

Governance and Policy Innovations for Food Security in a Buffer City: Causal Pathways and Evidence from Palopo, Indonesia

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Abstract

This study analyses the drivers of low food security in Palopo City, Indonesia, and proposes locally relevant policy options. As an autonomous buffer city that supports surrounding regions through food distribution and trade, Palopo remains under-examined in debates on food security governance. The study contributes by foregrounding the governance challenges facing buffer cities while aligning with SDG 2 (Zero Hunger), particularly Targets 2.1–2.5 and 2.a–2.c on ending hunger, improving nutrition, strengthening sustainable and climate-resilient food systems, increasing agricultural investment, and stabilising food markets. Using a qualitative descriptive design, the research draws on official documents, regional policy instruments, and peer-reviewed literature. Data were analysed systematically in NVivo 12 Plus through import, coding, relationship mapping, and visualisation to identify recurring patterns. The findings indicate that Palopo's food security is constrained by limited local production, shrinking agricultural land, climate-related pressures on yields, weak distribution and logistics infrastructure, low purchasing power, and ineffective policy implementation. Inadequate logistics increase transport costs and contribute to price volatility, while poverty and food inflation restrict access to nutritious food. Policy priorities include boosting productivity via appropriate technologies and food diversification, upgrading distribution through technology-enabled logistics, strengthening purchasing power through food-based local economic programmes, and improving the targeting and effectiveness of subsidies and food assistance.

Keywords: Food Security; Multi-Stakeholder Collaboration; Policy Innovation

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Introduction

There is an urgent need for concrete and effective implementation of food security policies in Palopo City, particularly because the city's food security remains inadequate. In the 2022 Food Security Index, Palopo recorded a score of 73.41% and ranked 63rd out of 98 cities in Indonesia (BPN, 2022). This indicator reflects the broader economic and ecological condition of the city's food system. Accordingly, this study responds to the need for a more comprehensive understanding of the determinants of food security in Palopo City, with particular attention to food access and food policy. Access to food and food policy are critical components of food security (Edwards et al., 2024; Even et al., 2024). This research therefore seeks to clarify the key challenges and identify feasible solutions to ensure that the food system can sustainably meet local needs, while informing policy pathways to improve welfare across Palopo City.

Palopo is a buffer city with a strategic autonomous role in supporting South Sulawesi Province, notably as one of the centres of the Luwu Raya region for the distribution of food and services (Bagaskara et al., 2022; Metaragakusuma et al., 2017). Although Palopo is geographically distant from Makassar, its connectivity to the provincial capital and its function as a regional trading hub are integral to provincial economic performance and food security. Palopo also serves as a services and logistics centre that meets the needs of surrounding areas, including Luwu Regency, North Luwu, East Luwu, and highland regions such as Tana Toraja and North Toraja, particularly in relation to food commodities and essential services.

Food security refers to the sustained ability to access sufficient, safe, nutritious, and culturally acceptable food to live a healthy and active life, both physically and economically (Rashid et al., 2024; Timilsina et al., 2025). Food insecurity is a multidimensional condition encompassing interrelated domains, including the sustainability of food supply, food access, food availability, and food utilisation (Bhat et al., 2024; Ferguson et al., 2023; Ikudayisi et al., 2019; Mulyo et al., 2023; Rehman et al., 2024; Shah et al., 2025; Zhupley et al., 2021). Food security therefore extends beyond aggregate availability to include equitable access, ecosystem sustainability, and the socio-economic effects of food systems. In this sense, food security is central to community well-being (Safi et al., 2024; Tambe et al., 2023). Strengthening food security thus requires a livelihoods-oriented approach that integrates supply-side considerations with economic, environmental, and social dimensions to support sustainable welfare for the broader community.

Low food security has serious consequences, including heightened risks of nutritional deficiencies, particularly among vulnerable groups such as older people, pregnant women, and children (Hernández-Moreno et al., 2024; Nkoko et al., 2024; Olsoy et al., 2022; Zamaratskaia et al., 2023). When food supplies fluctuate or prices rise, malnutrition and micronutrient deficiencies can increase, with adverse effects on physical and mental health (Kantilafti et al., 2024; Phillips et al., 2024). Weak food security may also intensify social and political tensions, driven by competition over limited resources, and may exacerbate inequality and poverty (Aloui & Maktouf, 2024;

Malual & Mazur, 2022). Over time, persistent insecurity can undermine economic development, weaken social cohesion, and degrade environmental quality. Strengthening food security is therefore essential to securing prosperity and sustainability for communities (Spencer, 2023; Vipulaguna et al., 2025).

