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Derleme Makale /Review Article

OPTIMIZATION STRATEGIES IN SUPPLY CHAIN MANAGEMENT OF PERISHABLE PRODUCTS : A LITERATURE REVIEW

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Abstract: This study involved a comprehensive review of academic articles on perishable food products published between 2012 and 2022. The classification of the products throughout the evaluation procedure took into account the supply, manufacture, processing, storage, and consumption locations. General analyses were conducted on the articles reviewed within the purview of the study, including the distribution of the articles in terms of time, geography, index information, and citation data. The scope of the study in perishable supply chain management, the methodologies, and the objective function were classified for the pertinent articles in the detailed analysis. This study is distinct from other literature reviews in that it divides research on perishable food goods into categories based on the supply chain impact area.
Keywords: Perishable products, supply chain management, optimization

Bozulabilir Ürünlerin Tedarik Zinciri Yönetiminde Optimizasyon Stratejileri: Bir Literatür Taraması

Öz: Bu çalışma, 2012 ile 2022 yılları arasında çabuk bozulan gıda ürünleri hakkında yayınlanan akademik makalelerin kapsamlı bir incelemesini içermektedir. Değerlendirme prosedürü boyunca ürünlerin sınıflandırılmasında tedarik, üretim, işleme, depolama ve tüketim yerleri dikkate alınmıştır. Çalışma kapsamında incelenen makaleler üzerinde, makalelerin zaman, coğrafya, indeks bilgileri ve atıf verilerine göre dağılımlarını içeren genel analizler yapılmıştır. Bozulabilir tedarik zinciri yönetiminde çalışmanın kapsamı, metodolojileri ve amaç fonksiyonu, detaylı analizde ilgili maddeler için sınıflandırılmıştır. Bu çalışma, çabuk bozulan gıda ürünleriyle ilgili araştırmaları tedarik zinciri etki alanına göre kategorilere ayırması bakımından diğer literatür incelemelerinden farklıdır.
Anahtar Kelimeler: Bozulabilir ürünler, tedarik zinciri yönetimi, optimizasyon

Introduction

Production processes can become more productive thanks to developing technology and engagement with other markets has also risen thanks to the growth of communication channels. Global competition has risen as a result of this circumstance. Businesses have started using alternate searches to stay sustainable in this cutthroat atmosphere as a result of the rise in worldwide competitiveness. In this endeavor, they sought to reduce lost expenses while maintaining quality by utilizing already-available resources including personnel, time, cost, and capacity. Because of this, they have begun to employ operations research (OR) techniques to reduce expenses, identify bottlenecks in the system, and enhance procedures.

The OR solution examples are based on F. Wilson Taylor's strategy for using scientific methods to boost industry production (Öztürk, 2013). OR attempts to identify the best course of action for the chosen aim by developing a mathematical model for the issue. The process of allocating limited resources also employs OR approaches (Öztürk, 2013). In this situation, specialists look at logistics expenses as a scarce resource and use OR techniques to develop better alternatives for decision-makers.

Logistic expenses can reach %30 of the product's selling prices (Şen, 2014). Since the rate of costs of logistics activities is high, supply chain issues have become important in recent years to reduce these costs (Mönch et al., 2018). Supply chain management (SCM) performance in the agricultural industry has become more important as product decay costs are added in addition to logistics costs in perishable goods (Kumar et al., 2020).

Depending on the specifics, SCM process components can be separated into a variety of stages. SCM is categorized generally into three stages: supplier, business, and customer (Basset et al., 2018). Planning, estimating, raw material supply, storage, production, distribution, retailing, and end-user customer are the SCM phases that are broken down into further detail (Anitha and Patil, 2018).

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In the context of this study, 50 academic articles were reviewed, including optimization studies done in SCM procedures for perishable goods. The SCM process has been assessed in five parts, including the acquisition of raw materials, production, processing of the created product, transfer or storage of the processed products to the sales points, and the client side where the consumption point is at the last step. Analyzed were the stage in the SCM processes where the evaluated articles were, the problem they solved, the areas where academic research are centered, the techniques employed, and the overall descriptive statistics of the pertinent articles. To establish which areas could be explored in the upcoming periods, a gap analysis was done.

Literature

Research on perishable products conducted in various years and with various focuses was analyzed in literature review articles that looked at articles on perishable product SCM optimization that were finished between 2012 and 2022.

SCM, which occurs between the production and consumption locations of fresh goods including vegetables, fruits, and flowers, was the subject of an analysis of 86 academic studies done between 1989 and 2009. The articles under examination were categorized according to problem, technique, structural quality, background, and geographic region (Shukla and Jharkharia, 2013).

Amorim et al. (2013) looked at 33 papers, including models for the planning of perishable products in the production and distribution processes that were created between 1986 and 2011. The idea of perishability in TZs from various industries was looked at, process-based classifications were developed, and academic studies of production and distribution systems were looked at generally (Amorim et al., 2013).

For the purpose of enhancing the quality of TZ so that farm products like milk, meat, and vegetables, which have a rapid deterioration process, reach their consumption sites, 481 articles were reviewed from 1994 to 2013 in total. It was observed that the articles in the study, in which the TZ quality classification was produced, mostly focused on the supplier, distributor, producer, retailer and consumer processes. It has been noted that the quantity of articles varies depending on the countries' level of development (Siddh et al., 2015).

43 articles were reviewed about TZ research on agricultural products, conducted between 1983 and 2013, were looked at in their study. Studies that offer an integrated plan of harvesting and processing operations have been looked at to reduce product losses because agricultural products are very perishable (Kusumastuti et al., 2016).

In the context of Agricultural SCM, researches carried out between 2006 and 2016 were critically examined. Studies have been categorized into 4 categories: agricultural SCM, policies influencing agricultural SCM segments, SCM individual segments and TZ segment performances in order to highlight the gaps in the literature (Ganeshkumar et al., 2017).

42 articles were examined which are published between 1993 and 2015 on risk management for agricultural products. Using agricultural SCM, the models created for risk management were thoroughly reviewed (Behzadi et al., 2017).

When the studies on the sustainable logistics of perishable food products transported by cold TZ between 1985 and 2017 are examined, due to the lengthening of delivery times in cold TZ, It has been seen that the expenditures for energy and product wastes increase. Studies on the long-term viability of cold TZ transportation have grown in recent years. It has been noted that the USA and Italy have made the greatest academic contributions in this area (Vrat et al., 2018).

84 academic research on data-based SCM challenges, including FQ procedures for perishable food goods, as well as emerging technical prospects, such the internet of things, blockchain and big data, were reviewed and an application framework suggested (Kamble et al., 2020).

Given that sustainability plays a significant impact in SCM performance, 41 articles analyzed that were studied between 2014 and 2020 for sustainable SCM for perishable products (Nabil et al., 2021).

It was reviewed at 74 optimization studies for perishable food products that were designed for planning at the harvest and manufacturing stage and published between 2000 and 2020. The articles were looked at in three scopes: the problem's breadth, the generated model's qualities and its methodology. A new classification has been proposed for articles (Taşkıner and Bilgen, 2021).

In a study 54 articles looked at that published between 2005 and 2020 about the activities of production, inventory management and distribution in the Supply Chain (SC) for perishable products was undertaken (Mirabelli and Solina, 2022).

It was decided to conduct this study since there isn't one that assesses the optimization studies in SCM for perishable agricultural and food goods encompassing the years 2012–2022. 50 of the 243 articles found for

perishable food products between 2012 and 2022 were chosen in this context and thoroughly reviewed. Within the parameters of the review, the articles were first examined generally, including their geographic and temporal distribution, then were the articles' specifics examined in detail.

Method

SCM was rated as having 5 stages within the parameters of this study before articles were looked at. The steps between the manufacturing choice and the consumption point were considered when determining these stages.

Stage 1: It is the supplier stage. It is the supplier stage where the needs such as seeds, fertilizers, drugs and equipment belonging to the product decided to be produced are provided.

Stage 2: It is the field stage. It is the production stage where the planting, cultivation and harvesting processes of the product to be produced are managed.

