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Road Infrastructure Improvement Strategies to Support Community Economic Growth in North Labuhanbatu Regency

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Abstract

This study formulates a priority strategy for improving road infrastructure to support community economic growth in North Labuhanbatu Regency, North Sumatra. A descriptive qualitative field design was employed between July and August 2026. Primary data were obtained through field observations, guided in-depth interviews, documentation, and structured strategic-factor assessments involving key stakeholders from the Regional Development Planning Agency, the Public Works and Spatial Planning Office, subdistrict or village government, road users, and business actors. Secondary evidence was drawn from official statistics, planning documents, and relevant literature. The data were triangulated and analyzed through Internal and External Factor Evaluation, SWOT mapping, geometric-mean aggregation of expert judgments, and the Quantitative Strategic Planning Matrix. The findings reveal a sharp spatial disparity: central corridors enjoy relatively stable paved access, whereas the coastal and plantation-production corridors face severe deterioration, soft-soil constraints, tidal flooding, overloaded freight vehicles, and high last-mile transport costs. The strategic position lies in Quadrant I at (X, Y) = (+0.34, +0.39), indicating an aggressive-progressive posture. QSPM identifies accelerated coastal rigid-pavement construction financed through central-government transfers, particularly the Regional Road Presidential Instruction and earmarked physical transfers, as the leading priority with a Total Attractiveness Score of 6.12. Its effectiveness depends on complementary axle-load enforcement, corporate social responsibility consortia for maintenance, and spatially enabled complaint and monitoring systems. The study contributes an implementable, place-sensitive policy sequence that connects road investment with lower logistics costs, improved market access, and more inclusive rural income growth.

INTRODUCTION

Road infrastructure is a form of social overhead capital that shapes the speed, cost, and reliability of exchanges among households, production centres, markets, and public services. Its economic contribution is rarely automatic: the condition, location, governance, and maintenance of a road determine whether physical connectivity becomes productive connectivity. Recent Indonesian studies show that road provision and maintenance can support regional activity, but the magnitude and distribution of benefits vary across regions and institutional settings (Sawitri, 2023; Gertler et al., 2024; Kustanto & Mahi, 2025). This variation makes strategy formulation particularly important for resource-dependent rural districts where road failure directly increases transaction costs.

North Labuhanbatu Regency is an agrarian district in North Sumatra whose economic base is closely connected to oil-palm, rubber, forestry, fisheries, processing, and trade. Its 1,023.34-km district-road network links dispersed villages and plantation-production areas to mills, markets, administrative centres, and the Trans-Sumatra corridor. Official data compiled in the thesis indicate improvement in several surface categories, yet the network remains highly unequal. Paved roads increased from 274.72 km in 2021 to 432.96 km in 2025, but gravel and soil roads still accounted for 567.12 km in 2025. More critically, 585.10 km, or approximately 57.18% of the network, remained severely damaged in 2025.

The problem is geographically concentrated. Coastal districts such as Kualuh Hilir and Kualuh Leidong face soft alluvial or peat soils, tidal flooding, and recurrent inundation. Plantation and

interior corridors experience potholes, rutting, and structural failure intensified by over-dimension and overloaded freight vehicles. These physical constraints raise vehicle operating costs, increase travel time, damage perishable fresh-fruit bunches, and create additional last-mile or "transshipment" charges borne by smallholders. By contrast, the central corridor around Kualuh Hulu and Kualuh Selatan benefits from stronger integration with the Trans-Sumatra route and shows more visible agglomeration of retail, warehousing, repair services, and small enterprises.

The empirical literature does not produce a uniform conclusion. Road construction is frequently associated with improved market access and economic activity (Solihin et al., 2024; Sharma et al., 2024; Lestari et al., 2025; Putra & Rajiman, 2025), while other studies report small, insignificant, or context-dependent effects (Sawitri, 2023; Harsono et al., 2024; Hariarmis & Sabir, 2025). Indonesian and Malaysian evidence further indicates that network development must be interpreted through local geography, finance, and institutional capacity (Ridzuan & Maiddin, 2024; Sukesa & Papyrakis, 2023). This inconsistency suggests that kilometres of road alone are an incomplete policy metric. The financing mechanism, pavement design, freight regulation, maintenance regime, and spatial targeting determine whether an investment produces durable benefits.