Governments can address food insecurity through strategic interventions that improve access to food. These include upgrading transport networks and irrigation systems, providing financial or market support to farmers (Kozielec et al., 2024), promoting dietary diversity through education campaigns (Rono et al., 2023), and strengthening distribution systems to reduce bottlenecks and stabilise supply (Wu & Lin, 2023). In parallel, policies that support employment creation in the agricultural sector (Zhu et al., 2024) and encourage technological innovation in production and natural resource management can improve productivity and well-being (Kunyanga et al., 2023). When implemented coherently, these measures can strengthen food security and improve community welfare.

Evidence from Global South countries suggests that multisector, community-driven initiatives can be effective in addressing food insecurity, particularly in contexts characterised by weak infrastructure and unequal access to food, such as Palopo. Brazil's Fome Zero Programme combined food subsidies, investments in smallholders, and school-based nutrition programmes, contributing to reductions in hunger (Oliveira et al., 2023). In India, the public distribution system (PDS) expands access to subsidised staple foods for poor and low-income households (George & McKay, 2019; Sharma et al., 2024). Ethiopia links food assistance to labour-intensive public works and agricultural support (Bahru et al., 2020; Tadesse & Gebremedhin Zeleke, 2022). Across these cases, a shared insight is the importance of local government participation, the empowerment of smallholder farmers, and the strengthening of local food systems.

Table 1. Food Security Index Components in South Sulawesi Cities in 2022
Source: BPN (2022)

City	Accessibility	Utilisation	Composite
Makassar	88.51	80.05	83.86
Parepare	88.54	71.38	79.10
Palopo	77.54	70.02	73.41

Food security in Palopo City warrants serious attention. In 2022, Palopo scored 73.41% in the Food Security Index, ranking 63rd out of 98 cities in Indonesia (BPN, 2022). More importantly, Palopo recorded the lowest food security status among cities in South Sulawesi Province in the same year (BPN, 2022). Table 1 presents the relevant indicators.

The 2022 index shows that Palopo has the lowest composite score among the three cities. Palopo's affordability (accessibility) index was 77.54, substantially lower than Makassar (88.51) and Parepare (88.54). In terms of utilisation, Palopo again recorded the

lowest score (70.02), compared with Makassar (80.05) and Parepare (71.38). Taken together, Palopo's composite index of 73.41 indicates weaknesses across multiple dimensions of food security.

Against this background, the study addresses two research questions. First, what factors contribute to Palopo's low food security index, and how do these factors interact? Second, what evidence-based policy alternatives, drawn from experiences in other countries, could be adapted to strengthen food security governance in Palopo City? By addressing these questions, the study aims to improve understanding of the constraints shaping food security in Palopo and to propose policy implications that are both evidence-informed and sensitive to local conditions. The findings are expected to support the design of more targeted and sustainable policies to improve welfare through strengthened food security.

Although food security has been widely studied, in-depth analyses that combine local conditions with policy alternatives tailored to local contexts—such as Palopo—remain limited. Much existing research focuses on national or regional scales and often under-specifies the local dynamics that shape food security outcomes within the same province or region. By examining Palopo as a buffer city, this study contributes to a more context-sensitive understanding of constraints and opportunities and advances locally grounded policy recommendations. The novelty of this study lies in its focus on food security governance in a buffer city, an area that remains underexplored in the literature.

This research aims to analyse the factors contributing to low food security in Palopo City and to formulate relevant policy options to strengthen food security and community welfare. Specifically, it examines how constraints in production and distribution and limitations in purchasing power contribute to food insecurity. The study also develops policy recommendations that can enhance food security, improve welfare, and support sustainable livelihoods through adaptive strategies aligned with local conditions.

