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Supply Chain Management for Enhancing the Effectiveness of Free Nutritious Meal Programs

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ABSTRACT

The Free Nutritious Meal Program (Program Makan Bergizi Gratis/MBG) represents a key Indonesian government strategy designed to raise the nutritional health of school children or foster the cultivation of superior human resources. However, the effectiveness of this program largely depends on efficient kitchen operations and well-managed supply chains. This research intends to examine the specific impact of Supply Chain Management (SCM) on the effectiveness of the MBG Program at Dapur Sebelas Bandung, focusing on delivery timeliness, raw material availability, and raw material quality. A quantitative method utilizing a causal research framework was successfully implemented. Data were collected from 50 respondents involved in procurement, processing, and distribution activities using purposive sampling. Structured questionnaires were evaluated using SPSS through validity or reliability tests, descriptive analysis, or multiple linear regression. The results demonstrate that delivery timeliness and raw material availability significantly and positively influence the effectiveness of the MBG Program, emphasizing the critical importance for efficient distribution processes and accurate supply planning to ensure the overall success of this vital national nutritional initiative. Conversely, raw material quality does not show a significant partial effect.

Keywords: Delivery Timeliness; Demand-Based Availability; Raw Material Quality.

INTRODUCTION

Indonesia continues to face serious nutrition challenges, particularly among elementary school-aged children who are in a critical phase of physical and cognitive development. The 2022 Indonesia Nutrition Status Survey (SSGI) indicated a stunting prevalence of 21.6%. While this value reflects an improvement compared to previous years, it continues to surpass the World Health Organization (WHO) threshold remains at 20%, yet the national objective of reducing stunting prevalence below 14% by 2024 has not been successfully achieved. In addition to stunting, issues of wasting and underweight are also prevalent, particularly in 3T regions. This situation underscores the need for sustained and integrated nutrition interventions. Evidence suggests that nutritional interventions targeting school-aged children are important because adequate nutrition contributes significantly to children's physical growth, cognitive development, and learning performance (Nnan et al., 2019; UNICEF, 2023). As part of efforts to tackle nutritional challenges, the Indonesian government launched the Free Nutritious Meals Program (MBG) in early 2024. This initiative is intended to improve nutritional outcomes while strengthening the quality of human capital (Kementerian Kesehatan Republik Indonesia, 2022; Sarjito, 2024).

In an effort to overcome these nutritional issues, the Indonesian government has introduced a number of intervention initiatives, one of which is the Free Nutritious Meals Program (MBG), launched in support of the Indonesia Emas 2045 vision. The initiative intends to offer free, healthy, and nutritious meals to students, specifically those in elementary schools and equivalents, to improve nutritional status, attendance, and educational continuity. Previous studies on school feeding initiatives have demonstrated that providing free meals at school can improve dietary quality, increase nutrient intake, and contribute positively to students' educational participation (A. R. Abizari et al., 2021; Ayogu et al., 2018; Wang, 2021). This program specifically addresses marginalized populations, particularly youth from impoverished families who regularly experience constrained availability regarding nutritious and sufficient dietary resources. With a target beneficiary population of 82.9 million people and a focus on regions with high levels of nutritional vulnerability, the program is expected to deliver multidimensional impacts, including increased school attendance, reduced household economic burdens, and strengthened local economies through the utilization of local food products (Kementerian Koordinator Bidang Pembangunan Manusia dan Kebudayaan, 2024; World Food Programme, 2022). Its execution requires comprehensive cross-stakeholder cooperation, spanning central and regional authorities, academic organizations, plus a highly integrated food supply chain management system for optimal delivery (Kemenko PMK, 2024; Roothaert et al., 2021).

