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Research Article

Prioritizing Resilient Tourism Infrastructure in Tanah Kuning's Green Industrial Coastal Frontier, Indonesia

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Abstract

Coastal-infrastructure research largely emphasizes hazard-resistant assets, whereas tourism studies usually examine service quality or destination competitiveness; neither stream provides a transparent early-stage rule for prioritizing tourism-support infrastructure where large industrial development simultaneously changes mobility, service demand, local benefit chains, and environmental pressure. This study addresses that gap by formulating a resilience-sensitive screening model for Tanah Kuning, North Kalimantan. Six aggregate SPSS frequency-output datasets covered 43 indicators and 90 valid responses across accommodation, accessibility and transport, public facilities, cleanliness and environment, food and beverage, and social-economic conditions. Domain means, gap-to-ideal values, response-intensity groups, and a multiplicative priority index were calculated. Because respondent-level covariances were unavailable, causal inference was not attempted; instead, ranking robustness was assessed across gap-only, low-response-only, equal-weight additive, and multiplicative formulations. The hierarchy was invariant across all formulations. Accessibility and transport achieved the highest mean (M = 3.28), while food and beverage (M = 2.24), social-economic conditions (M = 2.39), and accommodation (M = 2.46) showed the largest deficits; the weighted overall mean was 2.79. The theoretical novelty is to treat coastal tourism infrastructure as a coupled mobility-service-community-environment system rather than a collection of assets. Practically, the model translates limited survey outputs into a defensible sequence: first strengthen food-service and local-enterprise nodes, then stay capacity and public facilities, while protecting environmental quality and separating tourism mobility from industrial logistics.

Introduction

Tanah Kuning, Bulungan Regency, North Kalimantan, is a coastal settlement where tourism potential intersects with the rapid development of Indonesia's Green Industrial Estate. Industrial investment may improve roads, logistics, and market access, but it can also increase heavy-vehicle conflict, land-use pressure, waste loads, and competition for public services. The planning question is therefore not whether infrastructure exists, but whether the combined mobility, service, environmental, and community-support system can remain functional and locally beneficial as industrial activity expands (Pemerintah Kabupaten Bulungan, 2021; Priyana & Prihartanto, 2025; Taena & Afoan, 2020; Więckowski & Timothy, 2021).

Tourism infrastructure operates as an interdependent destination system. Access has limited value when accommodation, food services, sanitation, public facilities, environmental management, or local enterprise capacity are weak. Integrated tourism-planning research consequently links physical assets with service quality, governance, and community participation (Inskeep, 1991; Ritchie & Crouch, 2003; Chettiar et al., 2022). Infrastructure-resilience scholarship similarly emphasizes robustness, resourcefulness, continuity, and adaptive capacity at community scale rather than the performance of isolated assets (Holling, 1973; Bruneau et al., 2003; Cutter et al., 2008). In Tanah Kuning, these perspectives imply that a relatively strong road or transport domain cannot by itself produce a resilient coastal destination.

Two specific research gaps follow. First, tourism studies commonly model infrastructure or service quality as an antecedent of satisfaction, competitiveness, or revisit intention, but they seldom establish how to rank infrastructure interventions under simultaneous industrial and coastal pressure (Bhattacharya et al., 2023; Cheunkamon et al., 2023). Second, engineering and industrial-development studies usually prioritize supply-side capacity and hazard resistance, while tourism services, local benefit chains, and environmental experience are rarely integrated as social-sustainability criteria. Existing coastal and regenerative-tourism studies confirm the importance of environmental quality and community value, but do not provide a simple intervention rule for aggregate baseline data (Abe et al., 2022; Bellato et al., 2024; Cuero Espinoza et al., 2025).

The conceptual model addresses these gaps through a directional planning chain rather than an untestable causal claim. Industrial-estate pressure and coastal sensitivity form the context; perceived readiness in six infrastructure domains constitutes the system state; the gap to an ideal score and the concentration of low responses diagnose the depth and breadth of each deficit; and their joint priority index determines the intervention sequence. The expected planning relationship is monotonic: a larger gap combined with a larger deficit concentration produces a higher intervention priority. The resulting actions are evaluated against three resilience outcomes - continuity of visitor and resident services, retention of local economic benefits, and protection of coastal environmental quality. Respondent-level causal relationships are reserved for a later phase because the present files contain marginal frequency outputs rather than a joint data matrix.

Accordingly, this study (1) compares readiness across accommodation, accessibility and transport, public facilities, cleanliness and environment, food and beverage, and social-economic conditions; (2) estimates gap-to-ideal values; (3) distinguishes low, moderate, and high response concentrations; (4) ranks domains using a multiplicative gap-deficit index; and (5) tests whether the ranking remains stable under alternative monotonic formulations. The analysis uses 43 indicators and 90 valid responses summarized in six SPSS frequency-output datasets.

