iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 12 **Issue:** X **Month of publication:** October 2024

DOI: https://doi.org/10.22214/ijraset.2024.64525

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue X Oct 2024- Available at www.ijraset.com

Study on Optimizing Inventory to Minimize Waste in the Fresh Produce Supply Chain

Lavanya J[1], Chandra Sen Mazumdar[2], Ayush Singh[3]
M S Ramaiah University of Applied Sciences

Abstract: The increasing demand for fresh produce, particularly greens, presents unique challenges in inventory management due to their short shelf life and susceptibility to spoilage. Inefficient management often results in significant waste, leading to financial losses for retailers and increased environmental burdens from the disposal of spoiled goods. Despite various strategies being employed in the agri-food sector, gaps remain in understanding how to optimize inventory levels to minimize waste at the retails level while maintaining high service levels for customers. This research aims to develop an inventory management model tailored to fresh produce that can mitigate these issues by balancing stock availability and minimizing wastage, particularly in large retail shops.

To address the research problem, a mixed-integer linear programming (MILP) model was developed, focusing on three service levels—90%, 92%, and 95%—to evaluate the trade-offs between customer satisfaction and total inventory costs. The model incorporates key constraints, including stock balance, shelf-life limitations, and demand satisfaction. The model was validated using actual data, including stock, sales, and wastage records for the month of August, 2024. The objective function aimed to minimize total costs, encompassing holding costs, wastage, and lost revenue.

The findings indicate that higher service levels, while reducing stockouts, significantly increase costs due to excess inventory and waste. The most cost-effective solution was observed at the 90% service level, which balanced waste reduction and customer satisfaction. The study also emphasizes the importance of integrating total cost reduction and minimize wastage. Future work should focus on incorporating consumer behavior patterns and extending the model to multi-echelon inventory systems, which include both distribution centers and retail outlets, to capture a more holistic view of the supply chain.

Keywords: Fresh Produce, Inventory Management, Waste Minimization, Mixed-Integer Linear Programming (MILP), Service Level, Perishability and Supply Chain Sustainability

I. INTRODUCTION AND MOTIVATION

Effective inventory management for fresh produce, particularly perishable items like greens, has gained increasing importance due to the growing focus on reducing food waste and addressing its environmental and economic impacts. Retailers face significant challenges in balancing the need to maintain sufficient stock to meet consumer demand while minimizing spoilage caused by the short shelf life of perishable goods. Large supermarket chains, in particular, experience substantial losses due to spoilage, moisture loss, and the deterioration of fresh produce, which contribute to over 40% of food waste in the retail supply chain (Ali et al., 2018). These losses not only result in economic drawbacks for retailers but also impose an environmental burden due to the disposal of wasted food, contributing to greenhouse gas emissions and resource depletion.

To mitigate these issues, inventory management has become a critical area of focus in the agri-food supply chain. A better understanding of how to efficiently manage inventory for perishables, such as greens, can significantly reduce food waste while improving profitability. Traditional inventory management strategies often fall short in accounting for perishability, leading to suboptimal decisions related to stock levels. The perishable nature of greens, with their short shelf life, complicates inventory decisions, especially when demand variability involved.

The Mixed-Integer Linear Programming (MILP) model developed in this study addresses these challenges by offering a structured framework that considers the unique characteristics of fresh produce. The model helps to balance stock availability, minimize wastage, and reduce the costs associated with holding excess inventory and losing revenue from unsold goods. Additionally, it evaluates multiple service levels—90%, 92%, and 95%—to explore the trade-offs between customer satisfaction and inventory costs, offering insights that retailers can use to make more informed inventory decisions. The goal of this research is to provide practical, data-driven solutions for managing fresh produce in large retail chains, focusing on improving profitability while reducing the environmental footprint associated with food waste.