Most earlier studies estimate the relationship between infrastructure and economic growth using regression, panel, spatial, or time-series models. Those approaches are valuable for estimating average effects, but they provide limited guidance on how a local government facing fiscal scarcity, difficult geotechnical conditions, and fragmented stakeholder responsibilities should sequence its actions. A context-specific strategic analysis is therefore needed to translate infrastructure needs into a ranked and implementable policy portfolio.

This study addresses that gap by asking: (1) what internal strengths and weaknesses and external opportunities and threats shape road-infrastructure improvement in North Labuhanbatu; (2) what strategic posture is appropriate; and (3) which alternative should receive first priority. Its novelty lies in integrating stakeholder-based qualitative evidence, field conditions, SWOT positioning, geometric-mean expert aggregation, and QSPM prioritisation within a district-level economic-development framework. The objective is not merely to establish that roads matter, but to identify how road policy can reduce spatial inequality and improve the welfare of rural producers.

Table 1. District Roads by Surface Type, 2021–2025 (km)

Surface type	2021	2022	2023	2024	2025
Paved	274.72	260.61	365.34	365.34	432.96
Gravel	29.65	356.88	540.09	540.09	437.08
Soil	518.81	402.99	74.83	74.83	130.04
Other	200.15	2.50	43.08	43.08	23.26
Total	1,023.34	1,023.34	1,023.34	1,023.34	1,023.34

Source: Processed from the thesis research data (2026).

METHODS

This research used a descriptive qualitative field-study design. The approach was selected to capture institutional judgments, lived transport constraints, and the interaction between physical road conditions and local economic activity. Fieldwork was conducted in North Labuhanbatu Regency from July to August 2026. The unit of analysis was the district road-improvement strategy rather than an individual road project.

Informants were selected purposively because the study required participants with direct knowledge of planning, construction, local governance, transport, and business conditions. The stakeholder categories comprised officials from the Regional Development Planning Agency (Bappeda), the Public Works and Spatial Planning Office (PUTR), subdistrict or village governments, and community members who were road users or business actors. This design prioritised information relevance and triangulation over statistical representation.

Primary data were collected through structured field observation across the regency's eight subdistricts, guided in-depth interviews, documentation, and structured assessments of strategic factors. Secondary data included road-network statistics, budget and planning documents, official regional statistics, academic publications, and regulatory material. Interview and observational evidence were compared across stakeholder groups and checked against documentary records to strengthen credibility.

Analysis proceeded in four stages. First, observations and interviews were coded into internal strengths and weaknesses and external opportunities and threats. Second, expert assessments of current condition (scale 1–6) and handling urgency (scale 1–4) were combined using a geometric mean to reduce the influence of an extreme assessment. Relative weights summed to 1.00 in each internal and external matrix, while ratings were standardised to the 1–4 range. Third, weighted scores were used to calculate the SWOT Cartesian coordinates: the internal coordinate was the difference between aggregate strength and weakness scores, and the external coordinate was the difference between opportunity and threat scores. Fourth, feasible alternatives generated by the SWOT matrix were assessed using QSPM. Each factor received an Attractiveness Score from 1 (not attractive) to 4 (highly attractive); multiplying this score by the factor weight produced its Total Attractiveness Score, and the strategy with the highest aggregate score became the primary recommendation.

The procedure combined qualitative interpretation with transparent numerical prioritisation. Numerical scores were not treated as population estimates; they served as a disciplined decision aid grounded in expert judgment and triangulated field evidence. This limitation is considered when interpreting the results.

RESULTS AND DISCUSSION

Spatial Road Conditions and Economic Consequences

The field evidence identifies three distinct spatial clusters. The eastern coastal cluster, particularly Kualuh Hilir and Kualuh Leidong, has the most critical network. Many links consist of soft-earth or minimally gravelled surfaces that deform under rainfall, river overflow, and tidal flooding. Low-bearing-capacity soils make conventional flexible pavement short-lived and substantially increase construction costs. During wet periods, road segments can become deep mud corridors that interrupt freight movement.

The plantation and interior cluster—including Marbau, Aek Kuo, Aek Natas, and Na IX-X—has more stable mineral soils but suffers from potholes, rutting, and pavement disintegration. Repeated heavy movements of oil-palm freight, including loads beyond the capacity of district roads, accelerate deterioration. In the western upland areas, slope and landslide exposure add further maintenance risks. These failures translate into higher fuel use, faster wear of tyres and suspension, vehicle downtime, and unreliable delivery schedules.

The central cluster around Kualuh Hulu and Kualuh Selatan shows the strongest road condition and direct integration with the Trans-Sumatra corridor and the district capital, Aek Kanopan. Better access is associated with denser retail, repair, warehousing, food-service, and microenterprise activity. The contrast among clusters demonstrates that road quality structures the geography of opportunity: communities near reliable corridors can participate in wider markets, while peripheral producers lose income through isolation and high transport margins.

District-wide figures reinforce the field findings. Although good-condition roads increased to 351.38 km in 2025, severely damaged roads remained dominant at 585.10 km. The fall from 718.57 km in 2021 represents progress, but the remaining backlog is too large for incremental, uniformly distributed intervention. Spatial prioritisation is required.

Table 2. District Roads by Condition, 2021–2025 (km)

Road condition	2021	2022	2023	2024	2025
Good	278.07	249.84	304.77	317.97	351.38
Moderate	14.30	103.00	24.10	46.64	74.91
Damaged	12.40	114.08	21.10	47.63	11.95
Severely damaged	718.57	556.41	673.37	611.10	585.10
Total	1,023.34	1,023.34	1,023.34	1,023.34	1,023.34

Source: Processed from the thesis research data (2026).

Internal and External Strategic Factors

The internal-factor evaluation produced a total weighted score of 2.00. Strengths include political commitment and alignment of road connectivity with the 2027 regional planning framework, recurring infrastructure budget lines, a valid spatial plan, certified road-right-of-way assets, and operational maintenance units. Nevertheless, these strengths are offset by limited heavy equipment and certified technical personnel, a high proportion of soil and severely damaged roads in production areas, weak enforcement against overloaded freight, insufficient routine-maintenance funding relative to deterioration, and an underdeveloped GIS-enabled complaint system.

The external-factor evaluation produced a total weighted score of 1.83. The strongest opportunities are central-government transfers through the Regional Road Presidential Instruction and earmarked physical grants, potential pooled corporate social responsibility financing from plantation companies, digital integration through the national planning system, relatively favourable commodity conditions, and cross-boundary connectivity projects. Threats include soft soils and coastal flooding, overlapping land or concession status, construction-material inflation, social conflict related to pollution and damaged public roads, and regulatory uncertainty in axle-load enforcement across jurisdictions.

After separating positive and negative components, the SWOT Cartesian result was (X, Y) = (+0.34, +0.39). Both coordinates are positive, placing the district in Quadrant I. This position supports an aggressive-progressive strategy: the local government should use its planning commitment and spatial readiness to capture external financing opportunities while simultaneously protecting new assets from foreseeable technical and regulatory risks.

Table 3. Summary of Strategic Evaluation Results

Dimension	Result	Interpretation
Internal factor score	2.00	Internal capacity exists but structural weaknesses remain substantial.
External factor score	1.83	Financing and coordination opportunities coexist with major environmental and regulatory threats.
SWOT coordinate	(+0.34, +0.39)	Quadrant I: aggressive-progressive strategic posture.

Dimension	Result	Interpretation
QSPM priority	TAS = 6.12	Accelerated coastal rigid pavement through central-government transfers.

Source: Processed from the thesis research data (2026).

Priority Strategy and Supporting Policy Package

The QSPM selected accelerated coastal rigid-pavement construction financed through central-government transfers as the first priority, with a Total Attractiveness Score of 6.12. This option aligns the district's strongest planning assets with the opportunity that most directly addresses its fiscal constraint. Rigid pavement is strategically appropriate for the coastal production corridors because it offers greater resistance to heavy loads and water-sensitive conditions than conventional asphalt, although detailed geotechnical design remains essential for each segment.

Central financing acts as fiscal leverage. The cost of coastal reconstruction—including subgrade treatment, drainage, imported aggregates, and rigid pavement—cannot be met rapidly through the district budget alone. Packaging priority corridors into technically mature proposals for the Regional Road Presidential Instruction and earmarked physical transfers can accelerate treatment without displacing essential local services. Integration with the national digital planning system should be used to demonstrate network function, economic beneficiaries, readiness of land, and measurable reductions in logistics costs.