During the practical execution of the Free Nutritious Meals Program, Supply Chain Management (SCM) serves as the primary mechanism coordinating the flow of food from producers to the organizers' kitchens and subsequently to beneficiary schools. Effective supply chain performance is critical to operational efficiency, timely distribution, and the sustainability of food provision. SCM encompasses all stages, from raw material procurement and processing to food distribution (Chopra & Meindl, 2019; Christopher, 2016). Within the framework of school feeding initiatives, a streamlined supply chain is vital to guarantee the accessibility, safety, and superior quality of meals delivered to beneficiaries (Gelli et al., 2019; Kretschmer et al., 2014). Nevertheless, a National Nutrition Agency report indicates that the MBG supply chain execution encounters various obstacles, including insufficient cold storage infrastructure, a lack of skilled personnel specialized in food handling, and inconsistent adherence to established food safety protocols across several key segments of the operational network.

Supply Chain Management (SCM), which is expected to integrate farmers, local food businesses, and public kitchens into the Free Nutritious Meals Program, has not yet been fully optimized. Various obstacles remain, including distribution delays, inconsistent food quality, and weak reporting and monitoring systems. These conditions often force public kitchen managers to make sudden operational adjustments, such as replacing unsuitable raw materials, slowing down production processes, or making emergency menu changes. Studies on food supply chains highlight that weak coordination among supply chain actors and limited logistics capacity can disrupt food distribution and reduce program efficiency (Gligor & Holcomb, 2012; Simchi-Levi et al., 2021). The Bandung City Food Security and Agriculture Agency (DKPP) emphasizes the importance of direct and regular inspections of the eleven MBG community kitchens, given that the quality of food ingredients from suppliers remains unstable.

This indicates that kitchen performance is highly dependent on how effectively Supply Chain Management (SCM) is implemented. This includes the timely provision of raw materials, ensuring the quantity of materials matches production needs, and meeting quality standards for the materials used. Effective supply chain coordination and quality control mechanisms are essential to ensure operational efficiency and service reliability in large-scale food distribution programs (Bowersox et al., 2020; Evans & Lindsay, 2020). When these aspects do not function optimally, the quantity of food produced may be disrupted, distribution delays may occur, menu changes may be made without proper planning, and the satisfaction of kitchen management staff may decline. Therefore, to ensure the Free Nutritious Meal Program runs smoothly and achieves its objectives, the implementation of SCM must be improved through enhancements to the distribution system, quality control of raw materials, and continuous monitoring of distributional network performance.

This research intends to analyze the operational dynamics of program implementation and to investigate the role for Supply Chain Management (SCM) in strengthening institution-based food security. The results are expected to provide practical guidance for improving food distribution systems, enhancing kitchen operational efficiency, and enhancing the practical execution of the Free Nutritious Meal Program across both regional and national institutional frameworks and operational levels.

LITERATURE REVIEW

Delivery Timeliness

elivery timeliness means that orders must be received in full according to the schedule agreed upon between the seller and the buyer, and ideally even sooner than the specified time. Timeliness as a critical aspect in decision-makers' use of information, where information must be available and utilized before it loses its value and relevance. Thus, for users, time is a crucial factor because the information provided must be current and relevant, not outdated or lacking strategic value.

Availability of Raw Materials

Inventory as an organization's current asset consisting for raw materials, work-in-progress, or finished goods. Inventory also as goods owned by a company for resale or use in operational activities. Additionally, inventory can be understood as unused resources that hold economic value in the future when utilized in production or operational processes.

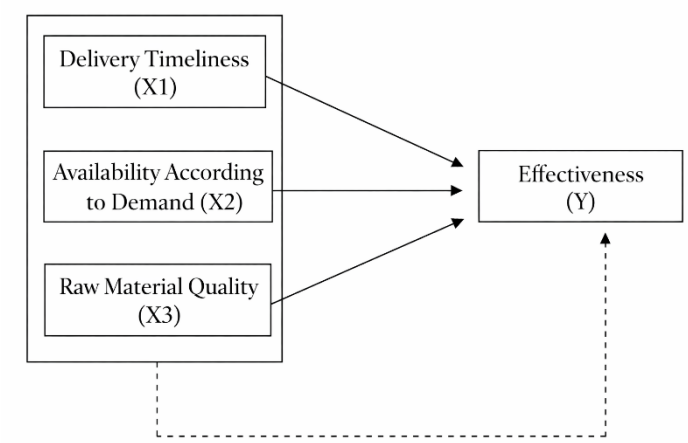
Raw Material Quality

Quality refers to a product, whether goods or services, ability to meet consumer needs and expectations. Quality also as a set of product characteristics that make it suitable for

its intended functions and purposes. Raw materials are the primary components used in the production process and form an integral part of the final product. Raw materials as the primary building blocks of finished products. The quality of raw materials is determined by their reliable origin and having undergone quality testing, making them suitable for use in the production process and directly contributing to the creation of a high-quality, functional final product.

A conceptual model that illustrates the relationships among the variables under study is referred to as a conceptual framework. The conceptual framework provides a structured framework for research, assisting the investigator in identifying the specific variables required for empirical analysis, the research methods to be applied, and the data analysis techniques to be used (Sugiyono, 2025). The conceptual framework regarding this investigation is exposed within Figure 1.

Figure 1. Conceptual Framework



Hypotheses Development

H1: Timeliness of raw material delivery in supply chain management (X1) has a significant influence on the effectiveness of the Free Nutritious Meals Program (Y) at Dapur Sebelas Bandung.

H2: The availability of raw materials according to operational demand within supply chain management (X2) significantly affects the effectiveness of the Free Nutritious Meals Program (Y) at Dapur Sebelas Bandung.

H3: Raw material quality in supply chain management (X3) significantly influences the effectiveness of the Free Nutritious Meals Program (Y) at Dapur Sebelas Bandung.

H4: Delivery timeliness (X1), demand-based raw material availability (X2), and raw material quality (X3) simultaneously have a significant effect on the effectiveness of the Free Nutritious Meals Program (Y) at Dapur Sebelas Bandung.

RESEARCH METHOD

This research utilizes a quantitative causal study framework to evaluate relationships between analyzed variables. Data were gathered through Likert-scale instruments distributed to participants within the Free Nutritious Meals Program, specifically focusing on operational kitchen staff and logistical distribution personnel. The researcher utilized the Likert scale (Sugiyono, 2018).

Sample

This research utilized a non-probability approach specifically through a purposive sampling, as the respondents possessed specific characteristics and were directly involved in kitchen operations and supply chain management, such as production staff, logistics personnel, kitchen supervisors, and those responsible for raw material distribution. Sample selection was based on the relevance of the respondents' roles and experience to the research subject (Sugiyono, 2019). Out of a total of approximately 60 active personnel at Dapur Sebelas Bandung, 50 respondents were selected as the research sample, which was deemed sufficient for quantitative analysis and regression testing.

Data Analysis Techniques

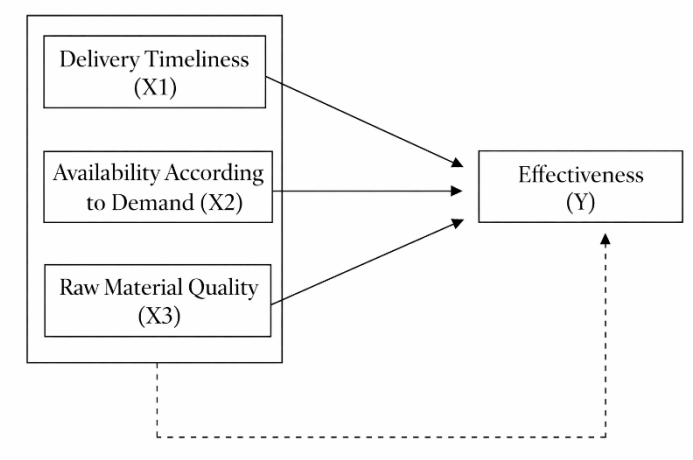
This research employed a quantitative approach with data processing conducted through the Statistical Package of the Social Sciences (SPSS). Information was collected using a survey instrument derived from theoretical constructs and evaluated to investigate associations between predictor and response variables inside the proposed framework. Methodological procedures comprised validity or reliability testing, descriptive statistics, the coefficient of determination, or multiple linear regression was implemented to assess individual and collective impacts exerted by independent factors upon the dependent variable. The use of SPSS aims to test and verify the research model that has been constructed based on theoretical foundations through systematic testing of classical assumptions and hypotheses (Sugiyono, 2018).

RESULTS

Descriptive Analysis

A summary of respondents' opinions from the descriptive analysis indicates that the performance of Supply Chain Management in the implementation of the Free Nutritious Meals Program falls into the "good to effective" category. The variable of delivery timeliness received a "on-time" rating, reflecting that food distribution generally proceeds according to schedule and logistical challenges can be addressed promptly, although the alignment of price with quality still needs improvement. The procurement of raw materials matching demand was similarly assessed as "adequate" indicating that the management of costs and raw material volumes has been efficient; however, strengthened oversight is still needed to maintain consistency in shipment quantities. Meanwhile, the quality of raw materials falls into the "high-quality" category, particularly regarding economic value and suitability for use, although supply continuity remains a challenge. Overall, the performance of the MBG Program is assessed as effective, as demonstrated by strong operational adaptability; however, improvements in quality control and distribution accuracy are still necessary to ensure the program's sustained effectiveness.

Figure 1. Conceptual Framework



Validity Test

Table 1. Validity Test Result

Variable	Indicator	R-Value	R-Table	Notes
Delivery Timeliness	X1.1	0.900	0.279	V
	X1.2	0.909	0.279	V
	X1.3	0.910	0.279	V
	X1.4	0.903	0.279	V
Availability According to Demand	X2.1	0.846	0.279	V
	X2.2	0.922	0.279	V
	X2.3	0.940	0.279	V
	X2.4	0.945	0.279	V
Raw Material Quality	X3.1	0.830	0.279	V
	X3.2	0.923	0.279	V
	X3.3	0.927	0.279	V
	X3.4	0.873	0.279	V
Program Effectiveness	Y.1	0.918	0.279	V
	Y.2	0.911	0.279	V
	Y.3	0.884	0.279	V

Source: Author's Data Analysis (2025)

From Table 1, based on validity assessment results, every item within each variable demonstrated a calculated r-value exceeding the critical r-table value. This indicates that the indicators for the variables of on-time delivery, on-demand availability, raw material quality, and program effectiveness have met the validity criteria; therefore, all questionnaire items are deemed suitable for use as research instruments.

Reliability Test

Table 2. Reliability Test Result

Variable	*Cronbach's Alpha*	Coefficient	Notes
Delivery Timeliness	0,924	0,60	Reliable
Availability According to Demand	0,933	0,60	Reliable

Raw Material Quality	0,909	0,60	Reliable
Program Effectiveness	0,883	0,60	Reliable

Source: Author's Data Analysis (2025)

As presented in Table 2, all variables in the study exhibit Cronbach's Alpha values above the threshold of 0.60, indicating acceptable reliability. These findings indicate that the instruments used to measure delivery timeliness, inventory, raw material quality, and program effectiveness have met the reliability criteria, thereby providing consistent and reliable measurement results.

Multiple Linear Regression Analysis

Table 3. Multiple Linear Regression Result

Mode	*Unstandardized. B.*	*Coefficient. Standar Error.*	SCB	t.	Sig.
Constant	1.327	0.418		3.178	.003
Delivery Timeliness	.381	.098	.559	3.890	.000
Availability According to Demand	.333	.076	.489	4.363	.000
Raw Material Quality	-.049	.067	-.072	-.722	.474

Source: Author's Data Analysis (2025)

Based on the above analysis (Table 3), the values obtained are a = 1.327, β1 = 0.381, β2 = 0.333, and β3 = -0.049. From these results, the following equation can be formulated:

$$Y = a + \beta1.x1 + \beta2.x2 + \beta3.x3 + \beta4.x4 + e$$

Y= 1.327 + 0.381 Delivery Timeliness + 0.333 Availability According to Demand - 0.049 Raw Material Quality + e

Interpretation:

1. The constant of 1.327 indicates the baseline level of Program Effectiveness (Y) when the variable delivery timeliness (X1), on-demand availability (X2), and raw material quality (X3) are at zero or have no influence. The constant value obtained in the regression model indicates that program effectiveness can still be maintained even without the contribution of the three independent variables examined in this research. This condition implies that there are other determinants outside the proposed research model that may also influence the effectiveness of the Free Nutritious Meals Program.
2. The delivery timeliness variable (X1) shows a regression coefficient of 0.381, which reflects a positive relationship for program effectiveness (Y). This result implies that improvements in the punctuality of raw material delivery tend to increase program effectiveness, assuming that the availability and quality of raw materials remain unchanged. The significance value of 0.000 (< 0.05) confirms that this correlation is on statistics significant. These findings highlight the importance of timely raw material distribution as a critical element in strengthening the overall

effectiveness of the Free Nutritious Meals Program. This finding aligns with previous scholarly research (Kretschmer et al., 2014) and (Souza & Fornazier, 2022), which emphasize that delivery timeliness contributes to improved operational efficiency and service performance. Therefore, the hypothesis proposing a positive influence of delivery timeliness on program effectiveness is accepted.

3. The on-demand availability variable (X2) has a regression coefficient of 0.333, indicating a positive influence on program effectiveness (Y). This indicates that an increase in the ability to supply raw materials on demand will drive an increase in program effectiveness, assuming other variables remain constant. The analytical results demonstrate a statistical significance level of 0.000 (< 0.05), demonstrating that the relationship is significant. These findings demonstrate that the procurement of raw materials matching demand establish a crucial role in maintaining the operational continuity and overall effectiveness of the Free Nutritious Meals Program. This result corresponds with previous scholarly research Kneafsey et al. (2013) and Carbone (2018), who emphasize the role of raw material availability in supporting service quality and supply chain continuity.
4. The raw material quality variable (X3) produces a regress coefficient of −0.049 at a significance level of 0.474 (> 0.05), indicating those this variable does not significantly influence program effectiveness (Y). The negative coefficient suggests that improvements in raw material quality do not necessarily translate into higher program effectiveness. This finding aligns with the views of Heizer and Render (2016) and Handoko (2011), who state that the impact of quality will be significant only if the supply chain and operational systems are functioning optimally. Furthermore, improving quality may also lead to trade-offs such as increased costs or supply delays, which can affect overall effectiveness (Chopra & Meindl, 2019). Consequently, within the Free Nutritious Meals Program, implementation effectiveness is more profoundly influenced by distribution efficiency and supply stability than by raw material quality, which generally adheres to established standards and fulfills the necessary criteria within the current logistical operational framework.

Analysis of The Coefficient of Determination

Table 4. Coefficient of Determination Result

Mode	R	R.*Square*	*Adjusted.R Square*	*Std. Error.of the Estimate*
1	.966	.933	.929	0.608

Source: Author's Data Analysis (2025)

Table 4, results of the coefficient of determination analysis, exposed a coefficient of determination (R^2) of 0.933. This finding indicates that on-time delivery, on-demand availability, and raw material quality together account for 93.3% of the variation in program effectiveness. Meanwhile, the residual 6.7% of the variance is assigned to element beyond this research model, such as internal policies, logistics management, human resource quality, and external conditions not analyzed in this study.

F-Test Hypothesis

Table 5. F-Test Hypothesis Result

Model.	*Sum of Squares.*	Df.	*Mean Square*.	F.	Sig.
Regression.	237.473	3	79.158	96.681	.000[b]
Residual	17.007	46	0.370		
Residual	254.480	49			

Source: Author's Data Analysis (2025)

Referring to Table 5 results from the simultaneous hypothesis testing (F-test) demonstrate a significance level of 0.000 (< 0.05), with an F-statistic of 214.101 exceeding the critical F-value of 2.79. This statistical evidence necessitates rejecting the null hypothesis (H_0) or accepting the alternative hypothesis (H_a). These findings confirm that delivery timeliness, demand-based raw material availability, and raw material quality jointly influence the effectiveness of the program. Consequently, the integration of these three independent variables provides a significant explanation for the variation observed in the effectiveness of the Free Nutritious Meals Program.

DISCUSSION

The findings of this investigation indicate that supply chain management set a crucial role in determining the effectiveness of all the Free Nutritious Meal Programs implemented specifically at Dapur Sebelas Bandung. Effective supply chain management coordinates the procurement, distribution, and operational processes required for large-scale meal preparation. In public food service programs, the effectiveness of service delivery is strongly influenced by how well logistics systems and resource flows are organized and integrated across operational units (Bowersox et al., 2020; Chopra & Meindl, 2019; Christopher, 2016; Simchi-Levi et al., 2021). Efficient supply chain coordination allows organizations to ensure consistent service provision while minimizing operational disruptions and resource inefficiencies (Handfield et al., 2019; Mentzer et al., 2001). Within public sector programs, well-managed operational systems are widely recognized as essential factors in achieving effective service outcomes (Andrews & Van de Walle, 2013; Boyne, 2003).

One of the main findings of this study is that delivery timeliness significantly contributes to program effectiveness. Timely delivery ensures that raw materials arrive according to production schedules, which is essential for maintaining smooth kitchen operations and continuous meal preparation. In supply chain management literature, delivery reliability is widely considered a key determinant of service performance because it ensures synchronization between supply activities and operational processes (Chopra & Meindl, 2019; Christopher, 2016; Krajewski et al., 2016). When logistics operations function efficiently, organizations can reduce delays, maintain operational stability, and improve overall service outcomes (Gligor & Holcomb, 2012; Granillo-Macias, 2021). Comparable results were previously identified in research concerning school feeding logistics, where reliable food distribution systems are critical for maintaining the consistency and effectiveness of meal programs (Kretschmer et al., 2014; Souza & Fornazier, 2022).

In addition to delivery timeliness, the availability of raw materials based on operational demand was also found to significantly influence program effectiveness. Adequate supply availability ensures that kitchen operations can continue without interruptions caused by shortages or procurement delays. From a supply chain perspective, demand–supply alignment is a fundamental principle for achieving operational efficiency and responsiveness (Chopra & Meindl, 2019; Simchi-Levi et al., 2021). Accurate demand forecasting and effective inventory planning allow organizations to maintain optimal stock levels and prevent supply disruptions (Handfield et al., 2019; Krajewski et al., 2016). In public food assistance programs, the stability of food supply is particularly important because supply interruptions can directly affect meal provision for beneficiaries (Gelli et al., 2019; Setiawan, 2024). Prior investigations also emphasize that efficient procurement and supply management systems play a crucial role in set the long-term success of school feeding initiatives (dos Santos et al., 2022; Roothaert et al., 2021).

Interestingly, the findings demonstrate that primary component quality lacks statistical significance direct effect on program effectiveness. This finding implies that within large-scale public food service operations, operational reliability and supply continuity represent more decisive factors than specific individual product attributes. In environments where food preparation follows standardized procedures and quality control systems, variations in raw material quality may have less influence on overall operational performance. Supply chain literature emphasizes that reliability, coordination, and process integration often represent the primary drivers of operational success in complex distribution systems (Christopher, 2016; Handfield et al., 2019; Simchi-Levi et al., 2021). Therefore, maintaining stable supply flows and reliable logistics coordination may contribute more significantly to program effectiveness than focusing solely on product-level characteristics.

Simultaneously, the combined influence of delivery timeliness, raw material availability, and raw material quality highlights the importance of integrated supply chain management in supporting program effectiveness. Integrated supply chain systems allow organizations to synchronize procurement, inventory management, and distribution processes, thereby improving efficiency and service reliability (Mentzer et al., 2001; Simchi-Levi et al., 2021). In large-scale food service and school feeding programs, integrated supply chain structures are considered essential for maintaining operational stability and ensuring that program objectives can be achieved effectively (Kretschmer et al., 2014; Liu, 2023).

These investigations are in line with prior investigations demonstrating the critical importance of efficient food distribution systems in supporting the overall success of school feeding programs. Empirical research in various countries shows that well-managed school meal programs contribute to improved nutritional intake and better dietary quality among school-aged children (A. R. Abizari et al., 2014; A.-R. Abizari et al., 2021; Ayogu et al., 2018). Systematic reviews further indicate that school feeding initiatives can generate positive impacts on children's health, nutrition, and educational participation when program implementation is supported by reliable operational systems (Destaw et al., 2022; Wang, 2021). International evaluations of food assistance programs also highlight that strong coordination between procurement systems, logistics management, and operational planning is critical for ensuring the sustainability and long-term effectiveness of such initiatives (World Food Programme, 2022; Zuercher et al., 2024).

From a practical perspective, these findings emphasize the importance of strengthening logistics coordination, demand forecasting, and inventory planning to increase operational efficiency of the Free Nutritional Food Program.. Strengthening these operational components can help ensure stable food supply, minimize logistical disruptions, and enhance the sustainability of program implementation. Considering the strategic role of nutritional assistance programs in improving human capital development, effective supply chain governance becomes essential to ensure that such programs operate efficiently and deliver consistent benefits to their target populations (Kementerian PPN/Bappenas, 2023; Marnia, 2024; Sarjito, 2024).

CONCLUSION

The result of this research demonstrate that Supply Chain Management plays a critical role in influencing the effectiveness of the Free Nutritious Meal Program at Dapur Sebelas Bandung. The results indicate that delivery timeliness and the availability of raw materials based on operational demand both exert a positive or statistically significant impact for the overall program effectiveness. This implies that well-managed distribution

processes and accurate supply planning are crucial factors in supporting efficient kitchen operations. In contrast, raw material quality did not show a significant direct effect, suggesting that logistics coordination and supply reliability are more decisive factors in supporting program performance. Simultaneously, the three variables collectively contribute to program effectiveness, highlighting the importance of integrated supply chain management in public food service programs. Practically, these findings imply the need to strengthen logistics coordination, demand forecasting, and inventory planning to improve operational efficiency and program sustainability. For subsequent investigations, it is advised to integrate further variables like human resource proficiency, distribution monitoring mechanisms, and logistical technology, while expanding the research to various locations and extended observation windows to improve the overall generalizability of the results obtained within this specific pilot study.

LIMITATION

Several constraints must be acknowledged when evaluating the outcomes of this investigation. This research was conducted within a singular program implementation unit, specifically Dapur Sebelas Bandung, which might limit the generalizability of these findings to alternative locations with differing operational frameworks. Furthermore, the study employed a relatively modest sample consisting of participants involved in procurement, processing, and distribution tasks. This restricted sample size may not comprehensively capture the intricate complexity of the broader supply chain architecture inherent to the initiative. Third, the analysis focused only on three Supply Chain Management variables such as delivery timeliness, availability according to demand, and raw material qualy, while other potential determinants, such as human resource competence, distribution monitoring systems, and logistics technology utilization, were not included in the model. These constraints imply that the findings must be evaluated strictly within the parameters of the specific research methodology and defined scope.

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DECLARATION OF CONFLICTING INTERESTS

This investigation was conducted without any potential conflicts of interest concerning its final publication.

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