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RESEARCH PAPER

Procurement strategy for fresh vegetable produces to mitigate food waste in the retail sector

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Abstract. Food waste is critical issue in developing countries, including Indonesia, affecting both the retail and consumers. In the case of vegetables, food waste frequently arises due to their short shelf life, spoilage, and physical damage. Additionally, the instability of vegetable prices creates challenges for consumers in meeting their needs. In sufficiency in the vegetable supply chain exacerbate the problem leading to leftovers and waste. This research aims to explore the causes of vegetable food and propose effective procurement strategies to mitigate it. A quantitative research approach was employed, with data collected through structured interviews involving 127 vegetable traders. The analysis utilized ANOVA to examine the effect of traders' demographic characteristics on factors contributing to food waste. The results showed that demographics factors, such as age, daily turnover, and market location, significantly influence procurement strategies. Key findings underscore the importance of proper packaging tailored to the specific type of vegetable and the need for supplier intervention, to ensure adequate packaging during delivery, thereby maintaining vegetable quality. Moreover, traders with higher turnover rates are advised to carefully manage their purchasing practices to minimize waste. These insights highlight the critical role of procurement strategies in reducing vegetable food waste and the need for targeted interventions across the supply chain.

Keywords: Food waste; Fresh vegetable; Procurement; Retail

1. Introduction

Food waste is a significant challenge for both developed and developing countries, including Indonesia. It occurs across the food supply chain, from the sales process to final consumption, often involving food products that remain edible or could otherwise be utilised (Tamara et al., 2020). Globally, nearly a one-third of all food produced is either wasted or lost annually, despite the persistent issue of hunger affecting millions. The widespread practices contributes over 1.3 billion tons of waste annually, with decomposing food waste releasing approximately 3.3 billion tons of greenhouse gases, thereby exacerbating environmental concerns (Jamaludin et al., 2022).

In Indonesia, food waste per capita is estimated at 300 kilograms annually, ranking the country as the second-largest food waste producer worldwide. This figure surpasses that of the United States, where food waste per capita is estimated at 277 kilograms per year (Mulyana et al., 2019). While, high levels of food waste in developed countries may be offset by stronger resources

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and infrastructure, the issue is particularly alarming in developing countries like Indonesia, where hunger remains a pressing and pervasive problem (Tamara et al., 2020).

Food waste in developing countries is often attributed to limited storage and refrigeration systems, inadequate infrastructure, and deficiencies in packaging, transportation, logistics, and marketing systems, which are frequently constrained by financial resources (Buzby et al., 2014). The products contributing most significantly to food waste are those with a short shelf life, such as fruits and vegetables (Mulyana et al., 2019). Factors such as limited short shelf life, spoilage, and damage to the product or its packaging are the key drivers of food waste (Eičaitė et al., 2022).

This phenomenon is not confined to supermarkets or food product stores. It is also prevalent among traditional vegetable sellers operating in local markets. Retailers aim to increase customer satisfaction by offering a wide variety of vegetables in substantial quantities (Guarnieri et al., 2021). However, procuring vegetables in excess without accurate demand forecasting often leads to overstocking of fresh produce (Calvo-Porral et al., 2017). The excessive stock of vegetables, when stored in inadequate facilities, are more susceptible to microbial contamination and spoilage. Part of the vegetables affected by microbial damage must be discarded to meet the quality standards expected by consumers.

Rotten vegetables are often discarded as they are deemed unsuitable for consumption, leading to financial losses for traders (Ortiz-Gonzalo et al., 2021). This is issue is exacerbated by inaccuracies in demand forecasting, inefficient replenishment policies, and the high quality standards expected by consumers, all of which contribute to food waste (Guarnieri et al., 2021). The growing demand for vegetables is driven by increased public awareness of the importance of plant-based nutrition.

On the other hand, the increase in consumption necessitates improvement in vegetable marketing. Due to the instability of vegetable prices, consumers continue to face difficulties in meeting their needs. The vegetable supply chain has been inefficient, leading to surplus and waste. Therefore, it is crucial to improve the implementation of the supply chain to optimise the commercial marketing of vegetables.