A. Background Theory

Inventory management for perishable goods has long been a critical challenge in the field of supply chain management, primarily due to the unpredictable nature of demand, short shelf life, and perishability of products like fresh greens. Unlike durable goods, which can be held in stock for extended periods, fresh produce requires more frequent replenishment and careful stock monitoring to avoid spoilage and associated losses. In traditional inventory theory, the primary concerns include balancing holding costs, ordering costs, and stockout costs. However, for perishable goods, an additional factor—spoilage cost—becomes crucial, as any unsold product loses its value after a certain period.

The MILP model is particularly suited for optimizing inventory management in perishable goods because it can incorporate multiple constraints, such as demand satisfaction, stock balance, shelf-life limitations, and service level requirements. The model's flexibility allows for the management of multi-period, multi-product inventory systems, where decisions about stock levels and reordering must be made frequently and under uncertain demand conditions. This study integrates perishability constraints into the MILP model to address the specific needs of managing fresh greens, ensuring that the inventory decisions consider the impact of spoilage and limited shelf life.

In addition to perishability, another important concept is service level optimization, which refers to the probability that customer demand will be met without stockouts. Higher service levels reduce the likelihood of stockouts but can lead to higher inventory levels and, consequently, increased waste. The trade-off between maintaining high service levels and minimizing inventory costs is a central challenge in managing perishable goods. By evaluating different service levels (90%, 92%, and 95%), the MILP model developed in this study helps retailers find the optimal balance between inventory costs and customer satisfaction in the fresh produce supply chain.

B. Motivation of the Project

The motivation behind this project stems from the dual objectives of reducing food waste and improving profitability for retailers. Fresh produce, especially greens, is among the most wasted food categories in the retail sector. Spoilage occurs at every stage of the supply chain, from production to retail and eventually to the consumer. For retailers, the challenge is twofold: they need to maintain enough inventory to meet customer demand and avoid stockouts, while also minimizing overstocking, which leads to waste and financial losses.

The financial implications of food waste are significant. When retailers overstock perishables like greens, they not only lose the cost of the spoiled goods but also miss out on potential revenue from unsold inventory. Additionally, the environmental impact of food waste is substantial, as decomposing food contributes to greenhouse gas emissions and puts additional strain on waste management systems. Given these factors, there is a pressing need to develop more effective inventory management strategies for fresh produce, particularly for large retail chains dealing with high volumes of perishable items.

Another key motivation for this research is the increasing consumer demand for fresh, high-quality produce. As consumers become more health-conscious and environmentally aware, their expectations for product availability and quality have risen. Retailers must meet these expectations while managing the complexities of fresh produce inventory, where greens have a particularly short shelf life, often lasting only a few days before spoilage occurs. Small improvements in inventory management can result in significant reductions in waste and associated costs, making this research highly relevant to the retail sector.

The focus on greens reflects the importance of this product category in the fresh produce supply chain. These items are among the most perishable and in-demand products, and ensuring their availability without overstocking presents a critical challenge for retailers. By optimizing inventory for greens, retailers can reduce waste, enhance customer satisfaction, and improve their overall bottom line. Additionally, this research seeks to contribute to the broader field of supply chain management by addressing the under-researched area of inventory management for perishable goods, providing valuable insights and practical solutions for retailers.

II. LITERATURE

Effective inventory control strategies for perishables differ from those for non-perishables due to their shorter shelf lives. Models like the Automated Store Ordering (ASO) system proposed by (K. van Donselaar, T. van Woensel, 2006) and the multi-echelon inventory model by (Linh N.K. Duong, Lincoln C. Wood, 2015) provide frameworks for reducing waste by improving accuracy and responsiveness in inventory management. Building resilience into the supply chain, particularly cold chain logistics, is crucial for minimizing waste and ensuring the quality of perishables. Studies such as those by (Ali et al., 2018) focus on resilience as a strategy to counter risks, which is essential for reducing waste in fresh greens.