Stage 3: It is the facility phase. It is the stage of the warehouse, facility or factory where the harvested product is stored, processed and packaged.

Stage 4: Retailer stage. It is the retailer stage that procures, stocks and sells products from the 3rd stage depending on the demand before the consumption point of the products.

Stage 5: It is the customer stage where the product is consumed.

These five stages are illustrated in detail in Figure 1.

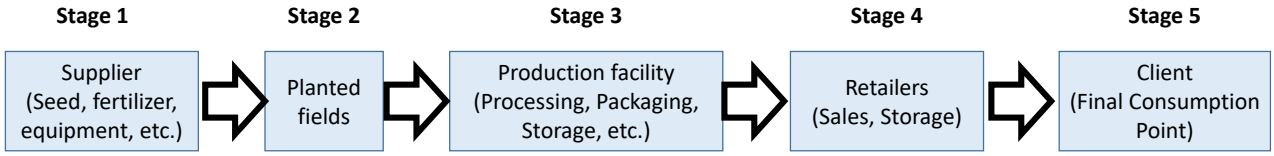

Figure 1. Agriculture products' operational phases between the points of production and consumption

For perishable food products published after 2012, use the terms facility site selection, harvest planning, routing, and inventory management in search engines like Google Scholar, Web Of Science, Scopus, etc. With the use of database searches, 243 articles were found in the first phase. 50 of these articles were chosen, and they underwent a thorough study. The chosen articles underwent a two-stage analysis. The first stage involved a broad examination of the articles' chronological and geographic distribution as well as an index study of the journals' which the articles had been published. A thorough study of the articles was done in the second stage. Brief summaries of the articles, the stages that the studies cover in Figure 1, the variety of the products examined as case studies, the distribution of citations, the methodologies used, the purpose functions and the analysis of the problems in which the study produces solutions in perishable SCM were all analyzed. An academic gap analysis was conducted as a result of the investigation, which identified the regions in which the articles were concentrated.

General assessment of the articles

This section examines the index reviews of the journals that contain the articles as well as the articles' overall chronological and geographic distribution. For the 50 articles that were examined, a total of 35 various scholarly journals were used. In Table 1, the index distributions of these journals and the total number of analyzed articles are given in detail.

Table 1. Quantity of Articles in Journals and Journal Indexes

Journals	Articles	SCI	Scopus	WOS	Others
International Journal of Production Economics	7	+			+
Computers and Industrial Engineering	6	+	+		+
European Journal of Operational Research	3	+			+
Annals of Operations Research	2	+	+		+
Applied Mathematical Modelling	2	+	+	+	+
Mathematics	1	+	+	+	+
Journal of Industrial Engineering International	1		+		+
biosystems engineering	1	+	+	+	+

Journals	Articles	SCI	Scopus	WOS	Others
Cleaner Product	1	+	+		+
Journal of Mathematical Modelling and Algorithms in Operations Research	1		+		
Computers and Chemical Engineering	1		+		+
Physica A: Statistical Mechanics and its Applications	1	+	+		+
Transportation Research Part E	1	+	+		+
Case Studies on Transport Policy	1		+		+
Production and Operations Management	1				+
Agricultural Systems	1	+	+	+	+
Computers and Operations Research	1	+			+
Journal of Manufacturing Systems	1	+	+	+	+
Journal of Modelling in Management	1		+		+
Axioms	1	+	+	+	+
Logistics Operations and Management for Recycling and Reuse	1				+
Mathematical Methods of Operations Research	1	+	+		+
Flexible Services and Manufacturing Journal	1				+
Modeling Food Processing Operations	1	+			+
IFAC-PapersOnLine	1		+	+	+
Procedia - Social and Behavioral Sciences	1	+			+
Research in Transportation Business & Management	1	+			+
Scientific Programming	1	+	+	+	+
Simulation Modelling Practice and Theory	1	+	+	+	+
International Journal of Production Research	1	+	+		+
Central European Journal of Operations Research	1	+	+		+
International Journal of Productivity and Performance Management	1				+
Scientia Iranica	1	+	+		+
Journal of Cleaner Production	1	+	+		+
Journal of Food Engineering	1	+	+	+	+

Figure 2 shows the breakdown of the reviewed articles by years.

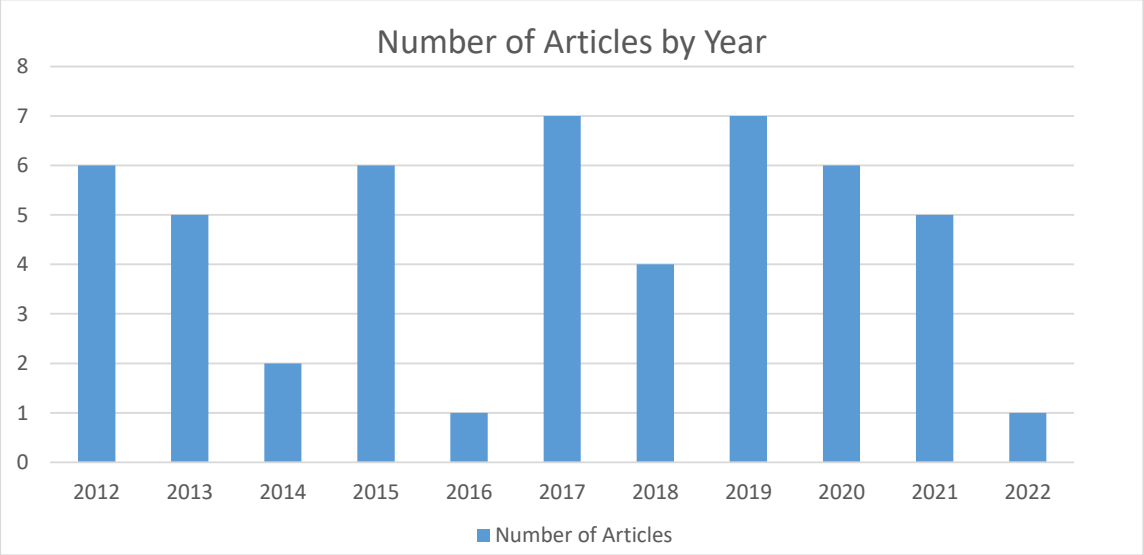

Figure 2. Distribution of articles by years

Figure 3 the distribution on the map in which regions the examined articles were studied.

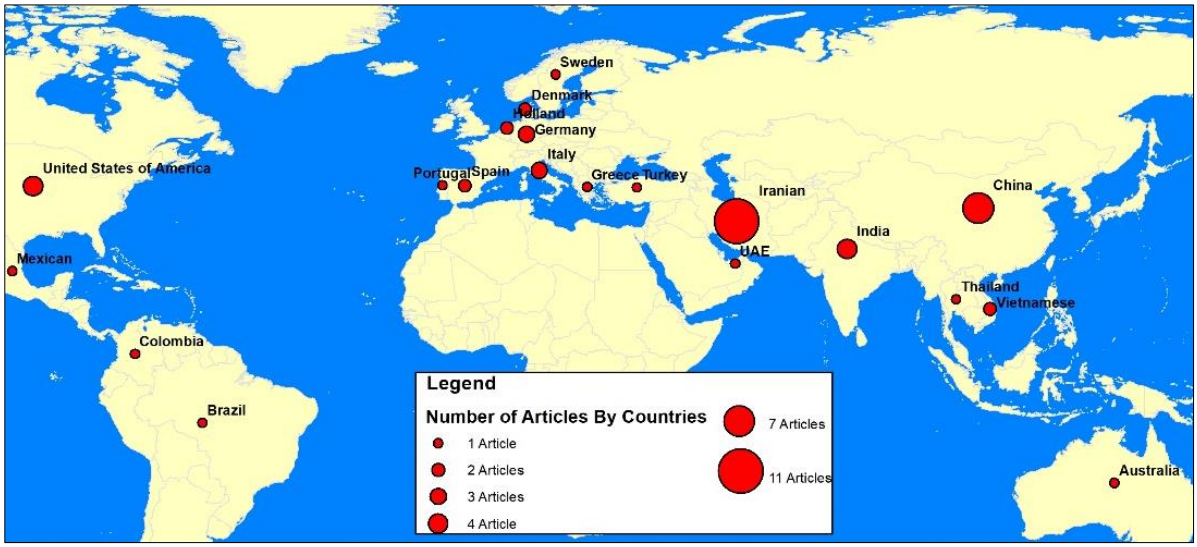

Figure 3. Article Distribution by Geographical Regions

Table 2 shows the distribution of the total number of citations of the articles by country. According to the academic significance of the relevant article, as well as its age and the caliber of the journal in which it was published, the number of citations varies.