The study's novelty is not the arithmetic index alone. It is the integration of destination competitiveness, service quality, community resilience, and infrastructure planning into an aggregate-data screening framework for a coastal-industrial frontier. The theoretical contribution is the access-service balance proposition: destination resilience depends on the configuration of mobility, service capacity, environmental management, and local participation, so a strong access domain may coexist with low system readiness. The practical contribution is a transparent investment sequence that local government and industrial-estate stakeholders can use before undertaking engineering condition surveys, geospatial hazard analysis, cost estimation, and respondent-level model testing.

Research Method

This study used a quantitative descriptive and decision-screening design. The empirical source comprised six SPSS frequency-output files representing accommodation, accessibility and transport, public facilities, cleanliness and environment, food and beverage, and social-economic conditions. Together they summarized 43 indicators from 90 valid respondents: 3 accommodation indicators, 18 accessibility and transport indicators, 4 public-facility indicators, 4 cleanliness and environmental indicators, 5 food-and-beverage indicators, and 9 social-economic indicators. The unit of comparison was the infrastructure domain, not the individual respondent, because only marginal frequency summaries were available.

The study area is Tanah Kuning, Bulungan Regency, North Kalimantan, a strategic coastal zone affected by Indonesian Green Industrial Estate development. The framework treats industrial logistics and land-use change together with coastal exposure as contextual pressures on a six-domain tourism-support system. The survey evidence represents perceived service readiness and is intended to complement, not replace, engineering audits of pavement condition, traffic load, drainage, water and sanitation systems, waste facilities, and coastal-protection performance.

The file names identified the six constructs, but the original item wording and respondent-level matrix were unavailable. Interpretation was therefore restricted to the domain level. A score of 5.0 was used as the ideal benchmark because it was the highest recorded readiness category. Score 0 was retained as a valid deficit response because SPSS treated it as valid rather than missing. For planning interpretation, scores 0-2 were grouped as low or deficit, score 3 as moderate, and scores 4-5 as high or adequate.

Table 1. Construct coverage, coding interpretation, and analytical role.

Domain	Items	Data source	Response interpretation	Use in analysis
Accommodation	3	SPSS frequency-output table	0–2 = low/deficit; 3 = moderate; 4–5 = high/adequate	Stay-capacity readiness
Accessibility and Transport	18	SPSS frequency-output table	0–2 = low/deficit; 3 = moderate; 4–5 = high/adequate	Mobility and access readiness
Public Facilities	4	SPSS frequency-output table	0–2 = low/deficit; 3 = moderate; 4–5 = high/adequate	Basic facility readiness
Cleanliness and Environment	4	SPSS frequency-output table	0–2 = low/deficit; 3 = moderate; 4–5 = high/adequate	Environmental service readiness
Food and Beverage	5	SPSS frequency-output table	0–2 = low/deficit; 3 = moderate; 4–5 = high/adequate	Culinary/service-node readiness
Social and Economic	9	SPSS frequency-output table	0–2 = low/deficit; 3 = moderate; 4–5 = high/adequate	Local benefit-chain readiness

The analysis proceeded in five steps. First, the available descriptive statistics and frequency counts were extracted. Second, each construct total-score mean was divided by its number of items to obtain a comparable domain mean (M). Third, readiness was normalized as 100(M/5), and the gap to ideal was calculated as G = 5 - M. Fourth, response frequencies were aggregated into low (0-2), moderate (3), and high (4-5) groups; the low-response proportion is denoted L. Fifth, domains were ordered using the multiplicative priority index P = G x L. This formulation is consistent with gap-based service diagnosis, while avoiding the assumption that a mean alone captures how widely a deficit is experienced (Parasuraman et al., 1988; Balouei Jamkhaneh et al., 2023; Bhattacharya et al., 2023).

The model specifies four planning relationships. Contextual industrial and coastal pressures frame the need for assessment but are not estimated as causal predictors. Domain mean M represents perceived readiness; G measures deficit magnitude; L measures deficit concentration; and P increases monotonically when either G or L increases. The intervention hierarchy links higher P values to earlier planning action. The model consequently tests a prioritization relationship among aggregate domain indicators, not relationships among latent respondent-level variables.

Approximate 95% confidence intervals were calculated as M +/- 1.96(SE), using the reported domain-level average-score standard deviation divided by the square root of N. These intervals describe uncertainty around aggregate means but do not reconstruct missing covariance. Although the source reports 90 respondents and 43 indicators, marginal frequency tables do not preserve which responses occurred together for the same person. Reliability coefficients, factor analysis, regression, and structural equation modeling would therefore be mathematically unsupported. This limitation is stated explicitly so that the screening model is not misrepresented as a validated causal measurement model.

Structural robustness was assessed through sensitivity analysis. The proposed multiplicative ranking was compared with three alternatives: gap-only ordering, low-response-only ordering, and an equal-weight additive score $A = 0.5(G/G_{max}) + 0.5(L/L_{max})$. Rank agreement was summarized with Spearman's rho. A hierarchy was considered robust when the same domain order persisted across all four formulations. This check evaluates whether the policy sequence depends on an arbitrary aggregation choice; it does not substitute for psychometric validation with raw data.

