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INVENTORY MANAGEMENT OF FMCG PRODUCTS WITH A SHORT SHELF LIFE – SYSTEMATIC LITERATURE REVIEW

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Purpose: The aim of this study is to examine the current state of research on inventory management models for fast-moving finished goods with limited shelf life through a systematic literature review.
Design/methodology/approach: The study was conducted through a systematic literature review and bibliometric analysis using the Prisma standard and VOSViewer tools. Five different keyword searches were conducted in the Scopus, Web of Science, and EBESCOhost Web databases. Key trends, leading authors, institutions, and research topics were identified, and the main areas of interest in this field were determined. Based on a narrative literature review of the most important publications, the characteristics, and key challenges for the FMCG sector around inventory management in the production-warehouse-customer chain were also presented.
Findings: The study identified a research gap in the application of a multidimensional approach to the inventory management of fast-moving finished goods with a short shelf life, considering the production-warehouse-customer supply chain. A lack of research was noted in terms of simultaneously considering key criteria such as minimizing production costs associated with decreasing batch sizes and the consequent rise in setup costs, reducing storage costs and losses related to product expiration, and maximizing product availability for customers.
Research limitations/implications: The scope of the study was restricted to identifying and analyzing comprehensive inventory management models discussed in the literature that consider both high product availability and limited shelf life. Future research will aim to develop a model for managing fast-moving finished goods in FMCG manufacturing companies to maximize product availability, minimize storage costs and losses from product expiration, and reduce production start-up costs for inventory replenishment.
Practical implications: At this stage, practical implications cannot yet be determined.
Originality/value: The originality of the article lies in examining the occurrence of inventory management models from production to distribution in the literature that consider short shelf life and high product availability. Further research developing such a model will be valuable for FMCG enterprises aiming to maintain high availability of short shelf life products.
Keywords: Fast Moving Consumer Goods, inventory management, product availability, short shelf life.
Category of the paper: Literature review.

1. Introduction

The fast-moving consumer goods (FMCG) market is characterized by intense competition, dynamic growth, and high customer expectations. The FMCG sector includes, in particular, everyday products, such as food, chemicals, cosmetics, pet food, and pharmaceuticals. Entities operating in the FMCG sector compete for customers primarily by offering products tailored to their expectations (Kabus, 2022). Today's consumers can choose from a wide range of products from different suppliers, so they pay attention not only to the high quality of the products offered, but also to order fulfillment time, reliability, and constant availability of products. In this context, failure to fulfill an order in full has significant consequences for the company. Customers whose needs have not been met often choose substitute products from other suppliers. For the company, this means not only a direct financial loss, but also a negative impact on the brand's reputation, which in the long term can translate into a weakening of its market position. In the FMCG sector, customer loyalty is very often determined by shopping experiences, so even temporary shortages in the product range can translate into a weakening of the company's market position in the long term.

Manufacturing companies in the FMCG sector usually have production lines dedicated to specific product groups. The production process involves long line changeover times due to technical and hygienic requirements. In addition, production cycles are highly variable depending on batch size, and a minimum batch size is specified for each product group to ensure the profitability of production due to changeovers.

In the case of FMCG enterprises, production planning requires freezing the plan for a fixed period to ensure the availability of materials. At the same time, warehouse stock levels must be adjusted to the intensity of demand due to the short shelf life of the products.

Inventory management models tailored to different situations have been developed for over 50 years. An analysis of inventory management models and the above challenges has identified **a research problem**, namely the inventory management of fast-moving finished goods with a short shelf life, to ensure high product availability while minimizing the costs associated with creating and maintaining inventory at the appropriate level and minimizing losses associated with the disposal of expired products or those with a very short shelf life.

The subject of finished goods inventory management is discussed in literature in various aspects. More often, the subject of analysis is the warehouse-customer relationship, and less often the production-warehouse and production-warehouse-customer relationships.

In the **warehouse-customer relationship**, effective inventory control systems are sought to reduce inventory levels and avoid customer order shortages. One such system is the VMI service (Harrison et al., 2019). Cooperation within the supply chain has been strongly supported by both researchers and consultants since the mid-1990s through concepts such as Vendor Managed Inventory (VMI), Collaborative Forecasting Planning and Replenishment

(CPFR), and Continuous Replenishment (CR) (Holweg et al., 2005). The policy of inventory management through the VMI system is often considered a win-win solution: the supplier can better coordinate deliveries to customers based on observed inventory levels at the customer's site rather than on replenishment orders from customers; in turn, the customer does not have to devote its resources to inventory management (Coelho, Cordeau, Laporte, 2012). Enforcing a VMI policy effectively is not easy, as the supplier must deal with a complex problem consisting of its own decisions regarding vehicle routes and decisions regarding customer inventory (Raa, Aghezzaf, 2009). This integrated problem is known as IRP (Inventory Routing Problem) and refers to the coordination of inventory management and vehicle routing (Jemai et al., 2013). In the traditional Vehicle Routing Problem (VRP) model, the supplier strives to fulfill customer orders to minimize the total cost of distribution - to plan routes accordingly. In contrast, in IRP, orders are determined by the supplier based on input data regarding customer demand. Furthermore, in IRP, the supplier seeks to manage customer inventory in such a way that they do not experience stockouts, whereas traditional VRP does not consider this aspect. The presence of an inventory component in IRP adds a time dimension to the associated routing problem. The VRP system is used for short-term problems, and IRP for medium-term problems. The IRP system assumes an unlimited shelf life for products, as it does not allow for the decline in shelf life to be considered – this is one of the main challenges of using IRP in the logistics of FMCG companies.

From a **production-warehouse perspective**, suitable models for production management in the FMCG sector are sought that will ensure production flexibility in relation to variable demand, as a different approach from the classic one, focused on minimizing planned production costs. Various approaches to solving the integrated problem of batch size and scheduling and minimizing changeover costs are reviewed and compared (Lueb, 2014).

When analyzing the **production-warehouse-customer relationship**, there is a clear problem of a widening gap between inventory management theory and practice and the latest developments aimed at bridging this gap. The need for a central information system that enables supply chain members to exchange information in real time in order to minimize inventory is emphasized (Kumar, Mishra, George, 2013). The growing demand for a make-to-availability production management model is also highlighted, which performs better than a make-to-stock model due to the minimization of inventory creation costs, storage costs, and customer demand fulfillment costs (Ciechańska, Szwed, 2020).