Table 2. Number of Citations of Articles by Country

Country	Citations	Country	Citations
Denmark	722	Spain	104
Iranian	577	Holland	87
Germany	505	Turkey	79
Chinese	354	Vietnamese	77
USA	334	Portugal	66
Mexican	324	Colombia	52
UAE	299	Thailand	33
Italy	203	Brazil	32
India	187	Australia	21
Sweden	152	Greece	16

Detailed analysis of articles

The studies' evaluated articles all came out after 2012, according to the study's focus. The distribution of the articles is primarily dispersed in a way to cover the production, facility, and retail processes, as can be observed when the distribution is analyzed in accordance with the five stages described at the beginning of the chapter. Figure 4 gives the graph of the repetition frequencies of this distribution. The references for the stages that the pertinent articles cover are included in accordance with the five stages identified in Table 3 below.

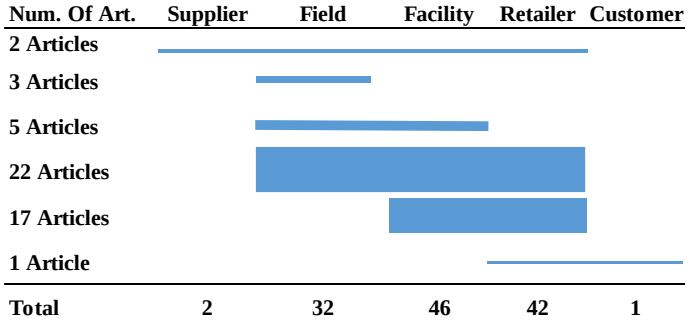

Figure 4. Article distribution based on coverage

Table 3. Article scopes and references to related articles

Article Scopes	**Related Article Ref.**
Studies on the processes of acquiring raw materials, producing it, processing it at the plant, and selling it	(Huh et al., 2020), (Goli et al., 2020)
Studies focusing on the topic disciplines' development stages	(Toro et al., 2012), (Huh and Lall, 2013), (Junqueira and Morabito, 2019)
Studies covering the stages of production in the field, processing at the facility, and retail studies covering the processing and retail stages of the research facility studies covering the phases between production and facility in the disciplines of research	(Diatha et al., 2012), (Khamjan et al., 2013), (Jonkman et al., 2018), (Suryawanshi and Dutta, 2021), (Ge et al., 2022)
Studies on the consumer and retail stages of research	(Ahumada et al., 2012), (Demirtaş and Tuzkaya, 2012), (Morganti and Feliu, 2014), (Govindan, et al., 2013), (Ghezavati et al., 2015), (Keizer et al., 2015), (Etemadnia et al., 2015), (Wu et al., 2015), (Castro et al., 2017), (Pasandideh et al., 2017), (Zhang et al., 2017), (Keizer et al., 2017), (Dai et al., 2018), (Ge et al., 2018), (Lia et al., 2019), (Dutta and Shrivastava, 2019), (Chao et al., 2019), (Yakavenka et al., 2020), (Liu et al., 2021), (Kieu et al., 2021), (Wang et al., 2021), (Esteso et al., 2021)
Studies on the processes of acquiring raw materials, producing it, processing it at the plant, and selling it	(Amorim et al., 2012), (Drezner and Scott, 2013), (Manzini and Accorsi, 2012), (AriaNezhad et al., 2013), (Khalili-Damghani et al., 2015), (Flores et al., 2015), (Hiassat et al., 2016), (Rashidi et al., 2016), (Azadeh et al., 2017), (Musavi and Amiri, 2017), (Accorsi et al., 2017), (Albrecht and Steinrücke, 2018), (Rahbari et al., 2019), (Navazi et al., 2019), (Onggo et al., 2019), (Ji et al., 2020), (Alkaabneh et al., 2020)
Studies focusing on the topic disciplines' development stages	(Farahani et al., 2012)

It was observed that 29 articles made case studies for processed items with limited shelf life, and 21 articles made case studies for unprocessed agricultural products, while considering the product distribution in the sectors, which was done as a case study in the articles.

When the articles' keywords were examined, it was discovered that "Supply Chain," "Perishable," and "Location" were the first three most frequently used terms.

Table 4 shows the distribution of the most repeated keywords expressions.

Table 4. Frequency of Keywords

Keywords	**Frequency**	**Keywords**	**Frequency**
Supply Chain	31	Agricultural	9
Perishable	25	Metaheuristic	8
Location	21	Distribution	7
Routing	16	Model	6
Inventory	14	Sustainability	6
Food	13	Transport	6
Optimization	12	Scheduling	5
Algorithm	11	Network	5

When the methods used in the examined articles were examined, it was seen that more than one method could be used in some articles. When the number distribution of the methods in the articles is examined, it is seen that predominantly mixed integer linear programming model is created. Repetition frequencies of other methods are shared with Figure 5.

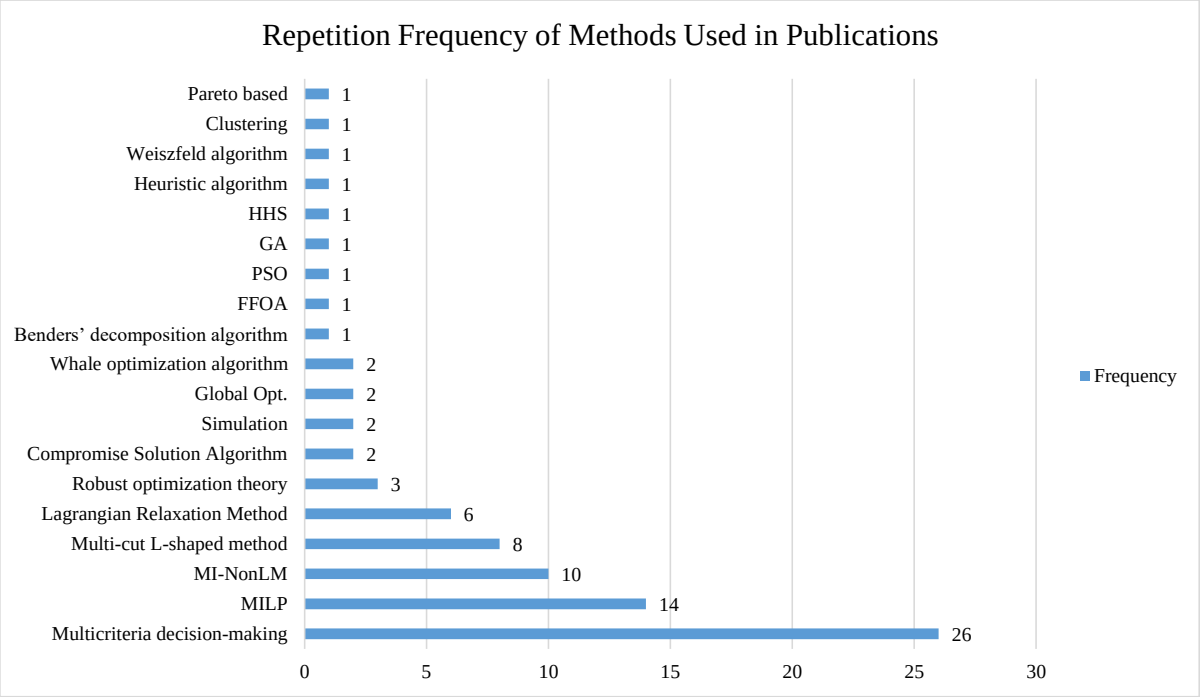

Figure 5. Repetition Frequency of Methods Used in Articles

In the cases analyzed for the articles, 21 of them have capacity restrictions, and 8 of them provide outcomes with a time window. Examining the article scopes revealed that certain items were examined in more than one scope. When the articles' specific foci were investigated, it became clear that 31 of them were positioned, 28 were assigned, 28 were routed, 23 were about inventory management, and 8 were about harvest time.

