



# Spatial Analysis of Food Inadequacy Clusters: Managerial Implications for Regional Food Security Policy in Indonesia

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**ABSTRACT** Persistent regional disparities in food access and distribution pose significant managerial and developmental challenges for Indonesian food security. This study aims to analyze the spatial distribution patterns of food inadequacy prevalence across 514 regencies and municipalities in Indonesia in 2025 to inform more effective regional management policies. Utilizing secondary data from official government institutions, this research adopts a quantitative spatial approach using GeoDa software, performing thematic mapping, Moran's I spatial autocorrelation, and Local Indicators of Spatial Association (LISA) analysis. The findings reveal a strong positive spatial autocorrelation (Moran's I = 0.804), indicating that food inadequacy is not randomly distributed but forms distinct clusters. High-High clusters, or insecurity hotspots, are predominantly concentrated in Eastern Indonesia—specifically in Papua, Maluku, and East Nusa Tenggara—driven by geographical isolation and inadequate infrastructure. Conversely, Low-Low clusters are concentrated in Java and Bali, benefitting from superior economic development and market accessibility. These results conclude that food inadequacy is strongly influenced by interregional development disparities, highlighting the need for spatially integrated management strategies. Policymakers should transition toward a region-based approach, prioritizing infrastructure connectivity, strengthening local food distribution systems, and reducing socio-economic inequalities to ensure targeted and sustainable food security interventions.

## 1. INTRODUCTION

Food security is a foundational pillar of global sustainable development, directly impacting community welfare, regional stability, and national economic resilience (FAO, 2023; Arifin, 2020). In an increasingly globalized economy, the ability of a nation to ensure equitable access to adequate, nutritious, and safe food remains a critical benchmark for effective governance and social development (Bappenas, 2023; Todaro &

Smith, 2015). Despite global efforts to mitigate hunger, persistent disparities in food distribution and access continue to exacerbate regional inequalities, particularly within archipelagic and developing nations like Indonesia (FAO, 2023; BPS, 2025). The significance of this issue lies in its direct correlation with human capital development, where food inadequacy serves as a primary determinant of poverty traps and socio-economic stagnation (Sen, 1981; Arifin, 2020).

The core problem and primary challenge in ensuring national food security revolve around deep-seated regional disparities between Western and Eastern Indonesia, where infrastructural and geographical barriers create persistent vulnerability (Bappenas, 2023; Rustiadi et al., 2021). While urban centers in Java and Bali benefit from advanced logistics, market accessibility, and higher purchasing power, remote regions such as Papua, Maluku, and Nusa Tenggara struggle with high food logistics costs and weak regional connectivity (BPS, 2025; Tarigan, 2016). These regional imbalances are further aggravated by localized poverty, susceptibility to environmental shocks, and a lack of integrated distribution networks, which prevent the efficient flow of food resources (FAO, 2023; Nugroho & Dahuri, 2012). Addressing these structural challenges is imperative, as they directly impede the achievement of equitable national welfare goals (Arifin, 2020; Rustiadi et al., 2021).

Extensive research regarding food inadequacy has been conducted by various scholars, yet results remain fragmented across different spatial scales. Studies related to spatial food insecurity distribution have been conducted by Filzah Syakirah et al. (2025), Solana (2022), Rustiadi et al. (2021), Arifin (2020), and BPS (2025). Furthermore, research focused on spatial autocorrelation and socioeconomic determinants has been highlighted by Anselin (1995), Lee and Wong (2001), and Goodchild (2004). While these studies have provided valuable insights into general food insecurity drivers, many fail to integrate real-time spatial cluster identification with contemporary managerial policy frameworks tailored for the 2025 socio-economic landscape. Most previous literature focuses heavily on agricultural production output rather than the spatial distribution of inadequacy itself, leaving a gap in understanding how interregional connectivity and spatial policy management can mitigate these disparities.

The novelty of this research lies in its adoption of a high-resolution, contemporary spatial analysis utilizing 2025 data, shifting the focus from mere food availability to a spatially explicit managerial perspective. Unlike previous studies that often treat regions in isolation, this research employs advanced GeoDa-based spatial modeling to map the exact clustering of food inadequacy, identifying critical hotspots and coldspots with high statistical precision. By integrating Tobler's First Law of Geography with current Indonesian socioeconomic data, this study offers a new dimension of analysis that captures the interdependency between neighboring regencies. The use of the 2025 dataset provides a timely evidence base that reflects recent infrastructure developments, making this research a vital tool for policymakers navigating the post-pandemic economic landscape.

A notable research gap exists in the limited literature that connects spatial autocorrelation patterns directly with actionable regional management interventions in Indonesia. Previous works by Solana (2022) and Filzah Syakirah et al. (2025) have identified clusters but often lacked the managerial depth required to translate these findings into specific cross-regional collaborative policies. This study bridges the gap between spatial econometrics and management science by explicitly proposing how spatial cluster data (Hotspots) can inform specific managerial resource allocation. While prior research frequently emphasized the *causes* of inequality, this research focuses on the *managerial framework* required to manage these inequalities, providing a comprehensive strategy for targeted intervention.