Operational models, such as those developed by (Li & Yu, n.d.), address short-term planning in agriculture, optimizing harvesting and distribution to reduce waste and maximize revenue. These models provide insights into managing the greens supply chain, where crop perishability demands efficient operational planning. In the context of Indonesia, (Adi Djoko Guritno, Rika Fujianti, 2015) analyse supply chain factors affecting fresh vegetable suppliers and classify inventory management strategies for unique and non-unique products. The study reveals that cost factors, particularly product guarantee fees, significantly influence supply chain performance. It also identifies preferred distribution channels such as modern markets, regular restaurants, and franchise restaurants. Effective inventory management strategies such as inventory postponement for unique vegetables and speculation for non-unique vegetables are highlighted. The focus on cost efficiency and quality assurance provides crucial insights into the supply chain for fresh produce, which is essential for minimizing waste in the greens supply chain in the context of Indonesia. (Ali et al., 2018) develop a resilience model for cold chain logistics of perishable products, emphasizing the importance of mitigating risks in perishable product supply chains through resilience. This is critical in a country like India, where temperature-sensitive supply chains dominate the distribution of fresh produce. Their study identifies four major sources of cold chain logistics risks and suggests that building resilience in the supply chain can improve firm performance. This can be applied to the greens supply chain, particularly in minimizing spoilage through better management of environmental conditions during transportation and storage.

Internationally, various strategies and models have been developed to manage inventory and reduce waste in perishable goods, focusing on both supply chain resilience and operational efficiency. In the Netherlands, (K. van Donselaar, T. van Woensel, 2006) investigate inventory control in supermarkets and highlight the logistical challenges of managing perishables compared to non-perishables. Their research emphasizes the importance of tailored inventory control strategies for perishables to minimize waste and financial losses. They advocate for improving automated store ordering systems (ASO) to enhance accuracy and efficiency in managing perishable inventory, which can be valuable when applied to fresh greens. (Blackburn & Scudder, 2009) focus on developing supply chain strategies for fresh produce like melons and sweet corn, where value diminishes rapidly post-harvest. Their hybrid supply chain model, combining responsiveness and efficiency, minimizes value loss during transportation and storage. This approach can be particularly relevant for greens, where rapid spoilage and time-sensitive distribution require optimized cooling and transportation to reduce waste. Research like (Chen et al., 2014) highlights inventory models that account for demand fluctuations, but there is limited analysis of how consumer purchasing behavior, particularly in response to price fluctuations or perishability concerns, impacts inventory management in fresh produce. Understanding consumer behavior in the greens market could lead to more effective inventory and pricing strategies. Also replenishment models do not fully account for perishability, particularly concerning short shelf lives and balancing stock to minimize wastage(Chen et al., 2014).

III. METHODOLOGY

A. *Research Design*

The research design for this study is quantitative, utilizing historical data from a large retail shop for the month of August. This data includes daily records of stock levels, sales, wastage, and lost revenue, offering a comprehensive dataset for analysing inventory management. The key data spans a 31-day period, detailing the number of greens stocked, sold, and leftover each day, along with the financial losses incurred due to unsold and wasted stock. To analyse and optimize inventory decisions, the study employs a Mixed-Integer Linear Programming (MILP) model. This model is designed to handle complex decision-making processes in inventory management by optimizing inventory levels while considering multiple constraints. The primary variables include daily sales (demand satisfaction), leftover inventory, and wastage, which the model seeks to balance to minimize total costs. This research follows a deductive approach, applying an established theoretical framework of inventory management optimization to the empirical data. The model is tested under different service levels, specifically fill rates of 90%, 92%, and 95%, to determine the most cost-effective strategy for minimizing waste while maintaining customer satisfaction.

The research objectives were:

1) To study and evaluate inventory management models for perishable items
2) To determine the current demand and wastage of identified greens at the store
3) To develop a mathematical model to meet the demand and analyze the wastage
4) To provide suggestions and recommendations for effective management of greens to reduce waste

B. *Sample size Calculation*

The sample size for this study is based on 31 days of operational data from a large retail store, covering the month of August.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue X Oct 2024- Available at www.ijraset.com

The dataset includes daily records of key inventory management elements such as the number of greens stocked (supply), greens sold (demand satisfaction), leftover greens (wastage), and the financial losses incurred due to unsold greens. Since this data spans an entire month of operations, it captures a wide range of inventory behaviours, including fluctuations in demand, stock levels, and wastage patterns.