Finally, this research explicitly contributes to Sustainable Development Goal 2 (Zero Hunger) by linking the analysis and policy implications to relevant targets: Target 2.1 (ending hunger and ensuring access to safe, nutritious, and sufficient food), Target 2.2 (ending all forms of malnutrition), Target 2.3 (doubling agricultural productivity and incomes of small-scale food producers), Target 2.4 (ensuring sustainable and climate-resilient food production systems), and Target 2.5 (maintaining genetic diversity of seeds, cultivated plants, and farmed animals), including Targets 2.a–2.c emphasising rural infrastructure investment, food market stability, and the prevention of food price volatility. These targets should be integrated consistently throughout the manuscript (Abstract, Introduction, Results, Discussion, and Conclusion) to demonstrate the study's SDG contribution in a clear and measurable manner.

Research Methods

This study employs a qualitative, descriptive research design. Data were collected through document analysis of official reports from the Central Statistics Agency, local government policy documents, newspapers, and peer-reviewed scientific articles

relevant to this study. The selection of these sources was intended to strengthen the credibility and accuracy of the evidence base, enabling an objective description of local food security conditions, policy trends, and locally experienced challenges. To maintain relevance, the analysis focused on documents published within the past ten years, particularly those addressing food security.

NVivo 12 Plus was used to support systematic and transparent qualitative analysis. The software facilitates thematic coding, data visualisation, and the integration of multiple documentary sources, which strengthens the rigour of the analytic process. The stages of data collection and analysis are presented in Figure 1.

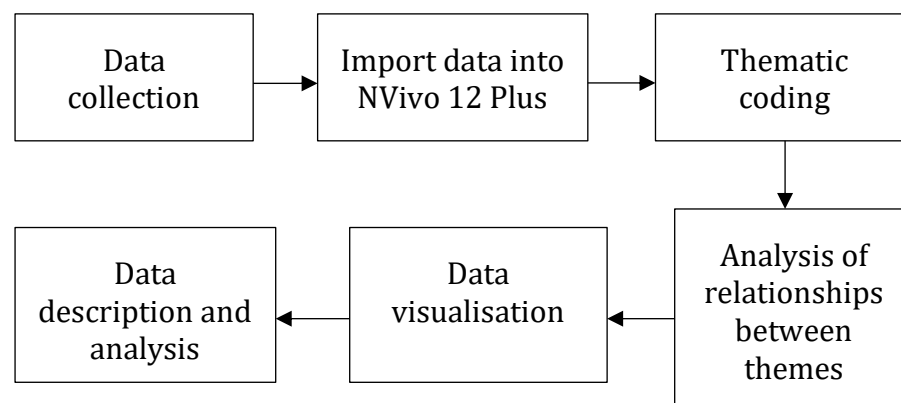


Figure 1. Stage of Data Collection and Analysis
Source: Processed by the Authors (2025)

The first stage involved importing data. All relevant documents (Central Statistics Agency reports, local government policy documents, scientific articles, and news reports) were compiled and imported into NVivo 12 Plus. The second stage was coding, in which the document content was coded into nodes representing emergent themes. Coding was conducted by highlighting relevant passages and, where appropriate, using keyword search features. The third stage involved examining relationships across nodes. NVivo queries and mapping functions were used to explore connections between categories and to identify patterns among key food security determinants. The fourth stage was data visualisation, using features such as project maps to represent key themes and relationships, which supported interpretation and the reporting of findings.

To enhance reliability and validity, the study applied a systematic coding procedure. First, interpretations were discussed with other researchers to check the coherence of the themes and subthemes generated through coding. Second, data source triangulation was undertaken by comparing official documents, scientific articles, and news reports to identify convergent evidence. Finally, analytical consistency was supported through clearly documented coding steps and the use of NVivo functions that enable the tracking of coding decisions. These measures were intended to strengthen the trustworthiness of the analysis and increase reader confidence in the findings.

Results and Discussion

This section examines the key drivers underlying Palopo City's low Food Security Index and identifies policy options that could be implemented to address them. The analysis is intended to clarify the nature of the problem and to inform evidence-based strategies for strengthening food security and improving community welfare in a sustainable manner.

Factors Influencing the Low Level of Food Security in Palopo City

Palopo City's food security remains low and continues to face persistent challenges. In 2022, Palopo recorded a Food Security Index score of 73.41% and ranked 63rd out of 98 cities in Indonesia (BPN, 2022). Over the 2021–2022 period, the affordability index declined from 79.28 to 77.54 and the utilisation index decreased from 72.37 to 70.02 (BPN, 2022). The composite index also fell from 75.48 in 2021 to 73.41 in 2022, indicating deteriorating conditions in food access and utilisation.

