

Enhance framework for fresh markets inventory management in malaysia

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Abstract. The fresh market sector holds a vital position in the food supply chain, serving as a crucial link between producers and consumers. This study research examines the inventory management practices within fresh markets in Malaysia. The aim is to identify both common and unique approaches and issues related to inventory management, with the objective of enhancing the efficiency of existing inventory management systems in Malaysian fresh markets. However, one of the key challenges faced by many retail groups in this sector is maintaining a balance between demand and supply. This imbalance often results in the issue of overstocking, leading to significant food loss. Upon thorough analysis of existing literature reviews, this study presents the framework for improving fresh food management and identifying flow-related challenges associated with current inventory management practices. The findings of this research serve to guide policymakers in adopting a comprehensive approach to tackle the issue of imbalanced food supply and address the shortcomings in inventory management within Malaysia.

1 Overview

Fresh markets, also known as wet markets, play a crucial and central role in Malaysia's rich and diverse food culture (Abdul Rahman et al., 2020; Ghani et al., 2022; Mat Lazim et al., 2020). These markets serve as the primary destination for consumers across the country to obtain fresh produce, seafood, and other perishable goods. Efficient inventory management is of utmost importance in maintaining the smooth functioning of fresh markets, enabling a consistent supply of top-quality produce while effectively reducing waste and losses (Banerjee & Agrawal, 2017; de Carvalho et al., 2022; Dolat-Abadi, 2021; Guritno et al., 2015; Kumar & Agrawal, 2023a; Liu et al., 2019). However, inefficient inventory management in these markets leads to significant waste generation. This report focuses on the potential solutions of

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resilient supply chain networks, circular economy strategies, and the integration of digitalisation and technology.

Malaysia faces challenges related to inventory waste generation in its fresh markets (Jereme et al., 2016; UNEP, 2021). The lack of efficient supply chain networks and inadequate inventory management practices contribute to significant waste, including food spoilage, unsold produce, and packaging waste. This waste not only has economic implications but also environmental and social consequences (Huang et al., 2021; Sepehri et al., 2021).

2 Introduction

Inventory waste generation in fresh markets contributes to environmental degradation through increased greenhouse gas emissions, land occupancy, and water usage (Martínez-falc & Eduardo, 2024; Paam et al., 2019; Shafiee et al., 2021). Moreover, it poses challenges to waste management infrastructure, affects public health, and exacerbates social inequality. Addressing these issues is crucial for sustainable development and the achievement of national and international goals, such as the United Nations Sustainable Development Goals (UNEP, 2021).

A resilient supply chain network is essential for minimising inventory waste and ensuring the smooth flow of goods in fresh markets (Akbari & Hopkins, 2022; Biuki et al., 2020; de Carvalho et al., 2022; Guritno et al., 2015; Kumar & Agrawal, 2023a; Woo et al., 2021). Resilience enables organisations to adapt and recover quickly from disruptions, reducing waste generation. It involves building strong relationships among suppliers, farmers, market vendors, and other stakeholders to enhance coordination, responsiveness, and adaptability (Gokarn & Choudhary, 2021; Kaur et al., 2022; Onwude et al., 2023).

Digitalisation and technology play a crucial role in addressing inventory waste generation in fresh markets (Han et al., 2021). Technologies, such as the Internet of Things (IoT), data analytics, and cloud computing, enable real-time monitoring of inventory levels, demand patterns, and product quality (Liu et al., 2019; Martínez-falc & Eduardo, 2024; Saurabh & Dey, 2021; Sepehri et al., 2021). By leveraging these technologies, market vendors can improve demand forecasting accuracy, optimise inventory levels, and enhance supply chain visibility, thereby reducing waste generation.

Addressing inventory waste generation in Malaysia's fresh markets requires proactive strategies. By adopting resilient supply chain networks, embracing circular economy principles, and leveraging digitalisation and technology, fresh markets can optimise their operations, reduce waste generation, and contribute to sustainable and efficient inventory management. These solutions will not only benefit the environment but also foster economic growth, improve resource utilisation, and enhance social well-being. It is crucial for policymakers, market vendors, and other stakeholders to collaborate and implement these strategies to create a more resilient, circular, and technologically advanced fresh market ecosystem in Malaysia.

This research endeavours to comprehend the evolution and distinctions among prevalent frameworks within the inventory management systems as revealed through the literature review. By focusing on the current practices of these frameworks, we aim to propose the development of a more constructive and comprehensive perspective that addresses the reduction of food waste and financial losses stemming

from overstocking and imbalances in the demand and supply within Malaysia's food supply chain.

3 Factors Influencing Supply Chain Performance

A study conducted by Guritno et al. (2015) focused on Indonesia's fresh market and highlighted the importance of effective inventory management optimization to ensure timely and accurate delivery of products. The report introduced a simulation-based optimization framework that incorporated a discrete choice model and heuristic replenishment policies. This approach aimed to optimise inventory management and contribute to pricing decisions specifically for perishable goods. The performance of the supply chain in the study was influenced by various factors, including supply chain costs, product sales, warranty costs, and employee productivity (Guritno et al., 2015).

Furthermore, lead times played a crucial role in order fulfilment between customers, suppliers, and the company's overall cycle time and delivery periods. These lead times influenced the efficiency of the inventory management process. Blumenfeld et al. (1999) emphasised the significance of consumer type, the nature of the supply chain, and bargaining power as key factors for effective inventory management.