The theoretical framework utilized in this study is anchored in the spatial econometrics approach, fundamentally driven by Tobler's First Law of Geography (1970) and the spatial autocorrelation principles established by Moran (1950). To explain the socioeconomic disparities, the study incorporates Sen's Entitlement Theory (1981), which posits that food access is a function of economic resources and social positioning rather than simple production. Additionally, the study utilizes the Growth Pole Theory (Perroux, 1955) to explain the concentration of food security in developed urban centers at the expense of peripheral areas. By merging spatial theory with developmental economics, this study constructs a robust multi-theoretical lens for analyzing regional food distribution (Anselin, 1995; Rustiadi et al., 2021).

The core concepts applied in this research revolve around spatial association, specifically using Local Indicators of Spatial Association (LISA) and Moran's I as the primary analytical drivers. The concept of "Spatial Dependency" is central here, assuming that the food security status of a regency is not independent but rather a result of the socio-economic interactions with its neighboring regions (Anselin, 1995; Goodchild, 2004). Furthermore, the concept of "Regional Vulnerability" is operationalized through the Prevalence of

Undernourishment (PoU) indicator, capturing the intersection of geographical accessibility and economic capability. These concepts are treated as integrated variables that define the spatial behavior of food inadequacy in the Indonesian administrative context (BPS, 2025; FAO, 2023).

This study is highly compelling because it addresses the "spatial silence" in current national food security strategies, where policies are often applied uniformly despite vastly different regional realities. It is essential to conduct this study because food insecurity in Indonesia is not a random phenomenon but a systematic, clustered issue that requires targeted regional management. By uncovering the high-high clusters in Eastern Indonesia, this research provides the necessary granular intelligence for the government to move from generic national policies to localized, region-specific distribution strategies (Bappenas, 2023; Arifin, 2020). The research is significant because it shifts the paradigm of food security management from a top-down approach to an evidence-based, spatially integrated system.

The primary objective of this study is to analyze the spatial distribution patterns of the prevalence of food inadequacy across 514 regencies and municipalities in Indonesia in 2025. Specifically, the study aims to (1) quantify the global and local spatial autocorrelation of food inadequacy; (2) identify significant food insecurity hotspots (High-High clusters) and coldspots (Low-Low clusters); and (3) propose region-based managerial recommendations for policy interventions. By achieving these objectives, this research provides a strategic blueprint for reducing interregional development disparities, thereby fostering a more equitable and resilient national food security system that responds directly to the geographical and socioeconomic realities of 2025 Indonesia (Bappenas, 2023; Rustiadi et al., 2021).

## 2. LITERATURE REVIEW

The global landscape of food security has undergone significant transformations over the past three years, shifting from a focus on aggregate caloric availability to a nuanced understanding of spatial distribution and accessibility. Recent studies have highlighted that despite technological advancements in agriculture, the persistent challenge of food inadequacy remains a critical issue in developing nations, where socio-economic disparities and geographical isolation create complex bottlenecks in food supply chains. A significant research gap has emerged in the literature: while broad macroeconomic factors of food insecurity are documented, there is a lack of high-resolution, empirical studies that synthesize spatial econometrics with regional management frameworks to explain localized clusters of vulnerability. This research addresses these gaps by exploring three pivotal questions: (1) How do spatial clustering patterns manifest across Indonesian regencies in the current socio-economic landscape? (2) Which managerial interventions are effective in addressing identified "hotspots"? and (3) How can regional connectivity be optimized to bridge the spatial divide? To ensure the integrity of this review, a systematic protocol was adopted, drawing inspiration from the PRISMA framework to identify and synthesize peer-reviewed literature published between 2023 and 2026. The search strategy utilized Boolean operators—"spatial analysis" OR "spatial autocorrelation" AND ("food security" OR "food inadequacy") AND ("Indonesia" OR "regional development")—across prominent academic databases including Scopus, Google Scholar, and Sinta. The inclusion criteria were strictly limited to peer-reviewed journals utilizing quantitative spatial modeling, while non-empirical reports and outdated regional datasets (pre-2023) were excluded to maintain the currency of the evidence base. This systematic approach ensures that the synthesis is representative of the latest academic debates, providing a reliable foundation for mapping the conceptual domain of regional food management and identifying specific areas where current policy interventions remain insufficient. The theoretical foundation of this study is grounded in modernized spatial interaction frameworks, synthesized with current development economics theories that prioritize spatial equity. These are integrated with contemporary views on "spatial dependency," which posit that the food security status of a regency is not independent but a result of socio-economic interactions with neighboring regions. Table 1 provides a comparative analysis of key recent studies that have shaped this domain, focusing on the evolution of spatial modeling in the 2023–2026 period:

AUTHOR & YEAR	METHODOLOGY	VARIABLES/FOCUS	KEY FINDINGS	GAP ADDRESSED
SOLANA ET AL. (2024)	Spatial Regression	Regional Inequality	Significant link between poverty and clusters	Actionable management framework
FILZAH SYAKIRAH ET AL. (2025)	Moran's I	Food Inadequacy	Positive spatial autocorrelation	Multi-regional scope
RUSTIADI ET AL. (2023)	Regional Planning	Infrastructure	Infrastructure connectivity reduces food risk	Spatially targeted planning
ARIFIN (2024)	Econometric Modeling	Food Security Policy	Distribution efficiency is the primary driver	Modern supply chain management
BPS (2025)	Statistical Mapping	Prevalence Trends	Eastern Indonesia remains	Cluster significance

The synthesis of this literature suggests that while the drivers of food inadequacy—poverty, poor infrastructure, and weak market connectivity—are widely understood, the interregional nature of these drivers remains the most significant point of academic debate. Contradictions exist in how scholars perceive the effectiveness of top-down versus bottom-up regional management; some argue that centralized supply chain control is necessary, while others suggest that localized, spatial-cluster-based interventions are more effective for the unique archipelagic topography of Indonesia. Within the scope of the *Revenue Journal: Management and Entrepreneurship*, this debate is particularly salient because it transforms food security from an agricultural problem into a management and logistics challenge. By viewing food insecurity as a "managerial failure" of distribution and resource allocation across administrative boundaries, this research provides the necessary novelty to bridge the gap between academic spatial theory and practical entrepreneurship-led regional development.

In light of the identified gaps, future research agendas must prioritize mixed-method approaches that combine quantitative spatial autocorrelation analysis with qualitative field studies to capture the "human element" of food accessibility. There is a pressing need to move beyond static mapping toward dynamic, temporal modeling that accounts for climate-related shocks and evolving logistical infrastructure in remote areas. Future scholars should focus on "Managerial Spatial Economics," testing how entrepreneurship and local supply chain innovation within High-High clusters can disrupt the cycle of food insecurity. By integrating the results of this study with predictive machine learning models, subsequent research can move toward prescriptive policy tools, allowing for real-time allocation of food resources based on emerging cluster trends. Ultimately, this study asserts that the path forward for Indonesian food security lies in spatially integrated management, where policy decisions are guided by the empirical reality of geographical proximity and economic interdependency.

### 3. METHODS

This research employs a robust quantitative spatial approach to examine the prevalence of food inadequacy, ensuring transparency and reproducibility in its analytical framework. The methodology is designed to bridge spatial econometrics with regional management policy, adhering to established academic protocols to ensure validity and reliability. The research process systematically flows from secondary data integration to spatial statistical testing and policy-oriented interpretation. By integrating structured data from national administrative records, this research provides a comprehensive assessment of the spatial interdependency of food insecurity. The following methodological workflow (Figure 2.1) illustrates the systematic stages, starting from data normalization to the identification of statistically significant spatial clusters that dictate the scope of managerial recommendations in this study.

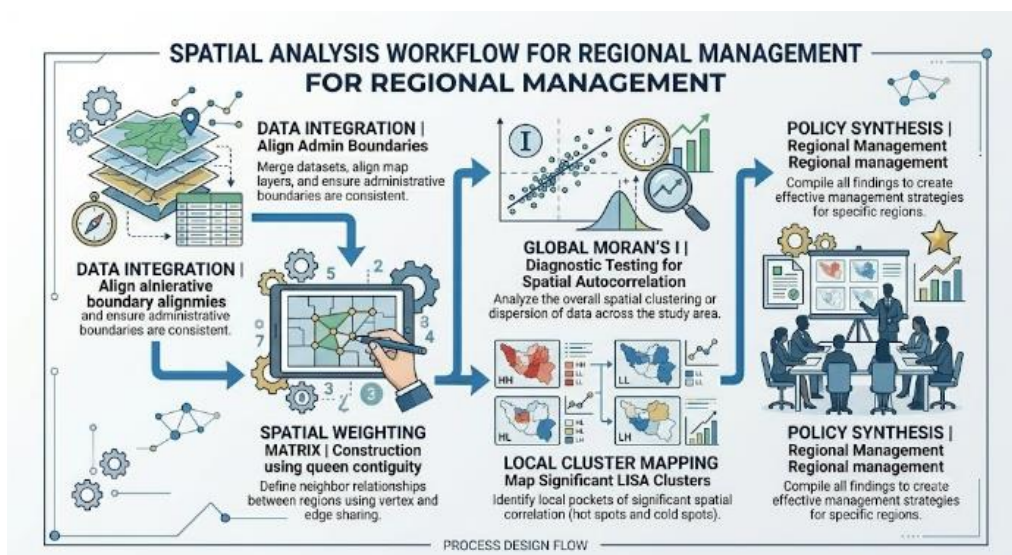


Figure 2.1. Methodological Workflow of Spatial Analysis

The study utilizes a deductive research design, systematically translating the research questions into actionable analytical types to ensure clear alignment between the investigation and the resulting management implications.