The aim of this article is to examine the current state of work on inventory management models for fast-moving finished goods with a short shelf life. On this basis, key trends, leading authors, institutions, and research topics have been identified, and the main areas of interest in this field have been determined.

This article consists of five parts. The Introduction presents the characteristics and current key challenges for the FMCG sector in the area of inventory management in warehouse-customer, production-warehouse, and production-customer-warehouse relationships,

and identifies the research problem. The Methodology section describes the literature analysis method used, namely a systematic literature review based on the Prisma standard. The Results section presents the results of a systematic literature review for five different keyword searches in the Scopus, Web of Science, and EBESCOhost Web databases. The Discussion section is devoted to a detailed analysis of the publications from the most advanced search. Using a narrative review of the most important areas related to inventory management, the literature was examined for comprehensive inventory management models from production to distribution that take into account the particular importance of product availability and freshness in the FMCG industry, while at the same time focusing on minimizing storage and production costs. The final section, Conclusions, summarizes the systematic review of the literature in the area of inventory management for FMCG products with a short shelf life and identifies a research gap and an outline for further research.

2. Methods

Currently, there are many publications in the field of inventory management in the FMCG industry. For this reason, it was necessary to take a systematic approach to the analysis and evaluation of publications, focusing on quantitative methods of data analysis. The literature review was conducted using the bibliometric analysis method, which involves the use of mathematical and statistical models (Mora, Bolici, Deakin, 2017). Recommendations from the PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) standard, which is key to systematic literature review, were also used. The guidelines for this standard were developed by a consortium of methodologists, journal editors, and authors of systematic reviews to address the problem of incomplete and unsatisfactory reporting in systematic literature reviews (Moher et al., 2007).

A systematic literature review should include planning, analysis, and summarizing the results. The authors suggest looking at the number of articles over the years, the journals with the most publications in a given subject area, the number of citations, the authors with the most publications, or the countries of publication, and then observing trends based on that. VOSViewer is a useful tool here for analyzing links between publications, keywords, and trends (Niñerola et al., 2019). The authors additionally add criteria related to the language of publication or type of publication in order to select the most important ones, including only English-language and full-text peer-reviewed articles, avoiding conference materials, or publications with anonymous authors (Lim et al., 2021). The literature review scheme, based on the PRISMA standard, is presented in Figure 1.

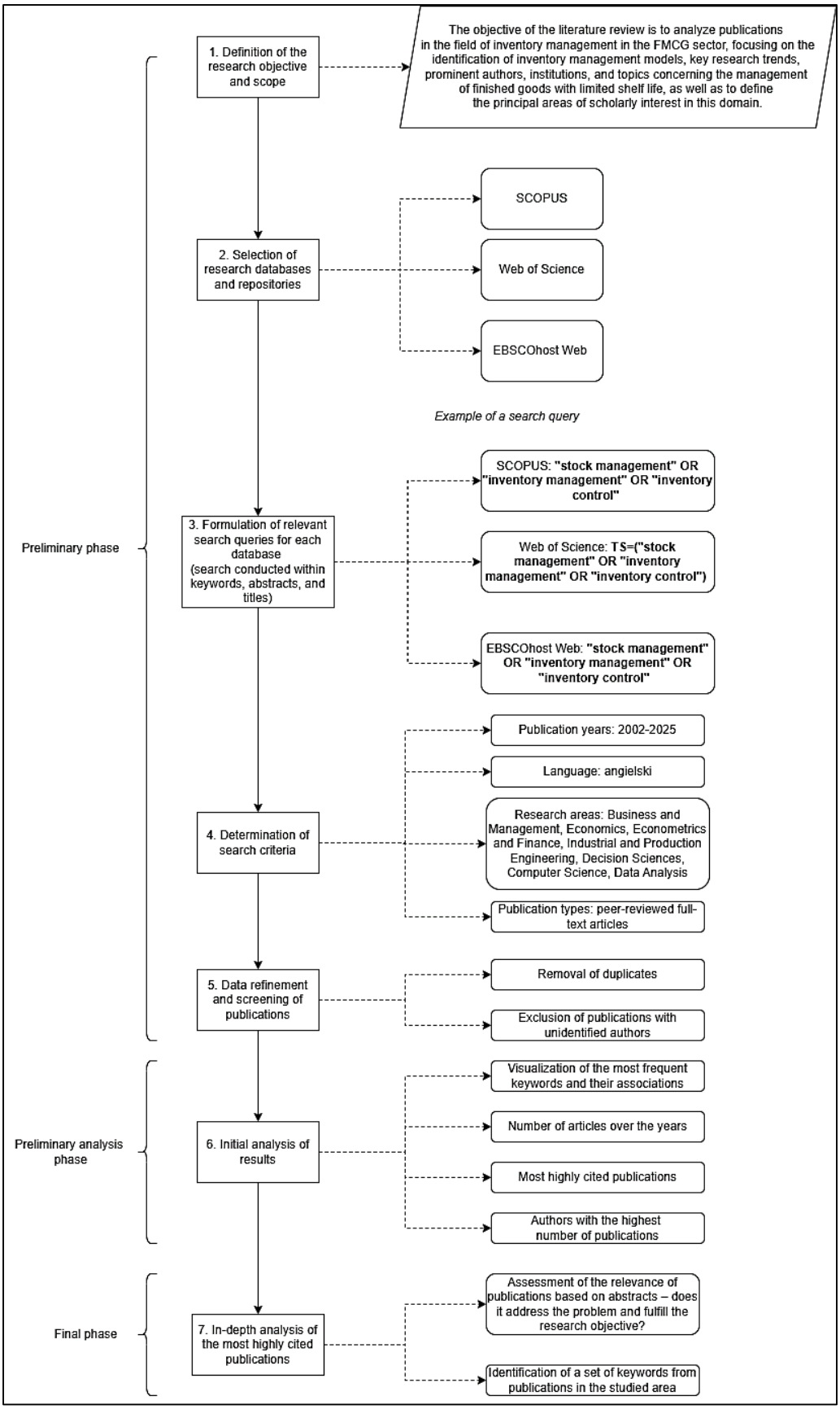

Figure 1. Subsequent stages of literature analysis.