Figure 1 formalizes the conceptual chain. Industrial and coastal pressures frame the six-domain readiness assessment; gap magnitude and deficit concentration operationalize shortfall; the priority index and sensitivity test produce a defensible sequence; and interventions target service continuity, local benefit retention, environmental quality, and mobility-conflict management. The figure distinguishes contextual influence, measured aggregate relationships, and outcomes that require subsequent field and respondent-level validation.

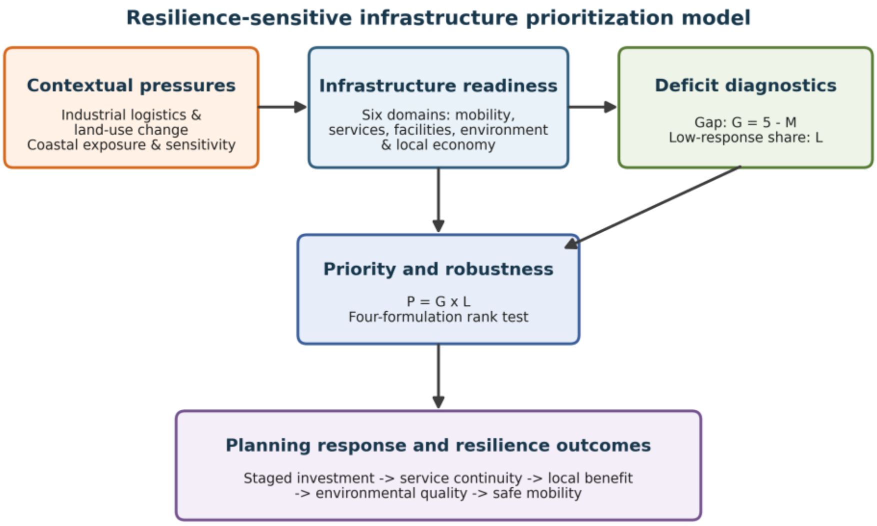

Figure 1. Conceptual relationships among contextual pressure, perceived infrastructure readiness, aggregate deficit diagnostics, priority robustness, and resilience-oriented planning outcomes.

Results and Discussion

The dataset contained 3,870 item-response units (43 indicators x 90 respondents). The weighted overall mean was 2.79 on the observed 0-5 scale, leaving a 2.21-point gap from the ideal. This is best interpreted as uneven, moderate-to-low system readiness rather than absence of infrastructure. The pattern supports integrated-destination theory, which predicts that competitiveness depends on the joint performance of access, services, environment, and governance, and it is consistent with empirical service-chain studies showing that a strong component cannot compensate for multiple weak links (Ritchie & Crouch, 2003; Chettiar et al., 2022; Bhattacharya et al., 2023). Exact score comparisons across studies are inappropriate because their instruments and contexts differ; the defensible comparison concerns the shared configuration of imbalance.

Table 2 presents construct-level statistics. Accessibility and transport obtained the highest mean score (M = 3.28; 95% CI = 3.14–3.41), equal to 65.5% of the ideal score. This domain is the only one above the practical midpoint of 3.0. Cleanliness and environment (M = 2.62), public facilities (M = 2.57), and accommodation (M = 2.46) formed a middle cluster, but all remained below the midpoint. Social-economic conditions (M = 2.39) and food and beverage (M = 2.24) were the weakest domains. The pattern shows that access is perceived as relatively stronger than the service and community-support infrastructure that converts access into a complete destination experience.

The gap analysis reinforces this asymmetry. Accessibility and transport had the smallest gap to the ideal score (1.72), whereas food and beverage had the largest gap (2.76). Social-economic conditions showed the second-largest gap (2.61), followed by accommodation (2.54), public facilities (2.43), and cleanliness and environment (2.38). The ordering matters because destination resilience depends on the weakest links in the visitor-service chain. A road can enable arrival, but food services, toilets, accommodation, environmental cleanliness, and local enterprise determine whether visitors stay, spend, return, and recommend the destination.

Figure 2 visualizes mean scores and gap-to-ideal values. The figure makes clear that the strongest component is not strong enough to compensate for weaker domains. Accessibility may support entry into Tanah Kuning, yet the remaining domains remain below the midpoint. This pattern suggests an access-led but service-constrained destination profile. In such a profile, external infrastructure investment may improve movement but not necessarily improve tourism competitiveness, visitor satisfaction, or local benefit retention.

Table 2. Construct-level descriptive statistics and infrastructure gap indicators.

Domain	N	Items	Mean	SD	95% CI	Readiness %	Gap	Low %	High %
Accessibility and Transport	90	18	3.28	0.63	3.14–3.41	65.5	1.72	26.3	43.6
Cleanliness and Environment	90	4	2.62	0.68	2.47–2.76	52.3	2.38	45.3	12.8
Public Facilities	90	4	2.57	0.67	2.43–2.71	51.3	2.43	51.9	11.4
Accommodation	90	3	2.46	0.74	2.31–2.62	49.3	2.54	54.1	12.6
Social and Economic	90	9	2.39	0.60	2.26–2.51	47.8	2.61	59.6	12.7
Food and Beverage	90	5	2.24	0.63	2.10–2.37	44.7	2.76	64.2	9.3

Note. Means are comparable construct-level scores. SD is the average-score standard deviation derived from total-score SD. Low = scores 0–2; High = scores 4–5.