In supplying goods to traditional markets, each institution within the supply chain should focus on key performance processes, including planning, procurement, delivery, and returns. By optimising these process, the performance of the vegetable supply chain in the traditional markets can be significantly improved (Soka et al., 2017).

Based on the above, it is necessary to conduct research addressing the causes of food waste in vegetables in traditional markets and to propose strategies for improving procurement practices. This research aims to optimise vegetable purchasing decision by retailers to better align supply with demand. The research was conducted in Purwokerto, city well-suited for business development, offering market opportunities in the agricultural sector, particularly for horticultural products such as vegetables. Purwokerto is strategically located and serves as a regional marketing hub and terminal for agricultural product distribution (Juanita & Pinandita, 2015).

The benefits of this research include assisting vegetable traders or retailers in reducing food waste and and losses, as well as contributing to vegetable effort aimed at improving vegetable quality in the market. Additionally, the study supports the government's initiatives in developing food waste reduction policies in Indonesia, with the aim of mitigating the environmental and economic impacts of food waste.

Food waste frequently occurs in perishable products such as fruit and vegetables. Contributing factors include inadequate facilities for storage, refrigeration, and packaging, as well as inefficient transportation systems, inappropriate demand forecasting, and a lack of knowledge and awareness among traders regarding food waste. As result, unsold food often ends up in landfills, as animal feed, or repurposed for non-food uses.

While food waste is often considered environmentally benign due to its biodegradable Nature, it actually poses significant environmental risks. The anaerobic decomposition of food waste generates methane gas, a potent greenhouse gas that contributes to global warming (Mulyana et al., 2019).

2. Methods

The study employed quantitative methods, using a survey approach to analyse the demographics of vegetable sellers. Data was collected through interviews with 127 vegetable traders. The ANOVA method was utilised to test the impact of the traders' demographic factors on variables that may contribute to food waste at Purwokerto Market. The demographic characteristics examined include age, gender, daily turnover, and the market name. Meanwhile, the factors contributing to food waste were identified as vegetable handling, storage, packaging, purchasing, transportation systems, and levels of information and knowledge. The hypothesis was formulated as follows: H1: The procurement strategy has a significant effect on the occurrence of food waste in the retail sector.

Food waste is a growing issue that harms both the environment and business economics. When vegetables are damaged by microbes or begin to rot, they are discarded as they are no longer suitable for consumption. As a result, traders incur losses, when this happens repeatedly. Therefore, a solution is needed to address the by uncovering the phenomenon of vegetable food waste in the retail sector by identifying the factors that contribute to it and determining appropriate mitigation strategies in relation to procurement. The logistics activities leading to food are summarised in Table 1.

Table 1. Cause of food waste attributes

Criteria	Code	Statements
Vegetable handling (Ali & Christiawan, 2019)	P1	Sold the following day
	P2	Sold at a low price
	P3	Defective vegetables are sold at a reduced price.
Storage (Azabağaoğlu, 2018; Balaji & Arshinder, 2016; de Moraes et al., 2020; Filimonau & Gherbin, 2017; Magalhães et al., 2021)	P4	Adequate space before sale
	P5	Adequate place after-sale
	P6	Storage bins shorten the vegetable's shelf life.
	P7	Cooling facilities
Packaging (Balaji & Arshinder, 2016; Filimonau & Gherbin, 2017; Magalhães et al., 2021; Mulyana et al., 2019)	P8	Packaging that cannot protect the product
	P9	Lack of packaging shortens shelf life.
	P10	Packaging without ventilation
	P11	Fresh and rotten vegetables stored in some container
	P12	Unsterilized containers
Purchasing (Filimonau & Gherbin, 2017; Magalhães et al., 2021)	P13	Off-market prices
	P14	Overstock
	P15	Demand forecasting
System transportation (Azabağaoğlu, 2018; Balaji & Arshinder, 2016; Chauhan et al., 2021; Magalhães et al., 2021)	P16	Inadequate transportation
	P17	Long delivery distances
Information (Magalhães et al., 2021)	P18	Error communication
Knowledge (Lee, 2018)	P19	Vegetable food waste

3. Result and discussion

3.1. The demographics of vegetable traders

Demographic data of vegetable sellers were obtained from 127 respondents at the Purwokerto Traditional Market. The results of the demographic analysis are presented in Figure 1.