Source: own study based on: (Zhao, Strotmann, 2015; Ertz, Leblanc-Proulx, 2018; Szum, 2021; Michałowska, Majchrzak, 2024; Czakon, 2021).

A systematic literature review consists of seven main stages. First, the objective and scope of the study are defined. In this case, the objective is to review publications in the field of inventory management in the FMCG industry, examine inventory management models, and identify key trends, leading authors, institutions, and research topics in the management of finished goods with a short shelf life, and to define the main areas of interest in this field. Next, databases are selected, and appropriate queries are defined for each database – in this case, Scopus, Web of Science, and EBESCOhost Web. The main bibliographic and abstract databases, Scopus and Web of Science, were selected due to their high quality, popularity in the scientific community, and the interdisciplinary nature of the articles. EBESCOhost Web, on the other hand, is a good complement to Scopus and Web of Science and offers high-quality interdisciplinary articles and full-text access to selected items. EBESCOhost Web is supplemented by, among others, full-text databases (Academic Search Complete, Business Source Complete, Health Source - Consumer Edition & Nursing/Academic Edition, MasterFILE Premier, Newspaper Source, Regional Business News), comprehensive data from international repositories, and bibliographic and abstract databases (Agricola, ERIC, GreenFILE, LISTA, MEDLINE). Since 2002, the databases analyzed show an upward trend in the number of articles in the field of inventory management. For each database, appropriately defined search criteria should be selected. In the example described, these are the years 2002-2025, items in English, fields of science: Business and Management, Economics, Econometrics and Finance, Industry and Manufacturing Engineering, Decision Making, Computer Science, Data Analysis, as well as publication type as full-text peer-reviewed items.

After completing steps 1–4, the downloaded databases are cleaned of records that do not qualify for the review, duplicates, and items with unknown authors. Once these steps have been completed, a preliminary analysis of the results can be performed, i.e.:

- Visualize the most common keywords and connections, e.g., using VOSViewer.
- Present the number of publications over the years in a graph.
- Present the countries, disciplines, and journals with the highest number of publications and, if necessary, analyze trends in this area over the years.

On this basis, literature analysis can proceed to the final stage, which is a detailed analysis of the results of the publications with the highest number of citations. For these publications, determine their usefulness based on the abstracts and identify a set of keywords from the publications in the area under study.

3. Results

Five different searches were conducted in the Scopus, Web of Science (WoS), and EBESCOhost Web databases and analyzed. The results are presented in Table 1. The number of articles analyzed was determined after cleaning the databases of duplicates, items not eligible for review, and items with unknown authors. The first search was conducted using the keywords stock management, inventory management, and inventory control, while the fifth search included: stock management, inventory management, inventory control, Fast Moving Consumer Goods, FMCG, product availability, stock levels, out of stock, overstock, shelf life, freshness, model, strategy, framework, review, literature review, systematic review.

Table 1.
Five subsequent article search queries in the databases

Item	Databases		
	Scopus	**WoS**	**EBESCOhost Web**
Query no 1	**"stock management" OR "inventory management" OR "inventory control"**	**TS=("stock management" OR "inventory management" OR "inventory control")**	**"stock management" OR "inventory management" OR "inventory control"**
All publications	**73 741**	**12 464**	**54 849**
Full-text peer-reviewed articles	**50 969**	**9 024**	**36 348**
Query no 2	**"FMCG" OR "fast moving consumer goods"**	**TS=("FMCG" OR "Fast Moving Consumer Goods")**	**"FMCG" OR "fast moving consumer goods"**
All publications	**11 953**	**1 494**	**25 749**
Full-text peer-reviewed articles	**9 577**	**1 147**	**4 505**
Query no 3	**"product availability" OR "stock levels" OR "out of stock" OR "overstock"**	**TS=("product availability" OR "stock levels" OR "out of stock" OR "overstock")**	**"product availability" OR "stock levels" OR "out of stock" OR "overstock"**
All publications	**10 714**	**2 311**	**10 928**
Full-text peer-reviewed articles	**8 212**	**1 796**	**5 383**

Cont. table 1.

Query no 4	**("stock management" OR "inventory management" OR "inventory control") AND ("product availability" OR "stock levels" OR "out of stock" OR "overstock") AND ("shelf life" OR "freshness") AND ("review" OR "literature review" OR "systematic review")**	**TS=("stock management" OR "inventory management" OR "inventory control") AND ("product availability" OR "stock level*" OR "out of stock" OR "overstock") AND ("shelf life" OR freshness) AND ("literature review" OR "systematic review" OR review)**	**("stock management" OR "inventory management" OR "inventory control") AND ("product availability" OR "stock levels" OR "out of stock" OR "overstock") AND ("shelf life" OR "freshness") AND ("review" OR "literature review" OR "systematic review")**
All publications	**391**	**4**	**3**
Full-text peer-reviewed articles	**330**	**4**	**3**
Query no 5	**("stock management" OR "inventory management" OR "inventory control") AND ("FMCG" OR "fast moving consumer goods") AND ("product availability" OR "stock levels" OR "out of stock" OR "overstock" OR "shelf life" OR "freshness") AND ("model" OR "strategy" OR "framework") AND ("review" OR "literature review" OR "systematic review")**	**TS=("stock management" OR "inventory management" OR "inventory control") AND TS=("FMCG" OR "fast moving consumer goods") AND TS=("product availability" OR "stock levels" OR "out of stock" OR "overstock" OR "shelf life" OR "freshness") AND TS=("model" OR "strategy" OR "framework") AND TS=("review" OR "literature review" OR "systematic review")**	**("stock management" OR "inventory management" OR "inventory control") AND ("FMCG" OR "fast moving consumer goods") AND ("product availability" OR "stock levels" OR "out of stock" OR "overstock" OR "shelf life" OR "freshness") AND ("model" OR "strategy" OR "framework") AND ("review" OR "literature review" OR "systematic review")**
All publications	**219**	**0**	**1**
Full-text peer-reviewed articles	**169**	**0**	**1**

Source: own study.

Almost all publications identified in the fifth search were included in the Scopus database (219), therefore detailed analyses for the fifth search using VOSViewer were performed for the Scopus database. Figure 2 shows the number of all publications by year in Scopus.