Table 2. Food Security Index Components in Palopo City
Source: BPN (2022)

Year	Affordability	Utilisation	Composite
2021	79.28	72.37	75.48
2022	77.54	70.02	73.41

Table 2 indicates a decline across all measured dimensions between 2021 and 2022. The reduction in affordability suggests growing barriers to food access, potentially linked to rising food prices, distribution constraints, and weakened purchasing power. The decline in utilisation may reflect challenges related to diet quality and nutrition, sustainable consumption practices, and access to health and sanitation services. Overall, the fall in the composite index highlights structural weaknesses in Palopo City's food security system.

The declining accessibility of food further suggests that increases in staple food prices were not matched by gains in household purchasing power. These pressures appear more acute in suburban areas where limited infrastructure constrains distribution. At the same time, lower utilisation points to challenges in the quality of food consumption, including limited access to nutritious foods, low nutrition literacy, and inadequate health and sanitation services. Food security in Palopo is therefore not solely a question of food availability, but also reflects socio-economic constraints and shortcomings in essential services that support safe and nutritious consumption.

The observed decline also indicates scope for more targeted interventions to strengthen food security sustainably. Regional government could expand distribution networks to improve affordability and reduce supply bottlenecks, while strengthening nutrition and sanitation education to support better utilisation outcomes. Increased

support for local agriculture could also contribute to greater supply stability and reduce dependence on external sources. Identifying the specific drivers of the decline is essential to inform appropriate policy responses and, ultimately, improve community welfare.

The decline in Palopo City's food security indicators is particularly concerning given the city's strategic role as a buffer and autonomous city supporting South Sulawesi Province's wider economy and food system. As a production, distribution, and trade centre for, among others, Luwu, North Luwu, East Luwu, Tana Toraja, and North Toraja, Palopo's food security conditions have direct implications for surrounding areas. The decline should therefore be treated as a priority for local government, including efforts to strengthen distribution networks, expand nutrition and sanitation education, enhance local agriculture and livelihoods support, and sustain household food security while improving overall well-being. Furthermore, this study maps several dominant factors contributing to Palopo City's low Food Security Index (Figure 2).

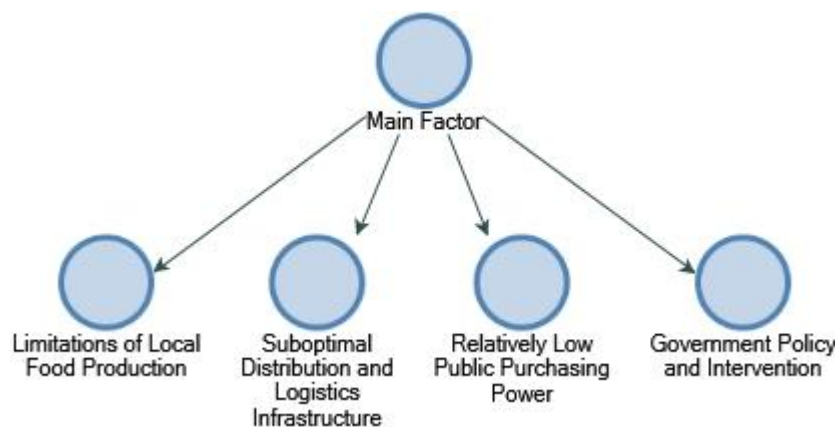


Figure 2. The Main Factors Contributing to the Low Food Security Index in Palopo City
Source: Processed by the Authors Using NVivo 12 Plus (2025)

Reduced local food production in Palopo City is a major determinant of regional food security. According to data from the South Sulawesi Central Statistics Agency, the area of productive agricultural land in Palopo City continues to decline due to land conversion into residential, commercial, and industrial areas. The recorded area of rice fields in Palopo City in 2020 was approximately 2,923 hectares, down from 3,161 hectares in 2019 (BPS, 2022). This contraction directly affects rice production, which remains a key staple commodity for many households. Climate change further compounds these pressures, as erratic rainfall and rising temperatures contribute to declining yields. Other studies have also shown that climate change has reduced agricultural productivity in tropical areas, including Indonesia (Kuswanto et al., 2018; Taniushkina et al., 2024). In Palopo City, these dynamics increase dependence on food supplies from outside the region, with associated risks of price fluctuations and uncertainty in food availability.

