research emphasized the benefits of JIT delivery, including reduced

inventory levels, improved product freshness, and lower inventory holding costs. JIT delivery enables perishable FMCG providers to optimize their inventory levels while ensuring timely replenishment.

3.6.6. Customer Satisfaction: A customer is a very important member of the value chain who contributes to the growth, development, and sustainability of cold chain logistics operations. Similarly, the customer is a valuable asset that is crucial to every cold chain logistics business survival because no single cold chain business entity can exist if its customers are not present [120]. According, to [8] cold chain logistics operations are focused on meeting consumer demands for high-quality, fresh, and healthy meals, which is the value requirement of its operations. Thus, it is therefore, important for cold chain businesses to keep satisfying their consumers who are their customers and service beneficiary. Cold chain logistics service providers must also ensure that customers requirement for fresh, quality products effectively, in order to be sustainable and maintain strong customer relations [121]. Furthermore, [105] argued that service providers must always remain innovative when satisfying customers' needs. This is so because customer loyalty is a critical factor that makes a business such as cold chains logistics business to succeed in today's highly competitive market.

3.6.7. Products Traceability and Transparency: Products traceability and transparency are essential elements in cold chain logistics for perishable FMCGs. Implementing track-and-trace technologies provides real-time visibility into the movement and conditions of perishable FMCG products throughout the cold chain. Studies by [122], [30], and [101] investigated the use of track-and-trace technologies, such as internet of things (IoT) technologies, cloud computing, block chain, Radio Frequency Identification (RFID) and barcode systems, 5G technologies in cold chain logistics. The research highlighted the benefits of these technologies in capturing data on product location, temperature, and handling events, enabling real-time monitoring and traceability. Track-and-trace technologies enhance supply chain visibility, reduce the risk of product loss or theft, and facilitate efficient recall management [71], [119], [122], [123]. Furthermore, product track and trace technologies enhance transparency in documenting temperature records and handling practices.

3.6.8. Innovations: Innovations are change elements that improve systems or service performance. It promotes and sustain cold chain logistics practices. Areas that require innovation in cold chain logistics operations are skills of service providers, technology, infrastructure, product handling and storage and distribution planning and implementation [15].

3.6.9. Collaboration and Partnerships: Collaboration and partnerships are essential elements in cold chain logistics for perishable FMCGs. It entails; a, building a strong relationship with suppliers, distributors, and retailers: b, building strong relationships with supply chain partners is crucial for the success of cold chain logistics for perishable FMCGs products. Furthermore, a study by [124] focused on building relationship between cold chain logistics service providers and retailers. The study emphasized the significance of having strong relationships between service providers and retailers is to build long-term partnerships based on shared goals, trust, and mutual benefits and to facilitate better demand forecasting, timely order fulfilment, and improved customer satisfaction.

3.6.10. Total Logistics Management (TLM): Total logistics management is based on a combination of three dominant concepts in Logistics Management, namely; Lean, Agile and Resilience [82]. According to [125] Total logistics management (TLM) is a management strategy that organizations and business utilize to make every part of their operations possible. Furthermore, [126] opined that TLM is one of alternatives ways in which third party logistics services (3PLs) take advantage of external organization with forth party logistics services 4PL in the physical distribution process, giving service user like shipper better logistics services, the tools for total logistics which are rationalization, unitization, hub and spoke network.

3.6.11. Supplier Networking: Suppliers constitute important providers of resources such as technologies, knowledge, skills which business may lack in their operations. Thus, [14] argued that networking with sustainable suppliers contributes positively towards economic growth of the society. Similarly, according to [127], managing supplier relationships, including overall supply portfolios, has been shown to increase the purchasing efficiency of businesses by streamlining resource acquisition and optimizing operational. Similarly, in view of the nature of cold chain activities which require a lot of specialized skills and infrastructure to perform effectively, it is advisable for cold chain service providers to collaborate and form partnerships in order to enhance service delivery [16], [52].

3.6.12. Efficient Information and Communication Management: Information management is a vital activity in cold chain logistics operation. Cold chains logistics require seamless information flow in its operation in order to perform optimally. Thus, cold chain logistics operation is coordinated from the upstream and downstream through proper information sharing by the practitioners [5], [112], [128].Thus, according to [129], information technology (IT) advancements is critical in improving the planning, implementation, and management of products, tracking and tracing services, information flows and storage from point of origin to point of consumption in order to increase consumer satisfaction. Information management provides real time information within the operating system and create ease for product tracking and tracing.

3.6.13. Sustainability and Environmental Considerations: Cold chain logistics performance in Nigeria is expected to increasingly incorporates sustainability and environmental considerations. A study by [40], [46], [130] examined the environmental impact of cold chain logistics in developing countries like Nigeria. The research highlighted the implementation of energy-efficient practices, use of eco-friendly refrigerants, and adoption of sustainable technology for refrigeration and communication, packaging solutions to minimize the carbon emissions and promote environmental sustainability.