17 of the items under examination have multiple uses. Examining the repetition frequencies of the objective functions, it was discovered that 45 articles, or 90% of them, concentrated on minimum cost. There are 22 articles that try to reduce the losses and decays linked to the lowest cost. Figure 6 provides repetition frequencies for additional uses.

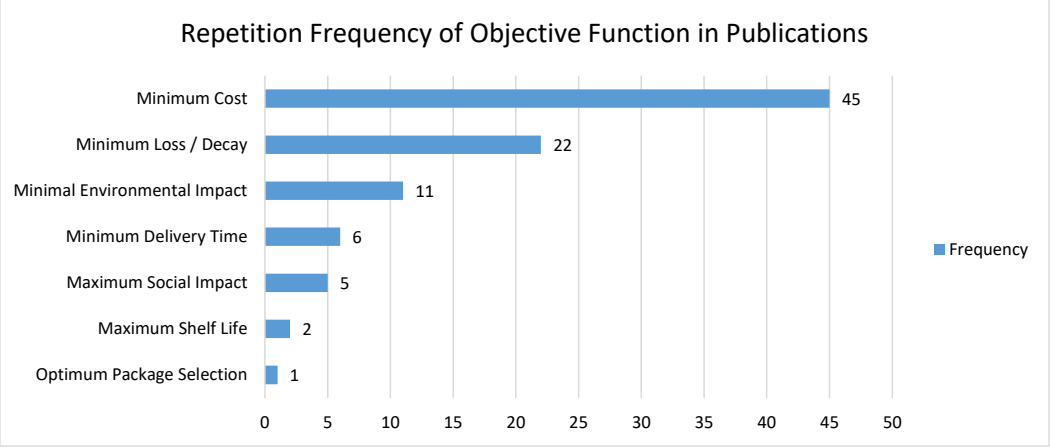

Figure 6. Frequency of Repetition of Objective Functions in Articles

In the previous sections, the agricultural production process was divided into 5 stages. The general summary of the studies, which limited the scope of the research to cover between the phase 1 and phase 4 according to these 5 stages, is given in Table 5.

Table 5. Academic Research Between the Stages of Supplier and Retailer (Phase 1 to Phase 4)

Ref.	Article brief summary
(Biuki et al., 2020)	A model for resolving integrated location, route, and inventory challenges has been created in order to enhance logistics processes for perishable food products. The model has three objectives. Particle swarm optimization, genetic algorithms, and mixed integer linear programming are employed. It

	sought to maximize the durability of the positive social impacts in the third goal while minimizing costs in the first and second goals and minimizing environmental problems in the third.
(Goli et al., 2020)	A multi-level, multi-period supply chain management model that encompasses many perishable food products has been built using integrated mathematics. The multi-purpose approach seeks to reduce expenses, reduce CO_2 emissions, and increase social effect. For issue solution, a brand-new hybrid algorithm built on the whale optimization algorithm (WOA) and genetic algorithm (GA) is suggested.

The general summary of the articles, which limited the scope of the research to cover only the phase 2, is given in Table 6.

Table 6. Academic Research Including the Field Stage (Phase 2)

Ref.	Article brief summary
(Toro et al., 2012)	The harvest model, which will forecast the maturity of the wheat based on the moisture in the wheat, has been simulated hourly throughout the 30-year harvest period while taking into account weather data from Stockholm, Sweden. As cost components for wheat, machinery, labor, punctuality, and drying process costs were included. For the three planting zones, various combinations were assessed.
(Huh and Lall, 2013)	For the farmers who produce using the contract farming application, a model that takes into account pricing and climate-related uncertainty optimizes the irrigation plan for the cultivated area. The type of crop planted and the local climate's precipitation can both be taken into consideration when deciding how much water to use for irrigation. Two stochastic models were created for problem-solving, and the Ganganagar region in Rajasthan, India, was used to assess the model's reliability.
(Junqueira and Morabito, 2019)	In Brazil's sugarcane production regions, a mixed integer programming model has been created to create harvest plans that minimize both costs and harvest times. The proposed model directed equipment like combine harvesters required for harvesting while taking into consideration vehicle capabilities. The concept allows for the creation of harvesting with a temporal window. The developed model was solved by heuristic approaches.

The general summary of the studies that limited the scope of the research to cover the phase 2 and phase 3 is given in Table 7.

Table 7. Academic Research Between the Stages of Field and Facility (Phase 2 to Stage 3)

Ref.	Article brief summary
(Diatha et al., 2012)	A model has been created for the production of mushrooms, which have a short shelf life, must be produced under precise guidelines, and degrade quickly after being harvested. When considering the shelf life of the product, prompt delivery to the market or packaging facilities after the mushrooms are harvested is essential. A versatile location-orientation model has been created using the established model to allow a dynamic purchase and distribution strategy.
(Khamjan et al., 2013)	In the process of harvesting goods in Thailand's sugarcane production regions, loading them from loading stations, and transporting them to the factory, a cost-minimization-oriented model has been created to pinpoint the sites of capacity-constrained loading stations. In order to maximize profitability, the objective function includes, in addition to investment and transportation costs, the goal of harvesting sugar cane during the time when it is most fruitful.
(Jonkman et al., 2018)	The Netherlands has devised a model to maximize profits in logistical and operational activities between the facilities where sugar beet processing is carried out and the fields where production takes place, as well as to lower environmental carbon dioxide emission values. It was observed that the model performed better when the stochastic structure took into account the uncertainty in demand and harvest efficiency.
(Suryawanshi and Dutta, 2021)	By simultaneously taking into account the demand uncertainties and product deterioration on a real scenario of a kiwi distribution company, a cost minimization oriented model has been constructed. The created model piecewise approach algorithm was employed in conjunction with mixed integer linear programming.
(Ge et al., 2022)	Regional food and wholesale centers, as well as small and medium-sized perishable product manufacturers and collection and distribution facilities, were the subjects of a research in the USA. The established model aids in identifying the ideal size, ideal number of businesses, and best locations for facilities.

The general summary of the studies that limited the scope of the research to cover the phase 2 and phase 4 is given in Table 8.

Table 8. Academic Research Between the Stages of Field and Retailer (Phase 2 to Stage 4)

