

## Sustainable Food Systems and Regional Development: Analyzing Food Security in Medan City's Underprivileged Areas, Indonesia

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### Abstract

*This study investigates the critical role of sustainable food systems in enhancing food security and regional development in the underprivileged areas of Medan City, Indonesia. Using Structural Equation Modeling (SEM) with a Partial Least Square (PLS) approach, data were collected from 400 respondents across the city's most impoverished districts. The findings indicate that sustainable practices in food availability, consumption patterns, and distribution systems are essential determinants of food security and regional development. By promoting local food production, encouraging balanced diets, and developing efficient distribution networks, policymakers can address food insecurity and support sustainable regional growth. The study underscores the necessity of integrating sustainability principles into food security strategies and regional development plans. This alignment with the Sustainable Development Goals (SDGs) aims to end hunger, achieve food security, and promote sustainable agriculture by 2030. Policy recommendations include investing in sustainable agricultural practices, improving infrastructure for food distribution, and implementing community-based nutrition education programs. These strategies are crucial for building resilient and equitable communities in Medan City and beyond.*

**Keywords:** *Food Security, Regional Development, Structural Equation Modeling, Sustainable Agriculture, Medan.*

### Introduction

Indonesia, located on the equator, benefits from its tropical climate and vast fertile lands, making it an ideal environment for agriculture [1], [2], [3]. As a staple food, rice significantly impacts the nation's food security and contributes to regional development [4]. Despite the country's abundant natural resources, Indonesia faces considerable challenges in ensuring food security and advancing regional development, particularly in its underprivileged areas [5], [6].

Food security, as defined by the World Health Organization (WHO) and the Food and Agriculture Organization (FAO), includes dimensions such as food availability, access, utilization, and stability. Food availability refers to having sufficient food to meet basic needs, while access involves the economic and physical means to acquire nutritious food. Food utilization concerns the proper and equitable use of food [7]. Ensuring these components is vital for providing all individuals with enough safe and nutritious food. However, many regions, including Medan City, struggle with food insecurity, exacerbated by poverty, inefficient distribution systems, and a lack of community awareness [8], [9].

Medan City, the capital of North Sumatra Province, illustrates these challenges. With its dense population and high poverty rates, many households in Medan experience food insecurity. The city's geographic setting, situated in a lowland area at the confluence of the Babura and Deli Rivers, poses unique challenges and opportunities for enhancing food security and regional development [10].

Previous research has emphasized the critical role of resource availability, consumption patterns, and distribution systems in achieving sustainable food security [11], [12], [13]. Advances in agricultural technology and the implementation of effective food policies are key factors in this context [14]. The

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Sustainable Development Goals (SDGs) agenda also underscores the importance of ending hunger, achieving food security, improving nutrition, and promoting sustainable agriculture by 2030 [15].

Planning for regional development requires a comprehensive approach that considers the efficient and sustainable use of resources. This includes setting clear goals and objectives, supported by institutional frameworks and regulatory measures, along with strategic actions for management and financing [16]. A well-rounded regional development plan must incorporate economic policies and development programs that address both social and environmental aspects to achieve sustainable and optimal welfare [17]. Effective strategies account for internal factors like natural resources, human resources, and technology, as well as external factors such as opportunities and threats from interactions with other regions [18].

Achieving food security involves ensuring that all individuals have physical, social, and economic access to sufficient, safe, and nutritious food at all times [19], [20]. This encompasses aspects of food availability, access, utilization, and stability [21]. In urban areas like Medan, addressing food insecurity requires tackling poverty, enhancing distribution systems, and increasing community awareness [22]. Sustainable strategies should prioritize leveraging natural resources, improving infrastructure, and fostering community participation [23].

This study aims to examine the impact of sustainable food systems—specifically resource availability, consumption, and distribution—on food security and regional development in Medan City's underprivileged areas. By investigating these factors, the research seeks to offer insights and policy recommendations that can improve food security and promote sustainable regional development.