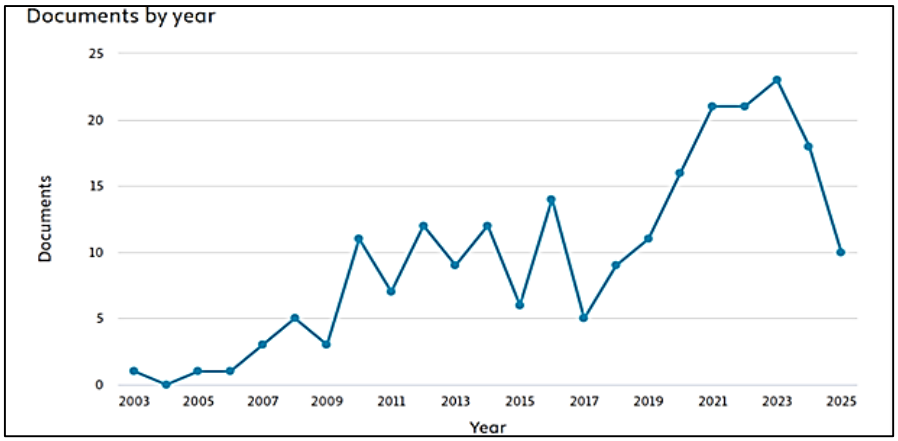

Figure 2. Number of publications in 2002-2025 in the Scopus database – fifth search.
Source: analysis tool from Scopus.

Since 2002, the Scopus database has shown an increase in the popularity of topics related to product availability and freshness for the FMCG industry, with the highest growth rate observed since 2017, although the number of articles each year is relatively small. In 2025, there are fewer publications due to the ongoing publication period, but a larger number of publications can be expected here (as of April 2025, there are already 10 publications in this area). An analysis was also conducted to determine which authors published the most material about product availability. Figure 3 shows the authors with the highest number of publications in the Scopus database.

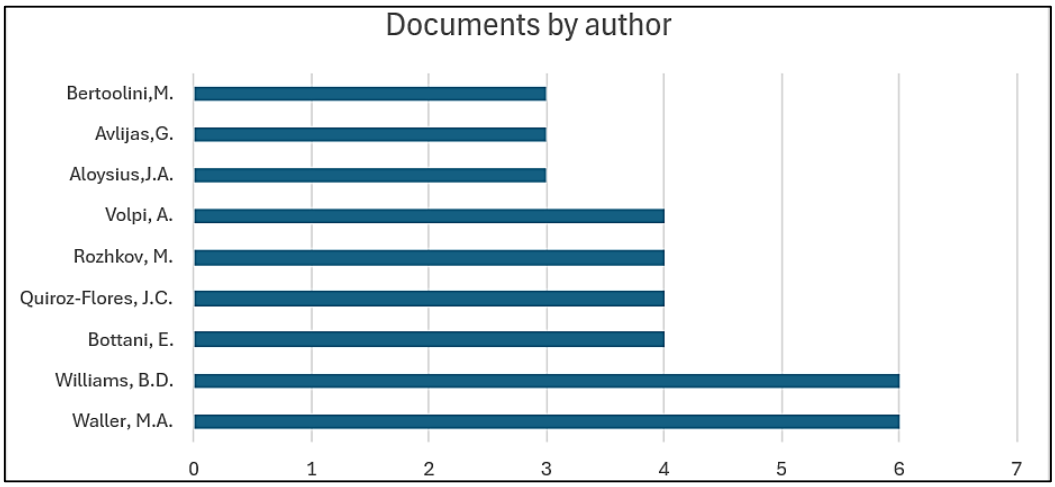

Figure 3. The most productive authors in the years 2002-2025 in the Scopus database – fifth search.
Source: own work based on the analysis tool from Scopus.

In the Scopus database, the most active authors published an average of three to six articles in the field of inventory management in the FMCG industry, considering inventory levels, product availability, and expiration dates. Figure 4 shows the share of publication types in the Scopus database.

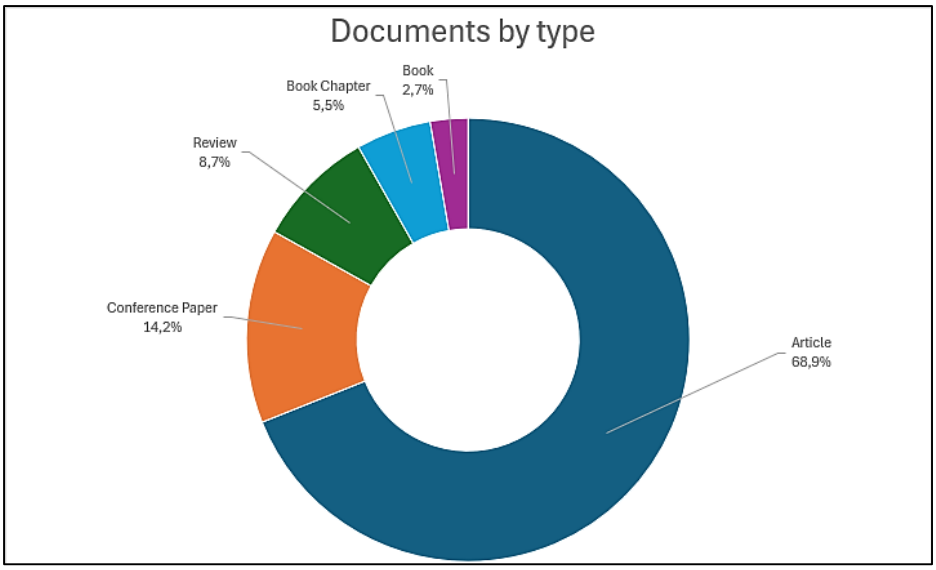

Figure 4. Share of publication types in 2002-2025 in the Scopus database – fifth search.
Source: own study based on the analysis tool from Scopus.

Most of the publications are journal articles. The second largest share is held by conference proceedings, followed by reviews and book chapters.

Another analysis of the results from the Scopus database concerns the countries of publication and the scientific fields in which the articles were published. The results are presented in Figures 5 and 6.