Singh et al. (2022) explored the significance and application of industry 4.0 technologies in horticulture, specifically in areas such as supply chain, disease detection, irrigation management, soil fertility, fertilizer management, maturity identification, marketing, and weather patterns. Han et al. (2021) reported the context of supply chain of fresh produce, with a focus on the production and distribution planning.

Kumar and Agrawal, (2023) identified the challenges and opportunities for Agri-fresh food supply chain management in India and restructuring the supply chains to be more effective and efficient. Thirty-four challenges across six drivers (facilities, inventory, transportation, information, pricing, sourcing) of the agri-fresh food supply chains were identified. Six opportunities for improvement were presented, including redesigning agri-fresh food supply chains, collaboration and coordination, enabling technologies, forecasting models, government roles and initiatives, and investments. Challenges related to facilities and information have received more attention from the research community, while challenges related to the perishable nature of agri-fresh items have received the maximum attention. A conceptual framework is developed to map each challenge to corresponding opportunities based on past research suggestions.

In summary, the studies in literature emphasises the importance of optimising inventory management to ensure timely product delivery (Alshehri, 2023; de Carvalho et al., 2022; Ghani et al., 2022; Görçün et al., 2023; Guritno et al., 2015; Kaur et al., 2022; Kumar & Agrawal, 2023a; Manavalan & Jayakrishna, 2019; Mantravadi & Srail, 2022; Nagarajan et al., 2022; Onwude et al., 2023; Saurabh & Dey, 2021; Woo et al., 2021; Yavari et al., 2020). Their simulation-based optimisation framework, incorporating discrete choice models and heuristic replenishment policies, contributed to pricing decisions for perishable goods. The studies highlighted the influence of factors such as supply chain costs, product sales, warranty costs, and employee productivity on supply chain performance.

Additionally, the studies underscored the significance of lead times and factors like consumer type, supply chain nature, bargaining power, and the relationship between customer needs and orders in effective inventory management. By considering these factors, organisations can enhance their ability to meet customer needs and improve inventory management practices.

4 Related Work

Herbon et al. (2014) builds upon previous literature on inventory management of perishable products, deteriorating inventory systems, and dynamic pricing. The article is based on the theoretical framework of the inventory routing problem (IRP) and its variations. It builds upon previous literature on IRP and incorporates new characteristics such as continuous-time consumption and time windows.

Building on Guritno et al.'s (2015) delved into strategies for effective inventory management of perishable products. The study introduced a simulation-based optimization framework incorporating a discrete choice model and heuristic replenishment policies.

Herbon, (2017) developed an advanced non-cooperative game model to optimise the management of multi-aged expiring inventory, considering the heterogeneous response of consumers to pricing and timing factors. The main objectives were to analyse the goals of price minimisation, freshness maximisation, and maximisation of the quantity on the shelf and to specify the conditions under which the coexistence of multiple types on the shelf is not beneficial to the retailer or the market.

Woo et al. (2021) develop a production-inventory control (PIC) model for a supply chain network (SCN) that minimises total network cost while ensuring no shortages of inventory and shutdown periods. The study was based on the theoretical framework of supply chain management, and production-inventory control. It builds upon previous research on coordination policies, such as the vendor-managed inventory (VMI) strategy, economic order quantity (EOQ) model, economic production quantity (EPQ) model, and integer-ratio cycle (IRC) policy. The results obtained by the algorithm developed in the study were compared to the results of existing models in the literature, and improvements were observed.

Gautam et al. (2022) develop a sustainable production inventory model that considers the greening degree and dual determinants of defective items. The objective was to be proposed two models for handling defective goods, one involving salvaging and the other involving reworking, and assess their sustainability and performance. The theoretical framework of the study revolves around sustainable supply chains, greening levels, and decision-making of manufacturers. The study incorporates concepts such as greening degree, pricing, defectives handling, and sustainability assessment to develop the production inventory models. However, the potential limitations and challenges of the aforementioned reported studies include the complexity of incorporating real-world factors into the mathematical models, assumptions made during model development, and the generalisability of the findings to different industries or contexts.

Alarcon-Ortega and Doerner, (2023) recently reported on continuous-time stochastic inventory routing problem with time windows (CTSIRPTW) and develop

a metaheuristic solution approach to efficiently plan delivery times and quantities while avoiding stock-out situations caused by continuous product consumption.

5 Summary of the related Framework

In this study a comprehensive literature review has been presented, focusing on various dimensions of fresh food supply chains, perishable product inventory management, and sustainable supply chain design. The studies explored in this chapter contribute valuable insights into the complexities and challenges inherent in managing these intricate systems (Table 5.1).

Table 5.1 Tabular Summary of Literature

No	Study	Optimization and Decision	Supply Chain performance	Waste Management	Sustainability	Information and Data	Infrastructure and Logistics	Stakeholder involvement
1	Guritano et al (2015)	✓	✓	✗	✗	✓	✗	✗
2	Biukiet al (2022)	✓	✓	✓	✓	✓	✓	✗
3	Ghani et al (2022)	✓	✗	✓	✓	✓	✓	✓
4	Gioia et al (2023)	✓	✓	✗	✓	✓	✗	✗
5	(Onwude et al (2023)	✓	✓	✗	✗	✓	✓	✓

The assessment of fresh vegetable supply chains demonstrates critical factors influencing performance, offering a foundation in understanding the dynamics of cost attributes and strategic inventory management. The introduction of simulation-based optimization provided a forward-looking perspective, showcasing the adaptability of

models to enhance inventory management and pricing decisions for perishable products.