### *Method*

This research was carried out in Medan City, which includes 21 districts and serves as the administrative center of North Sumatra Province. The city was chosen as the study area due to its unique geographical characteristics, situated in a lowland area at the confluence of the Babura and Deli Rivers. These features, coupled with the city's diverse socio-economic challenges, make it an ideal case study for exploring sustainable food systems and their impact on regional development.

The study employed a quantitative approach, utilizing both primary and secondary data sources. Primary data were collected directly from respondents through interviews and observations, providing firsthand insights into the issues at hand. Secondary data were obtained from various sources, including official documents, books, academic journals, and other relevant literature [24].

In 2023, data from the Central Bureau of Statistics indicated that Medan City had approximately 187,400 residents living in poverty. To ensure a representative sample, a proportional random sampling method was used, guided by the Slovin formula, resulting in a sample size of 400 individuals. The sample was proportionally distributed across four districts with the highest poverty levels: Medan Deli, Medan Labuhan, Medan Marelan, and Medan Belawan.

Data collection involved conducting detailed interviews with respondents, allowing for an in-depth understanding of their perspectives, while field observations documented observable phenomena related to the study. These methods were employed to enhance the accuracy and reliability of the data collected. Additionally, validity and reliability tests were performed to ensure the appropriateness of the research instruments.

The collected data were analyzed using Structural Equation Modeling (SEM) with a Partial Least Square (PLS) approach. This analytical method was chosen for its ability to model complex relationships between observed and latent variables, making it particularly suitable for evaluating the interactions between various components of sustainable food systems and their influence on food security and regional development. This robust analytical framework provided comprehensive insights into the dynamics of the studied variables and their interrelationships.

## Result and Discussion

### Validity Test

Validity and reliability tests were conducted to ensure that the research instruments were appropriate for use. The following are the results of the outer model analysis in the second stage:

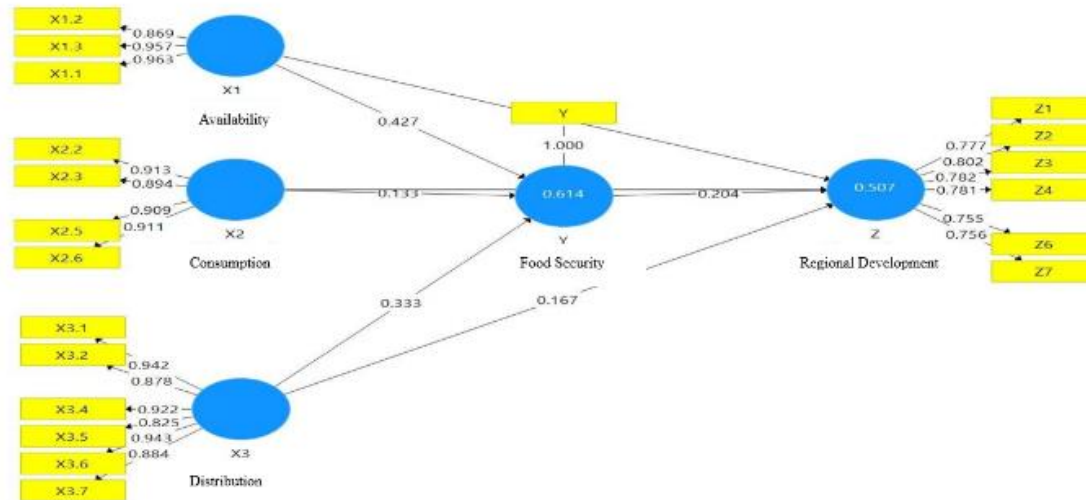


Figure 1. Outer Model Analysis Results

### Explanation:

- X1 = Availability
  - X1.1 = Production
  - X1.2 = Imports
  - X1.3 = Stock
- X2 = Consumption
  - X2.2 = Quantity
  - X2.3 = Education Level
  - X2.5 = Per Capita Expenditure
  - X2.6 = Number of Family Members
- X3 = Distribution
  - X3.1 = Access/Supply
  - X3.2 = Income
  - X3.4 = Employment Opportunities
  - X3.5 = Food Prices
  - X3.6 = Employment
  - X3.7 = Cooperation in Production Supply
- Y = Food Security
- Y = Food Security
- Z = Regional Development
  - Z1 = Economic Growth
  - Z2 = Human Resources
  - Z3 = Technological Advancement
  - Z4 = Human Development Index (HDI)
  - Z6 = Employment Absorption