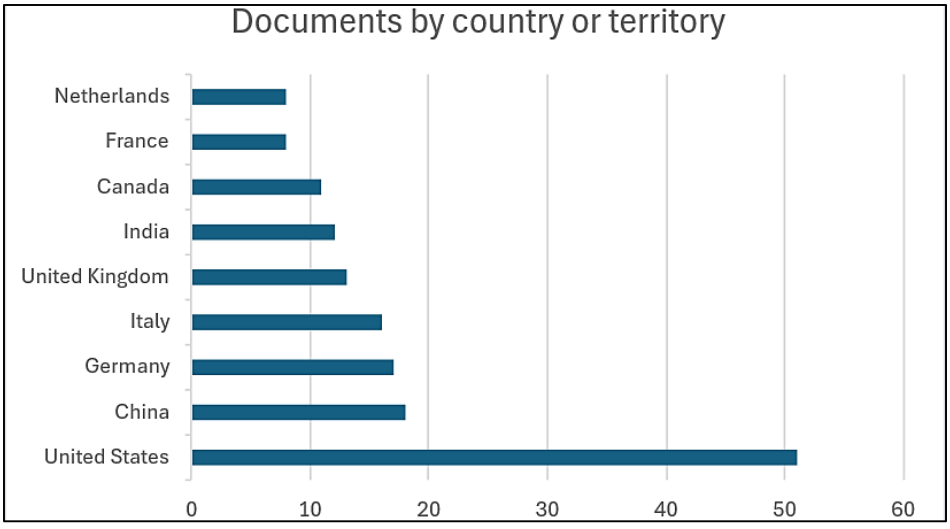

Figure 5. Countries of publication in 2002-2025 in the Scopus database – fifth search.
Source: own study based on the analysis tool from Scopus.

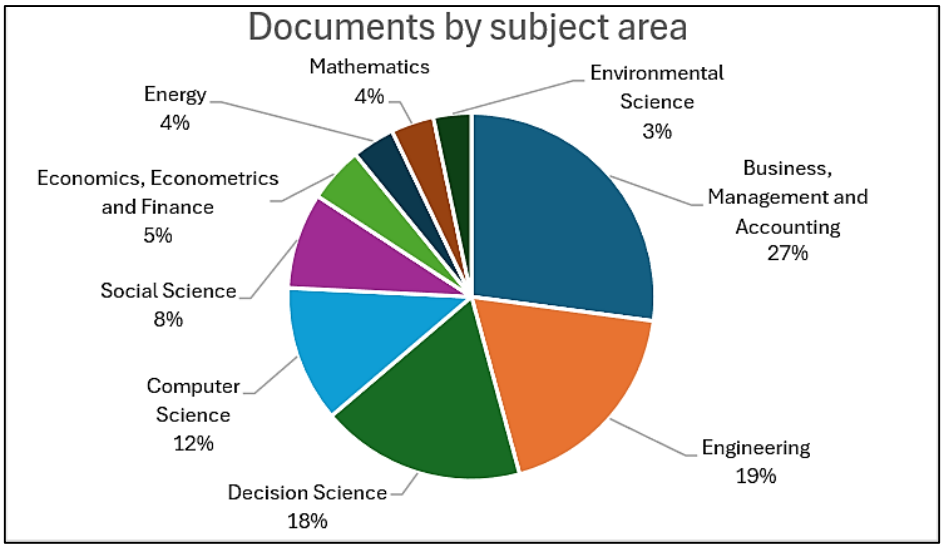

Figure 6. Fields of science in 2002-2025 in the Scopus database – fifth search.

Source: own study based on the analysis tool from Scopus.

In the Scopus database, most publications originated in the United States, China, Germany, and Italy. The most popular areas of publication are Business and Management, Engineering, Decision Sciences, and Computer Sciences, followed by Social Sciences.

The final area of analysis for the fifth search is the journals in which the scientific materials were published. The results of the analysis for the Scopus database are presented in Figure 7.

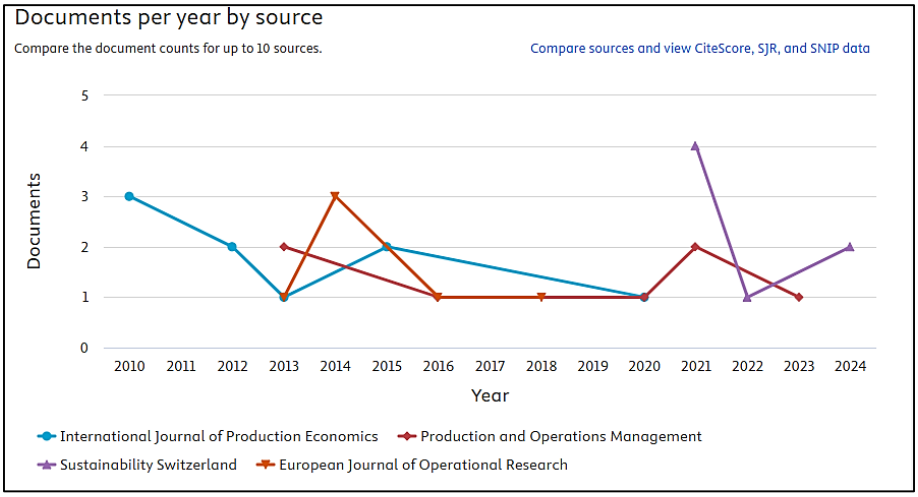

Figure 7. Journals with the highest number of publications between 2002 and 2025 in the Scopus database – fifth search.

Source: own study based on the analysis tool from Scopus.

In the Scopus database, the journal with the highest number of publications, which amounts to only 9 publications, is the International Journal of Production Economics, followed by journals with 7 publications, namely Production and Operations Management, Sustainability Switzerland, and then the European Journal of Operational Research with 6 publications. The remaining journals have fewer than five publications. In this case, it is difficult to talk about trends due to the small number of publications.

For the most advanced search, an analysis of the most frequently occurring keywords was also performed using the VOSViewer tool, as shown in Figure 8.