The data reveal that the majority of vegetable sellers are women, comprising of 74%, while men account for 26% (Figure 1(a)). Most vegetable sellers are over 50 years old, representing 56% of respondents, followed by those aged 46 – 50 years, who make up 18% (Figure 1 (b)). Regarding daily turnover, 78% of sellers earn less than IDR 5000,000, while 19% report a turnover of IDR 500,000 – IDR 1,500,000 (Figure 1 (c)). Most respondents were from Wage Market, which is one of the largest markets in Purwokerto, accounting for 44% of the sample. This is followed by Karanglewas Market (20%), Pon Market (18%), Proliman Market (13%), and Mersi Market (5%) (Figure 1 (d)).

3.2. Instrument test result

This research instrument test was processed to meet the criteria for the final analysis stage. This testing involved validity, reliability, and normality assessments. Data processing was conducted using Minitab 19 software, with a confidence level is 95% and an error rate of 5%.

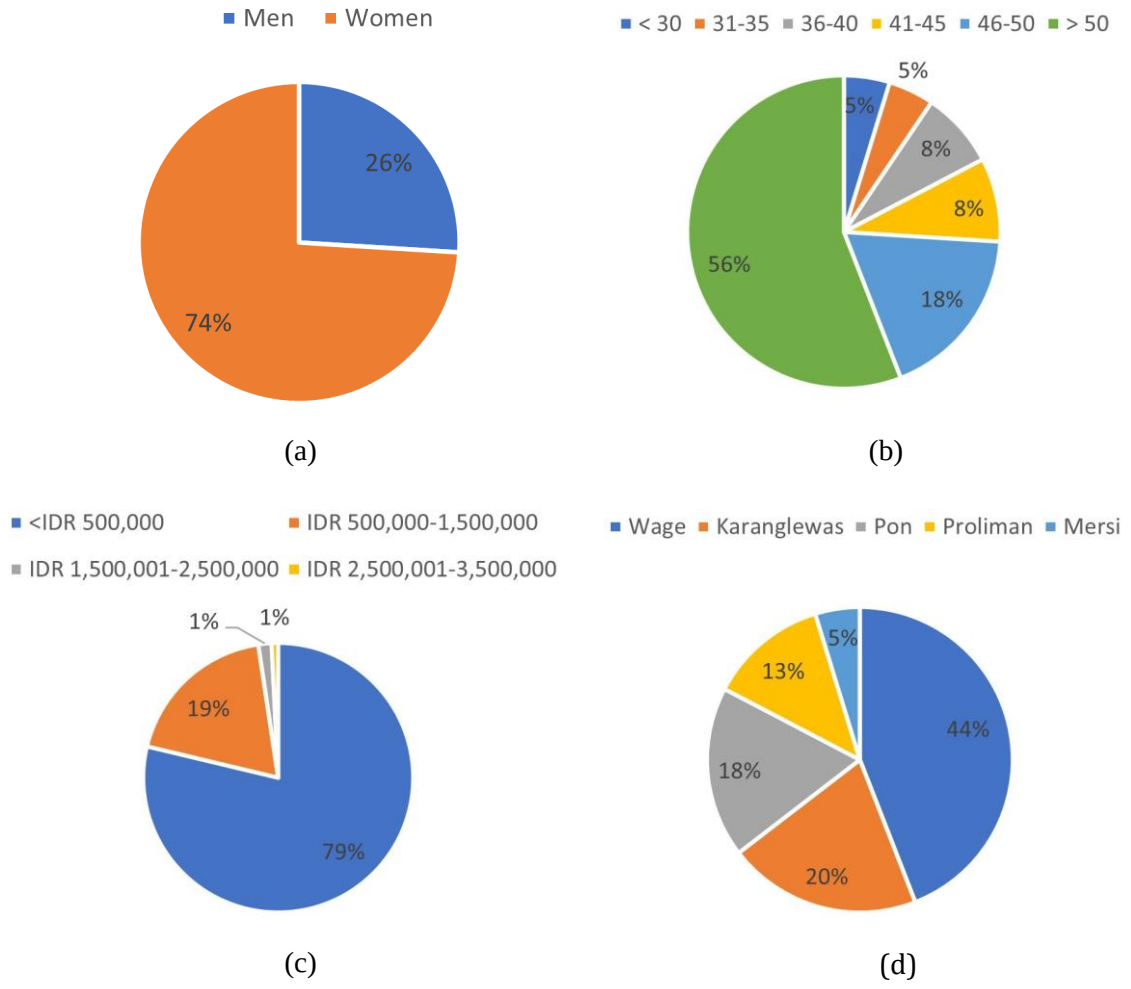

Figure 1. Demographics of vegetable sellers include gender (a), age (b), turnover per day (c), and market (d).

In this study, the validity test yielded a *p*-value greater than 0.05 for each questionnaire item. The validity test conducted for item P(1) to P(19) identified two invalid statements: P (5) related to storage, and P(11) related to packaging. These items were deemed invalid because their significance values exceeded the threshold of 0.05. Based on validity test results, all data were deemed suitable for use in this study except for statements P(5) and P(11), which were excluded from the reliability test calculation.

The next step involved conducting reliability test and normality test. The reliability test results indicated that the data were reliable, with a Cronbach's alpha value of 0.870, exceeding the threshold of 0.60. The normality test employed skewness and kurtosis measures. The result showed a skewness value of -0.48 and a kurtosis value of -0.95. These values confirm that the data meet the normality criteria, as kurtosis falls within the range of -7 and +7 and skewness within -2 to +2 (Ali & Qun, 2019; Fuey & Idris, 2018).

3.3. ANOVA test results

