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STRATEGIC ANALYSIS OF TRANSPORTATION INDUSTRY IN SABAH, MALAYSIA: A COMPREHENSIVE SWOT/TOWS-AHP APPROCH

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ABSTRACT

This study examines the transportation industry in Sabah, Malaysia, with a particular focus on the issue of limited rural connectivity. Despite government efforts and the existence of basic transportation infrastructure, many rural communities continue to face challenges such as poor road conditions, inadequate public transportation services, insufficient maintenance, and geographical barriers including mountainous terrain and seasonal flooding. To address these issues, the study employs an integrated SWOT, TOWS, and Analytic Hierarchy Process (AHP) approach to identify strategic factors, formulate improvement strategies, and prioritize actions for implementation. The SWOT analysis identifies key strengths, weaknesses, opportunities, and threats affecting rural transportation development. The TOWS matrix is then used to develop strategic alternatives, while AHP ranks these strategies according to their relative importance. The findings reveal that leveraging existing road networks and government commitment to expand digital infrastructure and smart transport solutions is the highest-priority strategy, followed by community engagement in multimodal transportation systems and the promotion of public-private partnerships. The study highlights the importance of infrastructure enhancement, technology adoption, community participation, and sustainable governance in improving rural accessibility. The proposed strategies provide practical guidance for policymakers and stakeholders to strengthen rural connectivity, support inclusive socio-economic development, and improve the quality of life of rural communities in Sabah.

Keywords: Rural Connectivity; Transportation Infrastructure; SWOT/TOWS Analysis; Analytic Hierarchy Process (AHP); Sabah Malaysia.

1. Introductions: Limited Rural Connectivity in Sabah

Being Malaysia's second largest state, Sabah has to face many serious challenges involving rural connectivity, which greatly slow down its economic and social developments. It is disheartening to find out that even though Sabah has a good number of valuable natural resources, it supports the development of many rural regions with a poor quality transportation network (Sarbatly et al., 2023). Roadways in such places are often in bad shape because they have outdated roads, cover few important spots, and do not receive sufficient routine maintenance, making it difficult both to get to important services and for the residents' economic opportunities. As a result of this difficulty, the cycle of rural poverty in Sabah remains and lowers the area's possible growth.

The research aims to check the status of rural infrastructure in Sabah, assess the social and financial issues linked to poor connectivity experienced by rural areas, and analyze the current transport policies being used (Gruidl et al., 2007). Further, this assessment wants to share useful suggestions to boost internet connection in rural places and aid the main aim of making progress more sustainable across the area (Neelima et al., 2024; Ovchinnikova & Asanova, 2023).

The study's importance comes from the fact that better rural connectivity might greatly contribute to the broader growth of Sabah. Building up transportation would achieve two things: first, more people could gain important services, and second, it would lower poverty and build a more inclusive economic model (Quium, 2019). This study aims to give meaningful knowledge to those in charge, who will be able to implement effective actions that directly solve the different problems experienced by rural areas in Sabah.

Transportation in rural areas of Sabah is challenging due to the bad state of the roads, increased flooding because of poor drainage, and the fact that many places remain isolated because of the limited road system. Lacking dependable public transport for moving people makes most people count on their own vehicles, and since there are not enough efforts to take care of roads and bridges, their condition gets worse.

Although there are many studies dealing with rural transportation issues in Malaysia, there aren't many that concentrate on the special needs of Sabah alone (Aratin et al., 2023). Many studies on rural transportation do not give sufficient attention to the unique background of Sabah, as a result, they ignore the concrete problems that rural communities face in the state. As a result, the research helps close this important gap in scholarly works by providing an in-depth and tailored assessment just for rural communities in Sabah to make sure the conclusions are helpful.

The investigation is fuelled by the need to address a major shortage of urban infrastructure in Sabah, since failing to do so would keep the gap between urban and rural towns. Strengthening connections in rural areas helps everyone develop equally, as everyone can then seize opportunities that benefit their lives. The goal of this inquiry is to support the growth of durable measures that address connectivity and support fairer growth in the rural parts of Sabah. Eventually, this should improve life for every resident.

2. Methodology SWOT-TOWS and AHP Analysis.

2.1 SWOT Methodology.

The SWOT method includes identifying the objectives of a company and checking it against what it does well, what it does poorly, the available benefits, and also the risks that could harm its objectives (see Figure 1).