Limited adoption of modern agricultural technology further exacerbates inefficiencies in local production. Farmers in Palopo City reportedly continue to rely on

traditional practices, with limited use of fertiliser and irrigation (Harahap et al., 2024). Prior research indicates that innovative technologies, such as drip irrigation systems and sensor-based fertiliser application, can increase yields (Aryal et al., 2018; Kumar et al., 2024; Murillo-Acevedo & Grande, 2024). However, small farmers often face barriers to adoption, including financial constraints and limited technical capacity. To date, the regional government has attempted to implement fertiliser subsidies and provide agricultural equipment assistance, yet implementation remains uneven and is often constrained by bureaucratic processes. More systematic approaches, including community-based technology training and policy support that prioritises sustainable production expansion, are therefore required.

Another driver of Palopo City's low Food Security Index is suboptimal distribution and logistics infrastructure. Transportation constraints limit the efficient movement of food from production areas to local markets, particularly in suburban areas with limited road networks. Reports indicate that some access routes in Palopo City remain severely damaged and unpaved (Arzad, 2022). These conditions increase transportation costs, which can raise food prices for consumers. Rojas-Reyes et al. (2024) provide further evidence that higher transportation and logistics costs contribute to supply-chain inefficiencies and food price increases (Rojas-Reyes et al., 2024). Given Palopo City's reliance on supplies from other regions, the local food system becomes particularly vulnerable when distribution disruptions occur.

Low purchasing power also contributes substantially to food insecurity in Palopo City. According to the Central Statistics Agency, the number of people living in poverty in Palopo City reached 14.78 thousand, higher than the provincial average for South Sulawesi (BPS, 2023). Meanwhile, Palopo City's minimum wage in 2022 was recorded at IDR 3,165,876, which remains relatively low compared with larger cities in South Sulawesi (Teraskata, 2024). Low income directly constrains households' capacity to purchase higher-quality foods, often pushing consumption towards cheaper but less nutritious options. Empirical studies similarly show that low-income households are more likely to consume carbohydrate-dense foods while consuming fewer protein-rich and micronutrient-dense foods, increasing malnutrition risks (Aceves-Martins et al., 2023; Mostenska et al., 2022).

In addition, external economic pressures, such as inflation and global crises, further reduce access to food. Reports from the Central Statistics Agency and the National Food Agency indicate that food price inflation reached 1.26% in 2022, contributing to increases in the prices of rice and sugar (Upland, 2023). Rising prices that are not matched by increased purchasing power heighten household food insecurity, especially among vulnerable groups such as daily labourers, small farmers, and informal workers. This aligns with frameworks of food accessibility, which emphasise that food security depends not only on physical availability but also on economic access (Capone et al., 2014; Schwartz et al., 2019).

Government policies and interventions to enhance food security in Palopo City also encounter obstacles in planning and implementation. One response has been the non-cash food assistance programme, yet reports suggest that only a limited number of poor

households received support, alongside allegations of misuse. Limited coverage and potential fraud in the programme present serious challenges to implementing effective and targeted food security policies.

Regulatory gaps remain evident in food production and distribution governance. For example, policies intended to control staple food prices are often ineffective in stabilising market prices. A Central Statistics Agency report indicated that rice price fluctuations in Palopo City were relatively high, particularly during the lean season, suggesting that price regulation mechanisms are not operating optimally. Coordination between local government and other stakeholders also requires strengthening. In line with food security governance concepts, food security cannot be achieved through isolated policy measures but requires coordinated action across social, economic, and environmental domains (Candel, 2014). Palopo City therefore needs to strengthen policy interventions by improving distribution and assistance effectiveness, tightening food market regulation, and enhancing coordination among stakeholders to achieve stable and sustainable food security.

The decline in local food production is likely to reduce the regional supply of primary food products, particularly rice as a staple commodity, and increase dependence on external sources. This reliance exposes Palopo to external shocks such as distribution delays, price rises in source areas, and disruptions in national and international markets. Low land productivity is further exacerbated by limited uptake of modern agricultural technology, constraining the region's capacity to respond flexibly to market pressures.

Inadequate distribution and weak supply-chain performance further intensify food accessibility challenges, particularly in remote areas with damaged road networks. High transportation costs are often passed on to consumers, worsening affordability. Table 3 presents recent changes in the market price of rice in Palopo City.