An ANOVA test was conducted to determine the significance of the relationships between responses and factors. The factors analysed included the demographics of the respondents: age, gender, daily turnover, and market name. The responses in this study pertain to factors contributing to food waste. The ANOVA test results indicated that three factors significant influenced food waste, as shown in Table 2.

Response P(6) demonstrates that age significantly affects traders who lack adequate storage facilities, leading to a shorter shelf life for vegetables. In general, vegetable traders at the Purwokerto Traditional Market sell their vegetables directly after obtaining it from suppliers, relying solely on the available storage facilities. Traders aged 41–50 years old and older were found to pay greater attention to vegetable storage. For instance, , traders selling green vegetables such as broccoli, cauliflower, spinach, and beans that are not sold within a day often take the unsold vegetables home. Depending on the type of vegetable, they store it either in open containers or refrigerator.

Response P(14) indicates that age and turnover significantly impact the procurement of vegetables prone to overstocking, which leads to a decline in quality and wastage. Traders aged 46–50 years and older tend to pay more attention to and carefully consider their procurement strategies. These traders purchase vegetables from suppliers based on their specific needs. Turnover also influences vegetable purchases, traders with a daily turnover of less than IDR 500,000 tend to buy fewer vegetables to align with their income. In contrast, traders with a daily turnover of IDR 500,000 – IDR 1,500,000 are more likely to procure large quantities of vegetables,

Table 2. ANOVA result

Demographic	Code	*p*-value	Demographic	Code	*p*-value
Daily turnover	P2	0.033	Age	P6	0.020
	P3	0.000		P14	0.037
	P4	0.043	Market	P1	0.002
	P8	0.000		P4	0.035
	P10	0.000		P8	0.012
	P11	0.020		P15	0.048
	P12	0.000		P16	0.042
	P13	0.000			
	P14	0.000			
	P16	0.000			

consistent with their higher turnover. Avoiding overstocking is crucial to prevent financial losses and ensure smooth cash flow (Indriyani & Budiawan, 2018).