## Z7 = Investment

Figure 1 showed that the evaluation of convergent validity, using the parameter loading factor values for each research variable, indicated that the availability variable, with its three construct indicators; the consumption variable, with its four construct indicators; the distribution variable, with its six construct indicators; the food security variable, with its six construct indicators; and the regional development variable, with its six construct indicators all fell into the valid category. Therefore, all construct indicators of each variable were used for further analysis in testing the hypotheses.

### *Reliability Test*

Reliability tests in PLS were conducted using two methods, namely Cronbach's alpha and composite reliability, which were present in each variable. Cronbach's alpha measured the lower limit of the reliability value of a construct, while composite reliability measured the actual reliability value of a construct. Cronbach's alpha values greater than 0.80 were considered to have good scales, Cronbach's alpha values greater than 0.70 were considered acceptable, and Cronbach's alpha values greater than 0.60 were considered exploratory estimates, including low estimates.

**Table 1. Validity and Reliability Result**

No	Variable		Cronbach's Alpha	Composite Reliability
1.	X1 Availability		0,922	0,951
2.	X2 Consumption		0,928	0,949
3.	X3 Distribution		0,953	0,962
4.	Y Food Security		1,000	1,000
5.	Z Regional Development		0,867	0,900

Source: Data processed, 2023

Based on Table 1, it was seen that the Cronbach's alpha values of all research variables were greater than 0.70. The availability variable (X1) was 0.922, the consumption variable (X2) was 0.928, the distribution variable (X3) was 0.953, the food security variable (Y) was 1.000, and the regional development variable (Z) was 0.867. Meanwhile, the composite reliability values of all research variables were greater than 0.70. The availability variable (X1) was 0.951, the consumption variable (X2) was 0.949, the distribution variable (X3) was 0.962, the food security variable (Y) was 1.000, and the regional development variable (Z) was 0.900. It was concluded that all constructs had composite reliability and Cronbach's alpha values above 0.7, indicating that all statement items in each construct were reliable.

### *Structural Model Test with Bootstrapping*

The bootstrap method was used as a tool to help reduce unreliability associated with the error of using a normal distribution. In bootstrap, pseudo data (shadow data) were created using information and characteristics of the original data so that the shadow data had similar characteristics to the original data:

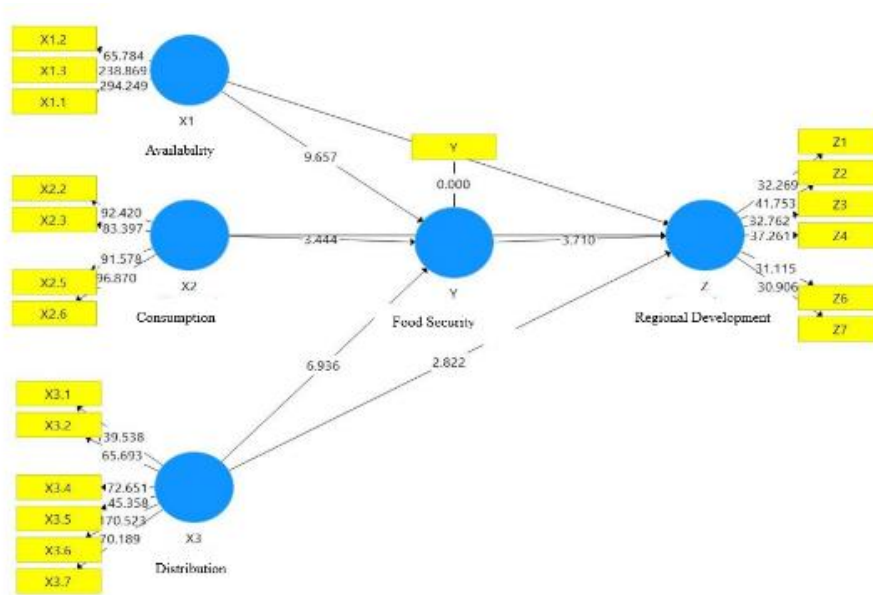


Figure 2. Structural Model Test with Bootstrapping Using PLS

The significance of the estimated parameters provided very useful information regarding the relationships between research variables. The basis used in testing the hypothesis of direct influence was the value contained in the path coefficient output in the form of output estimation for structural model testing. The significance on each path is summarized in Table 2 below:

Table 2. Path Coefficients and P-Values (Direct Effect Significance)

	Original Sampel (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistic (IO/STDEV)	P Values	Criteria	Decision
X1 Availability -> Y	0.427	0.428	0.044	9.657	0.000	a0.05	Accepted
X2 Consumption -> Y	0.133	0.133	0.039	3.444	0.001	a0.05	Accepted
X3 Distribution -> Y	0.333	0.334	0.048	6.936	0.000	a0.05	Accepted
X1 Availability -> Z	0.173	0.172	0.060	2.862	0.004	a0.05	Accepted
X2 Consumption -> Z	0.297	0.297	0.048	6.166	0.000	a0.05	Accepted
X3 Distribution -> Z	0.167	0.171	0.059	2.822	0.005	a0.05	Accepted

Source: Processed Data, 2023

Based on the results of the path coefficients and p-values in Table 2 above, the results of the path coefficients and significance tests of the direct influence of independent variables on the dependent variable are explained as follows:

*Availability (X1) Positively and Significantly Affects Food Security (Y)*

Based on the T-test results, the original sample value was 0.427 and had a t-statistic value of 9.657. Since the t-statistic value was greater than the t-table value ( $9.657 > 1.96$ ) and the P Value was 0.000, it was interpreted that food availability had a significant effect on food security.

*Food Consumption (X2) Positively and Significantly Affects Food Security (Y)*

Based on the T-test results, the original sample value was 0.133 and had a t-statistic value of 3.444. Since the t-statistic value was greater than the t-table value ( $3.444 > 1.96$ ) and the P Value was 0.001, it was interpreted that food consumption had a significant effect on food security.

*Food Distribution (X3) Positively and Significantly Affects Food Security (Y)*

Based on the T-test results, the original sample value was 0.333 and had a t-statistic value of 6.936. Since the t-statistic value was greater than the t-table value ( $6.936 > 1.96$ ) and the P Value was 0.000, it was interpreted that food distribution had a significant effect on food security.

*Availability (X1) Positively and Significantly Affects Regional Development (Z)*

Based on the T-test results, the original sample value was 0.173 and had a t-statistic value of 2.862. Since the t-statistic value was greater than the t-table value ( $2.862 > 1.96$ ) and the P Value was 0.004, it was interpreted that availability had a significant effect on regional development.

*Food Consumption (X2) Positively and Significantly Affects Regional Development (Z)*

Based on the T-test results, the original sample value was 0.297 and had a t-statistic value of 6.166. Since the t-statistic value was greater than the t-table value ( $6.166 > 1.96$ ) and the P Value was 0.000, it was interpreted that food consumption had a significant effect on regional development.

*Food Distribution (X3) Positively and Significantly Affects Regional Development (Z)*

Based on the T-test results, the original sample value was 0.167 and had a t-statistic value of 2.822. Since the t-statistic value was greater than the t-table value ( $2.822 > 1.96$ ) and the P Value was 0.005, it was interpreted that food distribution had a significant effect on regional development.