Strengths: the qualities that help a business compete effectively compared to its rivals.Weaknesses: certain traits that give the business a disadvantage compared to other companies.Opportunities: segments of the entire business environment that the organization could utilize for its gain.Threats: challenges that the business might come across in the environment.

2.1.1 Internal and external factors

SWOT analysis is mainly used to highlight aspects that can make or break a business's achievements, divided into two parts as internal strengths and weaknesses and external opportunities and threats.

The framework can assess internal factors as strengths or weaknesses because of how much they shape the company's objectives. Even so, strengths that are valuable for a purpose may be disadvantages in some other case.

Some external elements may be technological progress, decisions made by government, society's changes, variations in market activity, and alterations in the company's competition. It is common to consider SWOT analysis as a clear-cut planning tool.

During SWOT analysis, it is important to prepare for and look at every factor that matters to new products, technology, management, or strategic planning with care.

SWOT analysis provides only one method to group and organize things by their similarities and flaws. In some cases, it leads its users to make lists instead of considering the main elements needed to meet goals. In addition, it usually lists the identified outcomes without reviewing them carefully or organizing them clearly, which means that sometimes weak chances are given similar weight as significant issues.

We should evaluate every element in the SWOT analysis carefully before getting rid of it. The influence of every SWOT factor can be seen in how it affects the formation of a good strategy. For this reason, it is important to base a strategy on SWOT factors that are positive and to ignore the negative ones.

2.1.2 Strategy formulation

The application of SWOT analysis can be effectively employed to delineate organizational strategy. The methodology utilized to implement strategy-centric analysis encompasses the articulation of both internal and external variables (utilizing the well-known 2 x 2 matrix),

selection of a strategic option and assessment of the most consequential factors, as well as the identification of interrelations that exist between internal and external characteristics (Ashutosh et al., 2020).

It is apparent that a robust correlation between strengths and opportunities can promote a favorable condition within the organization and advocate for an assertive strategic approach. Conversely, a pronounced interplay between weaknesses and threats may be interpreted as a warning, thereby suggesting the adoption of a defensive strategy.

A SWOT analysis may serve to:

(1) Investigate innovative solutions to existing challenges

(2) Ascertain obstacles that may impede the achievement of goals/objectives

(3) Determine the trajectory that will yield optimal effectiveness

(4) Uncover opportunities and constraints for transformation

(5) Facilitate the revision of strategies to adeptly navigate systems, communities, and organizations

(6) Function as a brainstorming and documentation tool to enhance communication

(7) Augment the credibility of interpretation to be employed in presentations to organizational leaders or key stakeholders

2.1.3 Limitations of SWOT

The application of SWOT analysis may detrimentally affect organizational performance and that "no one subsequently utilized the outputs during the subsequent phases of the strategy." Additional critiques encompass the inappropriate employment of SWOT analysis as a methodology that can be rapidly constructed without engaging in critical analysis, resulting in a distorted representation of strengths, weaknesses, opportunities, and threats within the internal and external contexts of an organization

Moreover, a further limitation in the formulation of a SWOT analysis is the propensity to uphold previously established goals and objectives. This inclination imposes significant constraints on the brainstorming process and the authentic identification of pertinent variables.

2.2 TOWS Methodology

The TOWS Matrix, as articulated by Frank David, constitutes a strategic framework that extends the conventional SWOT Analysis by accentuating actionable strategies that arise from the alignment of internal factors (Strengths and Weaknesses) with external factors (Opportunities and Threats). In contrast to SWOT, which predominantly enumerates these elements, TOWS is concentrated on the formulation of strategic responses: SO (Strengths-Opportunities) strategies harness internal advantages to capitalize on external opportunities, ST (Strengths-Threats)

strategies employ strengths to mitigate threats, WO (Weaknesses-Opportunities) strategies confront weaknesses by leveraging opportunities, and WT (Weaknesses-Threats) strategies reduce risks through defensive tactics. Frank David's methodology underscores proactive decision-making, ensuring that organizations synchronize their capabilities with market dynamics to bolster competitiveness and alleviate vulnerabilities. This framework is particularly advantageous in dynamic industries where strategic agility is of paramount importance.