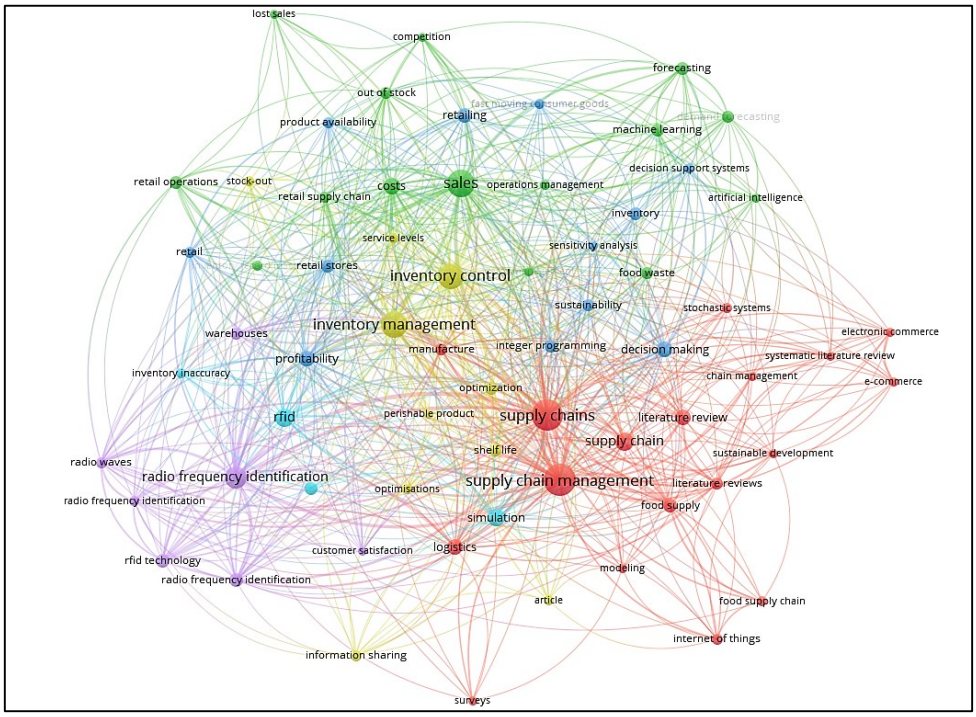

Figure 8. Most common keywords in the Scopus database – fifth search.

Source: own study based on the analysis tool from Scopus.

The most frequently occurring keywords are inventory control and inventory management, which directly correspond to the query, but there is also a noticeable frequency of keywords outside the query, including sales, supply chains, and supply chain management. The most popular keywords from the analyzed items are directly related to the topic of finished goods inventory management from production to distribution.

4. Discussion

The last and most advanced search was used to examine the occurrence of inventory management models in the literature that consider the importance of product availability and freshness in inventory management for the FMCG industry. Positions in this area were sought to properly identify the research gap and analyze the models found in the literature in this area. The results confirm that the topic of inventory management, in conjunction with product availability and freshness for the FMCG industry, has not been thoroughly analyzed, and no models have been found in the literature that comprehensively address inventory management in the FMCG industry from production to distribution, taking into account high availability and adequate product freshness, while minimizing storage and production costs.

The only articles that were related to the problem being solved to a limited extent were found in the Scopus database (a total of 219 items), which were subjected to further analysis.

During the study of the current state of work on inventory management models for fast-moving finished goods with a short shelf life, different approaches and strategies for inventory management were found depending on the industry sector and part of the supply chain to ensure high product availability. Further analysis revealed that authors often also identified critical areas that affect the availability of products for sale.

Over the past decade, research on finished goods inventory management has increasingly focused on digital technologies, lean methodologies, and advanced optimization techniques, including financial ones. Many literature sources indicate that predictive analytics, artificial intelligence, and machine learning improve demand forecasting and cost control.

Table 2 presents the key trends and issues identified in finished goods inventory management over the last 10 years.

Table 2.
Key trends and challenges in inventory management over the last 10 years.

Publication	Identified key trends	Related challenges	Potential benefits of applying trends	Sector
França et al., 2018	Lean tools (Kanban, value stream mapping, Heijunka)	Losses, inefficiency	Reduction of inventory and lead times	Furniture
Alvarez-Placencia et al., 2020	ABC analysis, min-max system, lean pull during COVID-19	Low product availability, pandemic	Improving service levels	Large industrial
Simić et al., 2019	Inventory optimization algorithms	Balancing demand fulfillment and costs	A model that minimizes inventory and costs	Automotive
Yeshwanth, Bhavana, 2022	ABC analysis, Just-In-Time, Kanban, automation	Disruptions in the supply of raw materials and throughout the supply chain	Increase in inventory turnover	Electronics
Lemke, 2015	Economic order quantity, Kanban, Vendor Managed Inventory (VMI), process integration	Lack of a universal strategy, poorly adapted performance measurement indicators	Proposal for alternative measures to improve efficiency	Manufacturing in the United States
Anisere-Hameed, Dare, 2021	Just-In-Time, process review	Frozen capital, risk of financial illiquidity	Improving profitability	Food and beverages
Adegbola et al., 2024	Integration of artificial intelligence, machine learning, and predictive analytics	Data quality, technology integration, ethical issues	Cost reduction, improved forecasting	Total production
Avilés-Sacoto et al., 2019	Industry 4.0, technology-based operations	Technology, data, cultural barriers, product life cycle reduction, flexible manufacturing to meet customer needs	Action plan for small and medium-sized enterprises to overcome barriers related to technology, data, and flexible production	Small and medium-sized enterprises, total production

Source: own study.

Based on the above summary, there is a visible trend in the use of lean tools such as Kanban, Value Stream Mapping, and Just-In-Time to increase operational efficiency. At the same time, the authors highlight various challenges in the area of finished goods inventory management. The problems are related to data quality, difficulty in integrating technology, and resource constraints. There are also challenges related to balancing demand fulfillment with costs, waste

and inefficiency, low availability of finished goods for sale, lack of a universal strategy, high inventory maintenance costs, and disruptions in raw material supplies and the entire supply chain. The main areas of research are inventory reduction, order fulfillment time reduction, cost reduction, service level improvement, and inventory turnover improvement.