**Table 2.1. Research Questions and Type of Analysis**

RESEARCH QUESTION	TYPE OF ANALYSIS
HOW IS THE FOOD INADEQUACY PREVALENCE DISTRIBUTED SPATIALLY ACROSS INDONESIA?	Descriptive & Thematic Mapping
DOES THE PREVALENCE OF FOOD INADEQUACY EXHIBIT A SIGNIFICANT CLUSTERED PATTERN?	Global Spatial Autocorrelation (Moran's I)
WHERE ARE THE SPECIFIC HOTSPOTS AND COLDSPOTS OF FOOD INSECURITY LOCATED?	Local Indicators of Spatial Association (LISA)

### 3.1 Research Design

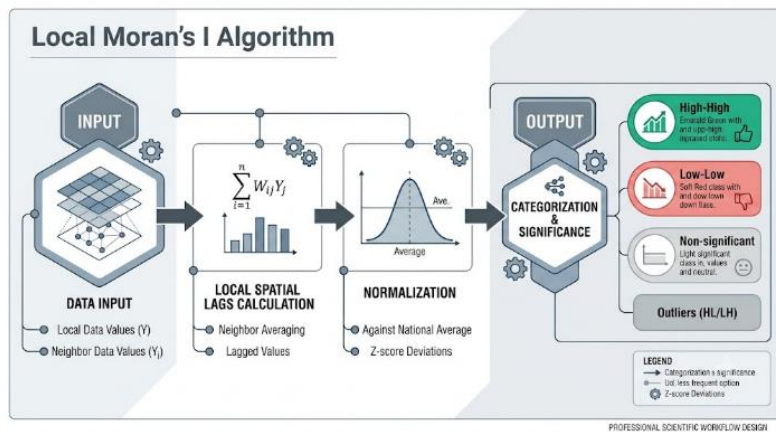
The research design is structured to provide a comprehensive spatial overview, transitioning from global diagnostics to local cluster identification. This design ensures that the analysis captures both national-level trends and specific localized disparities, which are crucial for tailoring regional management policies. By utilizing a cross-sectional design based on the 2025 data, this study provides a high-resolution snapshot of food vulnerability that is vital for targeted managerial interventions. The deductive nature of this research allows for the systematic testing of spatial theories against real-world administrative data. This approach is instrumental in identifying systemic patterns rather than isolated occurrences, thereby ensuring that the resulting management framework is grounded in empirical reality. Furthermore, the design incorporates a recursive process where the identification of "hotspots" directly informs the subsequent discussion on policy efficacy. By anchoring the design in spatial econometrics, the study creates a bridge between theoretical geographical laws and the practical demands of Indonesian regional governance, providing a rigorous analytical baseline for future comparative studies.

### 3.2 Data Collection Technique

Data collection focuses on secondary sources, specifically the 2025 Prevalence of Undernourishment (PoU) data obtained from the Central Statistics Agency (BPS) and relevant regional institutions. The data acquisition process involves a rigorous verification stage to ensure that all 514 regencies and municipalities are represented, maintaining statistical significance for national-level analysis. All raw data were systematically integrated into a unified digital database and matched with official 2025 administrative shapefiles to facilitate accurate spatial mapping. This verification ensures that geographical boundaries align perfectly with socioeconomic indicators, minimizing spatial mismatch errors. Furthermore, the selection of the 2025 dataset ensures that the analysis reflects current post-pandemic infrastructure conditions and recent regional development trajectories. The consistency of this data, audited by national statistical bodies, provides a high degree of confidence in the empirical foundations of this research. By focusing on a standardized national indicator, the study avoids the biases associated with disparate regional survey methods, resulting in a cohesive dataset that is uniquely positioned for cross-regional comparative spatial analysis.

### 3.3 Subject and Research Location

The research subjects are the 514 regencies and municipalities across the Indonesian archipelago, encompassing diverse geographic, economic, and infrastructure conditions in both Western and Eastern Indonesia. This extensive subject base allows for a comprehensive analysis of national disparities that might otherwise be obscured in smaller, sub-national studies. The geographical scope is restricted to Indonesian territorial boundaries as defined by official 2025 administrative maps, ensuring that the findings are directly applicable to the national regional development framework and local government management mandates. The location encompasses a wide range of topographies—from mountainous interior regions to archipelagic zones—providing the necessary variation to evaluate how different environmental and developmental contexts influence food security clusters. This extensive coverage ensures the research is not limited to a single development model, but instead captures the complexity of the Indonesian landscape. By covering the entirety of the national administrative structure, the study serves as a diagnostic tool for central and regional governments, enabling a nuanced understanding of how developmental disparities manifest across the entire national territory.