Sustainable supply chain design emerged as a crucial theme, with studies evaluating supplier sustainability and proposing integrated models for optimizing location, routing, and inventory decisions. The utilization of hybrid metaheuristics highlighted the commitment to addressing incorporating economical, ecological, and societal aspects in supply chain decision-making.

Scenario modelling in food flow management extended the analysis to national networks, emphasizing the importance of comprehensive approaches. The incorporation of socio-ecology concepts illustrated the interconnectedness of actors in the food supply chain, aligning with practice of sustainability goals and global initiatives. The exploration of bottlenecks in fresh food supply chains provided insights into challenges faced in different contexts. While specific challenges may vary, the overarching themes of transportation, cold chain management, and sustainability emerged as critical factors influencing the resilience of these supply chains.

In the chapters ahead, we delve into a focused examination of the fresh food supply chain, leveraging the insights gained from reviewed literatures to inform this research methodology and findings. Through an integrated approach, we aim to contribute meaningfully to the ongoing discourse on the optimization and sustainability of fresh food supply chains.

This chapter introduces an innovative framework aimed at enhancing supply chain performance within the context of fresh markets in Malaysia. Recognizing the complexities and dynamics of fresh food supply chains, the framework is constructed around three pivotal components: a Resilience Supply Network, Circular Economy principles, and Digitalisation and Technology. Each component is integral to the proposed framework, and their synergy is expected to drive significant improvements in supply chain performance (see Figure 6.1).

6 Enhance Framework for Fresh Markets Inventory Management in Malaysia

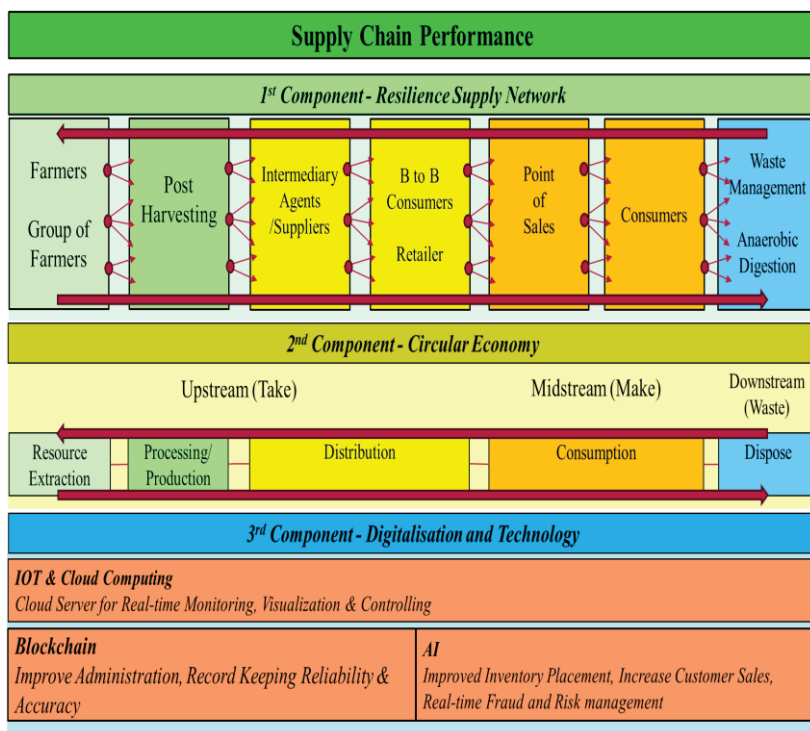


Fig .6.1. Enhance Framework for Fresh Markets Inventory Management in Malaysia

The resilient supply network component of the framework encompasses all the key actors and entities involved in the fresh market ecosystem. This includes farmers, postharvest handlers, intermediary agents or suppliers, business-to-business consumers or retailers, point-of-sale systems, end consumers, and waste management through anaerobic digestion. By establishing a resilient supply network, the framework aims to ensure the smooth flow of goods and services, minimise disruptions, manage risks, and enhance the overall responsiveness of the supply chain. The collaboration and coordination among these stakeholders are essential for effective and sustainable management of fresh markets.

The circular economy component emphasises the principles of resource extraction, processing/production, distribution, consumption, and disposal. It seeks to minimise waste generation, promote the reuse, recycling, and regeneration of materials, and reduce environmental impact. By adopting circular economy practices within the framework, stakeholders can optimise resource utilization, minimise waste generation, and create a sustainable and environmentally friendly fresh market ecosystem. This includes strategies such as implementing efficient packaging, encouraging product recycling, and promoting responsible disposal methods.

The digitalisation and technology component leverages the power of cutting-edge advancements to enhance the efficiency and effectiveness of fresh market operations. Key technologies include the Internet of Things (IoT) and cloud computing, which enable real-time monitoring, visualization, and control over supply chain activities. Cloud servers facilitate seamless data exchange and provide stakeholders with valuable insights and actionable information. Blockchain technology ensures

improved administration, record-keeping, reliability, and accuracy within the supply chain, offering enhanced traceability and transparency. Artificial intelligence (AI) plays a vital role in optimizing inventory placement, increasing customer sales through personalised recommendations, and real-time fraud management.

The integration of these three components in the framework offers numerous benefits and implications for managing fresh markets. These include: Enhanced supply chain resilience and responsiveness, Improved resource utilization and waste management, Reduced environmental impact and increased sustainability, Real-time monitoring and control for improved decision-making, Enhanced transparency and traceability throughout the supply chain, Increased efficiency and productivity through AI-driven optimisation, enhanced customer experience and personalisation.