Ref.	Article brief summary
(Ahumada et al., 2012)	They created a stochastic tactical planning model that takes into account the uncertainties in the processes of production and distribution plan development brought on by variations in the weather and consumer demand for the cultivation of perishable fresh produce. The approach gives firms the freedom to select a manufacturing strategy based on various levels of risk. The created model was investigated using a producer in Mexico who was producing fresh vegetables as a case. As opposed to analyses using a deterministic framework, analyses using a stochastic model produced more profitable outcomes and reduced product waste.
(Demirtaş and Tuzkaya, 2012)	They looked at research done on fruit and vegetable markets and considered how production, storage, and transportation could be factored into the development of a settlement model. According to the study, locating wholesalers and fruit and vegetable markets would have a good impact on urban traffic.
(Morganti and Feliu, 2014)	At urban food establishments, they looked at the supply chain for perishable goods. They looked at the idea of a food hub by highlighting the significance of public policy while also attempting to boost efficiency with traffic regulation and distribution services in Italy.
(Govindan, et al., 2013)	To manage the perishable food supply chain network, they created a multi-objective optimization model to meet economic and environmental goals. In the first stage of the model, fixed and variable costs are reduced, and in the second stage, environmental effects including carbon emissions and greenhouse gas emissions are reduced. Particle swarm optimization with multiple goals and genetic algorithms were compared in the model's solution.
(Ghezavati et al., 2015)	A mixed integer programming model has been created for the supply chain approach following tomato production in order to maximize profitability when making decisions about the distribution of fresh goods. The established model takes into account fair pricing in accordance with consumer satisfaction, the freshness and maturity of post-harvest products, and a pricing strategy based on freshness value. The Benders' decomposition method was used to find a solution due to the size of the model.
(Keizer et al., 2015)	They created a mixed integer programming model that can construct the most cost-effective network while taking into account the location and mobility of perishable goods between the storage facility and merchants. About MILP with hybrid optimization simulation, the model they created was utilized to establish assumptions for uncertainties in procurement, processing, and shipping. The study's findings revealed that a drop in product quality resulted in a drop in service quality and an increase in product loss.
(Etemadnia et al., 2015)	For effective management of the supply chain between the production and consumption points of perishable food goods, a mixed integer linear programming model has been created. The created model was applied to the analysis of several scenarios involving the production and distribution network of the vegetable and fruit industry in the USA.
(Wu et al., 2015)	They created a model for the provider with a single perishable food product for demand at retail outlets over a range of time periods with varying facility location problems. Cross-docking between the facilities is assumed, and the retail locations are expected to operate under the zero inventory order maxim. When solving problems, the derived mixed integer nonlinear model is linearized. The model's suggested solution attempts to reduce the fixed installation costs of the facilities, the total cost of the current facilities, the cost of transportation, and the cost of inventory.
(Castro et al., 2017)	A mixed linear programming model covering multiple products and multiple stages has been developed in order to reduce the product spoilage of fresh fruits grown in mountainous areas due to factors like relative humidity and temperature caused by topography, through transportation and packaging processes. By establishing a regional supply chain, it was shown that product collections saw 8% less loss than the overall average in the different scenario analyses they generated with the model result.
(Pasandideh et al., 2017)	In the supply chain network between supplier, distribution center, and retailer, they created a model for the inventory, location, and routing problem for perishable food products with stochastic demand. The study only spans a brief period of time. To resolve the issue, the Lagrange Relaxation Method was employed.
(Zhang et al., 2017)	For time-sensitive and speculatively demanded fresh food products supplied through electronic commerce, they created a two-stage strategy that streamlines the manufacturing, storage, and retail outlets. The created methodology seeks to optimize product freshness while reducing overall cost. The locations of distribution centers were chosen using the fruit fly optimization technique.

Ref.	Article brief summary
(Keizer et al., 2017)	A mixed integer linear model that will maximize profits by minimizing quality losses and decay due to supply time and temperature in the mixed product group in the process between the production point and the retail point of sale was developed for the supply chain process of perishable food products, and several tests were conducted in the horticultural industry.
(Dai et al., 2018)	They created a model to incorporate the location-inventory issue into the perishable food supply chain network. Hybrid genetic algorithms (HGA) and hybrid harmony search (HAA) techniques are used in the problem's solution phase since the created model is a mixed integer nonlinear problem. It has been observed that HGA provides a solution more quickly than HAA, however the quality of the solution is worse.
(Ge et al., 2018)	For the best site choice between production and consumption points of perishable fresh products in the USA, they created a mixed integer linear programming model. With the use of economies of scale, the study seeks to reduce the overall cost.
(Lia et al., 2019)	They looked into the facility and routing issues for perishable food goods at the same time as the packaging strategy. A mixed integer linear program model was created to address the issue. The issue was developed in two steps. A total of 320 randomly produced samples from 4 factories, 50 merchants, 6 periods, and 3 package options were used for the calculations.
(Dutta and Shrivastava, 2019)	A cost-oriented 2-stage nonlinear mathematical model was built after the optimal warehouse sites between the producer and retail outlets were established in stochastic conditions where demand is uncertain due to supply, demand, and process. An actual scenario of milk distribution in India has been used to test the pertinent model. Five different scenarios were used to conduct the analyses.
(Chao et al., 2019)	A mixed integer linear programming model has been created that will consider the quality of perishable products in addition to lowering the overall cost of logistical procedures. The created model is divided into two phases: the location-inventory problem is solved in the first phase with the aid of a time window, and the transportation issue is resolved in the second phase while accounting for vehicle limits. In the study employing the distance-based cluster and heuristic approaches, it has been seen that the convergence speed will increase.
(Yakavenka et al., 2020)	To reduce the price, social time, and emission values of perishable food goods, a multi-purpose mixed integer linear programming model has been created. The proposed methodology was implemented in the North-Eastern European region's fruit importer's logistics procedures. By taking into account these three criteria, the created model examines potential sustainable alternatives.
(Liu et al., 2021)	The three-step integrated location-inventory-orientation problem for perishable food products has been modelled using linear programming. In the model they created, the overall cost is lowered in the first step, the carbon emission values during the procurement process are decreased in the second stage, and the product freshness is attempted to be maintained at the highest level in the third stage.
(Kieu et al., 2021)	By simultaneously analyzing quantitative and qualitative data in the facility location selection process, a hybrid multi-criteria decision making model based on the Global Fuzzy Analytic Hierarchy Process (SF-AHP) and the Combined Reconciliation Solution (CoCoSo) algorithm has been established. In the supply chain process for the sweet potato product in the Mekong Delta of Vietnam, they used the model they established to apply the model in which they could determine the position of the facility between the supply and demand locations.
(Wang et al., 2021)	For fruits produced in the Mekong Delta of Vietnam, a multi-purpose mathematical model is created to reduce costs, transportation times, emissions, and supply-demand mismatches over time. By weighing, the created model integrated the previous objectives into a single goal. The model provides tactical options for decisions like harvest time, delivery time, transportation type, and route in addition to strategic ones for plant location and size, staff requirements, and product flow.
(Esteso et al., 2021)	To account for product perishability, which is taken into account in tactical and operational choices in the supply chain for agricultural products, during the design phase of SCM, a mixed integer linear programming model has been created. The proposed model underwent scenario analyses of several scenarios, taking into account the limitations of perishability in the process of planting, harvesting, and transportation. Economic performance has been seen to improve in designs that take the perishability of the product into account. The model aids in tactical planning for the investments required to increase the product's shelf life while preserving profitability.

The general summary of the studies that limited the scope of the research to cover the phase 3 and phase 4 is given in Table 9.

Table 9. Academic Research Between the Stages of Facility and Retailer (Phase 3 to Stage 4)