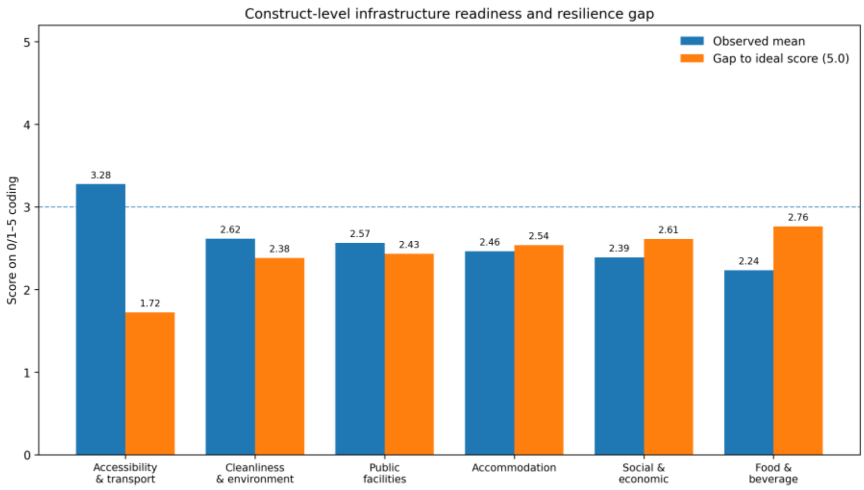

Figure 2. Construct-level readiness and gap-to-ideal values showing that access is the strongest domain while destination-service domains remain below the readiness midpoint.

Response-intensity analysis provides a more discriminating view than means alone. Food and beverage had the highest concentration of low or deficit responses, with 64.2% of responses falling into scores 0–2. Social-economic conditions followed with 59.6%, accommodation with 54.1%, and public facilities with 51.9%. Cleanliness and environment had a substantial low-response share of 45.3%. Accessibility and transport was clearly different: only 26.3% of its responses fell in the low category, while 43.6% were high or adequate responses. Figure 3 shows this contrast between a relatively stronger mobility domain and weaker destination-service domains.

These distributions are important because they reveal how average scores can conceal service fragility. A domain with a mean below 3.0 and a majority of low responses is not merely underperforming; it is a systemic bottleneck. Food and beverage, social-economic conditions, accommodation, and public facilities fall into this category. These are not optional tourism enhancements. They are basic components of a functioning visitor economy. Weakness in these domains limits the ability of Tanah Kuning to capture benefits from increased access and industrially induced demand.

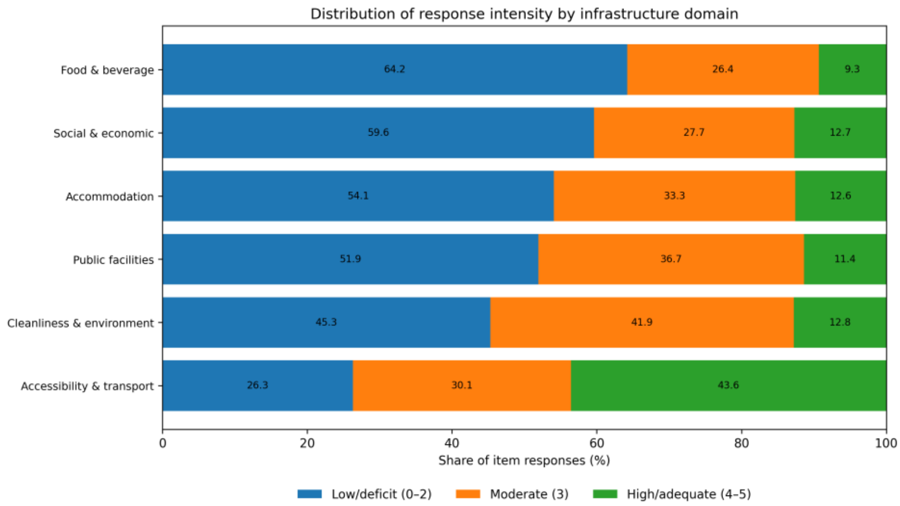

Figure 3. Response-intensity distribution indicating that service, social, accommodation, and public-facility domains contain the largest deficit concentrations.

Table 3 presents the resilience-based priority ranking. Food and beverage ranked first, with a gap of 2.76, a low-response share of 64.2%, and a priority index of 1.78. Social-economic conditions ranked second, with a gap of 2.61, a low-response share of 59.6%, and a priority index of 1.56. Accommodation ranked third, followed by public facilities, cleanliness and environment, and accessibility and transport. The ranking differs from a simple mean ranking because it weights both distance from the ideal and the intensity of low responses. This is useful for planning because it identifies where improvement is most urgent, not merely where scores are lowest.