3.6.14. Summary of Study Findings: All of the 130 papers reviewed argued that cold chain logistics operation will reduce food losses and increase food security. Similarly, all authors agreed that in order to achieve cold chain logistics sustainability there is need for improved service delivery. 42 of the papers reviewed argued that cold chain logistics sustainability relies on services adaption of new technologies like 5G technologies, Radio frequency technologies (RFID), Cloud computing, Vehicle monitoring and tracking technology in order to access real time data, information for better product monitoring tracking and tracing in order to minimize system risk, cost, and in order to boost internet of things (IoT) by service providers especially the 3PLs. Authors, also argued that cold chain logistics operations strive in developed countries due to available infrastructure and technologies. However, all papers reviewed insisted that cold chain logistics services depend on the availability of significant criteria such as good infrastructure, technology, skill, policy in developing economies. A lot of authors also looked at the relationship between cold chain performance and service efficiency in terms of use of information and mechanical technologies to promote ease of business. Multi decision making criteria and fuzzy AHP algorithm was also utilized to analyze the impact of cold chain operations on efficiency, service providers commitment to service delivery, sustainability, and customer satisfaction. It was also found that lack of synergy between service providers and stakeholders impede the development of cold chain logistics operations. This creates a vacuum of the absence and sufficient provision of cold chain logistics policy, regulation, skills, finance, infrastructure, innovation, information, cultural norms, income levels and technologies that impede cold chain logistics performance in Nigeria. These inadequacies also promote the broken chain operation which does not guarantee safe and quality service delivery. This summary is further highlighted in figure 3.

Table 3. Summary of major findings

Section No.	Major findings	Description
3.3.2, 3.4, 3.5.3,	Findings show that the adoption and adaption of information advanced	42 of the papers reviewed argued that cold chain logistics sustainability relies on services adaption of new technologies like 5G technologies,

Section No.	Major findings	Description
	information technology enhance the performance of cold chain logistics in the service environment.	Radiofrequency technologies (RFID), Cloud computing, Vehicle monitoring, and tracking technology in order to access real-time data, and information for better product monitoring tracking and tracing in order to minimize system risk, cost, and in order to boost internet of things (IoT) by service providers, especially the 3PLs. Authors, also argued that cold chain logistics operations strive in developed countries due to available infrastructure and technologies
3.5	Findings reveal that cold chain logistics services depend on the availability of significant criteria	Good infrastructure, technology, skills, finance, and policy in developing economies. A lot of authors also looked at the relationship between cold chain logistics performance and service efficiency in terms of the use of information and mechanical technologies to promote ease of business.
2.9 (Table 1)	Finding reveal that Multi decision-making criteria and fuzzy AHP algorithm impact on cold chain logistics efficiency.	This is through service providers' commitment to service delivery, sustainability, and customer satisfaction.
3.2 – 3.5	Lack Of Synergy Between Service Providers and Stakeholders Impede the Development of Cold Chain Logistics Operations	This creates a vacuum of the absence and sufficient provision of cold chain logistics policy, regulation, skills, finance, infrastructure, innovation, information, cultural norms, income levels, and technologies that impede cold chain logistics performance in Nigeria
3.6	The inadequacies in cold chain logistics operations arise as a result of absence and inadequacies of cold chain logistics significant criteria such as policy, regulation, skills, finance, infrastructure, technology, innovation	These inadequacies also promote the broken chain operation which does not guarantee safe and quality service delivery
3.2 – 3.5	The biggest risk issues identified are insufficient technology, ineffective transportation, and high facility costs, while the biggest restriction is a lack of laws and norms. Other factors include inadequate logistics infrastructure, improper resource distribution, irregular operations, and a lack of proper supervision.	These negatives impede cold chain logistics effective and efficient performance.

4. Conclusion

The study findings, bridge the gap between theory and practice. The study also reveal that Cold chain logistics service providers provide services that promote the performance of perishable food cold chains (PFCC). The study also reveal that the perishable food quality depends on cold chain logistics operations. The study also reveals that the high fresh tomatoes losses in Nigeria, is significant and contributes highly to food insecurity in Nigeria.

The biggest risk issues identified are insufficient technology, ineffective transportation, and high facility costs, while the biggest restriction is a lack of laws and norms. Other factors include inadequate logistics infrastructure, improper resource distribution, irregular operations, and a lack of proper supervision. The study reveals that absence of these significant criteria create bottleneck for the delivery effective cold chain logistics operations in the fresh perishable food FMCGs industry in Nigeria. Thus, this study provides the solution for achieving sustainable performance outcomes in cold chain logistics operations and in reducing FLW in the FMCGs and in Nigeria.

4.1. Study Contributions

This study's findings close the gap in earlier studies. First, the consequences of FLW were investigated, particularly in Nigeria. This review focused on the most pressing causes of FLW threats in Nigeria from the perishable food cold chains. Second, reviewed the performance of cold chain logistics service providers in the FMCGs industry in Nigeria.

This study will provide practitioners such as cold chain logistics service providers with practical advice on how to reduce their FLW losses and risk. This study also identifies significant criteria required to enhance the performance service providers in order to reduce the risks of FLW in the perishable food cold chain industry. The study also highlights that poor cold chain logistics performance occur as result

of inefficiencies in technology, a lack of proper regulations and standards, lack of skilled personnel, poor infrastructure, absence relevant adequate technology, funding and lack of synergy among stakeholders.

4.2. Limitation and Future Directions

This study focused only on performance criteria that can reduce perishable FLW in the FMCGs industry in Nigeria. Thus, based on the fact that the study focused on causes of FLW in the perishable food cold chains in Nigeria which is specific to the Nigerian geographical space, the results of this study might not generalize to other nations FLW causes. Thus, future studies could be channeled towards finding out the FLW of other perishable food products in Nigeria where it is unknown, and also studies on the impact of broken chain operation on cold chain logistics sustainability. This could open a new area for future research.

Declaration of Competing Interest

The authors certify that none of their known financial conflicts of interest or close personal ties might have appeared to have influenced the research presented in this study.

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