Ref.	Article brief summary
(Amorim et al., 2012)	In two distinct product groupings for perishable goods with and without a defined shelf life, a mixed integer 2-stage model was created. The first step of the model attempts to reduce product, transportation, and waste costs. The second stage attempts to maximize the shelf life of the products that are to be delivered. In the planning that was integrated with the established model, it was found that the economic gain was highly dependent on the product's shelf life.
(Drezner and Scott, 2013)	The inventory and location issue for perishable food goods between the distribution center and the point of sale has been modelled. The distribution center was placed in a flat location in accordance with the sales points in the model they devised in an effort to save warehousing and transportation. Within the context of their research, the Generalized Weiszfeld Algorithm (GWA) and Big Triangle Small Triangle (BTST) methods—two global optimization techniques—have been suggested for the resolution of the facility location problem. After doing a comparison examination, they discovered that while the BTST approach ensures the best outcome, the GWA produces outcomes quickly and with high precision.
(Manzini and Accorsi, 2012)	A conceptual framework has been developed using a multidisciplinary and integrated approach to food logistics by taking into account the criteria of quality, sustainability, logistical efficiency, and concurrent control. They conducted a case study on the packaging and distribution procedures in the oil sector in order to develop this conceptual framework.
(AriaNezhad et al., 2013)	It has been attempted to lower the maintenance expenses of a company that processes and packages perishable food goods by creating a two-stage model using a genetic algorithm. As a result, the issue is examined in a real-world scenario while taking into account real-world constraints including manufacturing time, storage capacity, stock level, transportation options, and sustainability.
(Khalili-Damghani et al., 2015)	For perishable food products with a short shelf life, a two-stage mixed integer programming model has been created to choose warehouse locations and map out truck routes with a focus on cost reduction. The Non-Dominated Sequencing Genetic Algorithm-II approach was tailored and employed for problem solving because the problem size is of Np-Difficult status.
(Flores et al., 2015)	A mixed integer mathematical fuzzy model that will execute the logistics tasks between the distribution center and the retail distribution sites in a multimodal manner and the deliveries with a time frame has been designed for the logistics procedures of fresh fruit. Additionally, the concept sought to raise client satisfaction. A two-part evolutionary algorithm is used to solve the issue since the uncertainties in the model constraints and the time frame increase the size of the model.
(Hiassat et al., 2016)	To examine the location and number of warehouses for perishable goods, the retailer's inventory level, and the routes taken by the vehicles that transport the goods, a location inventory and routing model has been developed. The genetic algorithm approach was utilized because the proposed model is NP-Hard.
(Rashidi et al., 2016)	For the location-inventory problem, a two-stage approach has been created in order to lower the costs in the perishable product supply chain. The process of dispatching between the primary distribution center and the sub-distribution centers, as well as between the latter two locations and the retail sites, is explored in the proposed model. The model was solved using a meta-heuristic based on Pareto. By analyzing the performance of the suggested strategy using genetic algorithms, it has been found that the Pareto approach produces good results.
(Azadeh et al., 2017)	For perishable food products with a limited shelf life, they created a model that concurrently solves the inventory and routing problems to reduce overall costs and loss. The NP-Difficult model was solved using a genetic algorithm, and the Taguchi approach was employed to improve the performance of the result. The model's reliability was examined in an Iranian dairy distribution business.
(Musavi and Amiri, 2017)	A multi-purpose complex validation program and sustainable center location-vehicle scheduling model have been developed for perishable food product distribution operations between the distribution center and the point of sale in order to optimize the overall cost, the freshness of the food at the time of delivery, and the total carbon emission values of the vehicles. Because of the enormity of the problem, the genetic algorithm method, one of the meta-heuristic approaches, was employed. A thorough solution is proposed using the created method for the supply chain method of perishable food products.
(Accorsi et al., 2017)	To plan the operations of cold storage of fresh cherries in the cold supply chain process and conveying them to the client with refrigerated vehicles, a mixed integer linear programming model has been created. Given that environmental temperature significantly affects the effectiveness of the cold chain, depending on the weather, its impact on energy expenditures during storage and transit was examined. Analysis is done on the economic and environmental impacts of adjusting cold chain activities according to the weather.

Ref.	Article brief summary
(Albrecht and Steinrücke, 2018)	To reduce delivery times for perishable food items and standardize delivery schedules in an effort to maintain the freshness of the product, a mixed integer linear programming model has been created. By examining 10 different scenarios that were generated randomly while taking into account various numbers of suppliers, warehouses, markets, and product categories, this study was found to be valid.
(Rahbari et al., 2019)	A two-stage approach has been established for product shipments from warehouse to customer in order to minimize costs and maximize product quality through cross-shipping from warehouses. The freshness rate of the supplied products can be up to 74.14% higher with the developed model, even while routing-related costs are lowered.
(Navazi et al., 2019)	A model has been developed for the location-orientation problem of the three objective functions that will collect the expired products from the retail points and reprocess them in the recycling facilities in the logistics operation for perishable food products while the vehicles are distributing fresh products. The created model's first goal is to reduce network costs, its second goal is to reduce environmental consequences, and its third goal, which will maximize factors like the development of new employment possibilities and employee happiness, is intended to maximize social impact. Two different multi-objective meta-heuristic algorithms have been created and modified to the NP-Hard answer due to the scale of the problem.
(Onggo et al., 2019)	Since there is only one distributor and client demand is stochastic, they created a mixed integer programming model to reduce inventory, transportation, food waste, and stockout costs in daily fresh milk delivery procedures. They suggested a simple approach to solve the problem, and they put it to the test using a Monte Carlo simulation. It has been found that this method, which enables inventory management and route choices to be made in conjunction with the established model, produces superior outcomes for present operational procedures with tolerable computation times.
(Ji et al., 2020)	For perishable food items with unknown demand, a two-stage model with a time window has been created. The first stage of the model is to find the most cost-effective number and placement of warehouses, and the second stage aims to reduce the expenses associated with routing goods between the warehouse and retail sales outlets. In order to solve the model, a robust optimization strategy was applied.
(Alkaabneh et al., 2020)	A vehicle routing research was done to solve the inventory routing issue for perishable food products in order to boost profits, cut down on fuel use, inventory holding, and greenhouse gas emissions. For problem-solving, Benders decomposition and a two-stage meta-heuristic technique were utilized. 60 clients successfully solved the case analysis including 6 planning periods and 4 vehicles within the parameters of the issue. The study's findings led to fuel savings of between 2% and 11%.

The general summary of the studies that limited the scope of the research to cover the phase 4 and phase 5 is given in Table 10.

Table 10. Academic Research Between the Stages of Retailer and Client (Phase 4 to Stage 5)

Ref.	Article brief summary
(Farahani et al., 2012)	They created a model using mixed integer linear programming for a catering firm serving Denmark that combines the production and delivery operations, reducing the time between these procedures and enhancing food quality. Aiming to reduce logistics and deterioration costs was the objective function of the model, and in practice, encouraging results were attained.

Conclusion

50 publications chosen from those published between 2012 and 2022 are studied and analyzed as part of this study's literature review.

The phased supply chain management for perishable food products was investigated in the article reviews. The stages are as follows: the procurement stage, where the needs for seeds, fertilizers, etc. for production are met; the field stage, where the products are produced; the facility stage, where the products produced and harvested in the field are processed and packaged; the retailer stage, where the storage and sales activities of the products ready for sale are carried out; and, at the final point, the customer stage.

In the publications under evaluation, it is clear that the supply chain management for perishable foods has lately increased the use of optimization approaches for the effective and efficient use of resources. It is clear that research mostly focus on "Field-Retailer" processes. The number of studies in the "Supplier - Field" and

"Retailer - Customer" stages has been seen to be less. According to the frequency of repetition, it has been found that the keywords in the articles primarily consist of the words "Supply Chain," "Perishable," "Location," "Routing," and "Inventory."

Weather conditions can have a favorable or negative impact on agricultural product production and supply chain management procedures. For instance, while rainy weather enhances the quality of the product throughout the growth phase, it can have a negative impact that raises harvest and logistical expenses during the harvest season. It has been noted that integrated plans based on weather conditions are absent from the planning of the harvesting processes in the articles under consideration. People who are interested in learning more about PSCM will keep researching it, helping to close this gap in the literature.

Author Contribution

The authors contributed equally to the preparation of the article.

Conflict of Interest

As the authors, we declare that there is no conflict of interest regarding the planning, execution and writing of the article.

References

Accorsi, R., Gallo, A., Manzini, R. (2017). A climate driven decision- A climate driven decision-support model for the distribution of perishable p support model for the distribution of perishable products. Cleaner Product, 165, 917-929. https://doi.org/10.1016/j.jclepro.2017.07.170

Ahumada, O., Villalobos, J.R., Mason, A.N. (2012). Tactical planning of the production and distribution of fresh agricultural products under uncertainty. Agricultural Systems, 112, 17-26. https://doi.org/10.1016/j.agsy.2012.06.002

Albrecht, W., Steinrücke, M. (2017). Coordinating continuous-time distribution and sales planning of perishable goods with quality grades. International Journal of Production Research, 56(7), 2646-2665. https://doi.org/10.1080/00207543.2017.1384584

Alkaabneh, F., Diabat, A., Gao, H.O. (2020). Benders decomposition for the inventory vehicle routing problem with perishable products and environmental costs. Computers and Operations Research, 113, 104751. https://doi.org/10.1016/j.cor.2019.07.009

Amorim, P., Günther, H.O., Lobo, B.A. (2012). Multi-objective integrated production and distribution planning of perishable products. International Journal of Production Economics, 138(1), 89-101. https://doi.org/10.1016/j.ijpe.2012.03.005

Amorim, P., Meyr, H., Almeder, C., Lobo, B.A. (2013). Managing perishability in production-distribution planning: a discussion and review. Flexible Services and Manufacturing Journal, 25, 389-413. https://doi.org/10.1007/s10696-011-9122-3