Response P(2) highlights that turnover significantly affects the sale of vegetables at reduced prices. This often occurs because vegetables that remain unsold from the previous day experience a decline in quality, compelling traders to sell them at lower prices. Similarly, Response P(3) demonstrates that turnover significantly impacts the sale of defective or damaged vegetables at discounted prices. Interviews and questionnaires with vegetable traders revealed that damage to vegetables frequently occurs during transportation. Leading traders to sell these items at reduced prices. This finding aligns with research by Hidayat et al. (2021), which noted that vegetable traders in the Borneo Traditional Market offer promotional or reduced prices to maintain income. In addition to transportation-related damage, some vegetable traders lack adequate storage and handling facilities, further exacerbating this challenge.

Response P(4) illustrates that turnover and the market where traders sell significantly influence the availability of adequate storage space before sales. Vegetable traders in Purwokerto Traditional Market typically sell produce immediately after receiving it from the suppliers. Traders with a daily turnover ranging from IDR 500,000 to IDR 1,500,000 generally sell vegetables on a large scale and are more likely to provide sufficient storage facilities, like Pasar Wage, one of the largest markets in Purwoketo, serves as a significant supplier for smaller markets. This aligns with research by Ali and Christiawan (2019), which highlights that factors influencing traders' participation in waste management include internal aspects such as education, income, awareness of waste, and knowledge about waste.

Response P(8) reveals that turnover and the market where traders sell significantly impact the choice of packaging, which in turn impacts the shelf life of vegetables. Selecting appropriate packaging can degrade vegetable quality. Traders with high turnover can more easily provide suitable packaging that protects vegetables and helps maintain their quality. Conversely, traders with lower turnover tend to overlook the importance of packaging, often leaving vegetables unpackaged. These traders are less concerned maintaining vegetables quality, which could be improved through appropriate packaging practices. Similarly, Response P(10) indicates that turnover affects the use of tight, non-ventilated packaging, which can also reduce vegetable quality. This issue arises due to errors in selecting packaging and a lack of understanding about proper handling methos for vegetables, ultimately decreasing the consumption rate.

Response P(11) indicates that turnover affects the practice of placing rotten vegetables in the same container as fresh vegetables, compromising the quality of the fresh vegetables. Traders with higher turnover are better positioned to provide separate containers or packaging to segregate spoilage from spreading to fresh vegetables, allowing traders to resell slightly wilted vegetables at reduced price, thus minimising financial losses.

Similarly, Response P(12) shows that traders with higher turnover are more likely to use cleaner containers, which help maintain the freshness of vegetables and prevent them from wilting quickly. In contrast, traders with lower turnover often resort to using basic or improvised containers.

Response P(13) indicates that turnover affects prices strategies, with excessively high price that deviate from market trends leading to reduce consumer interest in purchasing vegetables. In some cases, frozen vegetables are sold at high prices to specific traders, depending on their availability from suppliers. When vegetables are scarce, sellers may charge high price, and buyers often continue to purchase them out of necessity. However, if there is no scarcity and traders still sell high prices, consumer interest in buying vegetables declines significantly.

Response P(16) highlight that turnover and the type of market where vegetables are sold significantly influence transportation facilities, particularly inadequate refrigeration, which is essential for maintaining vegetable quality. Large-scale markets typically procure vegetables in bulk from suppliers, necessitating adequate transportation facilities to preserve the quality of

large shipments during transit. Traders with higher turnover are better equipped to make substantial purchases that require refrigeration throughout the delivery process. For example, Karanglewas and Wage Market, both sizeable markets, facilitate large-scale vegetable sales, resulting in substantial procurement from suppliers.

P(1) response reveals that the type of market where vegetables are sold significantly affects the handling of unsold vegetables. Larger markets typically procure substantial quantities from suppliers, as traders in these markets often serve as suppliers from smaller markets. Consequently, traders in large markets need adequate storage facilities to store unsold vegetables and sell them the following day. In contrast, smaller markets tend to purchase fewer vegetables, as they lack sufficient storage facilities and focus on selling only the amount that can be cleared within a day.