2.2.1 Strategic Formulation and Implementation using the TOWS Matrix

(1) Conduct a SWOT Analysis to Identify internal factors (Strengths (S),Weaknesses (W) and Identify external factors (Opportunities (O) and threats (T))
(2) Generate TOWS strategies by matching internal and external factors to create four strategic approaches SO Strategies (Strengths-Opportunities), ST Strategies (Strengths-Threats), WO Strategies (Weaknesses-Opportunities), WT Strategies (Weaknesses-Threats)
(3) Prioritize & Select Strategies with Evaluate strategies based on feasibility, cost, risk, and impact
(4) Develop an Action Plan with Define specific actions, timelines, resources, and responsibilities.
(5) Implement & Monitor
(6) Review & Adapt

2.3 Analytical hierarchy process (AHP) methodology

The Analytical Hierarchy Process (AHP) provides a systematic approach to deconstructing a complex issue into smaller, more manageable components arranged in hierarchical order (Saaty, 1980). This methodology was conceptualized by Thomas L. Saaty. AHP functions as a comprehensive decision-making structure that categorically separates decision issues into a hierarchical format marked by aims, criteria, sub-criteria, and alternatives.

The three components that constitute the terms Analytic, Hierarchy, and Process are elucidated as follows:

Analytic: The AHP methodology for selecting alternatives is predicated on sound mathematical and logical reasoning rather than mere intuition, thereby facilitating the justification of the decision-making process.

Hierarchy: The AHP framework systematically disaggregates the decision problem into smaller hierarchical elements that encompass objectives, criteria, sub-criteria, and alternatives. Because numerous decision-making contexts are fundamentally complicated and tough to handle in full, the layered framework allows those making decisions to hone in on a narrower array of options.

Process: The decision-making process encompasses learning, evaluating, deliberating, and refining ideas, which collectively constitute a typical decision-making paradigm. AHP has been explicitly designed to facilitate this decision-making process, ensuring that it remains unaffected by extraneous influences.

AHP offers a comprehensive analytical framework for structuring a decision problem, representing and evaluating its components, relating those components to overarching objectives, and assessing alternatives in a hierarchical format.

Upon the establishment of the hierarchy, the decision-maker (DM) systematically evaluates the various variables by conducting pairwise comparisons, referencing each variable against the one directly above it in the hierarchy. These comparative assessments are subsequently converted into numerical values by AHP, processed, and analyzed across the full spectrum of the problem. AHP proves to be particularly effective when addressing complex, critical issues of significant importance that involve human perceptions and judgments, whose resolutions may have enduring implications.

AHP serves as a rigorous mechanism for the relative ranking of ordinal-level data, which can be transformed into ratio-level data through the application of eigenvectors and matrix algebra. It evaluates the relative significance of each factor within the SWOT analysis framework. The AHP approach to decision-making consists of four distinct stages or levels

Stage 1: define the problem and establish the hierarchical structure

The initial stage involves delineating all decision components pertinent to the problem. The foremost level encompasses a broad, general objective, while the subsequent lower levels contain the sub-objectives and attributes that exert influence on the decision-making process itself. Various potential alternatives are situated at the lowest level.

Stage 2: Collection of Input Data

The term input data refers to the influence exerted by each component on the corresponding sub-objectives within the proximate superior tier of the hierarchical structure. The resultant information is organized within a matrix designed for pair-wise evaluations. For the sake of illustration, if seven components exist at level L and there are two components at level L1, one would build a 7 x 7 matrix for both components at level L1. This matrix is designated as the reciprocal judgment matrix. To populate this matrix, it is necessary to conduct 10L (L*(L1)/25, specifically 7*6/2) comparisons. The diagonal components of this matrix are marked by the number 1, as the remaining components hold reciprocal figures. The Analytic Hierarchy Process (AHP) employs a 1–9 scale for measurement in its pair-wise comparisons. A value of nine indicates a significantly preferred element in relation to the element with which it is compared. Conversely, a value of one denotes two elements of equal importance. The intermediate values denote varying degrees of relational significance.

Stage 3: Determination of Relative Weights Utilizing the Eigenvalue Method
The relative priorities assigned to various criteria (sub-criteria) are not readily discernible from the judgment matrix. In this phase, the relative weights for a collection of objects (criteria, sub-criteria, and alternatives) are computed using the pair-wise comparison matrix B5 bij, which is characterized by being both positive and reciprocal (ranging from 1–9 and 1–1/9).