Anitha, P., Patil, M.M. (2018). A review on data analytics for supply chain management: A case study. International Journal of Information Engineering and Electronic Business, 5, 30-39. DOI: 10.5815/ijieeb.2018.05.05

AriaNezhad, M.G., Makuie, A., Khayatmoghadam, S. (2013). Developing and solving two-echelon inventory system for perishable items in a supply chain: case study. Journal of Industrial Engineering Int., 39, 1-10. https://doi.org/10.1186/2251-712X-9-39

Azadeh, A., Elahi, S., Hosseinabadi Farahani, M., Nasirian, B. (2017). A genetic algorithm-Taguchi based approach to inventory routing problem of a single perishable product with transshipment. Computers and Industrial Engineering, 104, 124-133. https://doi.org/10.1016/j.cie.2016.12.019

Basset, M.A., Manograna, G. Mohamed, M. (2018). Internet of things and its impact on supply chain: A framework for building smart. secure and efficient systems. Future Generation Computer Systems, 86, 614-628. https://doi.org/10.1016/j.future.2018.04.051

Behzadi, G., Sullivan, M.J., Olsen, T.L., Zhang, A. (2017). Agribusiness supply chain risk management: A review of quantitative decision models. Omega, 79, 21-42. https://doi.org/10.1016/j.omega.2017.07.005

Biuki, M., Kazami, A., Alineshad, A. (2020). An integrated location-routing-inventory model for sustainable design of a perishable products supply chain network. Journal of Cleaner Production, 260(120842), 1-14. https://doi.org/10.1016/j.jclepro.2020.120842

Castro, J. A. O., Coronado, L. A. S., Lozano, A. M. P. (2017). Coupling facility location models in the supply chain of perishable fruits. Research in Transportation Business & Management, 24, 73-80. https://doi.org/10.1016/j.rtbm.2017.08.002

Chao, C., Zhihui, T., Baozhen, Y. (2019). Optimization of two-stage location-routing-inventory problem with time-windows in food distribution network. Annals of Operations Research, 273, 111-134. https://doi.org/10.1007/s10479-017-2514-3

Dai, Z., Aqlan, F., Zheng, X, Gao, K. (2018). A location-inventory supply chain network model using two heuristic algorithms for perishable products with fuzzy constraints. Computers & Industrial Engineering, 119, 338-352. https://doi.org/10.1016/j.cie.2018.04.007

Demirtaş, N., Tuzkaya, U.R. (2012). Strategic planning of layout of the distribution center: an approach for fruits and vegetables hall. Procedia - Social and Behavioral Sciences, 58, 159-168. https://doi.org/10.1016/j.sbspro.2012.09.989

Diatha, K.S., Karumanchi, R., Garg, S. (2012). Mobile enabled operations management using multi-objective based logistics planning for perishable products. Computers and Industrial Engineering, 1-15.

Drezner, Z., Scott, C.H. (2013). Location of a distribution center for a perishable product. Mathematical Methods of Operations Research, 78, 301-314. https://doi.org/10.1007/s00186-013-0445-6

Dutta, P., Shrivastava, H. (2019). The design and planning of an integrated supply chain for perishable products under uncertainties case study in milk industry. Supply chain for perishable products, 15(4), 1301-1337. https://doi.org/10.1108/JM2-03-2019-0071

Esteso, A., Alemany, M.M.E., Ortiz, A. (2021). Impact of product perishability on agri-food supply chains design. Applied Mathematical Modelling, 96, 20-38. https://doi.org/10.1016/j.apm.2021.02.027

Etemadnia, H., Goetz, S.J., Canning, P., Tavallali, M.S. (2015). Optimal wholesale facilities location within the fruit and vegetables supply chain with bimodal transportation options: An LP-MIP heuristic approach. European Journal of Operational Research, 244(2), 648-661. https://doi.org/10.1016/j.ejor.2015.01.044

Farahani, P., Grunow, M., Günther, H.O. (2012). Integrated production and distribution planning for perishable food products. Flexible Services and Manufacturing Journal, 24, 28-51. https://doi.org/10.1007/s10696-011-9125-0

Flores, R.G., Filho, O.V.S., Martins, R.S., Martins, C.V.B., Juliao, P. (2015). Using logistic models to optimize the food supply chain (pp. 307-330). Modeling Food Processing Operations. https://doi.org/10.1016/B978-1-78242-284-6.00011-8

Ganeshkumar, C., Pachayappan, M., Madanmohan, G. (2017). Agri-food supply chain management: Literature review. Intelligent Information Management, 9, 68-96. http://dx.doi.org/10.2139/ssrn.3093241

Ge, H., Goetz, S., Canning, P., Perez, A. (2018). Optimal locations of fresh produce aggregation facilities in the United States with scale economies. International Journal of Production Economics, 197, 143-157. https://doi.org/10.1016/j.ijpe.2018.01.007

Ge, H., Goetz, S.J., Clary, R., Yi, J., Gomez, M.I. (2022). Facility locations in the fresh produce supply chain: An integration of optimization and empirical methods. International Journal of Production Economics, 249, 108534. https://doi.org/10.1016/j.ijpe.2022.108534

Ghezavati, V.R., Hooshyar, S., Moghaddam, R.T. (2015). A Benders' decomposition algorithm for optimizing distribution of perishable products considering postharvest biological behavior in agri-food supply chain: a case study of tomato. CEJOR, 25, 29-54. ttps://doi.org/10.1007/s10100-015-0418-3

Goli, A., Tirkolaee, E.B., Weber, G.W. (2020). A perishable product sustainable supply chain network design problem with lead time and customer satisfaction using a Hybrid Whale-Genetic Algorithm (pp. 99-124). Logistics Operations and Management for Recycling and Reuse. https://doi.org/10.1007/978-3-642-33857-1_6

Govindan, K., Jafarian, A., Khodaverdi, R., Devika, K. (2013). Two-echelon multiple-vehicle location–routing problem with time windows for optimization of sustainable supply chain network of perishable food. International Journal of Production Economics, 152, 9-28. https://doi.org/10.1016/j.ijpe.2013.12.028

Hiassat, A., Diabat, A., Rahwan, I. (2016). A genetic algorithm approach for location-inventory-routing problemwith perishable products. Journal of Manufacturing Systems, 42, 93-103. http://dx.doi.org/10.1016/j.jmsy.2016.10.004, 93–103

Huh, W.T., Lall, U. (2013). Optimal crop choice, irrigation allocation, and the impact of contract farming. Production and Operations Management, 22(5), 1126–1143. https://doi.org/10.1111/poms.12007

Ji, Y., Du, J., Han, X., Wu, X., Huang, R., Wang, S., Liu, Z. (2020). A mixed integer robust programming model for two-echelon inventory routing problem of perishable products. Physica A: Statistical Machanics and its Applications, 548, 124481. https://doi.org/10.1016/j.physa.2020.124481

Jonkman, J., Povoa, A.P.B., Bloemhof, J.M. (2018). Integrating harvesting decisions in the design of agro-food supply chains. European Journal of Operational Research, 276(1), 247-258. https://doi.org/10.1016/j.ejor.2018.12.024

Junqueira, R.A.R., Morabito, R. (2019). Modeling and solving a sugarcane harvest front scheduling problem. International Journal of Production Economics, 213, 150–160. https://doi.org/10.1016/j.ijpe.2019.03.009

Kamble, S.S., Gunasekaran, A., Gawankar, S.A. (2020). Achieving sustainable performance in a data-driven agriculture supply chain: A review for research and applications. International Journal of Production Economics, 219, 179-194. https://doi.org/10.1016/j.ijpe.2019.05.022

Keizer, M., Akkerman, R., Grunow, M., Bloemhof, J.M., Haijema, R., Vorst, J.G.A.J. (2017). Logistics network design for perishable products with heterogeneous quality decay. European Journal of Operational Research, 262(2), 353-549. https://doi.org/10.1016/j.ejor.2017.03.049