Table 3. Resilience-based priority ranking for tourism infrastructure intervention.

Rank	Domain	Gap	Low %	Priority index	Planning implication
1	Food and Beverage	2.76	64.2	1.78	Immediate: build hygienic, community-linked food-service nodes.
2	Social and Economic	2.61	59.6	1.56	Immediate: strengthen local enterprise, skills, and benefit-sharing systems.
3	Accommodation	2.54	54.1	1.37	High: upgrade resilient small-scale stay capacity.
4	Public Facilities	2.43	51.9	1.26	High: improve toilets, signage, lighting, safety, and shared facilities.
5	Cleanliness and Environment	2.38	45.3	1.08	Medium: embed waste, drainage, and coastal monitoring.
6	Accessibility and Transport	1.72	26.3	0.45	Maintain: protect tourism access and separate it from industrial logistics.

Note. Priority index = gap-to-ideal score × proportion of low/deficit responses. The index is intended as a screening tool for early-stage planning.

The invariant order shows that the intervention sequence is not an artifact of choosing a multiplicative rather than additive rule. Because both gap magnitude and low-response concentration independently order the domains in the same direction, every monotonic formulation tested yields the same hierarchy. This supports structural robustness at the domain level while preserving the distinction between ranking validation and respondent-level psychometric or causal validation.

Table 4. Sensitivity analysis of priority-ranking robustness.

Domain	G rank	L rank	A rank	P rank	Robustness
Food and Beverage	1	1	1	1	Stable
Social and Economic	2	2	2	2	Stable
Accommodation	3	3	3	3	Stable
Public Facilities	4	4	4	4	Stable
Cleanliness and Environment	5	5	5	5	Stable
Accessibility and Transport	6	6	6	6	Stable

Note. Additive rank uses A = 0.5(G/Gmax) + 0.5(L/Lmax). The multiplicative rank uses P = G x L. Spearman's rho between the proposed multiplicative rank and each alternative rank is 1.00.

Figure 4 plots the domains in a priority matrix. Food and beverage, social-economic conditions, accommodation, and public facilities occupy the high-gap and high-deficit zone. Cleanliness and environment occupies a medium-priority position because its gap is large but the low-response share is slightly lower than the highest-priority domains. Accessibility and transport falls in the lower-gap and lower-deficit zone. This does not mean that accessibility should be ignored. It means that accessibility should be protected and managed while the planning agenda shifts toward service, community, and environmental infrastructure that currently lags behind.

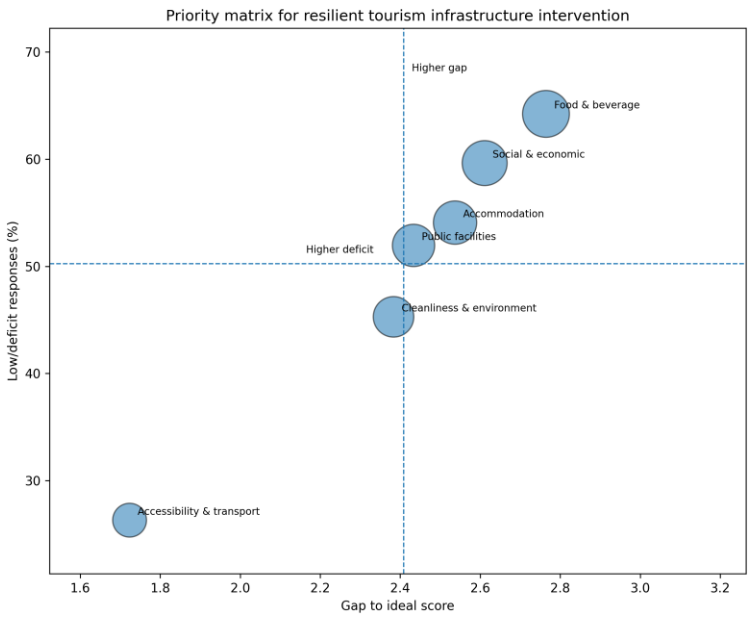

Figure 4. Priority matrix showing that food and beverage, social-economic conditions, accommodation, and public facilities occupy the high-intervention zone.

The central empirical result is an access-service asymmetry. Accessibility and transport had the highest mean (3.28), while the four highest-priority deficits were food and beverage, social-economic conditions, accommodation, and public facilities. This converges with Abdi and Vanoutrive (2026), Anis and Sacco (2024), and Cheranchery et al. (2025), who show that usable accessibility depends on reliability, user experience, and service integration rather than proximity alone. It also extends Chettiar et al. (2022) and Ritchie and Crouch (2003): in an industrial coastal frontier, connectivity can improve while destination competitiveness remains constrained by weak complementary infrastructure. Unlike those studies, the present data do not measure route performance or satisfaction pathways; they diagnose the imbalance that should determine the next field audit and investment sequence.