Therefore, the given matrix B such that

$$B=\begin{bmatrix} b_{11} & b_{12} & \dots & b_{1n} \\ b_{21} & b_{22} & \dots & \dots \\ \dots & \dots & \dots & \dots \\ b_{n1} & \dots & \dots & b_{nm} \end{bmatrix}$$

where $B_{ij}=1/B_{ij}$ for all I, j = 1, 2, 3. . ., n

Compute a vector of relative priorities w = (w1, w2. . . w3). The w is normalized so that it adds up to 1 or 100. If all the judgements are consistent, then

$$b_{ik}*b_{kj} = b_{ij} \text{ for all I ; j = 1, 2 …, n}$$

Then, normalizing any column j of matrix B will generate the wts

$$W_i = \frac{b_{ij}}{\sum_{K=1} b_{kj}} \text{ for all } I, j = 1, 2K \dots, n$$

Pair-wise judgement is often error-prone and condition in the second equation may not be confirmed. Consequently, the final result of priorities may depend upon the column chosen for normalization. Such a problem can be solved either by logarithmic least square (LLS) or eigenvector method developed by Saaty. Latter is a simpler procedure than former and also involves averaging all possible ways of comparing alternatives (Harker and Vargas, 1987). Calculations of the wt. vector as the right eigenvector of the matrix B:

$$Bw = \lambda_{max} W$$

where λmax is the maximum eigenvalue of matrix B. So the weight vector can be enumerated as

$$Wi = \frac{\sum_{j=1}^{N} bij*wj}{\lambda_{max}}$$

Inconsistencies in judgement can be calculated by eigenvector method. Satty research depicts for λmax n for positive reciprocal matrix. For a perfectly consistent matrix then λmax 5 nSatty defined a consistency index by the formula

$$CI = \frac{\lambda_{max} - n}{n-1}$$

Also consistency ratio (CR) is measured as ratio of CI and random index (RI)

$$CR= CI/RI$$

Therein RI the random index is computed as the mean of CI of randomly generated matrices of size n. If CR < 0.1, it is acceptable, and if CR > 1, the DM has to re-evaluate the decisions in order to reduce inconsistencies

Stage 4: Formulate a composite priority vector for the lowest tier of the hierarchy to evaluate alternative decision strategies.

The principal objective of employing the Analytic Hierarchy Process (AHP) is to systematically rank or prioritize various decision alternatives based on their effectiveness in achieving the specified objective or goal. The final cumulative ranking for the decision alternatives is derived by aggregating all the weighted eigenvalues associated with all hierarchical levels (extending down to the alternatives). Eigenvectors are weighted in accordance with the significance of the criteria.

The AHP methodology can be succinctly summarized as follows:
(1) The problem is structured as a hierarchical framework that encompasses the objectives, the alternatives, and the criteria/sub-criteria necessary for assessing the alternatives.

(2) Establish priorities among the variables within the hierarchy through a series of judgments predicated on pairwise comparisons of the elements.

(3) (4) (5) Integrate these judgments to generate a comprehensive set of overall priorities for the hierarchy. Conduct a consistency check on the judgments.

Conclude based on the outcomes of this analytical process (Saaty, 2008).

3. Analysis of Limited Rural Connectivity in Sabah.

3.1 SWOT Analysis

Strength
(S1) Existing basic road networks provide foundational access to rural communities (Ladin et al., 2019).
(S2) Community engagement in maintaining local paths and informal transport systems (Ariyanti et al., 2020).
(S3) Government commitment to rural infrastructure development through policies and funding (Ismail et al., 2021).
(S4) Availability of emerging technologies (e.g., GPS, mobile apps) to support rural transport logistics (Nordin et al., 2020).
Weakness

(W1) Poor road conditions causing frequent accessibility disruptions (Ladin et al., 2019).

(W2) Limited public transportation options, leading to reliance on costly private vehicles (Rahman et al., 2021).

(W3) Insufficient maintenance and lack of sustainable funding models for rural infrastructure (Ismail et al., 2021).

(W4) Geographical challenges such as mountainous terrain and seasonal flooding impeding connectivity (Nguyen & Lee, 2019).

Opportunities

(O1) Expansion of digital infrastructure to enable smart transport solutions (Nordin et al., 2020).

(O2) Increased public-private partnerships to finance rural connectivity projects (Rahman et al., 2021).

(O3) Integration of multimodal transport systems combining road, river, and alternative pathways (Ariyanti et al., 2020).

(O4) Leveraging community-based transport initiatives to enhance local access (Nguyen & Lee, 2019).

Threat

(T1) Climate change causing extreme weather events that damage rural roads (Ladin et al., 2019).