Table 3. Rice Price Increases in Palopo City in 2025

Source: Masyudi (2025)

Type of Rice	Normal Price (Rp/kg)	Current Price (Rp/kg)	Price Increase (Rp)	Percentage Increase (%)
Medium rice	12,500	15,500	3,000	24%
Premium rice	15,500	18,000	2,500	16%

The rise in rice prices in Palopo City indicates strong pressure on purchasing power, particularly among low-income households, and contributes to reduced access to sufficient and nutritious food. These dynamics show that logistics barriers are not purely technical, because they have distributive consequences that increase vulnerability and complicate government interventions aimed at stabilising the food system.

Overall, the low Food Security Index in Palopo City is shaped by interacting drivers: declining local production, constrained distribution networks, limited purchasing power, and weaknesses in policy implementation and coordination. Land conversion, climate pressures, and delayed technology adoption threaten production sustainability, while weak infrastructure and high logistics costs contribute to price instability that is particularly burdensome for poorer households. Existing policy instruments, including non-cash food assistance, also face constraints in coverage and effectiveness. These findings indicate the need for a more integrated policy approach that strengthens local availability while addressing economic access, essential services, and food security governance.

Alternative Policies for Food Security in Palopo City

The findings indicate that Palopo City's low Food Security Index is shaped by interconnected constraints, including limited local food production, suboptimal distribution and logistics infrastructure, low household purchasing power, and weaknesses in policy implementation. Sustainable and integrated policy responses are therefore required to strengthen food security in Palopo. International experience offers practical lessons: India has improved the targeting and efficiency of food distribution through digitalisation, while Brazil has strengthened food security through integrated social assistance and support for smallholders. These experiences provide relevant reference points for designing more effective and targeted policies in Palopo City. The mapping of policy alternatives to improve food security in Palopo City is presented in Figure 3.

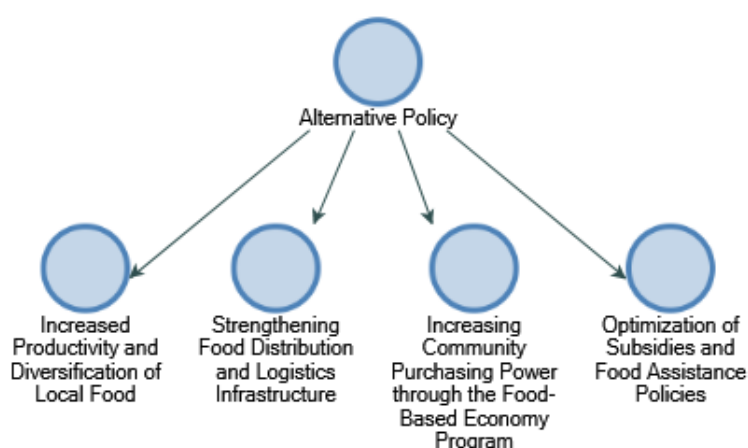


Figure 3. Mapping Alternative Policies to Improve Food Security in Palopo City
Source: Processed by the Authors Using NVivo 12 Plus (2025)

A priority area is strengthening local food production by improving agricultural productivity through modern agrotechnology, higher-quality seeds, and improved access to fertilisers and irrigation. In parallel, food diversification should be promoted to reduce dependence on a single staple commodity, particularly rice, by encouraging alternative

crops such as tubers and sorghum. Diversification can strengthen food security by reducing risks associated with crop failure and improving the nutritional quality of diets (Mihrete & Mihretu, 2025). International evidence suggests that productivity gains and diversification can be mutually reinforcing. Thailand, for example, has increased food production by promoting precision agriculture technologies and crop diversification programmes, supported through policies that encourage technology adoption among farmers to improve production efficiency (Tran et al., 2023).

Brazil provides a relevant model through agroecology and family farming. The Food Acquisition Programme incentivises smallholders to produce diverse local foods, which are purchased by the state to support national food programmes (Casagrande et al., 2024; Pereira et al., 2024). This approach stabilises markets for small farmers while expanding community access to nutrient-rich foods, contributing to domestic supply growth and reducing import dependence. The Brazilian experience demonstrates that technological support, combined with appropriate policy design, can strengthen food security sustainably.

