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OPTIMIZIN INVENTORY CONTROL OF FRESH VEETABLES AND FRUITS AT HYPERMART WTC JAMBI CITY

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ABSTRACT

This study aims to analyze demand patterns and determine appropriate inventory control methods for fresh vegetables and fruits at Hypermart WTC Jambi City. The study employed ABC analysis, the Single-Period (Newsvendor) model, and the Economic Order Quantity (EOQ) model to classify inventory priorities and optimize inventory decisions according to demand characteristics. The results indicate that vegetable commodities generally exhibit relatively stable demand, whereas fruit commodities experience greater demand variability. The ABC analysis reveals that a relatively small number of commodities account for the highest proportion of annual inventory value, highlighting the need for differentiated inventory control policies. The Single-Period model is more appropriate for commodities with fluctuating demand because it balances the risks of overstocking and understocking, while the EOQ model is better suited to commodities with relatively stable demand by optimizing order quantities and replenishment schedules. However, the findings also show that actual inventory practices at Hypermart WTC Jambi City do not always align with theoretical recommendations because inventory decisions are influenced by product perishability, supplier flexibility, and operational considerations. Therefore, integrating quantitative inventory control methods with practical operational factors can improve inventory efficiency, maintain product availability, and reduce losses associated with perishable products.

Keywords : *ABC classification, demand variability, economic order quantity, fresh produce, inventory control, single-period (newsvendor) model*

INTRODUCTION

Indonesia is one of the world's major producers of horticultural commodities due to its tropical climate, favorable agroecological conditions, and abundant agricultural resources (FAO, 2025). The horticultural sector plays an important role in supporting national food security, improving nutritional quality, and contributing to agricultural economic development (Badan Pusat Statistik, 2025). The increasing production and consumption of horticultural commodities have also increased the importance of efficient postharvest handling and inventory management, particularly in modern retail supply chains where product quality and availability directly influence consumer satisfaction.

Regular consumption of fresh vegetables and fruits is widely recognized as an essential component of a healthy diet because they provide vitamins, minerals, dietary fiber, and bioactive compounds that contribute to disease prevention and immune function (Setiyani *et al*., 2023). Conversely, insufficient consumption of fresh vegetables and fruits is associated with an increased risk of non-communicable diseases and remains one of the leading dietary risk factors contributing to global mortality (WHO, 2024).

Fresh vegetables and fruits are highly perishable commodities characterized by short shelf lives, quality deterioration, and uncertain consumer demand. Consequently, effective inventory management is essential to balance product freshness, minimize spoilage, reduce inventory costs, and ensure product availability throughout the supply chain. Recent studies have further emphasized that inventory optimization is essential not only for improving operational efficiency but also for minimizing food waste across fresh produce supply chains through more balanced inventory decisions. These challenges are particularly relevant in modern retail supermarkets, where maintaining product availability while minimizing inventory losses requires appropriate inventory

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control strategies (Chen *et al*., 2024; Sandora *et al*., 2023).

Hypermart World Trade Center (WTC) Jambi City is one of the leading modern retail supermarkets supplying fresh vegetables and fruits to urban consumers. As a modern retail supermarket managing a wide variety of perishable products, Hypermart WTC Jambi City faces significant inventory management challenges arising from fluctuating consumer demand, limited product shelf life, and the need to maintain product quality while controlling inventory costs. These operational conditions increase the risk of overstocking, stockouts, product spoilage, and reduced customer satisfaction. Consequently, developing an appropriate inventory control strategy is essential to improve inventory efficiency while maintaining product availability and minimizing waste.

Previous studies have shown that ABC analysis, Economic Order Quantity (EOQ), and Single-Period Inventory Models are effective tools for improving inventory management performance of perishable products (Eraslan & Iç, 2020; Sandora *et al*., 2023; Wei & Chen, 2021). Recent developments have further enhanced inventory management practices through multicriteria ABC classification, which improves product prioritization by considering multiple decision criteria rather than relying solely on annual consumption value (Karagiannis, 2021; Liu & Ma, 2020). Other studies have incorporated dynamic replenishment strategies and integrated pricing-ordering decisions to better address demand uncertainty and the perishability characteristics of fresh produce (Chen *et al*., 2024; Z. Wang *et al*., 2025).

Despite these methodological advances, limited studies have integrated ABC classification, EOQ, and the Single-Period Inventory Model into a comprehensive inventory control framework for fresh vegetables and fruits in modern retail supermarkets, particularly in developing countries such as Indonesia (Chen, 2025; Sandora *et al*., 2023). Consequently, comprehensive inventory control frameworks that simultaneously integrate product prioritization, ordering decisions, and demand uncertainty for highly perishable fresh vegetables and fruits remain limited.

These research limitations are particularly relevant to Hypermart WTC Jambi City, where inventory management decisions must consider fluctuating demand, product perishability, and operational efficiency. Without an integrated inventory control approach, retailers may face excessive inventory costs, higher product spoilage, and potential stock shortages.To address these research and operational gaps, this study proposes an integrated inventory control framework combining ABC classification, Economic Order Quantity (EOQ), and the Single-Period model to optimize the inventory management of fresh vegetables and fruits in modern retail supermarkets Accordingly, this study aims to evaluate the applicability of the integrated inventory control framework at Hypermart WTC Jambi City and identify the most appropriate inventory strategies for improving operational efficiency, minimizing spoilage, and maintaining product availability.

METHODS

This study employed a case study approach at Hypermart World Trade Center (WTC) Jambi City. The research site was purposively selected because it represents a modern retail supermarket with a wide variety of fresh vegetable and fruit commodities, relatively high sales volume, and comprehensive operational records, making it suitable for evaluating fresh produce inventory management practices.