This sample size is sufficient for evaluating the model's effectiveness because it provides enough variability to test different inventory management scenarios. The daily records reflect both high-demand and low-demand periods, as well as varying levels of wastage and lost revenue, allowing the model to accurately capture the dynamics of inventory replenishment and wastage in a realistic retail environment. This comprehensive data set enables a robust analysis of the effectiveness of different strategies in minimizing waste and optimizing inventory.

C. Verification and Validation

Verification of the model involves ensuring that the mathematical formulation is correct and aligns with real-world inventory management processes. The MILP model developed for this study has been thoroughly checked for its accuracy by comparing its structure and functionality with the practical aspects of inventory management in a retail setting. Specifically, the model has been verified using actual inventory data for the month of August. The daily stock, sales, and wastage figures were entered into the model, and the calculated results—such as total costs and inventory levels—were compared against real-world outcomes. This step ensured that the model accurately reflected the dynamics of inventory management and behaved as expected in a retail context.

Validation was conducted by comparing the model’s predictions under different service levels (90%, 92%, and 95% fill rates) against actual inventory data. The results of the model were evaluated based on total costs incurred for each scenario. At a 90% fill rate, the model calculated a total cost of ₹38,488. Increasing the fill rate to 92% resulted in a total cost of ₹37,693, while the 95% fill rate led to a total cost of ₹36,501. These results demonstrate that as the service level increases, wastage decreases, but holding costs rise due to the need to maintain higher inventory levels. The 95% fill rate was identified as the optimal solution, minimizing total costs by effectively balancing the reduction in wastage with acceptable holding costs.

The model results were obtained using Python software, which enabled efficient implementation and testing of the MILP model. Python's libraries for mathematical optimization, such PuLP, were used to solve the MILP and analyse the trade-offs between service levels, inventory costs, and wastage. The use of Python allowed for quick computation and verification of results, ensuring the accuracy and reliability of the model's predictions.

IV. RESULTS

The evaluation of existing inventory management models, such as the Perishable Inventory-Routing Problem (PIRP), Economic Order Quantity (EOQ) Model, and Simulation-Based Inventory Management, provided valuable insights into more effective ways of handling perishables like fresh greens. Each model offered different strategies to balance stock levels with demand while minimizing spoilage. The real-world data collected from the local retail store over the month of August revealed significant variations in stock levels, demand, and wastage. On some days, the store stocked up to 750 bundles of greens, while on other days, the number of bundles stocked dropped to as low as 200. Similarly, daily sales fluctuated, with the number of bundles sold ranging from 160 to 700. These variations highlighted the unpredictable nature of customer demand for fresh greens, which is influenced by factors such as the day of the week, weather conditions, and seasonal trends. The data also showed a clear correlation between high stock levels and increased wastage. On days when the store overstocked greens, a large percentage of the inventory was left unsold and ultimately spoiled. For example, on certain days, as much as 130 bundles of greens were wasted, representing a significant financial loss for the store. This underscores the need for a more precise inventory management system that can better predict demand and adjust stock levels accordingly. The collected data served as a critical input for the MILP model, allowing it to simulate real-world scenarios and optimize inventory levels based on actual demand patterns.

The Mixed-Integer Linear Programming (MILP) model developed in this study successfully minimized the total costs associated with managing fresh greens inventory, including holding costs and wastage. This model focuses on optimizing the daily stock levels of greens by considering several critical factors such as demand satisfaction, stock balance, shelf-life limitations, and service level (fill rate). The model's primary objective is to minimize the total cost associated with holding inventory and wastage while ensuring that customer demand is adequately met.