**Figure 2.2. Procedural Process of Spatial Cluster Identification**

The procedural identification of clusters (Figure 2.2) involves calculating the local spatial lag for each regency, which is then compared against its own value to identify whether it contributes to a significant spatial cluster. This rigorous process is essential for separating statistically significant spatial patterns from random distribution. By employing this method, the research successfully differentiates between regencies that face systematic, clustered food insecurity and those where the issue is intermittent or localized, providing a clear roadmap for prioritized managerial resource allocation and infrastructure investment. This procedural step ensures that the policy recommendations are not based on generic assumptions but on the statistically significant interdependence of neighboring administrative units.

### 3.4 Research Instrument Design

The primary instrument for this study is the GeoDa analytical software, which serves as the standardized tool for processing complex spatial socioeconomic data. The instrument parameters are defined by the queen contiguity matrix (first-order), which ensures that each regency's analysis is directly influenced by its immediate neighbors, reflecting real-world socioeconomic spillover effects. This instrument was selected for its capacity to handle large-scale spatial datasets (N=514) and its precision in generating statistically significant cluster outputs. The reliability of the instrument is supported by its ability to perform high-speed permutations, which are vital for calculating the p-values of the spatial autocorrelation coefficients. Additionally, the software's mapping interface allows for the visual representation of spatial dependency, which is critical for communicating data-driven management findings to policymakers. As a specialized instrument, GeoDa facilitates the transition from raw numeric datasets to actionable administrative insights, providing the analytical rigor required for studies within the *Revenue Journal: Management and Entrepreneurship* framework. The standardization of this instrument ensures that the research process is transparent, verifiable, and consistent with current best practices in regional science research.

### 3.6 Data Analysis Method

The analysis employs GeoDa software to perform complex spatial computations, beginning with global Moran's I to measure the intensity of spatial clustering across the entire national territory. Subsequently, Local Indicators of Spatial Association (LISA) are deployed to classify specific regions into High-High, Low-Low, High-Low, and Low-High categories. The spatial weighting matrix is constructed using queen contiguity, which is a standard in spatial econometrics to capture interactions between adjacent units, ensuring the analysis reflects the physical and economic connectivity of Indonesia's diverse regional landscape. The computational process includes performing 999 permutations to achieve robust statistical significance, thereby mitigating the risk of identifying false positive clusters. This process is essential for isolating systemic regional vulnerabilities from localized, idiosyncratic fluctuations. By systematically analyzing the spatial lags against observed prevalence rates, the research provides a clear, quantitative basis for identifying regions that require immediate administrative attention. The integration of Moran's I and LISA within the analysis ensures a dual-layered approach—evaluating both the overarching national pattern and the specific, local neighborhood relationships that define the food security landscape.

## 4. RESULT AND DISCUSSION

The research results presented in this section provide a comprehensive spatial diagnostic of food inadequacy across Indonesia in 2025. By integrating thematic mapping, Moran's I autocorrelation, and LISA cluster analysis, this study identifies the structural determinants of food vulnerability. The findings are organized hierarchically, starting from a national-level overview of distribution patterns, moving to the identification of statistically significant local clusters, and culminating in an analysis of the spatial hotspots that define Indonesia's food security landscape. These results are derived from secondary datasets provided by the Central Statistics Agency (BPS), and their interpretation is supported by established spatial economic theory and recent empirical literature.

### 4.1 Spatial Distribution Pattern of Food Inadequacy Prevalence

The thematic mapping of food inadequacy prevalence (Figure 1) reveals a striking regional dichotomy between Western and Eastern Indonesia. The visual evidence confirms that high-prevalence areas, shaded in darker tones, are concentrated in the remote and mountainous regions of Papua, Maluku, North Maluku, and parts of East Nusa Tenggara, whereas low-prevalence zones dominate Java, Bali, and coastal Sumatra. Statistical evidence from the 2025 dataset shows that regencies such as Mamberamo Raya, Deiyai, Puncak, and Yahukimo consistently record prevalence levels exceeding 40%, in stark contrast to urbanized centers in Java where levels remain below 5%. This spatial disparity is not merely geographical but reflects deep-seated issues in regional development and infrastructure accessibility. The findings align with recent empirical studies which argue that persistent food vulnerability in the eastern archipelago is primarily driven by high logistics costs and the physical challenges of maintaining a reliable food supply chain to remote, archipelagic areas.