In the context of the FMCG sector, the identified trends are particularly significant due to short product life cycles, high demand variability, and the necessity to maintain a high level of finished goods availability. Research findings indicate that lean tools and methods such as Kanban, Just-In-Time, and ABC/XYZ analysis can be effectively adapted within this sector, provided that they are complemented by solutions that enhance flexibility and responsiveness across the supply chain. Furthermore, evidence from other industries (e.g., automotive, electronics, heavy industry) highlights the importance of data integration, process automation, and the application of predictive methods, which can be partially transferred to FMCG to improve demand forecasting and reduce losses associated with short product shelf life. In the FMCG sector, however, dynamic adjustment of operational strategies is of paramount importance—combining lean principles with modern digital tools and predictive inventory planning. This approach simultaneously enables cost efficiency improvements and maintains high product availability, representing one of the main challenges for manufacturing enterprises in this sector.

As part of a systematic review of the literature, inventory management strategies, their impact on product availability, and key success factors were also examined. Table 3 presents the results for representative items in this area.

Table 3.
The impact of inventory management strategies on product availability

Publication	Supply chain scope	Main inventory management strategy	Key metrics	Key success factors
Boone et al., 2013	Spare parts inventory management in military/ defense	Strategic alignment of inventory management	Continuity, resilience	Integration of several strategies, streamlining of the process
Hetzel, 1993	Manufacturing and distribution in production (films)	Lot size optimization, safety stock placement	Cycle time, inventory reduction, cost savings	Forecast accuracy, coordination at various stages of the supply chain
Alvarez-Placencia et al., 2020	Manufacturing and distribution of industrial products	ABC analysis, Min-max inventory control method, Lean Pull Replenishment	Service level, inventory costs, delivery time	Integration of several strategies, streamlining of the process
Blomgren, Eriksson, 2016	Sales, purchasing, logistics in distribution	ABC analysis, cost-based inventory management	tied-up capital, turn-over rate	Integration of several strategies, streamlining of the process
Lundberg, Tranchell, 2017a	Distribution and inventory control in mining and construction	Product segmentation, differentiated inventory management	Not mentioned	Differentiated strategies based on product characteristics

Cont. table 3.

Keene et al., 2006	Manufacturing and distribution of construction equipment	Six Sigma, inventory optimization at various stages of the supply chain	Order fulfillment time, product availability, total inventory in the supply chain	Forecast accuracy, coordination at various stages of the supply chain
Lundberg, Tranchell, 2017b	Distribution and inventory control in mining and constructions	Product segmentation based on sales volume, inventory life cycle stages, cost size, and frequency	Not mentioned	Diversified strategies based on product characteristics
Polak, 2014	Manufacturing and distribution in retail sales	Optimizing inventory at different stages of the supply chain	Safety margin, service level	Forecast accuracy, coordination at various stages of the supply chain
Montiel Pineda, Caballero-Morales, 2023	Manufacturing (air conditioning)	ABC classification, periodic inventory review, continuous inventory review models	Costs, level of service	Simulation-based validation
Lemke, 2015	Manufacturing operations	Various strategies: Economic Order Quantity (EOQ), kanban, Vendor Managed Inventory (VMI), process integration	Inventory efficiency	Tailoring strategies to specific applications – tailor-made strategies

Source: own study.

Many items used a variety of strategies and diverse key indicators, pointing to a comprehensive approach to inventory management across different sectors and areas of the supply chain. Indicators related to product availability include customer service levels, order fulfillment times, and safety stock. Inventory management strategies that integrate multiple approaches have a measurable impact on product availability at the manufacturing and distribution stages. Research documents that strategies balancing demand forecasting, information sharing, and process integration not only reduce overall inventory and cycles but also improve order fulfillment times and reduce product availability volatility. Within the FMCG industry, these findings underscore the critical importance of strategies that enable rapid responses to demand variability and short product life cycles. Approaches that integrate production planning, distribution, and inventory management—based on continuous monitoring of stock levels and information sharing across the supply chain—prove particularly significant. Although many strategies discussed in the literature were developed for other industries (e.g., automotive, heavy industry, or aerospace), some of them—especially those concerning flow coordination, finished goods segmentation, or the application of ABC/XYZ methods—can be effectively transferred to the FMCG sector when adapted to its specific characteristics, namely short shelf life, high inventory turnover, and stringent product availability requirements. From this perspective, flexible strategies combining production, warehousing, and distribution form the foundation for maintaining high product availability in the dynamic FMCG environment.

The literature review also identified key factors influencing product availability in the supply chain for selected publications from the bibliometric analysis. The results are presented in Table 4.

Table 4.
Critical areas for product availability in the FMCG industry

Publication	Research area	Supply chain areas covered	Key conclusions
Chauhan et al., 2023	Logistics distribution efficiency in the FMCG sector	Transport and warehousing	Optimizing transport and storage efficiency has a positive impact on logistics distribution efficiency.
Ali et al., 2020	The bullwhip effect in the case of multiple products for a supply chain consisting of multiple links	Retailer, Distributor	Centralized information exchange reduces the bullwhip effect, improves supply chain efficiency, and product availability.
Jepherson et al., 2021	Logistics management systems for manufacturers in the FMCG industry	Order management, inventory management, transportation, information flow, warehousing, packaging	Logistics management systems have a positive impact on supply chain efficiency.
Anwar et al., 2023	Logistics efficiency in the FMCG industry	Logistics activities (transport, warehouse operations and storage, product availability)	Transportation, warehouse operations, storage, and product availability significantly impact logistics efficiency.
Mbhele, 2013	Central distribution system in the retail food industry	Distribution centers and replenishment of stocks in retail stores	The Central Distribution System improves product availability through integrated information exchange.
Njuguna, Ndolo, 2021	Logistics management systems for manufacturers in the FMCG industry	Warehousing and inventory management	Inventory and warehouse management systems significantly impact supply chain efficiency.
Bala, Kumar, 2011	Supply chain performance attributes in the FMCG industry	Procurement, production, logistics, customer service	SCOR (Supply Chain Operations Reference) a model tailored to the FMCG industry, focusing on quality, safety, and supplier reliability.
Shakur et al., 2024	Challenges associated with the implementation of Industry 4.0 in the FMCG sector	Manufacturing, physical distribution, wholesale and retail sales	Investments, technological infrastructure, and value chain structure are key challenges for the implementation of Industry 4.0.
Neboh, Mbhele, 2021	Supply chain resilience in the FMCG retail industry	Retail stage, focus on the transport network	Technology, economic indicators, and transport networks influence supply chain resilience.
Singh, 2013	Implementation of Vendor Management Inventory in the FMCG industry	Inventory management between supplier and customer (buyer)	VMI optimizes product availability and reduces inventory-related costs.