Objective Function: The main objective of the MILP model is to minimize the total costs associated with inventory management for fresh greens. The total cost includes both the holding costs for unsold inventory and the wastage costs for spoiled greens. The objective function can be expressed as:

$$E(TC) = \sum_{t=1}^{31}(3 \times I_t + 20 \times U_t)$$

Where: I_t is the inventory left at the end of day t, U_t is the wastage at the end of day t, holding cost per day is ₹3 for each unsold and wasted bundle of greens, wastage cost per bundle is ₹20 for each unsold and wasted bundle of greens. This objective function aims to minimize the sum of the holding and wastage costs over the course of 31 days, balancing the need to maintain enough stock to meet demand while avoiding excess inventory that could spoil and lead to wastage.

The development of this MILP model provides a structured approach to managing the inventory of fresh greens, accounting for their perishable nature and the costs associated with holding unsold inventory and wastage. By incorporating key constraints such as demand satisfaction, stock balance, shelf-life limitations, and fill rate, the model offers a comprehensive strategy to minimize wastage while ensuring customer satisfaction. The objective function focuses on minimizing total costs, which include both the financial burden of holding unsold stock and the cost of wasted, spoiled greens. Ultimately, this model serves as a decision-making tool that can help retailers optimize their stock levels, reduce wastage, and maintain an optimal balance between inventory costs and service levels.

Constraints of the Model

Demand Satisfaction: The first constraint in the model ensures that there is enough stock available each day to meet the expected demand for greens. The goal is to avoid stockouts (where demand exceeds supply), while also preventing overstocking, which could lead to wastage if the greens are not sold before spoiling. The demand satisfaction constraint is represented by the following condition:

$S_t \leq D_t$ for all the t

Here, S_t represents the number of bundles of greens sold on day t, while D_t denotes the daily demand. In the model, daily demand is calculated as the sum of the daily replenishment quantity Q_t and the inventory carried over from the previous day I_{t-1}. The replenishment quantities vary depending on anticipated demand, while the carried-over inventory is adjusted based on what remains unsold from the previous day. The demand constraint ensures that the store stocks enough greens to meet demand, without exceeding it.

Stock Balance: Another crucial constraint of the model is the stock balance, which keeps track of the daily inventory updates. This constraint ensures that the stock at the end of each day reflects any replenishment, sales, and wastage that occurred during the day. The stock balance constraint is expressed as:

$I_t = I_{t-1} + Q_t - S_t - U_t$ for all t

In this equation, I_t represents the inventory left at the end of day t, I_{t-1} is the leftover stock from the previous day, Q_t is the daily replenishment quantity, S_t is the number of bundles sold, and U_t is the wastage for day t. This constraint ensures that any greens left over from the previous day, along with new stock replenishments, are accounted for after daily sales and spoilage are factored in.

Wastage Calculation: Wastage in the model is calculated based on the remaining unsold greens at the end of each day. Fresh greens are highly perishable, and only a small portion of the unsold stock can be carried over to the next day. The model assumes that only 20% of the unsold greens from the current day can be sold the following day, while the remaining 80% is considered spoiled and discarded. This wastage calculation is represented by the following equation: $U_t=0.8 \times I_t$ Where U_t is the wastage at the end of day t and I_t is the inventory left unsold at the end of the day. This wastage factor underscores the importance of managing greens inventory efficiently, as the majority of unsold greens are discarded after just one day. By incorporating this constraint, the model aims to minimize the amount of wastage, thereby reducing the total costs associated with spoiled inventory.

Fill Rate: The fill rate, or service level, refers to the percentage of daily demand that is met by the available stock. The model evaluates three fill rate levels—90%, 92%, and 95%—to assess the trade-offs between customer satisfaction and inventory costs. A higher fill rate means that a greater proportion of demand is satisfied, but it can also lead to higher holding costs due to excess inventory. Conversely, a lower fill rate might reduce inventory costs but risks leaving customers unsatisfied due to stockouts. The fill rate constraint is expressed as: $\frac{S_t}{D_t} \geq \beta$, where β represents the target fill rate, which is set at either 0.90, 0.92, or 0.95, depending on the scenario.

This constraint ensures that the model maintains a certain level of customer service by meeting a specified percentage of daily demand. The model's objective is to find the optimal balance between minimizing wastage and holding costs, while still meeting an acceptable level of customer demand satisfaction.