6.1 Importance of Supply Chain Performance

The performance of supply chains is critical to the success of fresh markets. Efficient supply chains can reduce waste, lower costs, and improve product quality and availability. The proposed framework seeks to optimise these aspects, facilitating better outcomes for all stakeholders from farmers to consumers. Enhancing supply chain performance is particularly vital in the context of fresh markets, where perishability and demand variability pose unique challenges.

6.2 First Component – Resilience Supply Network

The Resilience Supply Network is designed to withstand and quickly recover from disruptions. This component encompasses the entire flow from farmers to consumers, ensuring that each link in the chain—from post-harvesting to point of sales is robust and adaptable. It includes strategies for managing waste and incorporates anaerobic digestion for waste-to-energy processes, closing the loop in the supply chain and contributing to its resilience.

Kuligowski et al., (2023) utilised Kitchen waste as a better fertiliser than mineral fertiliser. The report supports the adoption of anaerobic digestion of kitchen waste to improve agronomic effectiveness compared to microorganism-incubated kitchen waste. The study also suggests that kitchen waste introduced to the soil improved soil properties compared to mineral fertiliser.

Sharma et al., (2023), converted food waste into biofertilizer through techniques like anaerobic digestion, composting, and vermicomposting which helps to close nutrient loops, reduce waste, and contribute to environmental sustainability.

6.3 Second Component – Circular Economy

Embedding Circular Economy principles into the supply chain addresses the upstream (take), midstream (make), and downstream (waste) phases. By emphasizing responsible extraction of natural resources, such as water and raw materials, necessary for agricultural production (Martínez-falc & Eduardo, 2024). The conversion of raw materials into finished products, ensuring minimal waste generation and efficient utilization of resources (Ghani et al., 2022). The efficient movement of products from producers to consumers, minimizing transportation-related emissions and optimizing logistics (Ramírez et al., 2022). Encouraging

responsible consumption practices, such as reducing food waste and promoting sustainable purchasing habits (Fukase & Martin, 2020). Proper waste management practices, including recycling, composting, and responsible disposal to minimise environmental impact (Huang et al., 2021).

6.4 Third Component – Digitalisation and Technology

The integration of IoT & Cloud Computing, Blockchain, and AI is the third cornerstone of the proposed framework. This technological triad facilitates real-time monitoring, visualization, and controlling; enhances administration and record-keeping reliability; and improves inventory placement. Furthermore, it enables real-time fraud and risk management, thus bolstering the supply chain's efficiency and security.

Pal and Yasar, (2023) state that the benefits of incorporating IoT includes, better management of information and aspects of the SCM system, such as improving the overall efficiency. Utilizing IoT sensors and devices to collect real-time data on various aspects of the supply chain, such as temperature, humidity, and product quality (Agnusdei et al., 2022; Aytac & Korçak, 2021; Kumar Kasera et al., 2024; Mantravadi & Srail, 2022; Nagarajan et al., 2022; Ramirez et al., 2022). Cloud computing enables the storage, analysis, and sharing of this data in real-time, allowing stakeholders to make informed decisions (Karumanchi et al., 2022; Shreya et al., 2023; Singh et al., 2022). A decentralised and secure digital ledger that ensures transparency, traceability, and reliability of transactions and data throughout the supply chain (Alshehri, 2023; de Carvalho et al., 2022; Saurabh & Dey, 2021). AI algorithms can analyse vast amounts of data to optimise inventory management, predict demand, personalise customer experiences, and detect and prevent fraudulent activities (Akbari & Hopkins, 2022; Kumar Kasera et al., 2024; Mat Lazim et al., 2020).

6.5 The Combination of the 3 Components in Supply Chain Performance

The synergy of the three components creates a robust supply chain capable of exceptional performance. The Resilience Supply Network ensures continuity of operations, the Circular Economy maximises resource efficiency, and Digitalisation and Technology bring precision and intelligence to operations. Together, they form a cohesive framework that can significantly elevate the standard of fresh markets' supply chains.

The proposed framework represents a holistic approach to revamping the supply chain operations of fresh markets in Malaysia. By incorporating resilience, sustainability, and technological innovation, the framework is not just a response to current challenges but a proactive step towards future-proofing the industry. Its implementation could set a new benchmark for supply chain performance, with the potential to resonate beyond the national context and influence global best practices in fresh market supply chain management.

7 Conclusion

In conclusion, the research presented in this study offers significant and valuable insights into the existing practices and challenges related to inventory management within the context of Malaysian fresh markets. The primary objective of the research is to identify the key issues and propose a comprehensive framework that combines resilient supply network principles, circular economy approaches, and digitalisation and technology advancements to address these challenges. The implementation of this framework has the potential to bring about significant positive impacts. It can result in enhanced coordination and collaboration among market stakeholders, leading to improved inventory management practices and reduced inefficiencies. The principles of the circular economy, such as waste reduction and resource optimization, can contribute to the sustainability and environmental friendliness of fresh market operations. Additionally, the integration of digitalisation and technology can enable real-time monitoring, data-driven decision-making, and improved supply chain visibility.

8 Recommendations and suggestions for future research

Building upon the insights obtained from this study, it is recommended that future research endeavors focus on addressing the identified gaps by exploring a broader range of market environments throughout Malaysia. This entails investigating how distinct regional practices and challenges can influence inventory management strategies within fresh markets.