Strengthening distribution and logistics is equally important. Japan, for example, operates an efficient supply-chain system supported by advanced cold-chain infrastructure and Internet of Things (IoT) technologies for real-time monitoring of food conditions (Yamabe-Ledoux et al., 2023). This system has reduced food loss and supported more even distribution, including to remote areas. With improved supply-chain efficiency, operational costs can decrease, helping to stabilise food prices. Similarly, the Netherlands illustrates how strategic investment in agrologistics can support food security. Investments in storage infrastructure, integrated transport strategies, and digital market information systems have strengthened distribution efficiency (Castelein et al., 2022). Initiatives such as Food Valley link farmers, food-processing industries, and research centres within a supportive ecosystem (Omta & Fortuin, 2013), reducing delivery times and contributing to price stability and improved access. These cases indicate that robust logistics infrastructure is central to sustainable food security.

Improving purchasing power and strengthening household resilience is another policy pathway. Brazil's Fome Zero programme combined direct cash transfers to vulnerable groups with support for small producers, including access to credit, financial subsidies, and food cooperatives that shorten distribution chains (Oliveira et al., 2023). This integrated approach reduced hunger and improved purchasing power among low-income households, while supporting food price stability and local availability. Ethiopia's Productive Safety Net Programme also provides relevant lessons. By linking food and cash assistance to participation in labour-intensive public works and local infrastructure development, including irrigation and agricultural roads, the programme strengthened local economies and improved food access for vulnerable households (Bahru et al., 2020; Tadesse & Gebremedhin Zeleke, 2022). This approach reduced reliance on humanitarian aid while improving purchasing power through a livelihoods-based model supported by food-system infrastructure.

Optimising subsidies and food aid policies are also crucial. India's Public Distribution System illustrates how digital reforms can strengthen programme targeting.

Smart cards linked to biometric databases have improved beneficiary identification, reduced leakage, and enhanced accountability in subsidy delivery (George & McKay, 2019; Sharma et al., 2024). Reforms to distribution systems can also reduce illegal hoarding and subsidy abuse, improving supply-chain efficiency. Brazil's Bolsa Família further demonstrates how conditional cash transfers, supported by national data systems, can strengthen welfare outcomes and improve food consumption among low-income households (Neves et al., 2022). Together, these examples indicate that accurate data systems and technology-enabled delivery mechanisms can enhance the reach and effectiveness of social programmes and support food security in a sustainable manner.

Lessons are also available from other buffer and medium-sized cities. In Querétaro, Mexico, an urban agroecology project reportedly increased local dietary diversity and supported a more resilient biocultural food system and local productivity (Villavicencio-Valdez et al., 2023). In Quito, Ecuador, the Participatory Urban Agriculture Project has connected more than 12,000 urban and peri-urban farmers and supplies approximately 400 tonnes of organic food annually to vulnerable neighbourhoods, strengthening local food availability and household-level resilience (Rodríguez et al., 2022). These experiences highlight the value of investing in local logistics, supporting peri-urban food production, and strengthening cross-regional governance to maintain stable and equitable food supplies.

Taken together, these cases underscore that food security is multidimensional and requires complementary interventions. Improving food security involves raising agricultural productivity, strengthening distribution infrastructure, increasing purchasing power, and ensuring that food assistance and subsidy policies are well targeted. Thailand and Brazil provide lessons in diversification and production support, Japan and the Netherlands illustrate the importance of resilient supply chains, and India, Brazil, and Ethiopia demonstrate how technology-enabled social assistance and livelihoods-based programmes can strengthen access to food (Bahru et al., 2020; Casagrande et al., 2024; Castelein et al., 2022; George & McKay, 2019; Neves et al., 2022; Oliveira et al., 2023; Omta & Fortuin, 2013; Pereira et al., 2024; Rodríguez et al., 2022; Sharma et al., 2024; Tadesse & Gebremedhin Zeleke, 2022; Tran et al., 2023; Villavicencio-Valdez et al., 2023; Yamabe-Ledoux et al., 2023). For Palopo City, these lessons can be adapted through strengthened local production and diversification, improved logistics and distribution systems (including digital solutions), and social protection policies that enhance household purchasing power. With a systematic and data-informed approach, Palopo City can build a more resilient and sustainable food system to address future challenges.