This finding has direct implications for a destination affected by a green industrial estate. Industrial development may produce road upgrades, logistics routes, and new transport demand. These changes can help tourism if visitor flows become safer and more efficient. However, they can also produce congestion, heavy-vehicle conflict, parking pressure, dust, and the perception that the destination is becoming an industrial transit corridor rather than a coastal tourism space. Studies of frontier and remote Indonesian connectivity emphasize that transport innovations and regional access improvements are necessary but insufficient unless they are matched by regulatory, operational, and service-capacity improvements (Fauzi et al., 2026). For Tanah Kuning, the task is therefore to protect accessibility gains while separating tourism mobility from industrial logistics wherever possible. These statements are interpreted as contextual planning risks, not as direct engineering measurements from the present dataset. The available data are perception and frequency summaries; therefore, future field audits are required to measure pavement condition, traffic loads, drainage capacity, and coastal-protection performance.

Food and beverage produced the lowest mean (2.24), the largest gap (2.76), and the highest low-response share (64.2%). The direction is consistent with Baby and Kim (2025), Castillo-Manzano et al. (2025), and Çetinkaya et al. (2026), which associate food quality, atmosphere, and visible sustainability cues with destination experience. Erdoğan et al. (2025) further demonstrates the salience of food-related evaluations in digital hotel reviews. The Tanah Kuning result adds an infrastructure interpretation: the deficit is not limited to culinary preference but concerns the enabling bundle of clean water, sanitation, waste handling, seating, lighting, and local supply. Because item wording was unavailable, this mechanism remains a planning proposition to be checked in the next survey rather than an item-level causal conclusion.

For Tanah Kuning, food-and-beverage infrastructure should be treated as a resilience node. A hygienic culinary cluster supported by clean water, drainage, waste management, seating, lighting, and local-product branding can convert visitor flows into community income. Without this bundle, increased access may advantage external suppliers while local residents remain weakly integrated. The recommended first intervention is therefore an integrated food-service node with public-health, enterprise, visitor-comfort, and environmental functions, followed by monitoring of hygiene compliance, local-vendor participation, and visitor use.

The social-economic domain ranked second (M = 2.39; 59.6% low responses), confirming that resilience is not purely physical. Baghirli (2026) and Georgopoulos et al. (2025) show that resident and visitor priorities can diverge, making participatory governance necessary. Diarta and Pitana (2022) link local ownership and service management with visitor satisfaction in Indonesian community-based ecotourism, while Bacter et al. (2025) identifies skills, fair work, and institutional capacity as components of human sustainability capital. The present finding converges with these studies but shifts the unit of concern from attitudes or firm capacity to infrastructure planning: training space, enterprise support, market access, and decision forums function as enabling infrastructure.

For Tanah Kuning, social-economic infrastructure should include tourism-business training, cooperative workspaces, micro-enterprise kiosks, homestay assistance, digital-promotion support, community guiding, transparent benefit-sharing, and regular forums connecting village actors with government and industrial-estate stakeholders. These actions should be monitored through participation, local procurement, enterprise survival, and benefit-distribution indicators. The domain's weakness is therefore a central infrastructure deficit, not a secondary social outcome.

Accommodation ranked third (M = 2.46; 54.1% low responses), indicating a risk that Tanah Kuning remains a transit rather than stay destination. Abdul-Aziz Ahmad and Jais (2024), Al-Kumaim et al. (2025), and Aydogan et al. (2024) consistently connect lodging competitiveness with service quality, logistics resources, safety, hygiene, digitalization, and adaptive continuity. Dai et al. (2026) and Chattopadhyay and Mitra (2024) further show that relationship quality and clearly communicated amenities shape loyalty and trust in homestay or platform settings. The comparison supports targeted upgrading, but it does not imply demand for large hotels; the scale and ownership model must follow local demand, carrying capacity, and community-benefit objectives.

The appropriate early pathway is resilient small-scale accommodation: safe and clean homestays, modest lodging, worker-visitor guesthouses, and community-based standards that are digitally visible and environmentally appropriate. Priority actions are minimum service standards, water and sanitation checks, emergency and accessibility provisions, booking visibility, and links to local food and guiding services. Demand and occupancy data should precede any expansion to larger facilities.

Public facilities ranked fourth (M = 2.57; 51.9% low responses), but their cross-cutting role makes them foundational. Bui (2026) demonstrates that physical and supporting environments are integral to perceived service quality; Bhattacharya et al. (2023) similarly identifies tangible facilities within tourism-service gap diagnosis; and Parasuraman et al. (1988) establishes the enduring role of tangibles, reliability, and responsiveness in service assessment. Ritchie and Crouch (2003) place supporting factors and resources within destination competitiveness. Together these studies support investment in toilets, parking, signage, rest areas, information, lighting, prayer rooms, safety facilities, and inclusive access. The Tanah Kuning contribution is to place these shared-use facilities within a ranked industrial-frontier program rather than treat them as isolated amenities.