Moreover, there is a promising avenue for incorporating advanced technological solutions, such as artificial intelligence (AI) and machine learning, into predictive inventory management. By leveraging these technologies, the efficiency of the supply chain can potentially be revolutionized. It would be beneficial to collaborate with technology companies and government bodies to implement and test these solutions in real-world settings. Such collaborative efforts can pave the way for significant improvements in inventory management practices.

Furthermore, it is important to evaluate the proposed framework in future research work. By conducting a comprehensive evaluation, the effectiveness and applicability of the framework can be assessed, thus providing valuable insights for its refinement and potential adoption in Malaysian fresh markets.

References

1. Abdel-Basset, M., Manogaran, G., & Mohamed, M. (2018). Internet of Things (IoT) 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>
2. Abdul Rahman, M. H., Sadi, T., Ahmad, A. A., Masri, I. N., Mohammad Yusoff, M., Kamaruddin, H., Shakri, N. A., Hamid, M. A. A., & Ab. Malek, R. (2020). Inventory and composting of yard waste in Serdang, Selangor, Malaysia. *Heliyon*, *6*(7), e04486. <https://doi.org/10.1016/j.heliyon.2020.e04486>
3. Agnusdei, G. P., Coluccia, B., Elia, V., & Miglietta, P. P. (2022). IoT technologies for wine supply chain traceability: Potential application in the

- Southern Apulia Region (Italy). *Procedia Computer Science*, 200(2019), 1125–1134. <https://doi.org/10.1016/j.procs.2022.01.312>
4. Akbari, M., & Hopkins, J. L. (2022). Digital technologies as enablers of supply chain sustainability in an emerging economy. *Operations Management Research*, 15(3–4), 689–710. <https://doi.org/10.1007/s12063-021-00226-8>
 5. Alarcon Ortega, E. J., & Doerner, K. F. (2023). A sampling-based matheuristic for the continuous-time stochastic inventory routing problem with time-windows. *Computers and Operations Research*, 152(January), 106129. <https://doi.org/10.1016/j.cor.2022.106129>
 6. Alshehri, D. M. (2023). Blockchain-assisted internet of things framework in smart livestock farming. *Internet of Things (Netherlands)*, 22(March), 100739. <https://doi.org/10.1016/j.iot.2023.100739>
 7. Anand, S., & Barua, M. K. (2023). Evaluating intensity of barriers to implementing collaborative practices in the agri-fresh produce industry: A graph theoretic and matrix approach. *Journal of Cleaner Production*, 395(February), 136395. <https://doi.org/10.1016/j.jclepro.2023.136395>
 8. Aytaç, K., & Korçak, Ö. (2021). IoT based intelligence for proactive waste management in Quick Service Restaurants. *Journal of Cleaner Production*, 284. <https://doi.org/10.1016/j.jclepro.2020.125401>
 9. Banerjee, S., & Agrawal, S. (2017). Inventory model for deteriorating items with freshness and price dependent demand: Optimal discounting and ordering policies. *Applied Mathematical Modelling*, 52, 53–64. <https://doi.org/10.1016/j.apm.2017.07.020>
 10. Biuki, M., Kazemi, A., & Alinezhad, A. (2020). An integrated location-routing-inventory model for sustainable design of a perishable products supply chain network. *Journal of Cleaner Production*, 260, 120842. <https://doi.org/10.1016/j.jclepro.2020.120842>
 11. Blumenfeld, D.E., Daganzo, C.F., Frick, M.C., and D. J. A. G. (1999). Impact of Manufacturing Response Time on Retailer Inventory. *International Journal of Production and Operations Management*, 19(8), 797–811.
 12. de Carvalho, P. R. V., Naoum-Sawaya, J., & Elhedhli, S. (2022). Blockchain-Enabled supply chains: An application in fresh-cut flowers. *Applied Mathematical Modelling*, 110, 841–858. <https://doi.org/10.1016/j.apm.2022.06.011>
 13. de Moraes, C. C., Costa, F. H. de O., da Silva, A. L., César, A. da S., Delai, I., & Pereira, C. R. (2022). Causes and prevention practices of food waste in fruit and vegetable supply chains: How is Brazil dealing with these issues? *Waste Management*, 154(October), 320–330. <https://doi.org/10.1016/j.wasman.2022.10.021>
 14. de Vass, T., Shee, H., & Miah, S. J. (2021). Iot in supply chain management: a narrative on retail sector sustainability. *International Journal of Logistics Research and Applications*, 24(6), 605–624. <https://doi.org/10.1080/13675567.2020.1787970>
 15. Dolat-Abadi, H. M. (2021). Optimizing decisions of fresh-product members in daily and bourse markets considering the quantity and quality deterioration: A