The findings from this study underscore the crucial role of food availability, consumption, and distribution in both food security and regional development in underprivileged areas of Medan City. The significant positive effects observed across these variables provide valuable insights for policymakers and stakeholders aiming to enhance food security and foster sustainable regional development.

## **Dicussion**

### *Food Availability and Its Impact*

Food availability was identified as a critical component in both food security and regional development. The strong positive correlation between food availability and food security underscores the importance of maintaining a steady supply of food resources. This finding is consistent with prior research that highlights the significance of local food production and efficient resource management [11], [25]. Increasing agricultural productivity and decreasing dependency on food imports can significantly bolster food availability, thereby enhancing food security and contributing to regional development.

### *Food Consumption Patterns*



The study also revealed the considerable influence of food consumption patterns on food security and regional development. Community education on proper nutrition and the promotion of balanced diets are crucial steps towards improving food security. The positive relationship between food consumption and regional development indicates that better nutrition can enhance human capital, leading to increased productivity and economic growth. This finding aligns with [25] work, which emphasizes the importance of dietary education and higher per capita food expenditure in achieving sustainable development.

#### *Food Distribution Systems*

Efficient food distribution systems are essential for ensuring equitable food access and supporting regional development. The significant positive impact of distribution on both food security and regional development highlights the necessity of robust infrastructure and logistics networks. By enhancing access to food supplies and ensuring fair pricing, distribution systems can alleviate the effects of food insecurity in underprivileged areas. This observation is supported by studies from [17] which stress the importance of effective distribution channels in promoting food security.

#### *Regional Development and Food Security*

The study provides evidence of a strong interconnection between food security and regional development, with improvements in one area positively influencing the other. Enhancing food availability, consumption, and distribution not only addresses immediate concerns about food security but also contributes to broader developmental objectives. Integrating food security strategies into regional development plans is vital for building resilient and sustainable communities. This comprehensive approach aligns with the Sustainable Development Goals (SDGs), particularly the goals of ending hunger, achieving food security, and promoting sustainable agriculture by 2030 [26].

#### *Policy Implications*

Based on the study's findings, several policy recommendations are proposed:

**Increase Local Food Production:** Investing in agricultural technology and supporting local farmers can enhance food production and reduce reliance on imports.

**Improve Distribution Systems:** Developing infrastructure and logistics to facilitate efficient food distribution can improve food access and stabilize prices.

**Nutrition Education:** Implementing community-based programs to promote healthy eating habits can improve food consumption patterns and overall health.

**Integrated Development Planning:** Incorporating food security into regional development plans can create synergies that foster economic growth and social well-being.

### **Conclusion and Recommendations for Development**

This study has demonstrated the significant influence of food availability, consumption, and distribution on food security and regional development in underprivileged areas of Medan City. Ensuring a stable and sufficient supply of food resources, promoting balanced diets through community education, and developing efficient food distribution systems are crucial for addressing food insecurity and fostering economic growth. These findings underscore the importance of a holistic approach that integrates food security strategies into regional development planning. Policy recommendations include increasing local food production, improving distribution infrastructure, and implementing comprehensive nutrition education programs. By addressing these key determinants, policymakers can enhance food security, promote social well-being, and support sustainable development, aligning with the Sustainable Development Goals (SDGs) of ending hunger, achieving food security, improving nutrition, and promoting sustainable agriculture by 2030.

The broader implications of this study extend beyond Medan City, offering valuable insights for other regions facing similar challenges. Future research could explore similar analyses in different geographical contexts and conduct longitudinal studies to understand the long-term effects of food security interventions on regional development. Additionally, examining the role of policy implementation and governance could provide practical guidance for enhancing food security and regional development. By focusing on these key areas and integrating them into broader development strategies, it is possible to create more equitable and sustainable communities. This research lays the groundwork for such efforts, offering a foundation upon which effective and transformative policies can be built, ultimately contributing to a more resilient and food-secure future.

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