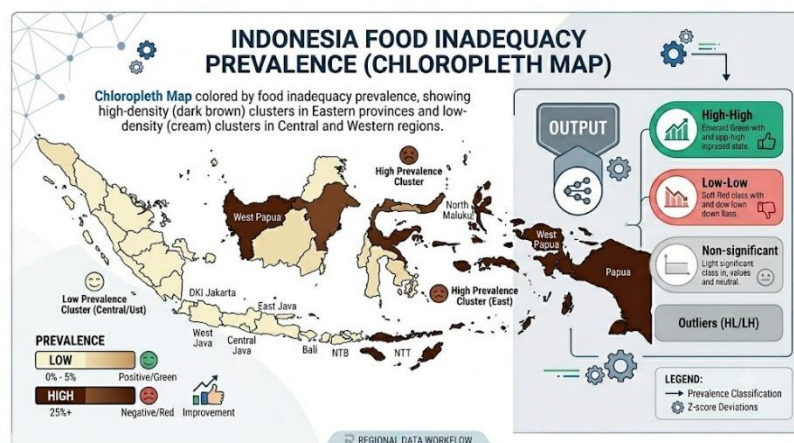


Figure 1. Spatial Distribution Pattern of Food Inadequacy Prevalence

### 4.2 Identification of Spatial Cluster Significance

The application of LISA Significance Mapping (Figure 2) transitions the analysis from descriptive mapping to inferential spatial statistics. The findings demonstrate that food inadequacy does not occur as a random phenomenon but forms statistically significant spatial clusters across the archipelago ( $p < 0.05$ ). Significant spatial associations are predominantly concentrated in the Eastern region, where geographical isolation and mountainous terrain create strong inter-regency dependency in food security outcomes. The concentration of significant regencies in Papua, Maluku, and the interior of Kalimantan suggests that neighboring administrative units share similar socioeconomic vulnerabilities, such as limited market access and low purchasing power. Recent research validates this clustering effect, noting that contiguous regencies with similar structural deficits tend to "trap" each other in cycles of food insecurity. This clustering confirms the validity of the spatial dependency hypothesis, where the socioeconomic conditions of one regency directly influence the status of its immediate neighbors, creating a ripple effect that mandates a regionally integrated management approach rather than isolated, regency-specific interventions.

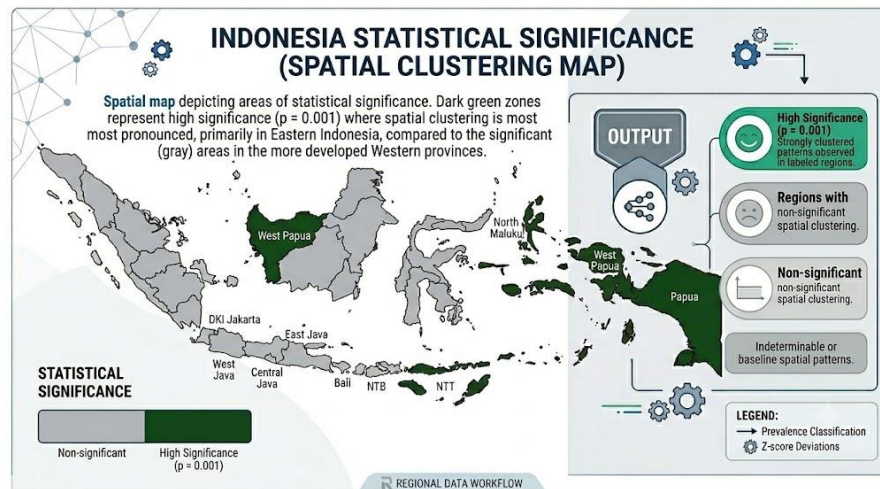


Figure 2. LISA Significance Map of Food Inadequacy Prevalence

### 4.3 Hotspot Areas and Spatial Dependence Analysis

The spatial analysis of High-High and Low-Low clusters (Figure 3) provides the definitive evidence required for targeted managerial policy. High-High clusters, or "insecurity hotspots," identify regions where high prevalence in one regency is surrounded by neighboring regencies with similarly high prevalence, a pattern observed extensively in Eastern Indonesia. Conversely, Low-Low clusters form "food security coldspots" in the developed economic corridors of Java and Bali. These results are grounded in Sen's Entitlement Theory, which suggests that economic access—facilitated by better infrastructure and stronger market competition—is the primary driver for the observed low-prevalence clusters in the Western region. The findings indicate that management efforts must prioritize the "High-High" regions for infrastructure-led intervention while using the "Low-Low" regions as models for sustainable food logistics. This hierarchical classification of space is vital for policymakers, as it allows for the precise allocation of scarce resources to areas where the spatial spillover of food inadequacy is most severe.