Cleanliness and environment ranked fifth (M = 2.62; 45.3% low responses), yet this relative position should not be read as low strategic importance. Abe et al. (2022) shows that tourism, conservation, and local stakeholder perceptions are interdependent in coastal management; Cuero Espinoza et al. (2025) links tourism viability to water governance; and Aliyah et al. (2025), Birinci et al. (2025), and Chang et al. (2024) associate credible environmental practice with perceived quality and loyalty. Chen et al. (2025) adds evidence that low-impact operating technologies can jointly benefit experience and ecology. Tanah Kuning's lower rank is thus a sequencing result, not permission to defer environmental safeguards: waste, wastewater, drainage, beach cleanliness, and coastal monitoring must be embedded in every earlier intervention.

The environmental implication for Tanah Kuning is that cleanliness cannot be treated as routine maintenance alone. It is part of destination identity and industrial-risk management. If visitors or residents perceive a decline in beach cleanliness, water quality, or visual landscape, the green-industrial narrative may be contested at the local level. Studies of sustainable destination management and green hotels indicate that environmental responsibility can influence perceived service quality and customer loyalty when it is visible and credible (Aliyah et al., 2025; Birinci et al., 2025; Chang et al., 2024). Studies of lagoon ecotourism further show that low-impact technologies and operator practice can produce both visitor-experience and ecological benefits (Chen et al., 2025). Tanah Kuning therefore needs waste systems, drainage control, beach-cleaning routines, coastal monitoring, and environmental communication as infrastructure functions.

The priority hierarchy also supports a governance comparison. Chettiar et al. (2022) argues for integration across tourism, spatial planning, economic development, and public investment. Bhattacharya et al. (2023) shows how gap-based multi-criteria assessment can translate service evidence into priorities, while Chanthawong et al. (2023) and Gherdan et al. (2025) demonstrate transparent ranking and consensus-building in tourism development. The present model is simpler because its aggregate source cannot support expert-weight elicitation or respondent-level validation. Its advantage is auditability: local actors can see how the gap and deficit concentration produce each rank and can replace the screening weights when better data become available.

This governance challenge is amplified by the industrial-estate setting. A green industrial estate can claim sustainability through energy, industrial efficiency, and emissions narratives, but local sustainability also depends on whether surrounding communities gain infrastructure, environmental protection, and economic participation. Regenerative and nature-based tourism literature argues that sustainability-oriented business models must move beyond fragmented initiatives and increase the capacity of support systems to generate net-positive social and ecological effects (Abreu et al., 2025; Bellato et al., 2024). The Tanah Kuning findings suggest that food, social-economic, accommodation, and public-facility deficits are the points where such claims will be tested in practice.

Methodologically, the study shows how marginal survey outputs can support a transparent first-stage decision screen without pretending to estimate latent relationships. The sensitivity analysis is the key internal validation: gap-only, low-share-only, equal-weight additive, and multiplicative formulations all produced the same order, and Spearman's rho between the proposed ranking and each alternative was 1.00. This invariance occurs because the six domains are ordered consistently on both input dimensions.

It strengthens confidence in the intervention sequence, although it does not validate the questionnaire, causal pathways, or external transferability.

The next analytical layer requires the raw respondent-level matrix, original item wording, and respondent characteristics. Those data would permit reliability analysis, factor-structure testing, subgroup comparisons, and models linking service quality, destination image, trust, satisfaction, and behavioral intention, as demonstrated in recent tourism research (Bui & Hoang, 2025; Cheunkamon et al., 2023; Eviana, 2025; Gopinath & Jyotsna, 2025). It should also integrate engineering field audits, geospatial exposure, traffic and pavement measurements, water and sanitation performance, facility inventories, and lifecycle cost estimates.

The practical roadmap derived from the findings has four stages. The first stage is quick-win service infrastructure: hygienic food and beverage nodes, organized local culinary spaces, waste bins, clean water points, lighting, seating, and managed parking. The second stage is stay-capacity upgrading: homestay readiness, basic lodging standards, toilets, visitor information, signage, and rest areas. The third stage is environmental and mobility resilience: waste management, wastewater control, coastal cleanliness monitoring, safe tourism routes, traffic separation, and road-safety measures near visitor nodes. The fourth stage is governance: a multi-stakeholder forum involving village institutions, local government, tourism actors, community groups, universities, and industrial-estate stakeholders. This roadmap turns the priority index into an implementation sequence.

Four limitations bound the findings. First, marginal frequency outputs do not preserve respondent-level covariance, so no reliability, factor, regression, or causal model can be validly estimated. Second, missing item wording limits interpretation to six domains. Third, the evidence measures perceived coded readiness rather than observed engineering condition. Fourth, the model is place-specific and uses an ideal benchmark of 5 and a 0-2 deficit threshold; other settings may require different benchmarks. The sensitivity result supports the internal rank order but does not eliminate these measurement and external-validity limits.