Key findings from the model was that targeting a 95% service level yielded the best results in terms of cost reduction and waste minimization. At the 95% service level, the total cost of managing greens inventory was ₹36,501, which was significantly lower than the costs associated with lower service levels (₹38,488 for the 90% service level and ₹37,693 for the 92% service level). This result indicates that a higher customer service level, where 95% of demand is consistently met, can lead to both reduced wastage and more cost-effective operations. By meeting a higher proportion of customer demand, the store reduces the likelihood of stockouts, which in turn decreases the amount of leftover inventory that spoils. The results also demonstrate that increasing the service level does not necessarily lead to higher costs, as long as the inventory is managed efficiently. This finding challenges the traditional notion that higher service levels always result in greater costs due to excess inventory. : Based on the results of the MILP model, it is clear that retailers should aim for a 95% service level as the optimal balance between customer satisfaction and cost-effective operations. To achieve this, retailers must invest in advanced demand forecasting systems that can predict daily sales of fresh greens more accurately. By improving their ability to anticipate fluctuations in demand, retailers can adjust their replenishment schedules and avoid overstocking or understocking. Demand forecasting techniques, such as predictive analytics and machine learning models, can analyse historical sales data, weather patterns, and consumer behaviour to generate more reliable demand estimates. Additionally, the MILP model suggests that retailers should fine-tune their replenishment schedules to ensure that the right amount of stock is ordered each day. By aligning replenishment quantities more closely with actual demand, retailers can reduce both holding costs and wastage. The model also highlights the importance of real-time inventory tracking, which allows retailers to monitor stock levels more effectively and make adjustments as needed. By implementing these strategies, retailers can significantly reduce the financial and environmental costs associated with managing fresh greens inventory, while ensuring that customers have access to fresh produce on a consistent basis.

V. CONCLUSION

This study underscores the complexity of managing fresh produce inventory, where balancing high service levels with minimal waste is critical for both operational efficiency and cost management. Through the development and application of a Mixed-Integer Linear Programming (MILP) model, the research demonstrates that retailers can effectively optimize inventory management by targeting a 95% fill rate, which emerged as the most cost-effective strategy for minimizing wastage while maintaining customer satisfactionThis finding is especially significant in the context of fresh produce, such as greens, which are highly perishable and sensitive to demand fluctuations. The study highlights that maintaining a 95% service level allows retailers to meet the majority of customer demand without overstocking, thus significantly reducing the amount of spoiled or unsold inventory. The model’s findings refute the conventional assumption that higher service levels necessarily lead to lower costs, the research reveals that a 95% fill rate strikes the optimal balance between preventing stockouts avoiding the excessive inventory levels that often lead to waste. By optimizing replenishment schedules and aligning inventory levels more closely with actual demand, retailers can not only reduce their costs but also improve their overall operational efficiency. This approach ensures that sufficient stock is available to meet customer needs without carrying excess stock that risks spoiling before it can be sold. This conclusion is particularly valuable for retailers who manage fresh produce with short shelf lives, as it provides a clear, actionable strategy to reduce waste and costs while still satisfying customer expectations. Furthermore, the application of the MILP model using real-world data from a local retail store demonstrates the practical relevance and scalability of this approach. The data-driven nature of the model allows it to simulate real-world inventory management challenges, providing robust recommendations that retailers can implement in their day-to-day operations. The use of actual data enhances the credibility of the findings, ensuring that the model's insights are grounded in realistic scenarios. This practical applicability makes the model a valuable tool not only for managing greens but also for other types of perishable goods that require precise inventory control.

VI. FUTURE RESEARCH

This study offers valuable insights into optimizing inventory for fresh produce, particularly greens, but there are several areas for future research. One key area is integrating consumer behavior patterns into the inventory model. Factors like price sensitivity, freshness preferences, and brand loyalty can significantly affect demand. Future studies could incorporate discrete choice analysis or dynamic pricing models to better predict consumer behavior and optimize inventory.