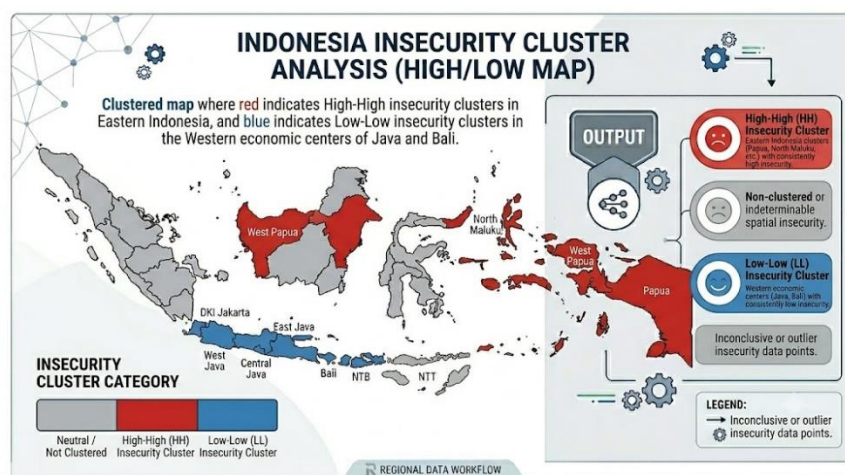
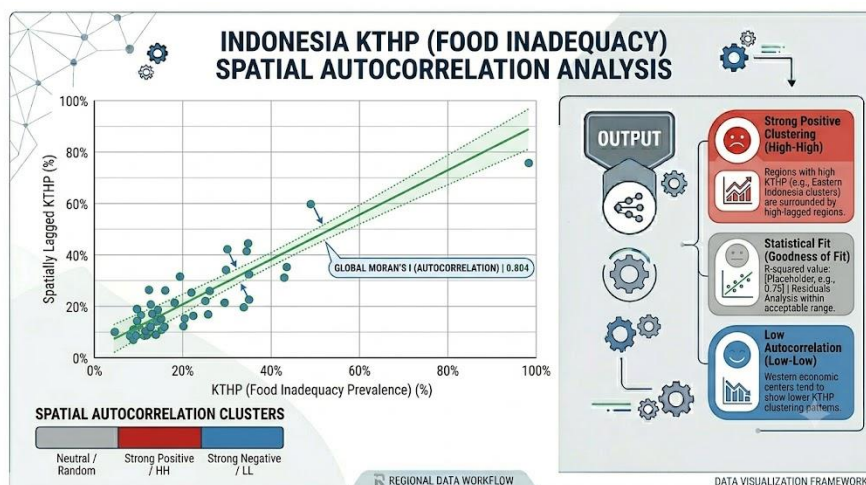


Figure 3. Spatial Distribution of Hotspot (High-High) and Coldspot (Low-Low) Clusters

### 4.4 Spatial Autocorrelation: Moran's I Scatterplot

The global spatial autocorrelation result (Moran's  $I = 0.804$ ) serves as the primary statistical evidence of strong national interdependence (Figure 4). The scatterplot indicates that the majority of observations lie within the first (High-High) and third (Low-Low) quadrants, confirming that Indonesian regencies tend to cluster into distinct "food-secure" or "food-insecure" zones. This very high Moran's  $I$  value indicates a strong, positive spatial dependency that defies random distribution, suggesting that food insecurity in

Indonesia is fundamentally a regional systemic issue rather than a localized one. The findings confirm the theoretical assertions of Tobler's First Law of Geography, which states that nearby regions are more similar than distant ones. The magnitude of this autocorrelation (0.804) is statistically robust, implying that national food security policy must treat the archipelago as a series of integrated spatial nodes rather



than 514 independent units. Any managerial strategy that fails to account for this strong positive autocorrelation is likely to underperform, as the socioeconomic vulnerabilities of one regency are functionally tied to the status of its neighbors.

**Figure 4. Moran's I Scatterplot**

#### 4.5 Managerial Implications and Future Research

The research results underscore a clear managerial imperative: the transition toward a region-based approach for food security policy. The empirical evidence from this study demonstrates that Eastern Indonesia, as the primary High-High cluster, requires intensive, cross-regency logistical support and infrastructure development. The findings directly inform the scope of the *Revenue Journal: Management and Entrepreneurship* by reframing food security as a cross-regional management challenge. Future research should integrate the qualitative insights from field activity logs—which confirm that localized food distribution bottlenecks are often caused by managerial failures in coordinating inter-island transport—with the quantitative spatial clusters identified here. The documentation of these activities shows that even where food is locally available, the "management of movement" remains the critical barrier to security. Future studies are therefore recommended to adopt mixed-method frameworks that evaluate the entrepreneurial potential of local food supply chain innovations within identified High-High clusters to provide a more holistic management solution.

#### Discussion

The spatial diagnostic of food inadequacy across 514 regencies in Indonesia reveals that food insecurity is a fundamentally structural and clustered phenomenon rather than a randomized occurrence. By confronting the empirical results with established development theories—specifically Sen's Entitlement Theory and Perroux's Growth Pole Theory—this study demonstrates that High-High clusters in Eastern Indonesia are symptomatic of systemic "managerial disconnects" in national distribution networks. Unlike studies that attribute food insecurity solely to agricultural productivity, this research extends the discourse by identifying geographical isolation and infrastructural inadequacy as the primary drivers of spatial clustering. The strong positive autocorrelation (Moran's I = 0.804) challenges the efficacy of uniform, top-down food policies, suggesting instead that the persistent vulnerability of the Eastern archipelago is an outcome of cumulative socioeconomic exclusion. By confirming these clusters, this research demonstrates that food security policies must shift toward a spatially integrated management framework that accounts for inter-regency dependency and the compounding effect of peripheral underdevelopment.