Keizer, M., Haijema, R., Bloemhof, J.M., Van Der Vorst, J.G.A. (2015). Hybrid optimization and simulation to design a logistics network for distributing perishable products. Computers & Industrial Engineering, 88, 26-38. https://doi.org/10.1016/j.cie.2015.06.017

Khalili-Damghani, K., Abtahi, A.R., Ghasemi, A. (2015). A new bi-objective location-routing problem for distribution of perishable products: evolutionary computation approach. Journal of Mathematical Modelling and Algorithms in Operations Research, 14(3), 287-312. https://DOI:10.1007/s10852-015-9274-3

Khamjan, W., Khamjan, S., Pathumnakul, S. (2013). Determination of the locations and capacities of sugar cane loading stations in Thailand. Computers & Industrial Engineering, 66(6), 663–674. https://doi.org/10.1016/j.cie.2013.09.006

Kieu, P.T., Nguyen, V.T., Ho, T.P. (2021). A Spherical Fuzzy Analytic Hierarchy Process (SF-AHP) and Combined Compromise Solution (CoCoSo) Algorithm in distribution center location selection: A case study in agricultural supply chain. Axioms, 10(2), 53. https://doi.org/10.3390/axioms10020053

Kumar, R., Ganapathy, L., Gokhale, R., Tiwari, M.K. (2020). Quantitative approaches for the integration of production and distribution planning in the supply chain: a systematic literature review. International Journal of Production Research, 58(11), 3527-3553. https://doi.org/10.1080/00207543.2020.1762019

Kusumastuti, R.D., Donk, D.P., Teunter, R. (2016). Crop-related harvesting and processing planning: a review. International Journal Production Economics, 174, 76-92. https://doi.org/10.1016/j.ijpe.2016.01.010

Lia, Y., Chu, F., Cote, J.F., Coelho, L.C., Chu, C. (2019). The multi-plant perishable food production routing with packaging consideration. International Journal of Production Economics, 221, 107472. https://doi.org/10.1016/j.ijpe.2019.08.007

Liu, A., Zhu, Q., Xu, L., Lu, Q., Fan, Y (2021). Sustainable supply chain management for perishable products in emerging markets: An integrated location-inventory-routing model. Transportation Research Part E, Logistics and Transportatiın Review, 150, 102319. https://doi.org/10.1016/j.tre.2021.102319

Manzini, R., Accorsi, R. (2012). The new conceptual framework for food supply chain assessment. Journal of Food Engineering, 115(2), 251–263. https://doi.org/10.1016/j.jfoodeng.2012.10.026

Mirabelli, G., Solina, V. (2022). Optimization strategies for the integrated management of perishable supply chains: A literature review. Journal of Industrial Engineering and Management, 15(1), 58-91. http://dx.doi.org/10.3926/jiem.3603

Morganti, E., Feliu, J.G. (2014). City logistics for perishable products. The case of the parma's food hub. Case Studies on Transport Policy, 3(2), 120-128. https://doi.org/10.1016/j.cstp.2014.08.003

Mönch, L., Uzsoy, R., Fowler, J.W. (2018). A survey of semiconductor supply chain models part I: semiconductor supply chains, strategic network design, and supply chain simulation. International Journal of Production Research, 56(13), 4524-4545. https://doi.org/10.1080/00207543.2017.1401233

Musavi, M., Amiri, A.B. (2017). A multi-objective sustainable hub location-scheduling problem for perishable food supply chain. Computers & Industrial Engineering, 113, 766–778. https://doi.org/10.1016/j.cie.2017.07.039

Nabil, O.M., Afia, N.H., Shihata, L.A. (2021). Sustainable supply chain design for perishable products: A literature review. Journal of Engineering, 49(1), 1 -22. DOI: 10.21608/jesaun.2020.133685

Navazi, F., Sedahgat, A., Moghaddam, R.T. (2019). A new sustainable location-routing problem with simultaneous pickup and delivery by two-compartment vehicles for a perishable product considering circular economy. IFAC-Papers OnLine, 52(13), 790–795. https://doi.org/10.1016/j.ifacol.2019.11.212

Onggo, B.S., Panadero, J., Corlu, C.G. (2019). Agri-food supply chains with stochastic demands: A multi-period inventory routing problem with perishable products. Simulation Modelling Practice and Theory, 97, 101970. https://doi.org/10.1016/j.simpat.2019.101970

Öztürk, A. (2013). Yöneylem araştırmasının tarihi gelişimi ve özellikleri. Alphanumeric Journal, 1(1), 1-11.

Pasandideh, S.H.R., Naderi, B., Majd, Z.R. (2017). Modeling and solving the integrated ILRP in a multi-period and multi-perishable product supply chain with uncertainty: lagrangian relaxation algorithm. Computers and Chemical Engineering, 109, 9-22. https://doi.org/10.1016/j.compchemeng.2017.10.013

Rahbari, A., Nasiri, M.M., Werner, F., Musavi, M, Jolai, F. (2019). The vehicle routing and scheduling problem with cross-docking for perishable products under uncertainty: Two robust bi-objective models. Applied Mathematical Modelling, 70, 605–625. https://doi.org/10.1016/j.apm.2019.01.047

Rashidi, S., Saghaei, A., Sadjadi, S.J., Nezhad, S.S. (2016). Optimizing supply chain network design with location-inventory decisions for perishable items: A Pareto-based MOEA approach. Scientia Iranica - Transactions E: Industrial Engineering, 23(6), 3035-3045. doi: 10.24200/SCI.2016.4009

Shukla, M., Jharkharia, S. (2013). Agri-fresh produce supply chain management: a state-of-the-art literature review. International Journal of Operations & Production Management, 33(2), 114-158. https://doi.org/10.1108/01443571311295608

Siddh, M.M., Son, G., Jain, R. (2015). Perishable food supply chain quality (PFSCQ) A structured review and implications for future research. Journal of Advances in Management Research, 12(3), 292-313. https://doi.org/10.1108/JAMR-01-2015-0002

Suryawanshi, P., Dutta, P. (2021). Distribution planning problem of a supply chain of perishable products under disruptions and demand stochasticity. International Journal of Productivity and Performance Management, 72(1), 246-278. https://doi.org/10.1108/IJPPM-12-2020-0674

Şen, İ.K. (2014). Lojistik faaliyetlerin yönetimi ve maliyetleme yaklaşımları. Çankırı Karatekin Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 3(1), 83-106.

Taşkıner, T., Bilgen, B. (2021). Optimization models for harvest and production planning in agri-food supply chain: A systematic review. Logistics, 5(3), 52. https://doi.org/10.3390/logistics5030052

Toro, A., Gunnarsson, C., Lundin, G., Jonsson, N. (2012). Cereal harvesting e strategies and costs under variable weather conditions. Biosystems Engineering, 111(4), 429-439. https://doi.org/10.1016/j.biosystemseng.2012.01.010

Vrat, P., Gupta, R., Bhatnagar, A., Pathak, D.K., Fulzele, V. (2018). Literature review analytics (LRA) on sustainable cold-chain for perishable food products: research trends and future directions. Opsearch 55, 601–627. https://doi.org/10.1007/s12597-018-0338-9

Wang, C., Nhieu, N., Chung, Y., Pham, H. (2021). Multi-objective optimization models for sustainable perishable intermodal multi-product networks with delivery timewindow. Mathematics, 9(4), 379. https://doi.org/10.3390/math9040379

Wu, T., Shen, H., Zhu, C. (2015). A multi-period location model with transportation economies-of-scale and perishable inventory. International Journal of Production Economics, 169, 343-349. https://doi.org/10.1016/j.ijpe.2015.08.018

Yakavenka, V., MAllidis, I., Vlachos, d., Iakovou, E., Eleni, Z. (2020). Development of a multi-objective model for the design of sustainable supply chains: the case of perishable food products. Annals of Operations Research, 294, 593–621. https://doi.org/10.1007/s10479-019-03434-5

Zhang, H., Xiong, Y., He, M., Qu, C. (2017). Location model for distribution centers for fulfilling electronic orders of fresh foods under uncertain demand. Hindawi Scientific Programming. https://doi.org/10.1155/2017/3423562