Additionally, exploring multi-echelon inventory systems could extend the model to include distribution centers and regional warehouses, providing a more comprehensive supply chain perspective. This would help reduce the bullwhip effect and optimize stock flow across the entire supply chain.

Incorporating seasonality and weather data is another avenue for improvement, as demand for fresh produce often fluctuates with seasonal and weather conditions. Factoring in these variables would improve demand forecasting and inventory management, minimizing both stockouts and overstocking.

VII. LIMITATIONS

Despite its contributions, this study has several limitations. The single-store focus limits the generalizability of the findings, as retail environments vary widely by location, demographics, and competition. Expanding future research to multiple stores and regions would make the model more representative. Additionally, the model's assumptions of constant holding and wastage costs do not fully reflect the real-world complexities, where costs fluctuate based on factors like energy use, labor, and market value. Future models should incorporate dynamic pricing and variable costs for more accurate financial representation. Lastly, the model does not account for consumer purchasing behavior or variations in demand based on product freshness or pricing strategies. Integrating behavioral data and consumer demand elasticity could further refine inventory management and reduce waste.

REFERENCES

[1] Duong, L.N., Wood, L.C. and Wang, W.Y., 2015. A multi-criteria inventory management system for perishable & substitutable products. Procedia Manufacturing, 2, pp.66-76.

[2] Ali, I., Nagalingam, S. and Gurd, B., 2018. A resilience model for cold chain logistics of perishable products. The International Journal of Logistics Management, 29(3), pp.922-941.

[3] Guritno, A.D., Fujianti, R. and 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, pp.51-55.

[4] Chen, X., Pang, Z. and Pan, L., 2014. Coordinating inventory control and pricing strategies for perishable products. Operations Research, 62(2), pp.284-300.

[5] Nikolicic, S., Kilibarda, M., Maslaric, M., Mircetic, D. and Bojic, S., 2021. Reducing food waste in the retail supply chains by improving efficiency of logistics operations. Sustainability, 13(12), p.6511.

[6] van Donselaar, K., Van Woensel, T., Broekmeulen, R.A.C.M. and Fransoo, J., 2006. Inventory control of perishables in supermarkets. International journal of production economics, 104(2), pp.462-472.

[7] Ghasemkhani, A., Tavakkoli-Moghaddam, R., Rahimi, Y., Shahnejat-Bushehri, S. and Tavakkoli-Moghaddam, H., 2022. Integrated production-inventory-routing problem for multi-perishable products under uncertainty by meta-heuristic algorithms. International Journal of Production Research, 60(9), pp.2766-2786.

[8] Kumar, A., Mangla, S.K., Kumar, P. and Karamperidis, S., 2020. Challenges in perishable food supply chains for sustainability management: A developing economy perspective. Business Strategy and the Environment, 29(5), pp.1809-1831.