- waste-reduction approach. *Journal of Cleaner Production*, 283, 124647.
<https://doi.org/10.1016/j.jclepro.2020.124647>
16. Fukase, E., & Martin, W. (2020). Economic growth, convergence, and world food demand and supply. *World Development*, 132, 104954.
<https://doi.org/10.1016/j.worlddev.2020.104954>
 17. Gautam, P., Maheshwari, S., & Jaggi, C. K. (2022). Sustainable production inventory model with greening degree and dual determinants of defective items. *Journal of Cleaner Production*, 367(June), 132879.
<https://doi.org/10.1016/j.jclepro.2022.132879>
 18. Ghani, L. A., Mahmood, N. Z., Ismail, R., Sa'at, S. A., Ali, N., & Mohd Zakuan, S. A. (2022). Scenario modelling of proxy system in the context of Malaysian food flow management. *Heliyon*, 8(12), e12309.
<https://doi.org/10.1016/j.heliyon.2022.e12309>
 19. Giger, M., Mutea, E., Kiteme, B., Eckert, S., Anseeuw, W., & Zaehring, J. G. (2020). Large agricultural investments in Kenya's Nanyuki Area: Inventory and analysis of business models. *Land Use Policy*, 99(October 2019), 104833.
<https://doi.org/10.1016/j.landusepol.2020.104833>
 20. Gioia, D. G., Felizardo, L. K., & Brandimarte, P. (2023). Simulation-based inventory management of perishable products via linear discrete choice models. *Computers and Operations Research*, 157(August 2022), 106270.
<https://doi.org/10.1016/j.cor.2023.106270>
 21. Gokarn, S., & Choudhary, A. (2021). Modelling the key factors influencing the reduction of food loss and waste in fresh produce supply chains. *Journal of Environmental Management*, 294(December 2020), 113063.
<https://doi.org/10.1016/j.jenvman.2021.113063>
 22. Gong, M., Lian, Z., & Xiao, H. (2022). Inventory control policy for perishable products under a buyback contract and Brownian demands. *International Journal of Production Economics*, 251(October 2020), 108522.
<https://doi.org/10.1016/j.ijpe.2022.108522>
 23. Görçün, Ö. F., Aytakin, A., & Korucuk, S. (2023). Fresh food supplier selection for global retail chains via bipolar neutrosophic methodology. *Journal of Cleaner Production*, 419(July).
<https://doi.org/10.1016/j.jclepro.2023.138156>
 24. Guan, Z., Mou, Y., & Zhang, J. (2023). Incorporating risk aversion and time preference into omnichannel retail operations considering assortment and inventory optimization. *European Journal of Operational Research*, xxx.
<https://doi.org/10.1016/j.ejor.2023.09.034>
 25. Guritno, A. D., Fujianti, R., & Kusumasari, D. (2015). Assessment of the Supply Chain Factors and Classification of Inventory Management in Suppliers' Level of Fresh Vegetables. *Agriculture and Agricultural Science Procedia*, 3, 51–55. <https://doi.org/10.1016/j.aaspro.2015.01.012>
 26. Guritno1, A.D., Suwondo, E., and H. Yuliando, H. 2013. (2013). The inventory management approaches using inventory balance and decision of inventory across supply chain of fresh vegetables. *Proceeding of the International Conference on Operation Research OR 2013*,.

27. Haijema, R. (2014). Optimal ordering, issuance and disposal policies for inventory management of perishable products. *International Journal of Production Economics*, 157(1), 158–169.
<https://doi.org/10.1016/j.ijpe.2014.06.014>
28. Han, J., Lin, N., Ruan, J., Wang, X., Wei, W., & Lu, H. (2021). A Model for Joint Planning of Production and Distribution of Fresh Produce in Agricultural Internet of Things. *IEEE Internet of Things Journal*, 8(12), 9683–9696.
<https://doi.org/10.1109/JIOT.2020.3037729>
29. Herbon, A. (2017). A non-cooperative game model for managing a multiple-aged expiring inventory under consumers' heterogeneity to price and time. *Applied Mathematical Modelling*, 51, 38–57.
<https://doi.org/10.1016/j.apm.2017.06.006>
30. Herbon, A. (2021). Managing an expiring product under a market that is heterogeneous in the sensitivity to the retailer's reputation. *International Journal of Production Economics*, 232(September 2020), 107990.
<https://doi.org/10.1016/j.ijpe.2020.107990>
31. Herbon, A., Levner, E., & Cheng, T. C. E. (2014). Perishable inventory management with dynamic pricing using time-temperature indicators linked to automatic detecting devices. *International Journal of Production Economics*, 147(PART C), 605–613. <https://doi.org/10.1016/j.ijpe.2013.07.021>
32. Hou, X., Haijema, R., & Liu, D. (2017). Display, disposal, and order policies for fresh produce with a back storage at a wholesale market. *Computers and Industrial Engineering*, 111, 18–28. <https://doi.org/10.1016/j.cie.2017.06.038>
33. Huang, I. Y., Manning, L., James, K. L., Grigoriadis, V., Millington, A., Wood, V., & Ward, S. (2021). Food waste management: A review of retailers' business practices and their implications for sustainable value. *Journal of Cleaner Production*, 285, 125484.
<https://doi.org/10.1016/j.jclepro.2020.125484>
34. Innocent A. Jereme, Chamhuri Siwar, Rawshan Ara Begum, B. A. T. (2016). Addressing the problems of food waste generation in Malaysia. *International Journal of ADVANCED AND APPLIED SCIENCES*, 3(8), 68–77.
<https://doi.org/10.21833/ijaas.2016.08.012>
35. Karumanchi, M. D., Sheeba, J. I., & Pradeep Devaneyyan, S. (2022). Integrated Internet of Things with cloud developed for data integrity problems on supply chain management. *Measurement: Sensors*, 24(September), 100445.
<https://doi.org/10.1016/j.measen.2022.100445>
36. Kaur, A., Singh, G., Kukreja, V., Sharma, S., Singh, S., & Yoon, B. (2022). Adaptation of IoT with Blockchain in Food Supply Chain Management: An Analysis-Based Review in Development, Benefits and Potential Applications. *Sensors*, 22(21). <https://doi.org/10.3390/s22218174>
37. Khalilpourazari, S., Pasandideh, S. H. R. (2019). Modelling and optimization of multi-item multi-constrained EOQ model for growing items. *Knowl. Base Syst.*, 164, 150–162.
38. Kiloes, A. M., Muflikh, Y. N., Joyce, D., & Abdul Aziz, A. (2023). Understanding the complexity of the Indonesian fresh mango industry in