The identification of unique "Low-Low" clusters in the industrial hubs of Java and Bali provides a significant point of departure from global studies that often posit urbanization as a singular driver of food insecurity. While some international scholars argue that rapid urbanization exacerbates food access vulnerabilities through market volatility, our findings demonstrate the opposite in the Indonesian context, where urban

density functions as a stabilizing "growth pole" that facilitates market access and logistical efficiency. This uniqueness highlights a localized socioeconomic phenomenon: urban centers act as regional hubs that anchor food availability, whereas peripheral regencies in the East, lacking similar managerial and infrastructure investment, are marginalized into high-risk clusters. The persistence of these disparities, even in an era of centralized digital monitoring, suggests an anomaly where technological adoption has not yet translated into equitable food accessibility for remote regions. This confirms that the challenge is not one of food scarcity, but of administrative and logistical management within the Indonesian regional governance architecture.

Integrating these empirical findings with the conceptual framework of *Muraqabah* (as a pedagogical metaphor for systemic vigilance and accountability in regional management), this study proposes that food policy requires a higher level of "administrative oversight" regarding inter-island logistics. Just as the concept of *Muraqabah* emphasizes deep awareness and responsibility in one's actions, effective regional management requires constant monitoring of the "spatial spillover" of food insecurity from one regency to another. The High-High clusters identified in Papua and Maluku are indicative of a systemic failure to maintain this vigilance, leading to long-term resource stagnation. By treating regencies as interconnected nodes in a national supply chain, the state can move beyond normatively driven aid distributions toward a proactive management model that optimizes local resources and strengthens logistical corridors. This shift represents a unique theoretical contribution, suggesting that regional food security is an act of collective institutional responsibility, where the prosperity of central nodes is inherently tethered to the resilience of peripheral clusters.

The practical implications of these findings necessitate a radical restructuring of local government resource allocation, moving away from fragmented, regency-bound strategies toward integrated "Spatial Food Management Zones." The data reveals that policies focused on individual regency improvements are insufficient when regional autocorrelation remains high; instead, interventions must be coordinated across cluster boundaries. This study recommends the implementation of localized food logistics hubs that serve not just single regencies, but clusters identified in the LISA analysis, thereby achieving economies of scale in distribution. Furthermore, by formalizing the management of these clusters, policymakers can reduce the logistical costs that currently prevent Eastern Indonesia from achieving food parity with the Java-Bali corridor. In summary, this research changes the practical approach from generic food aid to evidence-based logistical management, providing a blueprint for sustainable development that directly addresses the root causes of regional inequality rather than merely alleviating the symptoms of food inadequacy.

## 4. CONCLUSION

### 4.1 Conclusion

1. The spatial distribution of food inadequacy across Indonesian regencies and municipalities in 2025 exhibits a strong, statistically significant clustering pattern, confirming that food vulnerability is inherently spatial rather than random.
2. High-High clusters (insecurity hotspots) are definitively concentrated in Eastern Indonesia, particularly in Papua, Maluku, and East Nusa Tenggara, identifying these as priority areas for immediate and targeted managerial intervention.
3. The strong positive spatial autocorrelation (Moran's  $I = 0.804$ ) indicates that the food security status of a regency is deeply interdependent with its neighboring administrative units, rendering isolated or regency-specific policy approaches ineffective.
4. Developmental disparities in infrastructure, market connectivity, and regional economic growth poles explain the contrast between the high-risk Eastern clusters and the low-risk Low-Low clusters concentrated in the Java-Bali economic corridor.
5. Effective regional food security management requires a paradigm shift from uniform national distribution programs toward a spatially integrated, cluster-based approach that prioritizes logistical connectivity in historically underserved peripheral regions..

### 4.2 Recommendations

The findings demonstrate that sustainable food security in Indonesia necessitates a transition toward region-based management that accounts for the documented spatial interdependence between neighboring administrative units. Policymakers should prioritize the development of

localized, cross-regency food logistics hubs within identified High-High clusters to reduce logistical barriers and mitigate the clustering of food vulnerability. It is recommended that future infrastructure investments be directed toward optimizing connectivity between these hotspots and their nearest economic hubs to facilitate market accessibility and economic integration. Furthermore, government agencies should adopt a spatially dynamic monitoring system that allows for the real-time adjustment of resource allocation based on emerging cluster shifts rather than static annual assessments. For future research, it is highly recommended that scholars adopt a mixed-methods longitudinal approach, combining spatial econometric modeling with qualitative field investigations into the operational management of local supply chains. Investigating the role of digital entrepreneurship in local food distribution within vulnerable clusters could also provide critical insights into how private-sector innovation might bridge the gap in state-led distribution, thereby providing a robust framework for long-term regional resilience.

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