(T2) Urban migration reducing rural populations and weakening justification for investment (Ismail et al., 2021).
(T3) Policy inconsistency and fragmented governance leading to inefficient project implementation (Rahman et al., 2021).

(T4) Economic constraints limiting funds available for infrastructure upgrades (Nguyen & Lee, 2019).

Being unconnected from the rest of the country is an issue for rural areas in Sabah because it involves many strengths and weaknesses linked to several opportunities and challenges. It is noteworthy that even though the roads are very basic, they allow rural populations to access necessary travel needs (Ladin et al., 2019). In addition, local involvement in looking after transport options and roads makes them both safer and practical, allowing them to continue supporting the public in their everyday life (Ariyanti et al., 2020). On top of what

happens at the grassroots, policies and available funds from government help to support the improvement of rural services and connections (Ismail et al., 2021). Besides, the enhanced use of advanced tools, including GPS and mobile devices designed for rural transport, increase the chances for better arrangement of logistics. This helps identify more advanced and effective means of moving people and goods in rural regions (Nordin et al., 2020).

But at the same time, it is important to see that these strengths are greatly limited by serious weaknesses that hold back development. Most of the time, when roads in rural areas are not well paved, it interrupts how these populations communicate and do business. Since there are not enough trains or buses, most rural individuals turn to their personal cars, which are costly for people who cannot afford them (Rahman et al., 2021). There are not enough funds and infrastructure maintenance, which both add to the threat of rural transport failing to work well and break down over time (Ismail et al., 2021). The existence of high mountainous land and seasonal floods make it challenging for rural residents to be well connected (Nguyen & Lee, 2019).

In spite of all the difficulties, many positive prospects are still available that can be used to address these key issues. Improving digital infrastructure in rural areas can make it possible to introduce smart transport methods that will boost the quality of services and monitoring (Nordin et al., 2020). Increased connections between public and private sectors can form the base for strong funding strategies in the area of sustainable rural connectivity (Rahman et al., 2021). Using all three types of transport with roads, rivers, and additional routes offers a helpful plan for making travel accessible in different and complicated rural terrains (Ariyanti et al., 2020). Still, encouraging community-based transportation opens more opportunities for rural groups to help in planning and carrying out their own transportation improvements (Nguyen & Lee, 2019).

Yet, it is necessary to admit that there are many factors that could prevent security efforts from working. Climate change has become clearer when it results in severe extreme events that cause more issues for fragile rural roads, making it harder to ensure people stay well connected (Ladin et al., 2019). At the same time, people moving to cities lowers the number of rural residents and resulting in less interest from investors, which makes things more difficult. Different and inconsistent approaches in governance, in combination with lack of financial resources, stand in the way of making improvements to rural connectivity (Rahman et al., 2021; Nguyen & Lee, 2019). It is important to join the available resources with the upcoming possibilities, carefully watch out for and resolve the current issues, and prepare for new challenges ahead so that rural communities in Sabah can enjoy more equal and accessible service and connection in the days to come.

3.2 TOWS Matrix (Strategic Action Plan)

Internal Factors → External Factors ↓	**Strengths (S)** (S1) Existing basic road networks provide foundational access to rural communities (Ladin et al., 2019). (S2) Community engagement in maintaining local paths and informal transport systems (Ariyanti et al., 2020). (S3) Government commitment to rural infrastructure development through policies and funding (Ismail et al., 2021).	**Weaknesses (W)** (W1) Poor road conditions causing frequent accessibility disruptions (Ladin et al., 2019). (W2) Limited public transportation options, leading to reliance on costly private vehicles (Rahman et al., 2021). (W3) Insufficient maintenance and lack of sustainable funding models for rural infrastructure (Ismail et al., 2021). (W4) Geographical challenges such as mountainous terrain and seasonal flooding impeding connectivity (Nguyen & Lee, 2019).
Opportunities (O) (O1) Expansion of digital infrastructure to enable smart transport solutions (Nordin et al., 2020).	**SO Strategies (Maximize Strengths + Opportunities)** **SO1:** Leverage the existing basic road networks (S1) and	**WO Strategies (Minimize Weaknesses + Opportunities)** **WO1:** Address poor road conditions (W1) and