- delivering quality to markets: A systems thinking approach. *Food Policy*, 118(June), 102497. <https://doi.org/10.1016/j.foodpol.2023.102497>
39. Kuligowski, K., Konkol, I., Świerczek, L., Chojnacka, K., Cenian, A., & Szufa, S. (2023). Evaluation of Kitchen Waste Recycling as Organic N-Fertiliser for Sustainable Agriculture under Cool and Warm Seasons. *Sustainability (Switzerland)*, 15(10). <https://doi.org/10.3390/su15107997>
 40. Kumar, A., & Agrawal, S. (2023a). Challenges and opportunities for agri-fresh food supply chain management in India. *Computers and Electronics in Agriculture*, 212(December 2022), 108161. <https://doi.org/10.1016/j.compag.2023.108161>
 41. Kumar, A., & Agrawal, S. (2023b). Challenges and opportunities for agri-fresh food supply chain management in India. *Computers and Electronics in Agriculture*, 212(August), 108161. <https://doi.org/10.1016/j.compag.2023.108161>
 42. Kumar Kasera, R., Gour, S., & Acharjee, T. (2024). A comprehensive survey on IoT and AI based applications in different pre-harvest, during-harvest and post-harvest activities of smart agriculture. *Computers and Electronics in Agriculture*, 216(October 2023), 108522. <https://doi.org/10.1016/j.compag.2023.108522>
 43. Lee, Y. M., Mu, S., Shen, Z., & Dessouky, M. (2014). Issuing for perishable inventory management with a minimum inventory volume constraint. *Computers and Industrial Engineering*, 76, 280–291. <https://doi.org/10.1016/j.cie.2014.08.007>
 44. Liu, L., Zhao, L., & Ren, X. (2019). Optimal preservation technology investment and pricing policy for fresh food. *Computers and Industrial Engineering*, 135(February 2018), 746–756. <https://doi.org/10.1016/j.cie.2019.06.041>
 45. Manavalan, E., & Jayakrishna, K. (2019). A review of Internet of Things (IoT) embedded sustainable supply chain for industry 4.0 requirements. *Computers and Industrial Engineering*, 127(November 2017), 925–953. <https://doi.org/10.1016/j.cie.2018.11.030>
 46. Mantravadi, S., & Srail, J. S. (2022). How Important are Digital Technologies for Urban Food Security? A Framework for Supply Chain Integration using IoT. *Procedia Computer Science*, 217(2022), 1678–1687. <https://doi.org/10.1016/j.procs.2022.12.368>
 47. Martínez-falc, J., & Eduardo, S. (2024). *Environmental Technology & Innovation Revolutionizing the circular economy through new technologies : A new era of sustainable progress*. 33(December 2023). <https://doi.org/10.1016/j.eti.2023.103509>
 48. Mat Lazim, R., Mat Nawi, N., Masroon, M. H., Abdullah, N., & Che Mohammad Iskandar, M. (2020). Adoption of IR4.0 into Agricultural Sector in Malaysia: Potential and Challenges. *Advances in Agricultural and Food Research Journal*, 1(2), 1–14. <https://doi.org/10.36877/aafjr.a0000140>
 49. Molotoks, A., Smith, P., & Dawson, T. P. (2021). Impacts of land use, population, and climate change on global food security. *Food and Energy Security*, 10(1), 1–20. <https://doi.org/10.1002/fes3.261>