Source: own study.

Many studies suggest that the integration of information exchange systems may be a critical factor influencing availability in the supply chain in the FMCG sector. The authors highlight various aspects and their impact on supply chain performance, including centralized information exchange, central distribution systems in the supply chain, digitization, technological advances, and the challenges associated with the implementation of Industry 4.0.

The review of articles also shows that effective inventory and warehouse management are critical factors affecting product availability in the FMCG supply chain. The authors highlight areas such as VMI, warehouse and inventory management systems, storage efficiency, comprehensive logistics management, as well as warehousing and warehouse operations. The authors also point out the need to focus on optimizing logistics and distribution, including in the areas of transport management, transport networks, lead time management, and distribution network efficiency. The analyzed publications highlight several performance indicators that affect the availability and overall efficiency of the supply chain: bullwhip effect, logistics performance, SCOR model attributes, product availability, supply chain resilience, operational efficiency, and inventory costs. The aggregate results of these studies indicate interrelationships between factors affecting supply chain performance. Improvements in one area lead to cascading benefits and enhanced performance in other indicators across the entire supply chain. This complexity is particularly evident in the FMCG industry, where achieving better performance requires the simultaneous consideration of multiple indicators and factors. In the FMCG industry, the above findings confirm that product availability is the result of an integrated approach to managing the entire supply chain, encompassing both logistical and informational processes. Solutions based on digitalization and data flow automation—such as central distribution systems, the Supply Chain Operations Reference (SCOR) standard, Vendor Managed Inventory (VMI), or the implementation of Industry 4.0 technologies—play a critical role, as they enable faster responses to demand fluctuations and reduce replenishment lead times.

Analyzing the results presented in Tables 2, 3, and 4, it is evident that in recent years, both new trends in inventory management and the associated strategies and critical factors affecting product availability have become increasingly apparent. The approaches identified in the literature—from lean tools and optimization methods, through inventory management strategies, to the integration of logistical processes—highlight the growing need for a comprehensive, integrated approach to supply chain management.

5. Conclusions

Through systematic literature review and bibliometric analysis, as well as selection based on abstracts and analysis of full publications of selected articles, a research gap was identified, namely the need for a multifaceted approach to managing fast-moving finished goods with a short shelf life, considering the three main elements of the production-warehouse-customer supply chain. In the framework of further research, the development of a conceptual model has been proposed to describe and illustrate the relationships among these three areas. The model aims to provide an understanding of the mechanisms through which production decisions

(e.g., changeover frequency, batch size) affect warehouse inventory levels and, subsequently, product availability for customers. The interrelationships among these areas serve as a foundation for the development of a future simulation model.

The available literature lacks research that simultaneously considers key criteria such as:

1. In the area of production – minimization of production costs due to reduced batch sizes and the resulting increase in setup costs.
2. In the area of warehousing – minimization of storage costs and losses associated with product expiration.
3. On the customer side – maximization of product availability for customers.

The analysis of the relationships among these areas indicates that decisions in one domain directly affect the others. More frequent production changeovers increase operational costs but simultaneously shorten lead times and reduce inventory costs as well as the risk of product obsolescence. In turn, higher warehouse inventory levels enhance product availability but also lead to increased inventory maintenance costs and potential losses (e.g., disposal of expired products, price reductions for products with lower than acceptable freshness). Additionally, a prolonged production plan freeze allows for better resource utilization and raw material delivery planning, yet it limits the flexibility to respond to sudden market demand changes, potentially causing temporary product shortages. On the other hand, high production flexibility, and thus excessively frequent plan modifications, may overload production lines and increase the number of changeovers. Producing excessively large batches reduces unit production costs but increases inventory levels and the risk of product obsolescence, whereas overly small batches generate excessive changeovers and higher production costs. Frequent market demand fluctuations and sales seasonality impact both production planning and inventory levels. An increase in demand necessitates more frequent production runs, raising changeover costs but improving product availability and customer service levels. Conversely, a decrease in demand results in excessive inventory, increasing storage costs and the risk of product value loss. For these reasons, accurate demand forecasting and information integration across the entire supply chain are crucial. Decisions made in one area (production–warehouse–market) can simultaneously improve cost and operational efficiency in one area while negatively affecting it in another. Understanding these interdependencies is essential for developing a model that enables optimization of the balance among costs, product availability, and customer service levels in the FMCG sector.

The literature review also revealed an absence of simulation modeling applications as a tool for examining a multidimensional approach to managing inventories of fast-moving finished goods with a short shelf life. The future simulation model will therefore incorporate dependent and independent variables across three areas: production (e.g., changeover costs, batch size, resource utilization), warehousing (e.g., inventory holding costs, risk of product obsolescence, lead times), and market (e.g., demand, seasonality, order fulfillment timeliness). The model's

objective function will be defined as minimizing total supply chain costs while simultaneously maximizing product availability for customers.

The aim of further research is to develop an inventory management model for fast-moving finished goods in manufacturing enterprises within the FMCG sector, focused on:

- maximization of product availability for customers,
- minimization of storage costs and losses caused by product expiration,
- minimization of production start-up (line changeover) costs for inventory replenishment.

The proposed model will enable the identification of trade-offs among production flexibility, warehousing efficiency, and product availability. It will provide insights into how changes in parameters within one area (e.g., reducing production batch size) affect the other two areas, both in terms of costs and customer service levels. Constraints that should be considered in the model:

- freezing of the production schedule to ensure material availability (inability to immediately start production of a batch of products),
- minimum production order size due to changeover costs,
- product shelf life (losses related to price reductions or disposal of expired products).

Each of the above constraints affects other elements of the supply chain—for example, a long production plan freeze limits the flexibility to respond to variable demand, while a minimum production batch size determines inventory levels in the warehouse and, consequently, product availability.

The originality of the model to be developed in further research lies in its comprehensive approach to the production–warehouse–market chain, considering the constraints arising from the characteristics of FMCG sector enterprises, and focusing on minimizing production changeover and storage costs while maximizing product availability for customers.

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