(O2) Increased public-private partnerships to finance rural connectivity projects (Rahman et al., 2021). (O3) Integration of multimodal transport systems combining road, river, and alternative pathways (Ariyanti et al., 2020). (O4) Leveraging community-based transport initiatives to enhance local access (Nguyen & Lee, 2019).	government commitment (S3) to expand digital infrastructure (O1) for implementing smart rural transport solutions such as GPS-enabled logistics and mobile app services (S4). **SO2:** Utilize community engagement (S2) to integrate multimodal transport systems (O3), combining roads, rivers, and local pathways, enhancing connectivity in hard-to-reach areas. **SO3:** Use emerging technologies (S4) alongside government policies (S3) to foster public-private partnerships (O2) for sustainable rural transport financing. **SO4:** Empower community-based transport initiatives (O4) by building on the existing local path maintenance (S2), encouraging local ownership and sustainability.	insufficient maintenance (W3) by mobilizing public-private partnerships (O2) to secure sustainable funding and technical support. **WO2:** Mitigate limited public transport options (W2) by adopting digital platforms and mobile apps (O1, S4) to coordinate shared rides and informal transport systems. **WO3:** Counter geographical challenges (W4) through multimodal integration (O3), enabling alternative routes such as river transport where road access is limited. **WO4:** Enhance local access (O4) to reduce reliance on costly private vehicles (W2) by formalizing community transport initiatives with government backing (S3).
Threats (T) (T1) Climate change causing extreme weather events that damage rural roads (Ladin et al., 2019). (T2) Urban migration reducing rural populations and weakening justification for investment (Ismail et al., 2021). (T3) Policy inconsistency and fragmented governance	**ST Strategies (Leverage Strengths to Counter Threats)** **ST1:** Utilize government commitment (S3) and emerging technologies (S4) to implement climate-resilient infrastructure and real-time monitoring systems to respond to extreme weather (T1). **ST2:** Counter urban migration (T2) by	**WT Strategies (Defensive Actions)** **WT1:** Develop contingency plans and improve road maintenance (W1, W3) to reduce vulnerability to climate change impacts (T1), especially in flood-prone and mountainous areas (W4). **WT2:** Address funding and governance gaps (W3, T3, T4) by advocating for policy reforms that prioritize rural

leading to inefficient project implementation (Rahman et al., 2021). (T4) Economic constraints limiting funds available for infrastructure upgrades (Nguyen & Lee, 2019).	strengthening rural connectivity (S1) and community engagement (S2) to improve quality of life and economic opportunities in rural areas. **ST3:** Use existing policy frameworks and government support (S3) to improve governance coordination and reduce fragmented implementation (T3). **ST4:** Leverage community participation (S2) and technology (S4) to optimize limited financial resources (T4) through cost-effective, locally managed transport solutions.	transport infrastructure and transparent project management. **WT3:** Counteract limited public transport and high private vehicle reliance (W2) by incentivizing community-based transport models and subsidized shared mobility services. **WT4:** Mitigate the effects of urban migration (T2) by enhancing rural connectivity (W4) and improving access to services to retain rural populations.

Table 1: SWOT Analysis

The problem of poor connectivity in rural areas of Sabah can be handled by working with the region's strengths and at the same time managing its weaknesses through clever approaches. While building digital infrastructure (O1) for better smart transport (S4), solid networks (S1) and strong government policies and funding (S3) play a key role and make it easier to apply advanced solutions such as GPS in logistics and new applications on mobile devices. Moreover, with the participation of local communities in fixing and maintaining rural pathways (S2), there is a special chance to include various kinds of transportation such as roads, boats, and other pathways, which are all under O3, resulting in much better access for people in tough areas of the country.

On top of this, publicly supported and privately operated partnerships, called O2, along with new technological developments and suitable policies, give an effective choice to maintain financial support for rural transport projects. To fix the road deterioration highlighted as W1 as well as poor maintenance practices indicated in W3, it is useful to activate public-private partnerships recommended in O2, resulting in the collection of funds and technical assistance needed for improvement.

Mainly, the use of digital systems and handy mobile apps, represented as O1, encourages the development of shared and flexible transport services, fixing challenges caused by shortages of public transportation, identified as W2. Integrating several means of transport solves the geographical problems and supports use of the smaller rivers to make traveling easier. Encouraging community members to set up their own transport system, which is O4, and ensuring government assistance as shown in S3, helps people in the community depend less on

private vehicles, saving costs, and obtain greater access to basic resources and services.

Whenever outside threats to the country arise, the faithful S3 and its use of advanced technology, S4, ensure that the country and its people are protected and that any consequences of natural disasters, T1, are quickly tackled by the use of modern monitoring systems. S1, which means boosting rural connectivity, and S2, which refers to getting communities actively involved, can tackle the challenge of urban migration T2 by giving rural people more economic opportunities. Besides, the goal of enhancing how governance groups cooperate, termed S3, should help resolve the challenge of policy fragmentation, termed T3, while the involvement of locals, mentioned as S2, together with using modern technology, underscored as S4, provides another way to make use of scarce funds, called T4.

In order to keep systems risk-free in the face of changes in climate, organizations should develop backup plans and boost maintenance activities, as listed as W1 and W3. Still essential for progress in rural connectivity are efforts to support government efforts in T3 and T4 and achieve reforms that better allocate and distribute funds as stated in W3. In addition, offering incentives for community transport solves the barrier created by reduced public transport, as shown in W2 and at the same time helps overcome the negatives of migration to cities, as highlighted in W4 and T2. All in all, these connected methods have the ability to greatly enhance rural internet access in Sabah, helping to advance sustainable growth in the whole region.

3.3 The AHP Analysis

BIL	CRITERIA	PRIORITY	RANK	(+)	(-)
1	**SO1:** Leverage the existing basic road networks (S1) and government commitment (S3) to expand digital infrastructure (O1) for implementing smart rural transport solutions such as GPS-enabled logistics and mobile app services (S4).	17.3%	1	11.9%	11.9%
2	**SO2:** Utilize community engagement (S2) to integrate multimodal transport systems (O3), combining roads, rivers, and local pathways, enhancing connectivity in hard-to-reach areas.	17.1%	2	10.9%	10.9%

3	**SO3:** Use emerging technologies (S4) alongside government policies (S3) to foster public-private partnerships (O2) for sustainable rural transport financing.	15.1%	3	9.3%	9.3%
4	**SO4:** Empower community-based transport initiatives (O4) by building on the existing local path maintenance (S2), encouraging local ownership and sustainability.	5.9%	7	2.7%	2.7%
5	**WO1:** Address poor road conditions (W1) and insufficient maintenance (W3) by mobilizing public-private partnerships (O2) to secure sustainable funding and technical support.	7.3%	4	4.3%	4.3%
6	**WO2:** Mitigate limited public transport options (W2) by adopting digital platforms and mobile apps (O1, S4) to coordinate shared rides and informal transport systems.	6.1%	6	2.7%	2.7%
7	**WO3:** Counter geographical challenges (W4) through multimodal integration (O3), enabling alternative routes such as river transport where road access is limited.	6.9%	5	3.3%	3.3%
8	**WO4:** Enhance local access (O4) to reduce reliance on costly private vehicles (W2) by formalizing community	5.1%	9	2.1%	2.1%
	transport initiatives with government backing (S3).				

9	**ST1:** Utilize government commitment (S3) and emerging technologies (S4) to implement climate-resilient infrastructure and real-time monitoring systems to respond to extreme weather (T1).	4.8%	10	3.0%	3.0%
10	**ST2:** Counter urban migration (T2) by strengthening rural connectivity (S1) and community engagement (S2) to improve quality of life and economic opportunities in rural areas.	5.4%	8	2.5%	2.5%
11	**ST3:** Use existing policy frameworks and government support (S3) to improve governance coordination and reduce fragmented implementation (T3).	1.5%	14	0.6%	0.6%
12	**ST4:** Leverage community participation (S2) and technology (S4) to optimize limited financial resources (T4) through cost-effective, locally managed transport solutions.	1.6%	13	0.9%	0.9%
13	**WT1:** Develop contingency plans and improve road maintenance (W1, W3) to reduce vulnerability to climate change impacts (T1), especially in flood-prone and mountainous areas (W4).	1.7%	12	0.9%	0.9%
14	**WT2:** Address funding and governance gaps (W3, T3, T4) by advocating for policy	1.8%	11	1.0%	1.0%

	reforms that prioritize rural transport infrastructure and transparent project management.				
15	**WT3:** Counteract limited public transport and high private vehicle reliance (W2) by incentivizing community-based transport models and subsidized shared mobility services.	1.4%	15	0.7%	0.7%
16	**WT4:** Mitigate the effects of urban migration (T2) by enhancing rural connectivity (W4) and improving access to services to retain rural populations.	1.0%	16	0.4%	0.4%

Table 2: TOWS Analysis

The conclusions reached with the Analytic Hierarchy Process (AHP) help in arranging various strategic actions for improving rural connectivity by using a process based on carefully comparing established criteria. The priority action, getting a total of 17.3% of the funding, revolves around using existing main roads more effectively, an aim that can only be reached when governments equally play their part (SO1). The approach that stresses the role of local communities in integrating different transport systems by 17.1% stands in second, after community engagement (H54), with the focus on showing how vital community participation is in making rural areas better connected.