A further interpretation concerns the relationship between green industrialization and destination legitimacy. Large industrial projects often define success through investment realization, logistics capacity, technological modernization, and macroeconomic contribution. Those indicators are important, but they do not capture whether adjacent communities experience development as beneficial, fair, or compatible with existing livelihoods. Tourism is a sensitive lens for evaluating this issue because it depends on public space, environmental quality, local culture, service encounters, and everyday infrastructure. If a green industrial estate improves roads but weakens the coastal landscape, generates waste pressure, or excludes local enterprises from new service opportunities, the surrounding destination may experience development as extractive rather than resilient. The priority results therefore provide a way to translate local service deficits into measurable planning claims.

This study also implies that infrastructure investment should be sequenced rather than distributed evenly. Equal investment across all domains would ignore the urgency revealed by the priority index. The first tier should focus on domains with both large gaps and high low-response concentrations: food and beverage, social-economic conditions, accommodation, and public facilities. The second tier should consolidate environmental management because cleanliness and coastal quality protect destination image and public health. The third tier should maintain accessibility while preventing industrial mobility from degrading tourism safety and comfort. Sequencing matters because local budgets and institutional capacity are limited; a transparent hierarchy helps decision-makers defend why certain investments should precede others.

For industrial-estate stakeholders, the findings should be read as a social-sustainability diagnostic. The lowest-scoring domains are not outside the industrial project's sphere of influence. Food services, accommodation, transport safety, sanitation, and local enterprise capacity are precisely the systems that will absorb new demand from workers, contractors, visitors, government delegations, researchers, and investors. If these systems remain weak, the surrounding community may bear the pressures of industrialization without capturing proportional service-sector benefits. A corporate or public infrastructure program that supports hygienic culinary areas, MSME training, visitor information, waste systems, and safe access routes would therefore not be philanthropic add-on activity; it would be part of responsible spatial integration between industry and host community.

For local government, the findings provide a basis for aligning tourism planning with civil-infrastructure programming. Tourism offices may identify destination potential, but road agencies, public works offices, environmental agencies, village governments, and industrial authorities control many of the enabling assets. The priority index can help these actors agree on a shared intervention sequence. It can also be converted into a monitoring instrument. If the same six domains are measured annually, planners can evaluate whether interventions reduce gap values and low-response shares. This creates a simple performance framework that links infrastructure investment to perceived service improvement rather than counting outputs only as constructed facilities.

Taken together, the results advance the access-service balance proposition: tourism-infrastructure resilience in an industrializing coastal frontier depends on the configuration of mobility, service capacity, environmental management, and local economic participation, not on access infrastructure alone. Tanah Kuning's stronger accessibility should be maintained and protected from industrial-traffic conflict, while food and beverage, social-economic capacity, accommodation, and public facilities guide near-term investment. This configuration links civil-infrastructure programming to destination competitiveness and host-community legitimacy.

Conclusion

Tanah Kuning's tourism-support infrastructure is uneven rather than uniformly weak. Across 43 indicators and 90 valid responses, the weighted mean was 2.79. Accessibility and transport was the strongest domain (M = 3.28), while food and beverage (M = 2.24), social-economic conditions (M = 2.39), accommodation (M = 2.46), and public facilities (M = 2.57) combined large gaps with high concentrations of low responses. The resulting order - food and beverage, social-economic conditions, accommodation, public facilities, cleanliness and environment, then accessibility and transport - remained unchanged under gap-only, low-share-only, additive, and multiplicative formulations.

The theoretical contribution is the access-service balance proposition: a coastal-industrial destination may become easier to reach while remaining structurally unready when service capacity, environmental management, and local participation lag. The methodological contribution is a transparent aggregate-data screening framework that distinguishes deficit magnitude from deficit concentration and tests ranking sensitivity without making unsupported causal claims. Its practical contribution is a defensible sequence: establish hygienic community-linked food-service nodes and local-enterprise support; improve small-scale accommodation and shared public facilities; embed waste, wastewater, drainage, and coastal monitoring in all interventions; and maintain safe tourism access while separating it from industrial logistics.

The model is a baseline for planning, not a final engineering design or validated latent-variable model. The next phase should recover the respondent-level matrix and item wording, test reliability and factor structure, compare stakeholder groups, and integrate field measurements of road condition, traffic conflict, sanitation, waste systems, facility capacity, coastal hazards, lifecycle cost, and spatial accessibility. Repeated measurement can then determine whether prioritized investments reduce both gap values and low-response concentrations. Green industrial development in Tanah Kuning should ultimately be judged not only by industrial output and energy performance, but also by whether it strengthens public infrastructure, local livelihoods, and coastal environmental quality.

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Author Contributions

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Preparation, E.P.; Writing – Review & Editing, E.P.; Visualization, E.U.; Supervision, E.P.; Project Administration, E.U.

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The authors declare no conflict of interest.

Data Availability
The datasets generated during and/ or analyzedduring the current study are available from the corresponding author on reasonable request.

Use of Generative AI
No generative AI was used.

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