Although international best practices provide valuable reference points, policy adoption in Palopo City may face barriers such as limited institutional capacity, constrained funding, fragmented inter-agency coordination, and resistance from local actors who are less familiar with technology-driven schemes and dietary diversification. A phased implementation strategy is therefore recommended, including pilot initiatives to demonstrate feasibility and build community acceptance. Strengthening inter-departmental coordination through a regional food security task force, alongside training

for farmers and officials, could improve policy uptake. Public–private partnerships and other collaborative arrangements may also help address funding limitations and support the development of necessary infrastructure and innovation.

This study aligns with Sustainable Development Goal 2 (Zero Hunger), particularly the aim to end hunger and ensure year-round access to safe, nutritious, and sufficient food, especially for vulnerable groups. In Palopo City, constraints such as limited local production, weak distribution channels, and low purchasing power form key barriers to food security. Identifying these drivers supports the development of more targeted, evidence-based strategies to strengthen availability and improve access across social groups.

The findings also relate to SDG Target 2.3, which emphasises increasing agricultural productivity and the incomes and livelihoods of small-scale food producers, including groups commonly marginalised in food systems. For Palopo, strengthening local production and improving distribution can generate broader economic benefits across surrounding areas while supporting a more sustainable food system. In addition, the study is relevant to targets aimed at promoting sustainable food production systems and resilient agricultural practices that enhance productivity, protect ecosystems, and strengthen adaptive capacity to climate change, extreme weather, and disasters. Given Palopo's role as a buffer city within the Greater Luwu area, improving food security in Palopo can contribute to stabilising regional food supplies while supporting the national and international SDG agenda.

Overall, a thorough understanding of the drivers of low food security in Palopo City provides a scientific basis for evidence-based policy formulation and strengthens Palopo's strategic position as a buffer city within the food security governance of the Luwu Raya region. The findings speak directly to Target 2.1 (ending hunger through improved access), Target 2.2 (reducing malnutrition), Target 2.3 (increasing productivity and incomes of small-scale producers), Target 2.4 (strengthening sustainable and climate-resilient production systems), and Target 2.5 (maintaining genetic diversity), as well as Targets 2.a (investment in agricultural infrastructure), 2.b (food market stability), and 2.c (reducing food price volatility). In this way, the study contributes substantively to national and international efforts towards Zero Hunger by 2030, while supporting the development of a more inclusive, resilient, and sustainable food system.

Conclusion

Food security in Palopo City is constrained by four interrelated factors: limited local food production, suboptimal distribution infrastructure, weak household purchasing power, and ineffective policy implementation. Shrinking agricultural land, driven by land conversion and climate pressures, has reduced local output and increased reliance on external supply. At the same time, weak logistics infrastructure constrains distribution, raises transport costs, and contributes to price instability. High poverty incidence and food price inflation further limit households' ability to afford nutritious foods. Although

the government has introduced multiple programmes, their impact has remained limited due to implementation gaps and weak coordination across levels of government.

These findings point to an integrated policy response. First, agricultural productivity should be strengthened through modern technology adoption and food diversification to reduce dependence on a single staple commodity. Second, distribution capacity should be improved through upgraded infrastructure and technology-enabled logistics to enhance supply-chain efficiency and support price stability. Third, purchasing power should be strengthened through a food-centred local economic strategy that combines social protection with localised infrastructure development. Fourth, digital tools can improve the targeting and accountability of food assistance and subsidy programmes, reducing leakage and ensuring support reaches those most in need. Implemented systematically, these measures can strengthen Palopo City's food security through an adaptive and sustainable approach, while reinforcing Palopo's role as a buffer city that supports regional food distribution and trade for surrounding areas and the provincial capital.

The implications of this study emphasise that the Palopo City government should adopt a coordinated strategy that links productivity enhancement, efficient and digital-enabled distribution systems, and reforms to targeted social assistance. This approach aligns with Sustainable Development Goal 2 (Zero Hunger), particularly Targets 2.1–2.5, which focus on ending hunger, reducing malnutrition, increasing smallholder productivity and incomes, strengthening sustainable food systems, and maintaining genetic diversity of food resources. It also supports Targets 2.a–2.c by reinforcing investment in agricultural infrastructure, stabilising food markets, and reducing food price volatility. Further research should assess the longer-term effects of the proposed interventions and examine food security governance in other buffer cities, with particular attention to interregional linkages and the use of local data in policy adaptation.

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