The priority is not a stand-alone construction programme. Three complementary measures are required. First, the district should establish and enforce axle-load and vehicle-class controls, coordinated with adjacent jurisdictions and supported by physical portals where legally and operationally appropriate. Without load control, new pavement will depreciate prematurely. Second, plantation corporations should be organised into a transparent CSR or social-and-environmental-responsibility consortium focused on periodic maintenance and agreed logistics corridors. Such funding should complement rather than replace public responsibility. Third, PUTR should deploy a GIS-enabled road complaint and condition-monitoring platform so communities and maintenance teams can identify failures, flood damage, and emergency access constraints in real time.

The policy sequence therefore follows an asset-life-cycle logic: select high-economic-impact coastal links; complete geotechnical and drainage preparation; secure central financing; construct fit-for-condition rigid pavement; enforce load limits; and fund preventive maintenance using a mix of local budget and accountable corporate participation. This sequence is more credible than a fragmented "build-and-repair" cycle because it links capital investment to asset protection and operational response.

Economic Growth and Islamic Development Implications

The findings explain why road investment can produce different growth outcomes across settings. Reliable roads reduce travel time and vehicle operating costs, but their largest welfare effect in North Labuhanbatu comes from changing the bargaining environment of small producers. When roads are impassable, smallholders depend on intermediaries who can absorb transport risk and impose price deductions. Better access expands the feasible set of buyers, reduces spoilage and quality loss, improves access to price information, and increases the share of commodity value retained by producers. These mechanisms are consistent with evidence that maintenance and connectivity can stimulate local activity when road quality is sufficient and markets are accessible (Gertler et al., 2024; Julianti et al., 2025; Kustanto & Mahi, 2025). The proposed GIS component is also consistent with earlier calls for spatial road-condition information in North Labuhanbatu (Nasution & Amri, 2024).

The study also supports a more conditional interpretation of infrastructure-led growth. Construction alone is insufficient where overloading, poor drainage, and weak maintenance rapidly destroy the asset. This helps reconcile positive results in some studies with weak or insignificant estimates elsewhere. Economic impact depends on the durability and governance of connectivity, not merely the annual value of expenditure or the nominal length constructed.

From an Islamic-economics perspective, infrastructure policy should advance maslahah by widening access to livelihoods and public services, preventing avoidable harm, and reducing unjust spatial burdens. Qur'an 11:61 frames human development as a responsibility to cultivate and sustain the earth. In this context, public stewardship requires not only building roads but also protecting public assets, allocating resources fairly, and preventing private overloading practices from shifting costs onto rural households. A strategy that prioritises isolated production communities, preserves road life, and transparently coordinates public and corporate contributions therefore aligns economic efficiency with distributive justice (Irawan et al., 2024).

The practical contribution is a decision framework that local government can use to move from broad commitment to an actionable portfolio. The framework connects spatial evidence, institutional capacity, financing opportunity, engineering suitability, regulation, and maintenance. It also provides measurable implementation indicators: kilometres of critical corridor upgraded, average wet-season travel time, vehicle operating costs, frequency of road closures, commodity price deductions at farm gate, axle-load violations, and response time to GIS-reported failures.

CONCLUSION

North Labuhanbatu's road problem is both an infrastructure deficit and a mechanism of spatial economic inequality. Coastal and plantation corridors experience severe road deterioration, difficult soil and hydrological conditions, overloaded freight, and high logistics costs that reduce smallholder income and market access. Despite recent improvement, severely damaged roads still represented more than half of the district network in 2025.

The combined SWOT and QSPM analysis places the district in an aggressive-progressive position at (+0.34, +0.39). The primary strategy is accelerated rigid-pavement reconstruction in coastal production corridors using central-government transfers, with a QSPM Total Attractiveness Score of 6.12. Implementation should be supported by enforceable axle-load controls, an accountable plantation-sector CSR maintenance consortium, and GIS-based monitoring and rapid response.

The study is limited by its qualitative, case-specific design and reliance on a small purposive group of knowledgeable stakeholders. Strategic scores organise judgment rather than estimate causal economic effects. Future research should test the proposed transmission mechanisms longitudinally using district or corridor-level data, including travel time, farm-gate prices, logistics expenditure, road condition, and household income. Econometric approaches such as ARDL, panel models, or structural equation modelling could estimate the elasticity of improved road access with respect to regional income and welfare.

For policy, the immediate recommendation is to prepare technically complete, geospatially documented proposals for the Kualuh Hilir and Kualuh Leidong corridors, align them with the 2027 planning and budget cycle, and establish an asset-protection package before construction begins. This combination offers the strongest prospect for converting public infrastructure spending into durable, inclusive community economic growth.

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