50. Moran, A. J., Headrick, G., Perez, C., Greatsinger, A., Taillie, L. S., Zatz, L., Bleich, S. N., Rimm, E. B., & Khandpur, N. (2022). Food Marketing Practices of Major Online Grocery Retailers in the United States, 2019-2020. *Journal of the Academy of Nutrition and Dietetics*, *122*(12), 2295-2310.e2. <https://doi.org/10.1016/j.jand.2022.04.003>
51. Mou, Y., Guan, Z., & Zhang, J. (2024). Integrated optimization of assortment, inventory and pricing considering omnichannel retailer's risk aversion and customer's time preference. *Expert Systems with Applications*, *237*(PA), 121479. <https://doi.org/10.1016/j.eswa.2023.121479>
52. Nagarajan, S. M., Deverajan, G. G., Chatterjee, P., Alnumay, W., & Muthukumaran, V. (2022). Integration of IoT based routing process for food supply chain management in sustainable smart cities. *Sustainable Cities and Society*, *76*(October 2021), 103448. <https://doi.org/10.1016/j.scs.2021.103448>
53. Onwude, D., Motmans, T., Shoji, K., Evangelista, R., Gajardo, J., Odion, D., Ikegwuonu, N., Adekanmbi, O., Hourri, S., & Defraeye, T. (2023). Bottlenecks in Nigeria's fresh food supply chain: What is the way forward? *Trends in Food Science and Technology*, *137*(May), 55–62. <https://doi.org/10.1016/j.tifs.2023.04.022>
54. Paam, P., Berretta, R., Heydar, M., & García-Flores, R. (2019). The impact of inventory management on economic and environmental sustainability in the apple industry. *Computers and Electronics in Agriculture*, *163*(May), 104848. <https://doi.org/10.1016/j.compag.2019.06.003>
55. Pal, K., & Yasar, A. U. H. (2023). Internet of Things Impact on Supply Chain Management. *Procedia Computer Science*, *220*, 478–485. <https://doi.org/10.1016/j.procs.2023.03.061>
56. Pourmohammad-Zia, N., Karimi, B., & Rezaei, J. (2021). Food supply chain coordination for growing items: A trade-off between market coverage and cost-efficiency. *International Journal of Production Economics*, *242*, 108289. <https://doi.org/10.1016/j.ijpe.2021.108289>
57. Qin, Y., Wang, J., & Wei, C. (2014). Joint pricing and inventory control for fresh produce and foods with quality and physical quantity deteriorating simultaneously. *International Journal of Production Economics*, *152*, 42–48. <https://doi.org/10.1016/j.ijpe.2014.01.005>
58. Ramírez, C., Rojas, A. E., & García, A. (2022). A Cold Chain Logistics with IoT and Blockchain Scalable Project for SMEs: First Phase. *IFAC-PapersOnLine*, *55*(10), 2336–2341. <https://doi.org/10.1016/j.ifacol.2022.10.057>
59. Saurabh, S., & Dey, K. (2021). Blockchain technology adoption, architecture, and sustainable agri-food supply chains. *Journal of Cleaner Production*, *284*, 124731. <https://doi.org/10.1016/j.jclepro.2020.124731>
60. Senturk, S., Senturk, F., & Karaca, H. (2023). Industry 4.0 technologies in agri-food sector and their integration in the global value chain: A review. *Journal of Cleaner Production*, *408*(April), 137096. <https://doi.org/10.1016/j.jclepro.2023.137096>
61. Sepehri, A. (2021). Controllable carbon emissions in an inventory model for perishable items under trade credit policy for credit-risk customers. *Carbon*

- Capture Science and Technology*, 1(September), 100004.
<https://doi.org/10.1016/j.ccst.2021.100004>
62. Sepehri, A., Mishra, U., & Sarkar, B. (2021). A sustainable production-inventory model with imperfect quality under preservation technology and quality improvement investment. *Journal of Cleaner Production*, 310(January), 127332. <https://doi.org/10.1016/j.jclepro.2021.127332>
 63. Shafiee, F., Kazemi, A., Jafarnejad Chaghooshi, A., Sazvar, Z., & Amoozad Mahdiraji, H. (2021). A robust multi-objective optimization model for inventory and production management with environmental and social consideration: A real case of dairy industry. *Journal of Cleaner Production*, 294. <https://doi.org/10.1016/j.jclepro.2021.126230>
 64. Sharma, P., Bano, A., Verma, K., Yadav, M., Varjani, S., Singh, S. P., & Tong, Y. W. (2023). Food waste digestate as biofertilizer and their direct applications in agriculture. *Bioresource Technology Reports*, 23(January), 101515. <https://doi.org/10.1016/j.biteb.2023.101515>
 65. Shreya, S., Chatterjee, K., & Singh, A. (2023). BFSF: A secure IoT based framework for smart farming using blockchain. *Sustainable Computing: Informatics and Systems*, 40(August), 100917. <https://doi.org/10.1016/j.suscom.2023.100917>
 66. Singh, R., Singh, R., Gehlot, A., Akram, S. V., Priyadarshi, N., & Twala, B. (2022). Horticulture 4.0: Adoption of Industry 4.0 Technologies in Horticulture for Meeting Sustainable Farming. *Applied Sciences (Switzerland)*, 12(24), 0–19. <https://doi.org/10.3390/app122412557>
 67. Taheri, M., Sadegh Amalnick, M., Allah Taleizadeh, A., & Mardan, E. (2023). A fuzzy programming model for optimizing the inventory management problem considering financial issues: A case study of the dairy industry. *Expert Systems with Applications*, 221(October 2022), 119766. <https://doi.org/10.1016/j.eswa.2023.119766>
 68. UNEP. (2021). Food Waste Index Report 2021. In *Unep Food Waste Index Report 2021*.
 69. Vahdani, M., & Sazvar, Z. (2022). Coordinated inventory control and pricing policies for online retailers with perishable products in the presence of social learning. *Computers and Industrial Engineering*, 168(September 2021), 108093. <https://doi.org/10.1016/j.cie.2022.108093>
 70. Wallin, C., Rungtusanatham, M. J, E. R. (2006). What is the “Right” Inventory Management Approach for A Purchased Item? *International Journal of Operations & Production Management*, 26(1), 50–68.
 71. Woo, Y. Bin, Moon, I., & Kim, B. S. (2021). Production-Inventory control model for a supply chain network with economic production rates under no shortages allowed. *Computers and Industrial Engineering*, 160(October 2020), 107558. <https://doi.org/10.1016/j.cie.2021.107558>
 72. Xu, J., Lyu, G., Bai, Q., & Luo, Q. (2023). Robust pricing and inventory strategies for an omnichannel retailer under carbon tax and cap-and-offset regulations. *Computers & Industrial Engineering*, 185(September), 109615. <https://doi.org/10.1016/j.cie.2023.109615>

73. Yavari, M., Enjavi, H., & Geraeli, M. (2020). Demand management to cope with routes disruptions in location-inventory-routing problem for perishable products. *Research in Transportation Business and Management*, 37(August), 100552. <https://doi.org/10.1016/j.rtbm.2020.100552>