Response P(15) highlights that the market type also influences traders' decision-making, which can result in irregular vegetable turnover. Large markets, characterised by bulk purchases, often face challenges such as poor demand forecasting and inefficiencies managing vegetable turnover.

3.4. Implications of findings

Vegetable traders represent the final retail tier in the supply chain before vegetables reach consumers. They play a crucial role in maintaining the quality and safety of vegetables prior to consumption. However, these traders often prioritise the quantity of vegetables and economic gains, which can lead to food waste. Traders aged 41-50 years and older are more mindful of vegetable storage and handling. They also carefully plan their purchases from suppliers to avoid overstock. Age is a significant factor influencing attention span and mindset, as it can lead to changes in perspective, work capability, productivity, and decision-making processes (Azizah et al., 2021).

Turnover also plays a critical role. Traders with higher turnover often sell vegetables in large quantities, facilitated by adequate storage facilities in the market. These traders are better positioned to purchase vegetables from suppliers using appropriate transportation facilities, allowing them to maintain vegetable quality are more effectively. Such traders frequently separate or discard vegetables of lower quality.

In contrast, traders with lower daily turnover typically rely on existing, less optimal transportation facilities to minimize logistics costs. They tend to purchase only enough vegetables to meet immediate demand, thereby avoiding overstocking and waste. Regardless of turnover, both high- and low - turnover traders sell vegetables of reduced quality at lower prices to mitigate losses (Nainggolan et al., 2023).

Traders should minimize food waste by using packaging appropriate to the type of vegetable. Additionally, they should consider ordering small quantities more frequently, regularly evaluating ordering policies, and conducting strict inspections of easily perishable vegetables, which are primary source of food waste due to their short shelf life.

To maintain the freshness of unsold vegetables, traders can spray them with water, leave them in open spaces, or wrap them in plastic. If the freshness period has passed, an alternative is to prepare the vegetables for processing by cutting them into ready-to-use portions and selling them in bundles, such as mixed vegetable packs for soups (Mulyana et al., 2019).

The market size where vegetables are sold significantly influences the amount of food waste generated. Large markets typically purchase more from suppliers, which increases the likelihood of food waste. In contrast, small markets tend to smaller quantities, ensuring that their stock is sold out daily.

Traders in small markets often use a transhipment system, where they can obtain additional vegetables from nearby traders when they run out. This approach not only helps maintain supply but also reduces high logistics costs (Budi et al., 2020). Smaller markets, with their lower turnover and smaller purchases, tend to generate less food waste.

4. Conclusion

Food waste is influenced by factors such as short shelf life, spoilage, and damage. In case of vegetables, procurement strategies should focus on minimizing waste. The results show that demographic factors, including age, daily turnover, and market location, significantly affect procurement strategies. Food waste among vegetable traders is partly due to inadequate facilities, insufficient storage space, a lack of knowledge about vegetable shelf life, and improper practices. Activities contributing to food waste include vegetable handling, storage, purchasing, transportation, and gaps in information, and knowledge. Traders should pay attention to packaging that is appropriate for the type of vegetable. Suppliers also play a critical role in minimizing waste by ensuring that the delivery process adequate packaging to maintain vegetable quality. Traders with high turnover are encouraged to adopt effective purchasing strategy from suppliers to reduce vegetable waste. Additionally, they can mitigate losses by selling lower-quality of vegetables at reduced prices or offering them as part of bundling deals.

Moreover, traders, especially those operating on a large scale, are recommended to carefully consider their decisions when sourcing vegetables from suppliers. They are also encouraged to regularly evaluate their orders to align with market demand, ensuring that vegetable turnover is managed more efficiently. Future research could focus on specific types of vegetables to identify tailored treatments and preservation methods. Additionally, future studies could explore the role of suppliers' in reducing food waste in the retail sector, particularly through improved packaging and the strategic placement of vegetable layouts during distribution.

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