A qualitative and quantitative case study approach was employed to obtain primary and secondary data related to fresh vegetable and fruit inventory management. Primary data were collected through direct observation, semi-structured interviews, and documentation. Three key informants were selected, consisting of the Operational Manager, Warehouse Supervisor, and Logistics Staff member of Hypermart WTC Jambi City. The informants were chosen using purposive sampling because they were directly involved in inventory planning, procurement, storage, stock monitoring, and distribution activities. Therefore, they were considered capable of providing relevant information regarding inventory management practices and operational decision-making processes.

Secondary data were obtained from company sales and inventory records, publications of

Statistics Indonesia (BPS), company documents, books, and relevant scientific journals. The quantitative analysis utilized daily sales and inventory records covering the period from January to December 2024. These data were used to identify demand patterns and support the application of ABC classification, Economic Order Quantity (EOQ), and Single-Period (Newsvendor) Model analyses.

Data analysis was conducted using qualitative and quantitative approaches. Qualitative analysis was applied to describe the existing inventory management system and distribution practices for fresh vegetables and fruits. Quantitative analysis was conducted through four sequential stages. First, ABC analysis was performed to classify vegetable and fruit commodities into Categories A, B, and C based on their contribution to annual sales value. Second, demand patterns were identified to determine the appropriate inventory control method for each commodity. Commodities with relatively stable demand were analyzed using the Economic Order Quantity (EOQ) method to determine optimal order quantity, ordering frequency, and ordering interval. Meanwhile, commodities with fluctuating demand were analyzed using the Single-Period (Newsvendor) Model to determine optimal inventory quantities by considering the trade-off between shortage and overage costs. Finally, the theoretical inventory recommendations generated from these methods were compared with existing inventory practices at Hypermart WTC Jambi City to evaluate their applicability and identify potential improvements.

The variables analyzed included commodity type, selling price, sales volume, ordering cost, holding cost, shortage cost, overage cost, average demand, demand standard deviation, service level, optimal inventory quantity, ordering frequency, and ordering interval. Inventory cost parameters were obtained from company operational records and interviews with key informants. Ordering costs included transportation, administrative, and unloading expenses incurred during each procurement cycle. Holding costs consisted of storage, handling, refrigeration, and inventory carrying costs associated with maintaining fresh vegetable and fruit inventories. Shortage costs represented potential losses due to stockouts, whereas overage costs reflected losses caused by product deterioration and unsold inventory. Because some detailed financial information was confidential, several cost parameters were estimated based on company operational practices and validated through interviews with key informants. These assumptions were applied consistently throughout the inventory optimization analyses.

The credibility of the findings was ensured through source triangulation by comparing information obtained from observations, interviews, and documentation. This study was limited to a single modern retail supermarket, Hypermart WTC Jambi City, using operational data collected during the 2024 observation period. Furthermore, limited access to detailed financial information required several inventory cost parameters to be estimated based on company operational practices and validated through key informant interviews.

RESULTS AND DISCUSSION

FRESH PRODUCE INVENTORY MANAEMENT PRACTICES AT HYPERMART WTC JAMBI CITY

The findings revealed that the fresh produce inventory management system at Hypermart World Trade Center (WTC) Jambi City comprises five integrated stages: demand planning, procurement, ordering, receiving and quality inspection, and storage. These stages are interconnected to ensure product availability while maintaining freshness and minimizing inventory losses associated with perishable commodities.

Demand planning is conducted by the merchandising team using historical sales data to estimate future inventory requirements. This data-driven approach supports more efficient inventory planning while maintaining product freshness and product availability. The planning process also considers demand patterns and purchasing frequency, enabling inventory decisions to respond more effectively to changes in consumer demand. These findings are consistent with H. Li *et al*. (2024), who reported that data-driven replenishment models can optimize both the freshness and profitability of perishable products. Similarly, Chen (2025) emphasized that demand patterns and purchasing frequency are critical determinants of inventory management strategies in modern retail environments.

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Fresh produce procurement is carried out through two supply channels, namely the Distribution Center (DC) and direct suppliers, providing greater flexibility in responding to inventory requirements and market demand. This dual-sourcing strategy enables procurement decisions to be adjusted according to current inventory levels and fluctuations in consumer demand. Such flexibility is particularly important in fresh produce retailing because procurement decisions must consider demand uncertainty and product quality variations. Similar studies have highlighted the importance of incorporating demand uncertainty and product quality considerations in fresh produce procurement strategies (Liang *et al*., 2021).

These findings indicate that procurement flexibility plays an important role in reducing stockout risk while maintaining the quality of commodities with relatively short shelf lives. Similar findings were reported by Wang *et al*. (2023), who demonstrated that supply chain coordination supported by fresh-keeping services improves distribution efficiency while maintaining product quality. Likewise, Riesenegger & Hübner (2022) emphasized that close integration between suppliers and retailers is essential for effective fresh produce supply chain management.

Fresh produce ordering is conducted through a computerized Purchase Order (PO) system using the Riset 10 application, which supports demand recording, inventory estimation, and purchase order management. Procurement activities are generally conducted two to three times per week, depending on inventory requirements, product characteristics, and consumer demand. Order quantities are determined using historical sales data and supplier lead times to improve replenishment accuracy and reduce stockout risk. Supplier lead times range from one to two days for local suppliers within Jambi and three to six days for suppliers located outside the region, such as Palembang. To reduce the impact of supply uncertainty and unexpected demand fluctuations, Hypermart WTC also maintains safety stock for selected fresh produce commodities. This replenishment strategy demonstrates a proactive inventory management approach that balances inventory availability, operational efficiency, and product freshness. These findings are supported by J *et al*. (2024), who reported that effective inventory control policies, including inventory regulation and the First-In, First-Out (FIFO) principle, significantly reduce waste in fresh produce retailing. Furthermore, Nyitrai (2021) highlighted that maintaining appropriate safety stock enhances supply chain resilience under uncertain demand and supply conditions.

Upon arrival at Hypermart WTC, fresh produce undergoes a structured receiving process consisting of physical inspection, quantity verification, and quality assessment before being accepted into inventory. The receiving team verifies that the delivered products correspond to the Purchase Order (PO) and accompanying delivery documents while simultaneously inspecting the physical condition of each commodity to identify defects or signs of deterioration. Products meeting the required quality standards are subsequently transferred either to cold storage or directly to the display area according to their storage requirements. This receiving procedure functions as an important quality assurance mechanism by ensuring that only products meeting company quality standards enter the inventory system and are offered to consumers.

Fresh produce is stored according to its temperature requirements and physiological characteristics. Temperature-sensitive commodities, such as apples, pears, and grapes, are stored in cold storage, whereas commodities with greater tolerance to ambient conditions are stored at room temperature. Appropriate storage practices help preserve product quality, extend shelf life, and minimize post-harvest losses. These findings are consistent with Chowdhury *et al*. (2025), who identified storage efficiency as a key factor in reducing food loss throughout fresh produce supply chains. Similarly, Buisman & Rohmer (2023) reported that effective storage and inventory management contribute to lower waste levels and improved product preservation in fresh produce retailing.

Overall, the fresh produce inventory management practices implemented at Hypermart WTC Jambi City reflect several characteristics of modern inventory management by integrating demand-driven planning, flexible procurement, sys-

tematic replenishment, quality assurance, and appropriate storage practices. This integrated approach supports operational efficiency while maintaining product quality and availability, thereby addressing the challenges associated with perishable products and fluctuating consumer demand.

Although the existing inventory management practices demonstrate structured operational procedures, quantitative evaluation is required to assess inventory performance and determine appropriate control strategies. Therefore, ABC classification, demand pattern analysis, the Single-Period (Newsvendor) Model, and the Economic Order Quantity (EOQ) method were subsequently applied to evaluate inventory priorities and optimize fresh produce inventory decisions.

ABC ANALYSIS IN INVENTORY MANAEMENT

ABC analysis was conducted to classify fresh vegetable and fruit commodities according to their contribution to annual sales value. This classification provides a basis for identifying priority commodities that require different levels of inventory control. By applying the ABC approach, management can allocate greater attention and resources to high-value commodities while implementing simpler control procedures for lower-priority items. Therefore, ABC analysis serves as an important decision-support tool for establishing inventory priorities and improving the efficiency of fresh produce inventory management (Vergara *et al*., 2020; Silaen *et al*., 2024).

The implementation of ABC analysis began by compiling sales records for all 100 fresh vegetable and fruit commodities available at Hypermart WTC Jambi City during the study period. Each commodity was ranked according to its annual sales value, after which cumulative percentage values were calculated to classify products into Categories A, B, and C. Category A represents commodities with the highest contribution to annual sales value and therefore requires intensive inventory monitoring and control. The classification of Category A vegetable commodities is presented in Table 1.

Table 1. Category A Classification Based on ABC Analysis on Vegetable Sales in 2024

No	Vegetable Name	Unit (bunch/ pack)	Total Sales (Kg)
1	Enokidake Mushroom	Pack	435,9
2	Curly Lettuce	Bunch	26,0
3	reen Spinach	Bunch	15,8
4	reen Pakcoy	Bunch	15,6
5	Fresh-harvested Baby Carrots	Pack	13,1
6	Caisim	Bunch	13,1
7	Vegetable Soup	Pack	12,9
8	HPM Shallots	Pack	12,9
9	Large Spring Onions	Bunch	12,5
10	Fresh-harvested Beetroot	Pack	12,3
11	Water Spinach	Bunch	12,3
12	Sour Vegetables	Pack	11,8

Source: Research data processed (2025)

The results indicate that Enokidake Mushroom is the dominant Category A commodity, contributing the highest annual sales value among vegetable products. This commodity recorded a sales volume of 435.9 kg, which was substantially higher than other vegetables within the same category. Other Category A commodities, including Curly Lettuce, reen Spinach, reen Pakcoy, Fresh - harvested Baby Carrots, Caisim, Vegetable Soup, HPM Shallots, Large Spring Onions, Fresh-harvested Beetroot, Water Spinach, and Sour Vegetables, also contributed significantly to the total annual inventory value. These findings demonstrate that inventory value is concentrated among a limited number of vegetable commodities, reflecting the Pareto principle underlying ABC analysis. The ABC classification approach enables managers to prioritize inventory control efforts toward commodities with the greatest contribution to inventory value and sales performance (Vergara *et al*., 2020; Silaen *et al*., 2024). Because fresh vegetables have limited shelf life, inaccurate inventory decisions for Category A commodities may result in either stock shortages that reduce sales opportunities or excessive inventory that increases spoilage risk. Therefore, maintaining appropriate inventory levels for these priority commodities is essential to balance product availability and minimize inventory losses (Sandora *et al*., 2023). Compared with the existing inventory practices at Hypermart WTC Jambi City, where replenishment decisions are primarily based on managerial experi-

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ence and routine ordering schedules, ABC classification provides a more systematic basis for inventory prioritization. This approach enables management to focus forecasting, stock monitoring, and replenishment activities on Category A commodities while applying less intensive control to Categories B and C.

Based on the results of the ABC analysis, Category A vegetables consist of high-value commodities, such as Enokidake mushrooms, curly lettuce, green spinach, and green pakcoy. These products consistently contribute the highest sales value, indicating strong market demand and their important role in overall sales performance. Their high economic contribution suggests that these products should receive greater attention in inventory planning to ensure continuous product availability while minimizing the risk of stockouts and spoilage.

This finding is consistent with Clairine Papilaya *et al*. (2025), who reported that frequently consumed vegetable commodities tend to exhibit more stable demand patterns supported by established supply chains.

Furthermore, the results confirm the usefulness of the ABC method as a decision-support tool for inventory management. By identifying commodities with the greatest contribution to inventory value, managers can prioritize monitoring, forecasting, and replenishment activities for Category A items. This finding is supported by Silaen *et al*. (2024), who emphasized that ABC classification assists managerial decision-making by identifying products with the highest value contribution, thereby enabling companies to allocate inventory control efforts more efficiently.

Based on the ABC classification results for vegetable commodities, Category A items were identified as priority commodities requiring intensive inventory control. The same classification procedure was subsequently applied to fresh fruit commodities, with the results presented in Table 2.

Based on Table 2, Category A fruit commodities include red watermelon, several grape varieties, pears, mangoes, avocados, and dragon fruit, all of which represent a substantial proportion of the total annual sales value. Although the sales volume of these fruits is not consistently higher than that of vegetable commodities, their economic contribution is greater due to their relatively higher selling prices. This finding confirms that ABC classification is determined not only by sales volume but also by the monetary value generated by each commodity. Consequently, high-value fruit products require closer inventory monitoring because they represent greater inventory investment and may result in higher financial losses when spoilage occurs.

Table 2. Category A Classification Based on ABC Analysis on Fruit Sales in 2024

No	Fruit Name	Unit (Kg/Pack)	Total Sales (Kg)
1	Red Watermelon	Kg	143,04
2	Century Pear	Kg	122,09
3	Baby Black Beauty Red	Kg	87,42
4	Green Grapes	Pack	89,43
5	Red Globe RRC Grapes	Kg	87,72
6	Sunpride Pisang Cavendish	Kg	61,86
7	Red Globe Aust Grapes	Kg	58,94
8	Harumanis Super Mango	Kg	61,30
9	Rock Melon	Kg	48,91
10	Avocado	Kg	44,66
11	Red Dragon Fruit	Kg	39,35
12	Imported Lychee	Kg	41,80

Source: Research data processed (2025)

Overall, the ABC analysis indicates that fruit commodities contribute substantially to total inventory value despite exhibiting lower sales volumes for some products. This finding should be further interpreted together with demand variability analysis, which provides additional insight into the uncertainty characteristics of fresh fruit commodities. Therefore, fruit commodities require more comprehensive inventory management strategies that consider both economic contribution and demand uncertainty.

This result is consistent with Yiğit & Esnaf (2021), who highlighted that incorporating demand variability alongside inventory value can provide additional insights for improving inventory control decisions. Integrating ABC classification with demand variability analysis enables managers to prioritize inventory items based not only on their financial contribution but also on the uncertainty associated with customer demand.

However, the findings also reveal a difference between theoretical recommendations and current inventory practices at Hypermart WTC Jambi

City. Although ABC analysis identifies fruit commodities that require higher inventory control attention, replenishment decisions are still primarily based on stock turnover observations, product availability, and supplier delivery schedules rather than systematic inventory classification. Similar implementation challenges were reported by Eraslan & Iç, (2020), who found that the effectiveness of ABC analysis depends on its integration into organizational decision-making processes.

Therefore, implementing ABC classification more systematically would enable Hypermart WTC Jambi City to establish differentiated inventory policies for high-value fruit commodities. More frequent inventory monitoring, demand forecasting, and replenishment planning for Category A fruits could reduce spoilage losses while maintaining product availability, thereby improving inventory efficiency and overall sales performance.

DEMAND PATTERN ANALYSIS

The demand pattern for fresh vegetables and fruits at Hypermart WTC Jambi City can be classified into two categories: relatively stable demand and fluctuating demand. In general, vegetable commodities exhibited more stable demand than fruit commodities during the observation period, whereas fruit commodities showed greater demand variability. In contrast, fruit commodities show greater demand variability, reflecting the influence of seasonal availability, price changes, promotional activities, and shifting consumer preferences.

The analysis indicates that several fruit commodities, including grapes, mangoes, and avocados, experienced considerable fluctuations in demand, as reflected by substantial increases in sales during specific periods. These fluctuations suggest that demand for these commodities may be influenced by seasonal factors, promotional activities, and changes in consumer preferences. Conversely, commodities such as watermelon and bananas exhibited relatively stable demand patterns, making future demand easier to anticipate and inventory requirements more predictable.

Based on the identified demand patterns, the Single-Period (Newsvendor) Model was applied to commodities exhibiting fluctuating demand, particularly fruit commodities and several vegetables with high demand uncertainty. Unlike commodities with relatively stable demand, these products require inventory policies that balance the risk of stock shortages against potential losses due to spoilage. Therefore, the Single-Period Model was employed to determine the appropriate service level for these perishable commodities. The results of the service level calculations for vegetable commodities are presented in Table 3.

Table 3. Vegetable Service Level (SL) Calculation Results

No	Vegetables Types	Unit (kg/Pack)	SL
1	Fresh-harvest Baby Carrots	Pack	0,8501
2	Water Spinach Leaves	bunch	0,1521
3	Fresh-harvest Beet Root	Pack	0,8434
4	Caisim	bunch	0,1067
5	Packcoy Hju	bunch	0,5167
6	HPM Shallots	Pack	0,6875

Source: Research data processed (2025)

Based on Table 3, the calculated service levels vary considerably among vegetable commodities, indicating differences in the degree of demand uncertainty and inventory priorities. Fresh-harvest Baby Carrots and Fresh-harvest Beet Root exhibit relatively high service levels (0.8501 and 0.8434, respectively), suggesting that maintaining product availability is more beneficial than risking stock shortages. These relatively high service levels indicate that the expected cost of stockouts exceeds the cost of carrying additional inventory, making higher product availability economically desirable. According to the Newsvendor principle, commodities with higher service levels require inventory policies that prioritize product availability because the economic consequences of shortages are greater than those of excess inventory (Puranam *et al*., 2022). In contrast, commodities such as Water Spinach Leaves and Caisim show substantially lower service levels, implying that the potential cost of excess inventory may outweigh the benefits of maintaining high stock levels due to their higher spoilage risk and less predictable demand.

These variations demonstrate that inventory decisions for perishable vegetables should

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not be standardized across all products. Instead, each commodity requires an inventory policy that reflects its demand characteristics and the economic consequences of overstocking and understocking. This finding supports the fundamental principle of the Single-Period (Newsvendor) model, which determines optimal inventory levels by balancing expected shortage costs against excess inventory costs under uncertain demand conditions. Recent developments of the Newsvendor model also suggest that inventory policies should incorporate product-specific operational characteristics rather than relying on uniform replenishment decisions, thereby improving inventory responsiveness under uncertain demand (Puranam *et al*., 2022).

The results are consistent with Wei & Chen (2021), who emphasized that inventory decisions for products with short life cycles should be based on the trade-off between overstock and understock risks rather than on fixed replenishment rules. Similarly, Kirci *et al*. (2022) highlighted that perishability characteristics should be integrated into inventory planning because deterioration rates differ substantially among fresh produce commodities. Applying this approach enables retailers to reduce spoilage while maintaining an acceptable level of product availability. Furthermore, Anand & Barua (2022) demonstrated that inappropriate inventory decisions are among the major contributors to post-harvest losses in fresh produce supply chains, emphasizing the importance of balancing inventory availability with waste reduction.

However, current inventory practices at Hypermart WTC Jambi City still rely primarily on operational experience and routine replenishment rather than service-level calculations derived from demand uncertainty. This practice may result in excessive inventory for highly perishable vegetables while increasing the probability of stock shortages for commodities with relatively high demand. Incorporating the Single-Period method into inventory planning would therefore provide a more objective basis for determining order quantities for highly perishable vegetable commodities, thereby reducing spoilage losses while maintaining customer service levels. This recommendation is in line with X. Li (2022), who reported that analytical inventory optimization can improve replenishment efficiency and support better inventory decisions in fresh product supply chains.

A similar inventory management challenge is also observed in fruit commodities, which generally exhibit greater demand variability and are more susceptible to quality deterioration than many vegetable products. Consequently, applying the Single-Period method becomes even more relevant for fruit inventory management because the balance between shortage costs and spoilage risks is often more critical. Therefore, the results of the service level (SL) calculations for fruit commodities using the Single-Period method are presented in Table 4.

Table 4. Fruit Service Level (SL) Calculation Results

No	Fruit Types	Unit (Kg/Pack)	SL
1	Green Grape	Pack	0,4676
2	Red Globe Grapes RRC	Kg	0,5118
3	Red Globe Aust Wines	Kg	0,4329
4	Super Harumanis Mangoes	Kg	0,3823
5	Avocados	Kg	0,4190
6	Imported Lychee	Kg	0,5826

Source: Research data processed, (2025)

Based on Table 4, the calculated service levels for fruit commodities are generally at a moderate level, ranging from 0.3823 to 0.5826. These values indicate that inventory decisions for fruits are made more conservatively than for relatively stable commodities because of the higher uncertainty in demand and the perishable nature of the products. Maintaining excessively high inventory levels would increase the risk of spoilage, whereas insufficient inventory could result in lost sales during periods of increased demand. These findings are consistent with Liang *et al*. (2021), who emphasized that procurement decisions for fresh produce should account for stochastic demand and product quality uncertainty to determine economically optimal inventory levels. Likewise, the Single-Period (Newsvendor) approach recommends balancing the costs of overstocking and stock shortages when determining inventory policies under uncertain demand conditions (Wei & Chen, 2021).

The variation in service levels among fruit commodities also reflects differences in demand

uncertainty. For example, Imported Lychee has the highest service level (0.5826), suggesting a greater emphasis on maintaining product availability, whereas Super Harumanis Mangoes and Red lobe Aust rapes exhibit lo wer service levels, indicating that limiting excess inventory is considered more economically beneficial. These findings are consistent with the demand pattern analysis, which showed that fruit commodities generally experience greater demand fluctuations than vegetables. Such differences are also associated with variations in perishability and post-harvest deterioration among fruit commodities, which influence the economic consequences of excess inventory and product shortages. (Kirci *et al*. (2022) highlighted that perishability characteristics should be explicitly considered in inventory planning for fresh produce, while Anand & Barua (2022) demonstrated that inappropriate inventory decisions are among the major contributors to post-harvest losses throughout fresh produce supply chains.

The findings are consistent with Xu *et al*. (2026), who reported that fresh products possess complex supply chain characteristics, including high perishability and sensitivity to environmental and market factors. Consequently, inventory decisions for fresh fruits should be adaptive and responsive to demand uncertainty in order to balance product availability with spoilage risk. Similarly, Chen *et al*. (2025) emphasized that inventory decisions in fresh produce supply chains should respond dynamically to changing market demand because demand information significantly influences replenishment policies and overall supply chain performance. These findings reinforce the importance of incorporating market uncertainty into inventory decision-making for highly perishable fruit commodities.

However, inventory replenishment at Hypermart WTC Jambi City is still largely based on operational judgment and supplier schedules rather than service-level calculations. As a result, inventory decisions may not fully reflect the actual level of demand uncertainty or the economic trade-off between shortage and excess inventory costs. Incorporating the Single-Period approach into routine inventory planning would enable the company to establish more objective order quantities for highly perishable fruit commodities, thereby reducing inventory losses while maintaining an acceptable level of customer service. This recommendation is supported by Li (2022), who demonstrated that analytical inventory optimization improves replenishment efficiency for fresh products, and by Kosgoda *et al*. (2024), who found that inventory management systems are more effective when managerial decisions are guided by objective inventory performance indicators rather than subjective judgment alone.

To provide a more comprehensive evaluation of inventory management performance, the following section presents the analysis of optimal order quantities and the comparison between actual inventory levels and the recommended inventory policies. Therefore, the results of the optimal inventory calculation and inventory differences for vegetable commodities using the Single-Period method are presented in Table 5.

Table 5. Optimal Inventory and Difference in Vegetable Inventory Per Year (Kg/Pack)

No	Vegetable Name	Unit (Kg/Pack)	Standard Deviation	Z-Score	Average demand Per Year (Kg/Pack)	Optimal Inventory Per Year (Kg/Pack)	Difference (Kg/Pack)
			1	2	3	4=3+(2x1)	5=(4-3)
1	Fresh-harvest Baby Carrots	Pack	9,62	1,04	13,11	23,09	9,98
2	Water Spinach Leaves	Bunch	7,72	-1,03	12,25	4,31	-7,94
3	Fresh-harvest Beet Root	Pack	6,96	1,01	12,27	19,29	7,02
4	Caisim	Bunch	6,79	-1,24	13,08	4,64	-8,45
5	Packcoy Hju	Bunch	7,27	0,04	15,58	15,89	0,30
6	HPM Shallots	Pack	5,53	0,49	12,90	15,60	2,70

Source: Research data processed (2025)

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Based on Table 5, the calculated optimal inventory levels differ across vegetable commodities, reflecting variations in demand uncertainty and inventory risk. Fresh-harvest Baby Carrots, Fresh-harvest Beet Root, Pakcoy Hju, and HPM Shallots show positive inventory differences, indicating that the recommended inventory level exceeds the average annual demand. This suggests that maintaining additional safety stock for these commodities is economically justified to reduce the likelihood of stock shortages and maintain product availability. This finding is consistent with the Single-Period inventory principle, which recommends maintaining higher inventory levels when the expected cost of stock shortages exceeds the cost of carrying additional inventory under uncertain demand conditions (Puranam *et al*., 2022;Wei & Chen, 2021).

In contrast, Water Spinach Leaves and Caisim exhibit negative inventory differences, indicating that the optimal inventory level is lower than the average annual demand. This result suggests that a more conservative inventory policy is preferable for these commodities because the potential losses associated with spoilage outweigh the benefits of maintaining larger inventories. Considering the highly perishable nature of fresh vegetables, reducing excess stock can help minimize waste while maintaining acceptable service levels. Kirci *et al*. (2022) emphasized that perishability characteristics should be incorporated into inventory planning because products with shorter shelf lives are more vulnerable to quality deterioration and inventory losses. Similarly, Anand & Barua (2022) reported that excessive inventory is one of the primary causes of post-harvest losses in fresh produce supply chains. These findings illustrate the trade-off addressed by the Single-Period (Newsvendor) model, in which inventory decisions are based on balancing the expected costs of stock shortages against the costs of excess inventory. Rather than applying a uniform inventory policy to all vegetable commodities, the model recommends different inventory levels according to each product's demand characteristics and associated inventory risks. This interpretation is also supported by Puranam *et al*. (2022), who suggested that inventory policies should accommodate product-specific operational characteristics rather than applying standardized replenishment decisions.

Compared with current inventory practices at Hypermart WTC Jambi City, inventory replenishment is still predominantly determined by operational experience and routine ordering schedules. Consequently, inventory levels may not always reflect the optimal balance between product availability and spoilage risk. Applying the Single-Period model would enable management to establish more objective inventory policies for individual vegetable commodities, thereby improving inventory efficiency while reducing potential waste. This recommendation is supported by Li (2022), who demonstrated that analytical inventory optimization improves replenishment efficiency for fresh products, while Kosgoda *et al*. (2024) emphasized that inventory management systems become more effective when managerial decisions are based on objective analytical information rather than subjective operational judgment.

The same analytical approach was subsequently applied to fruit commodities, which generally exhibit greater demand variability than vegetables. Because fruit products are typically more susceptible to demand fluctuations and quality deterioration, determining optimal inventory levels becomes increasingly important to balance product availability with spoilage risk (Chen *et al*., 2025; Kirci *et al*., 2022). The results of the optimal inventory calculations for fruit commodities are presented in Table 6.

Based on Table 6, most fruit commodities exhibit negative inventory differences relative to their average annual demand. This finding indicates that the recommended inventory levels are generally lower than the historical average demand, reflecting a more conservative inventory strategy for highly perishable products. Such an approach minimizes the financial risk associated with spoilage while maintaining sufficient inventory to satisfy expected customer demand. This finding is consistent with Liang *et al*. (2021), who emphasized that procurement decisions for fresh produce should account for stochastic demand and product quality uncertainty to achieve economically efficient inventory levels. Likewise, the

Table 6. Optimal Inventory and Difference in Fruit Inventory Per Year (Kg/Pack)

No	Fruit Name	Unit (Kg/ Pack)	Standard Deviation	Z-Score	Average demand Per Year (Kg/Pack)	Optimal Inventory Per Year (Kg/Pack)	Difference (Kg/Pack)	Order Frequency (Times/ Week)
			1	2	3	4 = 3 + (2 x 1)	5 = (4-3)	6
1	Green Grape	Pack	73,45	-0,08	89,43	83,55	-5,88	1
2	Red Globe Grapes RRC	Kg	63,50	0,03	87,72	89,62	1,90	1
3	Red Globe Aust Wines	Kg	34,72	-0,17	58,94	53,03	-5,90	1
4	Super Harumanis Mangoes	Kg	60,09	-0,30	61,30	43,27	-18,03	3
5	Avocados	Kg	44,24	-0,20	44,66	35,81	-8,85	3
6	Imported Lychee	Kg	6,27	0,21	41,80	43,11	1,32	1

Source: Research data processed (2025)

Single-Period approach recommends reducing inventory when the expected costs of excess stock outweigh the potential losses associated with stock shortages (Wei & Chen, 2021).

The magnitude of the inventory differences varies across commodities, reflecting differences in demand uncertainty and inventory risk. For example, Super Harumanis Mangoes and Avocados show relatively large negative inventory differences, indicating that reducing excess inventory is economically preferable because these products are more vulnerable to spoilage and demand fluctuations. In contrast, Red lobe rapes RRC and Imported Lychee exhibit small positive inventory differences, suggesting that maintaining slightly higher inventory levels is justified to improve product availability and reduce the likelihood of stock shortages. These differences demonstrate that inventory policies should be tailored to the perishability characteristics and demand variability of each commodity. Kirci *et al*. (2022) emphasized that inventory decisions for fresh fruits and vegetables should explicitly consider deterioration rates because highly perishable commodities are more susceptible to quality losses during storage. Similarly, Anand & Barua (2022) reported that excessive inventory is one of the major contributors to post-harvest losses in fresh produce supply chains.

The recommended order frequency further supports these inventory policies. Fruit commodities with greater demand uncertainty, such as Super Harumanis Mangoes and Avocados, require more frequent replenishment (three times per week) to maintain product freshness while limiting inventory accumulation. Conversely, commodities with relatively more predictable demand can be replenished once per week without substantially increasing inventory risk. These findings demonstrate that replenishment frequency should be adjusted according to the demand characteristics and perishability of each commodity rather than applying a uniform ordering schedule. Chen *et al*. (2025) argued that demand information plays a critical role in determining replenishment decisions within fresh produce supply chains because market uncertainty directly influences inventory performance. Therefore, differentiated replenishment frequencies represent a practical strategy for balancing product availability with spoilage risk.

The results are consistent with Li (2023), who argued that inventory decisions for products with short life cycles should simultaneously consider demand forecasts and the trade-off between overstocking and understocking. Similarly, Pathy & Rahimian (2024) emphasized that companies operating under demand uncertainty often adopt risk-averse inventory policies by maintaining lower inventory levels to reduce potential losses associated with perishable products. These findings also support the development of adaptive inventory policies in which replenishment decisions are continuously adjusted according to changing demand conditions and product characteristics, rather than relying on fixed ordering schedules.

Compared with current inventory practices at Hypermart WTC Jambi City, replenishment decisions are still primarily based on operational experience and supplier delivery schedules. The Single-Period analysis provides a more systematic and quantitative basis for determining both inventory levels and replenishment frequency according to the demand characteristics of each fruit

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commodity. Implementing this approach would enable the company to reduce spoilage losses, improve inventory turnover, and maintain product availability more efficiently. This recommendation is supported by Li (2022), who demonstrated that analytical inventory optimization improves replenishment efficiency in fresh product supply chains. Furthermore, Kosgoda *et al*. (2024) highlighted that inventory management systems produce better operational outcomes when managerial decisions are guided by objective analytical information rather than subjective judgment alone

Overall, the Single-Period method proved effective in determining optimal inventory policies for fruit commodities with volatile demand. By simultaneously considering demand uncertainty, product perishability, and replenishment frequency, the method supports more efficient inventory management while balancing customer service objectives and inventory costs. These findings demonstrate that analytical inventory models provide a more reliable basis for managing highly perishable products than experience-based replenishment practices, particularly in modern retail environments where demand uncertainty and food waste remain significant operational challenges (Anand & Barua, 2022; Kirci *et al*., 2022).

Following the application of the Single-Period method to commodities characterized by uncertain and highly variable demand, the Economic Order Quantity (EOQ) method was subsequently applied to commodities exhibiting relatively stable demand patterns. Unlike the Single-Period approach, which focuses on balancing shortage and overstock risks for perishable products, the EOQ model determines the optimal order quantity by minimizing the total inventory cost through balancing ordering and holding costs. The results of the EOQ calculations for vegetable commodities are presented in Table 7.

Based on Table 7, the calculated EOQ values for vegetable commodities are generally relatively small, accompanied by relatively frequent replenishment schedules. This finding indicates that the optimal inventory policy for fresh vegetables is to order smaller quantities more frequently, thereby reducing the length of storage time and minimizing the risk of spoilage associated with perishable products.

The EOQ values vary among commodities because they are influenced by differences in annual demand, ordering costs, and inventory holding costs. For example, Enokidake Mushrooms have the largest EOQ value due to their substantially higher annual demand compared with the other vegetable commodities. Nevertheless, the recommended ordering policy still emphasizes frequent replenishment, reflecting the importance of maintaining product freshness while avoiding excessive inventory accumulation.

The recommended order frequency and ordering intervals further support this inventory strategy. Vegetable commodities with relatively stable demand can be replenished at regular inter-

Table 7. Results of Economic Order Quantity (EOQ) Calculation of Vegetables

No	Vegetable Name	Average demand Per Year (Kg/Pack)	Average Order Cost (Per transaction)	Storage Cost (2%) (Rp/Kg/ year)	Economic Order Quantity (EOQ) (Kg)	Order Frequency (time/year)	Order Interval (Week/ Once)	Order Frequency (Times/ Week)
		D	S	H				
		1	2	3	4	5 = (1/4)	6 = (52/5)	7
1	Large Scallion	12,50	19.615	171,59	5,00	2,500	20,80	2
2	Sour materials	11,83	16.979	160,97	4,86	2,432	21,38	2
3	reen Spinach Leaves	15,83	543	2,82	5,63	2,814	18,48	3
4	Enokidake Mushrooms	435,92	23.470	0,16	29,53	14,763	3,52	3
5	Curly Lettuce	26,00	3.656	6,92	7,21	3,606	14,42	3
6	Soup materials	12,92	17.708	134,34	5,08	2,541	20,46	2

Source: Research data processed (2025)

vals, ranging from approximately two to three orders per week, allowing the company to maintain continuous product availability while minimizing storage duration. This replenishment pattern is particularly suitable for fresh vegetables because shorter storage periods help preserve product quality and reduce spoilage losses.

These findings are consistent with recent studies highlighting that inventory decisions for fresh produce should consider not only the trade-off between ordering and holding costs but also product characteristics, demand conditions, and operational constraints (Chen, 2025; Maharani *et al*., 2025). For perishable products, inventory policies should therefore balance cost efficiency with product freshness, service performance, and operational flexibility. Compared with current inventory practices at Hypermart WTC Jambi City, ordering decisions are still largely based on routine operational experience rather than systematic EOQ calculations. Applying the EOQ method would provide a quantitative basis for determining optimal order quantities and replenishment schedules for commodities with relatively stable demand, thereby improving inventory efficiency, reducing unnecessary holding costs, and maintaining product quality.

To provide a more comprehensive evaluation of inventory management, the EOQ analysis was also applied to fruit commodities with relatively stable demand characteristics. The corresponding results are presented in Table 8.

Based on Table 8, the EOQ values for fruit commodities are generally higher than those of vegetables, resulting in lower recommended ordering frequencies. This finding reflects the relatively higher annual demand and ordering costs associated with several fruit commodities. Under the EOQ model, ordering larger quantities less frequently minimizes the total inventory cost by balancing ordering and holding costs.

The recommended ordering policy, however, differs among commodities. Fruits such as Red Watermelon, Century Pear, and Baby Black Beauty Red require relatively low ordering frequencies because their EOQ values are comparatively high. In contrast, commodities such as Sunpride Cavendish Banana, Rock Melon, and Red Dragon Fruit are replenished more frequently in practice to maintain freshness despite their calculated EOQ recommendations. This finding indicates that inventory decisions for fresh fruits are influenced not only by economic considerations but also by product perishability and quality maintenance.

Compared with the actual inventory practices at Hypermart WTC Jambi City, replenishment decisions are not always fully aligned with the EOQ recommendations. Ordering schedules are frequently adjusted according to product freshness, supplier delivery schedules, and operational conditions. This discrepancy demonstrates that while the EOQ model provides an economically optimal

Tabel 8. Fruit Economic Order Quantity (EOQ) Calculation Results

No	Fruit Name	Average Annual Demand (Kg/Pack)	Average Order Cost (Per transaction)	Storage Cost (2%) (Rp/Kg/ year)	Economic Order Quantity (EOQ) (Kg)	Order Frequency (Times/ Year)	Order Interval (Week/ Once)	Order Frequency (Times /Week)
		D	S	H				
		1	2	3	4	5 = (1/4)	6 = (52/5)	7
1	Red Watermelon	143,04	19.077	627,86	93,23	1,534	33,89	2
2	Century Pear	122,09	39.820	884,69	104,84	1,165	44,65	1
3	Baby Black Beauty Red	87,42	9.171	162,21	99,42	0,879	59,14	1
4	Sunpride Cavendish Banana	61,86	19.851	471,86	72,15	0,857	60,65	3
5	Rock Melon	48,91	13.123	1.361,03	30,71	1,593	32,65	3
6	Red Dragon Fruit	39,35	16.601	1.413,73	30,40	1,294	40,17	3

Source: Research data processed (2025)

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solution under deterministic assumptions, practical inventory decisions for fresh produce must also accommodate operational realities and demand uncertainty.

These findings suggest that the EOQ model should be applied as a decision-support tool rather than as a rigid inventory policy. Similar observations have been reported in recent inventory management studies, which emphasize that inventory decisions for perishable products should integrate economic considerations with operational flexibility and demand responsiveness.

Furthermore Maharani *et al*. (2025) highlighted that digital technologies and artificial intelligence can improve inventory decision-making by enhancing demand forecasting accuracy and supporting more responsive inventory management systems for agricultural products. Such technological support can complement the EOQ approach by enabling retailers to adjust replenishment decisions more effectively under dynamic market conditions.

Overall, the EOQ analysis demonstrates that inventory optimization for fresh fruit commodities cannot rely solely on mathematical calculations. Instead, effective inventory management requires balancing cost efficiency, product freshness, supplier capability, and demand variability. Integrating EOQ with modern inventory planning and demand forecasting would enable Hypermart WTC Jambi City to improve inventory efficiency while maintaining product quality and customer satisfaction.

SUESTIONS

Based on the findings of this study, the following recommendations are proposed to improve the efficiency and effectiveness of fresh fruit and vegetable inventory management at Hypermart WTC Jambi City:

1. Implement differentiated inventory policies based on ABC classification. Inventory control should be prioritized according to the economic importance of each commodity. Category A items require more intensive monitoring, frequent inventory reviews, and tighter stock control, while Categories B and C can be managed using less intensive inventory policies. This differentiated approach enables management to allocate resources more efficiently and focus on commodities with the greatest contribution to sales value.
2. Apply inventory control methods according to demand characteristics. Commodities with relatively stable demand should be managed using the Economic Order Quantity (EOQ) method to determine optimal order quantities and replenishment schedules. Conversely, commodities with highly fluctuating demand should be managed using the Single-Period (Newsvendor) method to balance the risks of overstocking and understocking. Selecting inventory methods based on demand characteristics can improve inventory efficiency while minimizing spoilage losses.
3. Strengthen demand forecasting through digital inventory systems.
   Hypermart WTC Jambi City is encouraged to integrate inventory management with digital information systems that support automated demand forecasting, real-time inventory monitoring, and data-driven decision-making. Such systems would improve forecasting accuracy, facilitate timely replenishment decisions, and enhance responsiveness to changes in consumer demand.
4. Enhance collaboration across the supply chain. Closer coordination with suppliers and the Distribution Center (DC) is essential to ensure timely product replenishment, maintain product freshness, and reduce supply disruptions. Improved information sharing throughout the supply chain will support more efficient inventory planning for perishable commodities.
5. Establish inventory performance indicators.
   Management should regularly monitor key inventory performance indicators, such as inventory turnover, service level, stock availability, spoilage rate, and inventory losses. Continuous evaluation of these indicators will enable the company to assess the effectiveness of its inventory policies and support continuous improvement in inventory management performance.

Overall, implementing these recommendations would enable Hypermart WTC Jambi City to develop a more systematic, responsive, and data-driven inventory management system. Such

improvements are expected to enhance inventory efficiency, maintain product availability and freshness, reduce food waste, and improve overall operational performance.

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