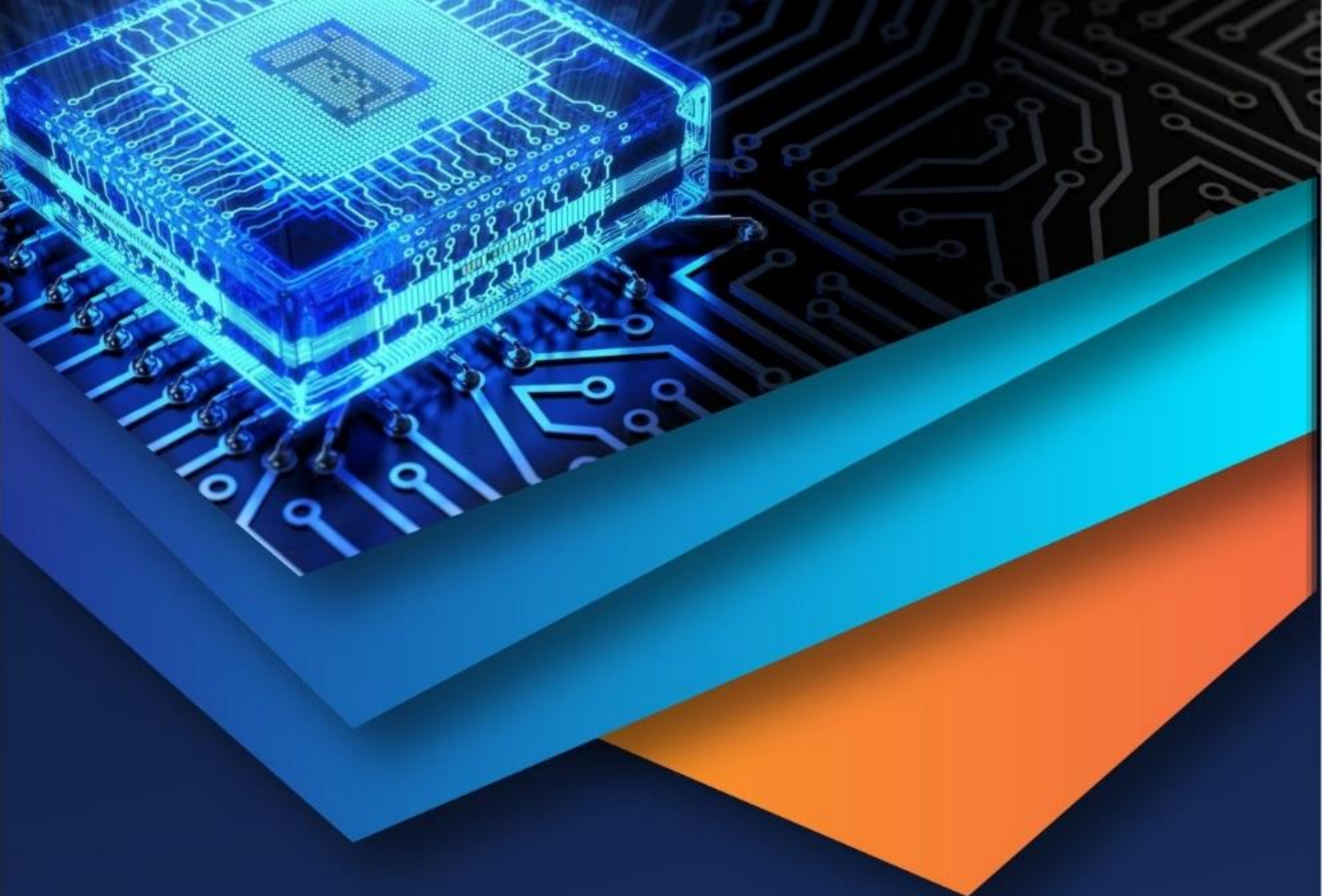
[9] Vostriakova, V., Kononova, O., Kravchenko, S., Ruzhytskyi, A. and Sereda, N., 2021. Optimization of agri-food supply Chain in a sustainable way using simulation modeling. International Journal of Computer Science & Network Security, 21(3), pp.245-256.

[10] Coelho, L.C. and Laporte, G., 2014. Optimal joint replenishment, delivery and inventory management policies for perishable products. Computers & Operations Research, 47, pp.42-52.

[11] Nikolicic, S., Kilibarda, M., Maslaric, M., Mircetic, D. and Bojic, S., 2021. Reducing food waste in the retail supply chains by improving efficiency of logistics operations. Sustainability, 13(12), p.6511.

[12] La Scalia, G., Micale, R., Miglietta, P.P. and Toma, P., 2019. Reducing waste and ecological impacts through a sustainable and efficient management of perishable food based on the Monte Carlo simulation. Ecological Indicators, 97, pp.363-371.

[13] Blackburn, J. and Scudder, G., 2009. Supply chain strategies for perishable products: the case of fresh produce. Production and Operations Management, 18(2), pp.129-137.



10.22214/IJRASET

INDEX COPERNICUS 45.98

ISRA JIF IMPACT FACTOR: 7.129

SJIFactor TOGETHER WE REACH THE GOAL IMPACT FACTOR: 7.429

ISI

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY