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STRENGTHENING FOOD SECURITY VIA ECONOMIC, BUDGETARY AND TRANSPARENCY

FORTALECIMENTO DA SEGURANÇA ALIMENTAR POR MEIO DA ECONOMIA, ORÇAMENTO E TRANSPARÊNCIA

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Abstract
The Free Nutritious Food (MBG) program in North Sulawesi aims to address the problem of malnutrition and stunting in Eastern Indonesia by giving schoolchildren access to healthy food. The purpose of this study is to investigate the economic impact, budget optimization, transparency, and mediating role of community participation in the management of MBG on food security. The quantitative method was used with a structured survey approach, and the data were taken directly from the respondents. The SmartPLS 4 application is used to perform structural equation modeling analysis based on Partial Least Squares (PLS-SEM). The research population consists of students, teachers, MSME actors or traders, and MBG kitchen managers. Because the population is unknown, the sample determination uses the Lemeshow formula so that the sample is at least 385 respondents. However, to obtain a representative sample, the questionnaire was

Resumo
O programa de Alimentação Nutritiva Gratuita (MBG) em Sulawesi do Norte tem como objetivo enfrentar o problema da desnutrição e do atraso no crescimento infantil no leste da Indonésia, proporcionando às crianças em idade escolar acesso a alimentos saudáveis. O objetivo deste estudo é investigar o impacto econômico, a otimização orçamentária, a transparência e o papel mediador da participação comunitária na gestão do MBG sobre a segurança alimentar. Foi utilizado o método quantitativo com uma abordagem de pesquisa estruturada, e os dados foram coletados diretamente dos respondentes. O aplicativo SmartPLS 4 foi usado para realizar a análise de modelagem de equações estruturais baseada em Mínimos Quadrados Parciais (PLS-SEM). A população da pesquisa é composta por estudantes, professores, empreendedores de MPMEs ou comerciantes e gestores das cozinhas do MBG. Como o tamanho da

distributed as widely as possible to the research population. A total of 971 respondents from six districts/cities, namely Manado, Bitung, Minahasa, Southeast Minahasa, Sangihe, and Sitaro, answered the questionnaire. The results indicate that all three independent variables contribute positively to increased food security, and this relationship is strengthened by active community engagement. Economic impact increases people's ability to meet their nutritional needs, budget optimization improves the efficiency of food distribution, and management transparency increases program accountability. Community participation ensures the sustainability and effectiveness of MBG.

Keywords: Budget Optimization. Community Participation. Economic Impact. Food Security. Free Nutritious Food Program (MBG).

população é desconhecido, a determinação da amostra foi feita utilizando a fórmula de Lemeshow, estabelecendo um mínimo de 385 respondentes. No entanto, para obter uma amostra mais representativa, o questionário foi amplamente distribuído entre a população pesquisada. Ao todo, 971 respondentes de seis distritos/cidades — Manado, Bitung, Minahasa, Minahasa do Sudeste, Sangihe e Sitaro — responderam ao questionário. Os resultados indicam que as três variáveis independentes contribuem positivamente para o aumento da segurança alimentar, e essa relação é fortalecida pelo engajamento ativo da comunidade. O impacto econômico aumenta a capacidade das pessoas de atender às suas necessidades nutricionais; a otimização orçamentária melhora a eficiência na distribuição de alimentos; e a transparência na gestão reforça a responsabilidade do programa. A participação comunitária garante a sustentabilidade e a eficácia do MBG.

Palavras-chave: *Impacto econômico. Otimização orçamentária. Participação comunitária. Programa de Alimentação Nutritiva Gratuita (MBG). Segurança alimentar.*

1 INTRODUCTION

1.1 Background of the study

The Free Nutritious Food (MBG) program was initiated in response to the high rates of stunting and malnutrition in Indonesia, particularly in the eastern region (KUSUMO *et al*., 2025; SUTANTO, 2025). The program's primary goal is to help people get more access to healthy food, especially those who are most at risk, like children, pregnant women, and breastfeeding mothers (RUFFINI; ÖZTÜRK; PEKGÜN, 2025). The World Health Organization (WHO, 2024) says that malnutrition is still one of the main reasons why children in developing countries, like Indonesia, do not grow properly. The Indonesian government needs the MBG program to help it become self-sufficient in food and improve the health of the 19.47 million people who benefit from it. The program

has a budget of IDR 71 trillion in the 2025 State Budget, which could go up to IDR 170 trillion (HAINORRAHMAN, 2025; YUANTISYA, 2025). This budget coverage, on the other hand, makes it harder to manage public finances, especially when it comes to making local food purchases clear and using revenue wisely (HAINORRAHMAN, 2025). The program will only work if resources are distributed quickly and fairly, and governments can make sure that happens. Food self-sufficiency is the primary goal of the national food security policy (ALIPOUR *et al*., 2025; XIE *et al*., 2025). The MBG program's goal is to help people become food self-sufficient by increasing the amount of food grown and eaten in their communities (BHAT *et al*., 2021; BILLINGS; CARTER, 2020; DE CAMARGO *et al*., 2024). One of the initiatives undertaken is the use of 30–40% of local food through MSMEs (XIE *et al*., 2025; FETRIYUNA *et al*., 2023; SANZ SANZ *et al*., 2024). However, no accounting system currently exists that ensures the budg*et al*igns with the local economy's production capabilities (AGÉNOR; DA SILVA, 2025). There are no technical instructions for buying food, and prices can vary by 15–20% between regions. This makes it more likely that the program will not work as well as it should (BILLINGS; CARTER, 2020; RUFFINI; ÖZTÜRK; PEKGÜN, 2025)

Poor management can lead to supply and distribution issues, making the MBG program less effective (SIDERIUS *et al*., 2024; ZHANG *et al*., 2025). Although being self-sufficient in food is challenging, the MBG program is also susceptible to corruption and waste of funds (BILLINGS; CARTER, 2020; POOLE *et al*., 2025). This indicates that prices can increase by 20–25% within the MBG supply chain, particularly during the buying and distribution stages. The lack of independent audits and the difficulty of coordinating between the central and local governments are making it more likely that the budget will be misused (FETRIYUNA *et al*., 2023; MAZZOCCHI, 2025). Without a sound monitoring system, funds for this program could be lost, making it harder to achieve its primary goal of improving community nutrition and the local economy through MSMEs and the agricultural sector (LI *et al*., 2024). One of the problems with implementing MBG from a public sector accounting perspective is that the public cannot access procurement records and program evaluations (KIDD; REYNOLDS, 2024).

For this program to work, the budget needs to be clear (BILLINGS; CARTER, 2020; KIELB *et al*., 2023). The Government Accounting Standards (SAP) reporting system does not yet have all of the requirements for real-time monitoring (KIELB *et al*., 2023). Because of this, the government struggles to determine the cost of each serving of

healthy food to the recipients. This reporting system's lack of efficiency can make it hard to evaluate programs. It can also make it take longer to fix problems that arise while MBG is being implemented. Another problem that needs to be fixed is the lack of coordination between the central government and local governments regarding financial matters. The MBG program can work better with a decentralized fund allocation system if it takes into account the regions' financial capabilities. National and regional budgets need to work together more closely to avoid duplicating efforts or implementing the same policies. This is necessary because the regional budget is expected to give IDR 23.77 trillion to this program (KUSUMO *et al*., 2025).

This study examines three key areas: the impact of MBG management on food security, strategies for improving budget effectiveness, and the transparency of management practices. The MBG program has a significant effect on Indonesia's economy and food security, both in the short and long term. This needs to be looked at. First, this plan boosts the demand for locally grown food by spending 30–40% of the budget on buying from local farmers and small businesses (AGÉNOR; DA SILVA, 2025; RUFFINI; ÖZTÜRK; PEKGÜN, 2025). Experts say that this will bring in IDR 63,500 for every IDR 1,000 spent. Pilot projects in ten areas also showed that MSMEs hired an average of three more workers, which made household income more stable. This program will also make MSMEs less dependent on imports, which will boost their income (VERICKER *et al*., 2023). The MBG program's primary goal is to improve food security structurally. It achieves this by leveraging local resources, collaborating with various groups, and optimizing budget utilization through fiscal efficiency techniques. The government took IDR 306.69 trillion from non-productive spending to pay for MBG. This raised the percentage of direct spending to the public in the 2025 State Budget from 62.4% to 72.1% (SOFIA, 2025; YUANTISYA, 2025). Hybrid financing methods, such as co-funding schemes and specific tax allocations, are also employed to ensure the program's sustainability without increasing debt (SETIAWAN, 2024). The management of the MBG needs to be transparent in order to improve Indonesia's food security.

Independent audits with clear reporting systems enable the public to monitor budget usage, reduce the risk of corruption, and ensure accountability (DAHL *et al*., 2024). Also, openness ensures that everyone has the same access, especially for vulnerable groups, and that the food that the beneficiaries receive is of good quality. Also, when people in the community help teach and keep an eye on nutrition, they learn more

about how important it is to eat healthy food. In general, being open helps the MBG program last longer, which makes the country's food supply and nutrition better.

In the last ten years, there has been more research on food security interventions, with a focus on their long-term viability, economic impact, and effectiveness (IKUDAYISI; ADEJUMO, 2025; MAZZOCCHI, 2025). Economic impact assessments show how food programs help families, lower poverty, and boost the local economy (AGÉNOR; DA SILVA, 2025). For instance, cash transfer and food assistance programs have been shown to make people spend more on food, eat a wider variety of foods, and be less likely to be affected by price shocks (DAD *et al*., 2023).

However, research in Indonesia and similar places suggests that these types of programs are only effective when they are well-targeted, appropriately delivered, and integrated with local economies (SETIAWAN, 2024). Programs that overlook the functioning of the local economy may unintentionally create dependency, disrupt local food markets, or fail to reach the most vulnerable groups (SAENZ; KESSLER; NELSON, 2022).

Due to limited resources, public budgets for food security programs must be optimized (IBOK *et al*., 2025). Budget optimization involves making the most of limited resources to achieve the best results. To do this, you need to plan based on data, do a cost-benefit analysis, and have strong monitoring systems (MELIALA; DJAMALUDDIN, 2024). Studies have shown that poor budgeting and disorganized program management can cause leaks, waste, and lower program effectiveness (ANOKYE *et al*., 2024b).

In Indonesia, reforms in the public sector have aimed to improve the budgeting process through the use of performance-based budgeting and digital financial management systems. However, there are still problems with implementation, especially at the local level, where there is not much technical expertise or oversight (SETIAWAN, 2024). Studies show that optimizing a budget is not just a technical problem, but also a problem of governance that needs cooperation between different sectors and levels of government (MELIALA; DJAMALUDDIN, 2024).

More and more people are realizing that openness is a key factor in the success of programs, especially those that deal with public food security (ANOKYE *et al*., 2024b). Open data, participatory monitoring, and social audits are examples of transparency mechanisms that let stakeholders follow the flow of resources, keep an eye on results, and hold implementers accountable (DAHL *et al*., 2024). Recent meta-analyses have shown

that being open and honest builds trust, cuts down on corruption, and makes social services work better (ANOKYE *et al*., 2024b; NUGROHO *et al*., 2022).

However, in many developing areas, where institutions are weak, access to information is limited, and citizens are not involved, achieving genuine transparency remains challenging (DAHL *et al*., 2024). Although there have been some improvements in government transparency efforts in Indonesia, the effectiveness of these changes at the programmatic level remains inconsistent.

Based on the information above, this study addresses several key research questions. It investigates whether the MBG program's economic impact contributes to food security in Eastern Indonesia, whether budget optimization within the program influences food security, and whether management transparency plays a significant role in achieving this goal. Furthermore, it examines whether community participation serves as a mediating factor that strengthens the effects of the MBG program's economic impact, budget optimization, and management transparency on food security. Aligned with the National Research Master Plan 2017–2045, which emphasizes issues in social sciences and humanities, particularly governance and research on food self-sufficiency, this study adopts a structured, quantitative approach. Its novelty stems from earlier collaborations where teachers evaluated the quality of local government financial statements and the management of regional general hospitals in North Sulawesi province. While prior research has assessed local government financial reports to understand business operations, there remains a gap in exploring how greater transparency and efficient budget use in government programs can improve food security. Moreover, no previous studies have analyzed the MBG program specifically from a Public Sector Accounting perspective.

2 LITERATURE REVIEW

Food security is at the center of health, social welfare, and sustainable development plans all over the world (HERLIANA *et al*., 2025; ZHANG *et al*., 2025). Food insecurity is one of the most persistent problems. It is closely related to poverty and malnutrition, as well as problems with policy effectiveness, institutional efficiency, and the long-term use of resources (Febriany, 2023; SAENZ; KESSLER; NELSON, 2022). Free healthy food programs have been widely used as a targeted intervention to help

people who are food insecure, especially those who are most at risk (DAHL *et al*., 2024; SETIAWAN, 2024). However, the success and long-term viability of these kinds of programs depend on how well they balance their economic effects, the best use of resources, and governance. This makes them perfect candidates for analysis using Sustainable Development Theory (SDT).

The World Commission on Environment and Development (WCED) came up with the idea of SDT in the Brundtland Report 1987 (BRUNDTLAND, 1987). It defines SDT as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." SDT stresses the need to find a balance between three interconnected areas: protecting the environment, including everyone in society, and growing the economy (BRUNDTLAND, 1987; KEEBLE, 1988). The theory has changed to support the United Nations' Sustainable Development Goals (SDGs), especially SDG 2—Zero Hunger, which focuses directly on food security and nutrition.

According to SDT, effective programs should not only meet their short-term goals (such as lowering hunger) but also be environmentally friendly, socially acceptable, and financially sound (LÉLÉ, 1991). SDT is a good theory to use when talking about free healthy food programs because it looks at economic sustainability (cost-effectiveness and efficient budgeting), social sustainability (equity, participation, and inclusion), and environmental sustainability (local sourcing, reducing waste, and ecological impacts). This approach with many dimensions lets researchers and policymakers figure out if food security programs are not only effective in the short term, but also long-lasting, adaptable, and sustainable (CERVANTES-GODOY; DEWBRE, 2020).

More than 700 million people are still chronically undernourished, even though the world is making progress. This problem is especially bad for children, women, and people living in rural areas of low- and middle-income countries (CERVANTES-GODOY; DEWBRE, 2020). The COVID-19 pandemic, climate change, conflict, and economic shocks have all made people more vulnerable. This is why food security is a top priority for both the world and the US (IBOK *et al*., 2025; MELIALA; DJAMALUDDIN, 2024).

Free healthy food programs have become an essential component of social protection policies, particularly in regions where market-based or self-provisioning solutions are insufficient. These initiatives typically include school feeding programs,

community-based meal services for the elderly and the impoverished, and targeted nutrition interventions for pregnant women and infants (MATSUZAKI *et al*., 2025; SETIAWAN, 2024). Beyond addressing hunger, such programs also contribute to broader outcomes in education, health, and social inclusion (ANOKYE *et al*., 2024a; ANOKYE *et al*., 2024b). Evidence from Southeast Asia and Sub-Saharan Africa demonstrates that well-managed free food initiatives can reduce stunting, enhance cognitive development, and build community resilience (SETIAWAN, 2024). Direct benefits include improved health outcomes, healthier eating habits, and reduced household food expenditures (MAZZOCCHI, 2025). In Indonesia, the expansion of school feeding programs has been linked to increased school attendance and reduced child labor (SETIAWAN, 2024). Indirect benefits also extend into local economies, as sourcing food locally strengthens rural supply chains, creates employment opportunities (ANGGRAENI; HANDAYATI; NOVANI, 2022), and supports local farming and businesses (MUSICUS *et al*., 2021), aligning with the economic pillar of the SDT.

H1: The economic impact of free nutritional meals has a positive effect on food security.

H2: Optimization of the MBG program budget has a positive effect on food security.

H3: The transparency of the MBG program has a positive effect on food security.

Despite these positive outcomes, challenges remain. The effectiveness of free food programs can be undermined by weak targeting and poor management (ANOKYE *et al*., 2024b). Moreover, careful program design is necessary to mitigate risks of dependency and potential market distortions (MAZZOCCHI, 2025). The SDT framework emphasizes the importance of cost-effectiveness to ensure long-term sustainability beyond short-term funding cycles (LÓPEZ-GAMERO *et al*., 2025). To achieve this, many organizations are adopting performance-based budgeting, flexible funding mechanisms, and real-time financial monitoring to maximize resource efficiency (MUSICUS *et al*., 2021). Evidence suggests that programs incorporating evidence-based budgeting and continuous feedback loops, both principles highlighted by the SDT, are more adaptable and sustainable over time (IKUDAYISI; ADEJUMO, 2025). In the Indonesian context, decentralized budget management and local government participation have been shown to enhance responsiveness and efficiency (SETIAWAN, 2024). Furthermore, digital innovations such as e-finance platforms and mobile reporting improve transparency and

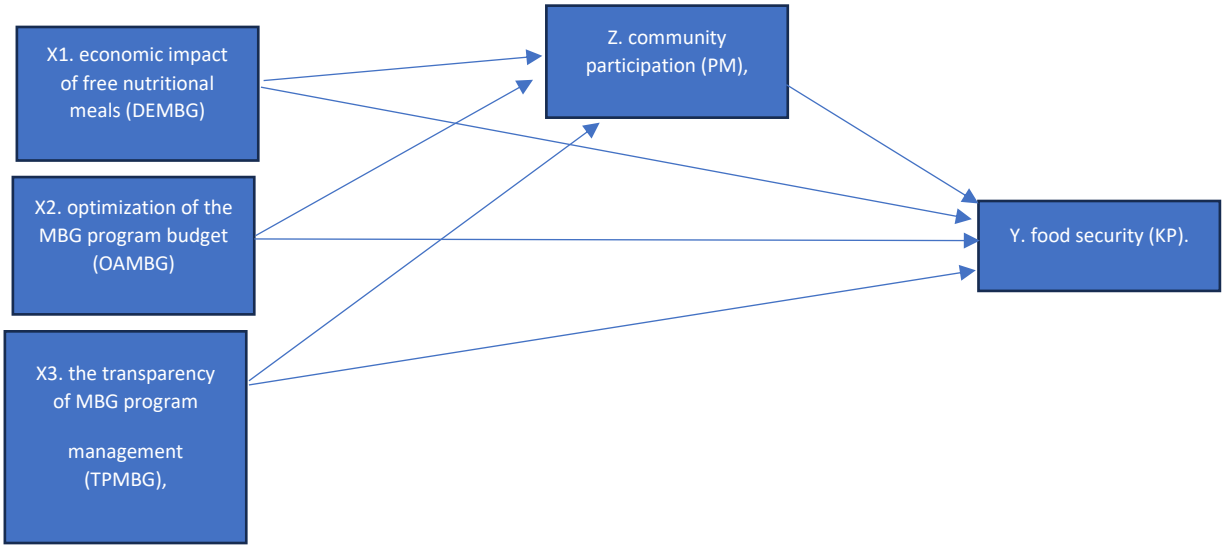
accountability by reducing opportunities for corruption and leakage (NUGROHO *et al*., 2022). Ultimately, ensuring transparency in program design, funding, and implementation, through mechanisms such as open data initiatives, participatory monitoring, and independent audits, remains fundamental to the long-term effectiveness and success of food security programs (KIDD; REYNOLDS, 2024).

H4, H5, H6: Community participation mediates the impact of economic impact, budget optimization, and MBG transparency on food security.

2.1 Conceptual framework

Figure 1

Research Framework



The study framework model is depicted in **Figure 1**.

3 MATERIALS AND METHODS

3.1 Methodology

To assess the success of the MBG Program in achieving food security in North Sulawesi, this study uses a quantitative method with a structural relationship survey approach because it can handle complex relationships between various interrelated variables (TANGESTANI *et al*., 2025). This method makes it possible to analyze the

direct influence of economic impacts, budget optimization, and transparency of the management of the MBG program on food security, as well as through community participation.

3.2 Place, population, and research sample

This research was conducted in regions in North Sulawesi that have implemented the MBG program, namely Manado City, Bitung City, Minahasa Regency, Southeast Minahasa Regency, Sangihe Regency, and Sitaro Regency. Primary and secondary data were used in this study. The population of this study includes all communities connected to the MBG program in North Sulawesi, as well as teachers, students, traders who supply MBG kitchen raw materials, and program kitchens. Primary data were taken directly from the study respondents through questionnaires. The determination of this research sample uses the Lemeshow formula. The use of the formula is because the population number is not known for sure, so the sampling technique is suitable with the Lemeshow formula (GIBSON *et al*., 2025; LI *et al*., 2013).

$$n = \frac{Z^2 \times \mathrm{P} \times (1-\mathrm{P})}{\mathrm{d}^2} \qquad (1)$$

Based on the Lemeshow formula, the minimum sample of this study is 385 with a confidence level (Z) of 95%, the proportion of the population (P) is 0.5, the expected margin of error is generally 5%, but the questionnaire is distributed as much as possible to the community connected to the MBG program, teachers and students who receive the MBG program, traders who have been or are currently suppliers of MBG kitchen raw materials and MBG program kitchens in Manado City, Bitung City, Minahasa Regency, Southeast Minahasa Regency, Sangihe Regency and Sitaro Regency. The number of respondents who filled out the questionnaire was 971 from 6 districts/cities.

3.3 Pre-test

The MBG Program is a new initiative implemented by the current Indonesian government. Following the statements or questions in this questionnaire, a pre-test is

necessary. This test is performed to test convergence, discriminant validity, and reliability validity. The pre-test procedure was carried out with 30 random respondents. The test results show that both the convergent, discriminant, and reliability validity of this study meet, namely the loading factor value for convergent validity above 0.6, the square root value of AVE for each construct is greater than the correlation value with the other constructs, and the reliability value of Cronbach's Alpha and composite reliability is greater than 0.7 (CHUA, 2023; HAIR *et al*., 2017; MIRAN; EVINITA; PESAK, 2025; SETIAWAN *et al*., 2025).

3.4 Measurement

The variables of this study are the economic impact of the MBG program (DEMBG), the optimization of the MBG program budget (OAMBG), the transparency of MBG program management (TPMBG), community participation (PM), and food security (KP). DEMBG, OAMBG, and TPMBG are independent variables, PM is a moderating variable, and KP is a dependent variable. The variables and research indicators were developed using SDT theory.

The economic impact of the MBG program refers to changes in socioeconomic conditions or increases in local income (AGÉNOR; DA SILVA, 2025; SETIAWAN, 2024). The indicators of this variable are increased income, reduced family expenses, increased productivity, and local economic growth (KUSUMO *et al*., 2025; SETIAWAN, 2024). The MBG program budget optimization variable refers to efforts to ensure that allocated funds are used effectively, efficiently, and transparently so that program costs can be controlled. Its indicators include budget use efficiency, budg*et al*location effectiveness, budget accountability, and funding sustainability (FATIMAH; RASYID; ARWAKON, 2024; KIELB *et al*., 2023).

The management transparency variable is defined as openness in planning, implementation, and reporting of budget and program distribution so that the general public and stakeholders can monitor it. The indicators for this variable are the provision of open and comprehensive financial and operational information, the quality and freedom of information flow that ensures accuracy and openness, active stakeholder participation in evaluation mechanisms, and compliance with applicable standards and regulations (HAINORRAHMAN, 2025).

The community participation variable, acting as a moderator, refers to community involvement in the MBG program, including active participation in all aspects of the program such as planning, implementation, monitoring, and evaluation (EZEKEKWU *et al*., 2022). This involvement ensures that the program is sustainable, responsive to the needs of beneficiaries, and efficient and transparent. Its indicators are the level of satisfaction, trust perception, community experience, and the existence of a complaint system (KENT *et al*., 2025; EZEKEKWU *et al*., 2022).

Finally, the food security variable in this study is defined as the sustainable fulfillment of the community's food and nutrition needs, both individually and nationally. The indicators of this variable are food availability, accessibility, utilization, and stability (EZEKEKWU *et al*., 2022; HASSNA *et al*., 2024).

3.5 Data analysis

This study applied descriptive analysis and inferential statistical methods, especially path analysis through Structural Equation Modeling (SEM), which was operated with SmartPLS 4 software (HAIR *et al*., 2017). SmartPLS was chosen for its ability to manage complex models, integrating reflective and formative constructs to analyze the relationship between economic impact, budget optimization, and transparency of MBG program management, and moderator variables such as community participation. Its robustness in analyzing small sample sizes, coupled with its ability to accommodate non-normal data distribution and exploratory research models, makes SmartPLS a perfect fit for this research.

This study used a reflective construct measurement model and performed repeated examinations. Using KLINE's (1998) guidelines, the general method bias (CMB) was first assessed by calculating the internal Variance Inflation Factor (VIF). We strive to achieve a VIF value below 5. This indicates that an outside load value of more than 0.7 and an Average Variance Extracted (AVE) of more than 0.5 are expected. Reliability is determined using the Composite Reliability and Alpha Cronbach tests. Acceptable values are more than 0.7. We calculated the external VIF for each item to check for collinearity between indicators. High collinearity indicates that specific indicators correlate with redundancy in formative measurements. In reality, the VIF should ideally be no more than five. In addition, using a new method, this study examined the bootstrap of the inner

model. The Bootstrapping approach was employed to examine the measurement model, assessing the significance level among variables, the Beta values, and testing the study hypotheses via the P-value, which should be less than 0.05 (HAIR *et al*., 2017).

4 RESULTS

4.1 Respondent profile

This study focuses on a sample of communities connected to the MBG program, namely the schools that receive the program, MSMEs or traders who provide raw materials, MBG kitchens, parents of MBG recipients and the community around MBG recipients, intending to analyze the economic impact, budget optimization and transparency of MBG management on improving food security with the participation of the community as a moderator. The demographic data obtained included age, role in MBG (occupation), and residence. The number of study respondents was 450; 46.3% were in the age range of 20 to 30 years. The second-largest group is those over 30 years old (22.6%), and the third-largest is those between the ages of 15 and 20 (15.3%). This indicates that most respondents work in the productive sector, possess intellectual capacity, and can critically analyze and provide input on the MBG program's implementation. The main participants of the program were those aged under 10 years (4.9%) and those aged 10 to 15 years (10.8%). This happens even though methodologically it requires supervision or companionship during the implementation of the instrument. Therefore, their participation is crucial for assessing the immediate benefits that beneficiaries receive.

The majority of respondents (65.4%) were from other parties who were aware of the MBG program, indicating the program's extensive public information and awareness. Another significant group, MBG recipients (20.4%), showed that this program directly targets the school-age population. The leading actors in the MBG implementation ecosystem are school teachers (6.4%) and MSMEs/traders (7.6%), particularly in procurement, distribution, and technical implementation in the field. The involvement of local economic actors is crucial for understanding the program's financial impact and potential to strengthen the micro-business sector. Although only 0.2% of the participants, the National Nutrition Agency reinforced the institutional view on policy evaluation.

The number of respondents was spread across six regions on average, with the highest concentrations in: Sangihe Islands (21.8%), Manado City (22.9%), and Southeast Minahasa (19.8%). This deployment reflects representations from coastal, archipelagic, and urban areas, each of which has different issues in the procurement, distribution, and monitoring of the MBG program. Archipelago areas, such as Siau Tagulandang Biaro Islands Regency (12.8%), demonstrate that geographical context is a crucial variable in evaluating program effectiveness and efficiency.

4.2 Loading factor and VIF

The extent to which each indicator reflects the latent construct being measured is called the loading factor. According to the theory of HAIR *et al*. (2017), the convergent indicator is valid with an ideal loading value of at least 0.7. All construct indicators show excellent convergent validity and ability to explain the latent variable measured, with loading values between 0.847 and 0.909. In reflective constructs, the VIF value is used to identify possible multicollinearity between indicators. A VIF value of less than 5 indicates the absence of significant multicollinearity (CHUA, 2023). The findings showed a total VIF value ranging between 2.1 and 4.07. All indicators meet the critical threshold of 5.0. Indicators. This supports the conclusion that there is no excessive collinearity between indicators.

In the PLS-SEM method, the internal consistency and convergent validity of each latent construct are evaluated as part of the measurement model assessment, also known as the outer model. Internal consistency refers to the extent to which the indicators in a single construct measure the same concept consistently. In this study, two main measures were used to evaluate internal consistency: Composite Reliability and Cronbach's Alpha. Cronbach's Alpha measures reliability based on the correlation between items and is considered adequate if it has a value of at least 0.70 (HAIR *et al*., 2017). However, in PLS-SEM, composite reliability is preferred over Cronbach's Alpha because it provides a more accurate estimate of construct reliability. A construct has high internal reliability and is considered feasible for structural model testing if it has a Composite Reliability value of at least 0.70.

Convergent validity, on the other hand, is assessed using the AVE metric. AVE reflects the proportion of variance in the indicators explained by the latent construct.

According to FORNELL and LARCKER (1981), the minimum recommended AVE value is 0.50, meaning that the construct can explain at least half of the variance of its indicators (CHUA, 2023; HAIR *et al*., 2017). In this study, any variable with an AVE value greater than the stated threshold indicated that its indicators had strong correlations and effectively represented the construct.

In summary, if Cronbach's Alpha, Composite Reliability, and AVE exceed the recommended academic thresholds, it can be concluded that the construct in the measurement model has strong reliability and convergent validity. Thus, the model can be further analyzed at the structural stage, or inner model.

The Fornell-Larcker Criterion was applied to assess discriminant validity in the measurement model by comparing the square root of the AVE with the correlations between constructs. A construct demonstrates good discriminant validity when its √AVE value is greater than its correlations with other constructs. The construct X1 (DEMBG, representing the MBG Economic Impact) has an AVE of 0.884, which is higher than its correlations with X2 (0.701), X3 (0.473), Y (0.602), and Z (0.627), confirming its discriminant validity. Similarly, X2 (OAMBG, or MBG Budget Optimization) has an AVE of 0.861, exceeding its correlations with X1 (0.701), X3 (0.782), Y (0.776), and Z (0.798), indicating that the criterion is met. The construct X3 (TPMBG, MBG Management Transparency) also meets the requirement, with an AVE of 0.897 that is greater than its highest correlation (0.782 with X2), further confirming discriminant validity. For the dependent construct Y (Food Security), the AVE value of 0.890 is likewise greater than its correlations with X1–X3 and Z, while Z (Community Participation) has the highest AVE value of 0.900, exceeding all its correlations with other constructs. Taken together, these results confirm that all constructs satisfy the Fornell-Larcker Criterion and therefore demonstrate good discriminant validity.

Table 2

R-Square Test Results

	R-square	R-square adjusted
Food Security (Y)	0.684	0.683
Community Participation (Z)	0.707	0.706

The R-Square value (R^2) is one of the important indicators in the evaluation of structural models. R^2 shows how much of a difference between endogenous and

exogenous structures can be explained in this model. The predictive ability of the model to these variables was positively correlated with the value of R^2 (HAIR *et al*., 2017). In **Table 2**, the R^2 value is seen as 0.684; the Food Security Structure (Y) shows that the exogenous constructs in the model are the economic impact of MBG, optimization of the MBG budget, transparency of MBG management, and community participation as mediating variables, each of which is responsible for 68.4 percent of the variability of food security. These values fall into the strong category, indicating that the model has a significant ability to predict food security (CHUA, 2023).

The Community Participation Construct (Z) has an R2 value of 0.707, which indicates that exogenous variables (X1, X2, and X3) can explain 70.7% of the variability of community participation in the MBG program. This structure also has robust predictive capabilities, which suggests that all three independent variables significantly affect the level of community participation in the MBG program.

The R-Square Adjusted value, which is slightly lower than the normal R^2 value, reflects a correction for the number of exogenous constructs in the model and the number of samples, making it more conservative compared to the regular R^2. The adjusted R^2 value in this study was only slightly lower, namely 0.683 for Y and 0.706 for Z, which indicates that the model did not experience overfitting, and the prediction results were stable and statistically valid.

4.3 Path coefficient test and significance

Based on the results of data processing using the Partial Least Squares Structural Equation Modeling (PLS-SEM) method, the path coefficient values, t-statistical values, and significance values (p-values) were obtained as shown in **Table 3**. The results of this test aim to determine the direct and indirect influence of independent variables on dependent variables.

Table 3

Path Coefficient, T Calculation, and Significance Value

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values	Information
X1.DEMBG -> Y.KP	0.093	0.091	0.044	2.114	0.035	Accepted
X2.OAMBG -> Y.KP	0.287	0.289	0.054	5.358	0.000	Accepted

X3.TPMBG -> Y.KP	0.179	0.177	0.048	3.727	0.000	Accepted
X3.TPMBG -> Z. PM -> Y.KP	0.142	0.143	0.024	5.838	0.000	Accepted
X1.DEMBG -> Z. PM -> Y.KP	0.068	0.069	0.017	3.992	0.000	Accepted
X2.OAMBG -> Z. PM -> Y.KP	0.124	0.125	0.027	4.635	0.000	Accepted

Table 3 demonstrates that all tested paths in the structural model have a significant influence on food security at the 95% confidence level ($\alpha = 0.05$). The direct effect of DEMBG on food security (X1 → Y.KP) shows a coefficient of 0.093 with t = 2.114 and p = 0.035, indicating a statistically significant relationship. Similarly, OAMBG has a stronger direct effect on food security (X2 → Y.KP), with a coefficient of 0.287, t = 5.358, and p = 0.000, confirming a positive and highly significant impact. Management transparency (TPMBG) also demonstrates a significant direct influence (X3 → Y.KP), with a coefficient of 0.179, t = 3.727, and p = 0.000. In addition to these direct effects, the mediating role of community participation (Z.PM) is also evident. Specifically, TPMBG shows a significant indirect effect on food security through community participation (X3 → Z.PM → Y.KP) with a coefficient of 0.142, t = 5.838, and p = 0.000. Likewise, DEMBG exerts a significant indirect effect (X1 → Z.PM → Y.KP) with a coefficient of 0.068, t = 3.992, and p = 0.000, while OAMBG also demonstrates an indirect influence (X2 → Z.PM → Y.KP) with a coefficient of 0.124, t = 4.635, and p = 0.000. These findings confirm that both direct and indirect pathways significantly enhance food security, thereby supporting and accepting all proposed hypotheses.

5 DISCUSSION

5.1 Economic impact of the MBG program and food security

The results of the inner model test showed that the economic impact of the MBG program had a positive effect on food security, which means that the economic benefits generated by the MBG program were able to enhance food security. The economic impact in question includes reducing household expenditure on food needs, reallocating funds to fulfill other needs, increasing community purchasing power, and improving community productivity. Expenses previously given by parents to children for school consumption or pocket money are reduced, especially for children living close to school. These savings

can then be allocated to meet other household needs. In addition, the MBG program can reduce stunting and other nutritional problems, especially among children, by providing access to sufficient food for underprivileged communities. A decrease in stunting rates will increase productivity, which in turn will raise family income.

In SDT, the provision of MBG is a strategic step that supports SDG 2, which aims to end hunger and ensure food security and healthy diets (FANZO, 2019; PÉREZ-ESCAMILLA, 2017). For programs to contribute effectively to food security in both the short and long term, BEUCHELT *et al*. (2022) argue that the right to food must be incorporated into sustainable development policies and standards. This approach emphasizes that building an inclusive and sustainable food system requires collaboration among many actors, including the private sector, government, and civil society (ALIYU *et al*., 2021).

Furthermore, the sustainability of free healthy food programs depends on the social capital of the community. Strong social relationships, both at the community and individual levels, can increase the effectiveness of food security programs (TERMEER *et al*., 2022). This social capital enables more equitable food distribution, responsiveness to local needs, and support for people in overcoming food insecurity (ESE, 2022). Community involvement in program design and implementation can also foster a sense of ownership and responsibility, which in turn improves program sustainability (AASSOULI; AKANDE; JUREIDINI, 2023; IBITOYE; OLUSESAN, 2024).

Overall, the provision of MBG can be regarded as one of the foundations for achieving the broader goal of food security within the framework of sustainable development. By adopting an inclusive and collaborative approach that considers both social and economic aspects, communities can be better prepared to address food security challenges and improve overall quality of life.

5.2 Budget optimization and food security

The hypothesis that optimizing the MBG program's budget has a positive effect on food security is supported by the results. Budget optimization refers to the effective use of available financial resources to run a program and achieve its goals. The MBG program can provide larger quantities of food, of better quality, and with more targeted

distribution by increasing the effectiveness of budg*et al*location. This directly contributes to improving the community's food security.

Public policies under the MBG program aim to increase public access to high-quality food, especially for vulnerable groups such as school-age children, low-income families, and rural or remote communities. In these cases, budget optimization includes the use of inexpensive but nutrient-rich foodstuffs, improving logistics management to reduce waste, and strengthening oversight systems to ensure that the management of public funds is transparent and accountable.

Effective budg*et al*location can enhance food security by maximizing the use of available resources, thereby reducing malnutrition and improving access to nutritious food for low-income communities. This is supported by research from OGERO *et al*. (2025), which shows that improving the efficiency of investment allocation in Kenya can reduce the prevalence of nutritional problems such as wasting and stunting in children. With the same budget, specific nutrition interventions can significantly lower malnutrition rates. This demonstrates how budget optimization can improve food security.

In the context of sustainable development, budget optimization has a significant impact on food security. Increasing people's access to sufficient, safe, and nutritious food can be achieved through effective and efficient budget management. A study by PARWODIWIYONO (2023) shows that access to food is closely related to the availability of resources and that income is an important component of household food security. This is in line with previous research showing that optimizing budg*et al*location in the food sector can increase food productivity and accessibility, as well as support poverty and hunger reduction goals as part of the Sustainable Development Program (PRABAYANTI, 2022).

In this context, transparent and accountable management of the MBG program budget, supported by sustainable funding, will strengthen food security, which must continue to be monitored. HASSNA *et al*. (2024) emphasize that to ensure better sustainability and food security in the face of climate uncertainty, it is crucial to implement a comprehensive optimization model in the global food supply chain that considers a variety of risk factors.

5.3 Transparency in MBG management and food security

Transparency in the management of the MBG program is defined as openness, clarity, and ease of access to information on policies, budgets, procurement, distribution, and program evaluation for communities and relevant stakeholders. Transparent management enables more targeted food distribution, ensuring that it is timely and of guaranteed quality. This directly increases food security, especially among vulnerable community groups, and ensures that public funds are used effectively.

The entire operational process of the MBG program, from procurement to distribution, is made transparent to the community so that they can ensure the program runs in accordance with its food security goals. In addition, the community, government, and stakeholders can actively participate in the evaluation process of the MBG program to ensure continuous improvement in food security. Each evaluation of the MBG program is carried out by paying attention to compliance with applicable regulations and standards for achieving community food security. Research by MACDONALD *et al*. (2023) shows that transparent and accountable government programs improve community food security by ensuring access to safe and nutritious food. In this context, third-party oversight and publicly accessible reports are essential. These measures increase public trust in the program and allow communities to oversee the use of the budget.

Moreover, the openness and accuracy of information regarding the development and implementation of the MBG program, along with its accessibility to the entire community without barriers, demonstrate that the program is well-managed and sustainable, ultimately supporting food security. In the context of sustainable development, transparency is recognized as a central pillar for the success of public policies related to food and nutrition. This aligns with the principles of the SDGs, especially Goal 16, which promotes inclusive, accountable, and transparent governance at all institutional levels (SACHS, 2015). Similarly, MCDERMOTT (2023) found that transparency plays a critical role in encouraging better governance in the food system, thereby driving policy improvements.

As highlighted by FANZO (2019), achieving the SDGs requires attention to the sustainability of the food system, which includes ensuring healthier and more sustainable consumption patterns. To enhance transparency in MBG programs, practices that promote food sustainability and diversity, such as the procurement of local foodstuffs, are needed.

These practices can help reduce dependence on imports and mitigate the risks posed by increasingly unpredictable and unsustainable food systems.

5.4 Community participation moderates the influence of economic impacts, budget optimization, and transparency in the management of MBG programs in the context of food security

This research shows that community participation can increase the effectiveness of food security programs and ensure that the benefits are widely felt. Community participation also plays an important role in moderating the economic impact of the MBG program, as well as in budget optimization and program transparency for food security. In this study, community participation refers to the involvement of the community in the planning and implementation of the MBG program, the community's trust in the program, the experience of those directly involved, and the existence of a complaint system that allows people to actively supervise the implementation and use of the budget to maintain food security.

The SDGs, especially SDG 2 (Zero Hunger), SDG 3 (Good Health and Well-being), and SDG 12 (Responsible Consumption and Production), are supported through the MBG program, which involves community participation. A strong and sustainable local food system is reinforced by the participation of local communities in food provision, community kitchen management, and nutrition training. Furthermore, this is related to Goal 16, namely inclusive and participatory governance (RONCAROLO; BISSET; POTVIN, 2016). To achieve food security goals, active community involvement in various phases of the program can increase economic impact, optimize budgets, and make the management of the MBG program more transparent (KIELB *et al.*, 2023).

The MBG program improves access to food, reduces malnutrition, and enhances economic and educational outcomes. Nevertheless, the success of this program depends heavily on community participation in its implementation and supervision. EZEKEKWU *et al*. (2022) conducted research showing that community-based interventions increase the consumption of nutritious foods and improve food security. Program effectiveness can also be improved by optimizing budgets through the use of public assets and cross-sector collaboration. KINSMAN *et al*. (2018) and MILINKOVIC *et al*. (2020)

emphasized that utilizing state assets such as school kitchens and sleeping areas can reduce logistics costs and improve program sustainability. By participating in the budgeting, planning, and implementation process, resources can be allocated more effectively and in line with local needs. To ensure sustainability and accountability in the management of MBG programs, transparency is essential. DONG *et al*. (2024) emphasized the importance of integrated data systems and community involvement in tracking programs to improve efficiency and prevent corruption. To increase the transparency and legitimacy of the program, community participation serves as a social control mechanism.

6 CONCLUSION

The outcomes of this study indicate that the MBG program in North Sulawesi significantly enhances food security through three primary mechanisms: economic impact, improved budget efficiency, and transparency in operations. All of these components exert beneficial impacts, either directly or indirectly via the intermediary role of community engagement. The program reduces food expenses for households, increases disposable income, and enhances productivity, so bolstering the local economy. Transparency in program operations fosters accountability, public confidence, and sustainable success. Furthermore, active community engagement enhances the collaboration of these components, underscoring the significance of participatory governance in the efficacy of food security initiatives. The MBG program serves as a strategic instrument to facilitate the attainment of the Sustainable Development Goals (SDGs), particularly in eradicating hunger, enhancing public health, and fortifying local food systems.

This study theoretically emphasizes the significance of community participation as a mediating variable linking economic efficiency, budget governance, and transparency to food security outcomes. It provides empirical evidence supporting participatory governance models in regional development theory. The results show that managers and policymakers need to use digital monitoring and evaluation methods to make things more open and cut down on budget problems. The MBG program is a good way to link local food supply chains with the empowerment of small businesses in Indonesia's MSME policy at both the national and regional levels. Improving

communication between MBG management and local MSME stakeholders can lead to new ideas for making and distributing food that are based on local knowledge. This will help the economy grow in a way that includes everyone. Policymakers should make these relationships official by using established frameworks and take specific steps to build capacity to ensure that the benefits of MBG programs are shared fairly and in a way that lasts.

This study has a number of issues. First, it exclusively examines six North Sulawesi cities or districts. Because of this, it might be challenging to extrapolate the findings to other regions with distinct social, economic, and geographic circumstances. Second, since a large portion of the data originates from survey respondents, there can be a perception bias. Third, the ability to draw strong causal conclusions is constrained by the cross-sectional design. Furthermore, the model does not include exogenous factors such as changes in policy, variations in food costs, and climate variability. Future studies should incorporate other variables like market integration, climate impacts, and digital governance frameworks, and employ longitudinal designs with broad regional representation. In order to improve the effectiveness of Indonesia's MSME-based food security plan throughout all of its provinces, this type of research may help us better understand how to expand and improve MBG-like programs.

AUTHOR CONTRIBUTIONS

Conceptualization, Florence O Moroki and James Manengkey; methodology, Ananta Dian Pratiwi; software, Pricilia Joice Pesak; validation, Florence O Moroki, James Manengkey and Ananta Dian Pratiwi; formal analysis, Florence O Moroki; investigation, Pricilia Joice Pesak; resources, Florence O Moroki; data curation, Florence O Moroki; writing—original draft preparation, Florence O Moroki; writing—review and editing, Ananta Dian Pratiwi; visualization, James Manengkey; supervision, Florence O Moroki; project administration, Florence O Moroki; funding acquisition, DPPM Kemdiktisaintek.

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Authors' Contribution

All authors contributed equally to the development of this article.

Data availability

All datasets relevant to this study's findings are fully available within the article.

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