Subject to a further study, the use of new technologies with help from public-private partnerships (SO3) came third in priority, as it scored 15.1% on the scale, confirming the sheer importance of employing advanced technology and cooperative strategies to tackle rural connectivity issues. On the other hand, although using local transport models (SO4) is acknowledged, it has only been ranked 5.9% as a priority, pointing out that it should be strengthened before it can have a broader impact in rural transportation.

To overcome problems caused by road problems and insufficient upkeep, the approach relying on public-private agreements to improve infrastructure has been prioritized and receives a score of 7.3%. Besides, strategies focusing on overcoming issues with public transport through digital services (WO2) and meeting geographic difficulties using different types of transport (WO3) have been rated with the priorities of 6.1% and 6.9% to highlight their importance in the entire strategy. In addition, steps taken to improve local access and encourage people to use alternatives to private cars (WO4) have scored the lowest and been given a priority of 5.1%.

Strategies concentrating on climate-resilient structures and equipment using government help and advanced technologies (ST1) received a scoring of 4.8%, while the idea to reduce

migration to cities by assisting connections and community participation has been assigned a 5.4% priority rank, pointing out their value in the general plan. At the same time, both policy coordination (ST3) and Sustainability Through Participation (ST4) have received low priority ratings, which shows that people see them as less pressing than other issues for now.

Actions focused on protecting and maintaining assets (WT1, WT2), and community transport (WT3) as well as tackling urban migration (WT4) have been seen as not important by the participants, with scores from 1.0% to 1.8%. The decision matrix that includes 120 pairwise comparisons, shows that the consistency ratio is 9.2%, proving that the judgments made within this framework can be relied on. Besides, with a main eigenvalue of 18.201 being calculated and the iteration process reaching convergence in eight tries, these results confirm that the effort is best placed on infrastructure, connecting the community, and introducing advanced technology for a real difference in providing sustainable rural connectivity in the region, as reflected in the priority ranking.

4. Critical Analysis and Strategic Interpretation of Sabah's Limited Rural Connectivity SWOT/TOWS-AHP Findings

In accordance with the key outcomes from AHP analysis combined with the TOWS framework, the full analysis reveals that using existing infrastructure and having a dedicated partnership with the government (SO1) plays the main role in improving rural connectivity. This fact shows just how vital important roads and suitable policies are for future development programs. Also, when community participation (SO2) is prioritized to the same degree, it means including locals in planning and giving them a role in actions, which makes rural transportation solutions more effective and encourages the population to feel concerned and invested in the community’s environment.

Giving high importance to technology adoption and joining public-private partnerships suggests that the region is switching to a strategy that embraces innovation and work with others to fix financial and geography matters it faces. Even so, the lack of resources and attention to grassroots transport projects (classified as SO4) hints that while their value is great, they will likely not greatly affect people until they are better included in larger infrastructural and policy frameworks.

Those strategies addressing issues related to roads and maintenance (WO1) show that the serious problems with infrastructures hamper the proper connections within these regions. The choice of multimodal transport integration (WO3) and the creation of digital platforms for organizing public transport (WO2) is a practical method to deal with the complicated geography and limits in transport Sabah has. The purpose of these approaches is to resolve the issues of cost and distance in rural areas by making good use of modern technologies and innovative systems.

Enhancing the city’s ability to cope with climate change (ST1) and checking the flow of migrants to urban regions (ST2) are considered important, but less urgent compared to other needs in the city’s development, showing that both threats are known and taken into account, but considered as less pressing for now. Although it is important to have defensive strategies in place, they have been put on the back burner. This might be a result of resource issues or the authorities’ preference for planning ongoing activities instead of reacting to them.

A strategic response derived from these findings should involve strengthening main infrastructure, establishing adequate policies, and at the same time encouraging people and new technologies in the community. As a result of this plan, Sabah can address its current needs for internet access as well as seek out solutions that are beneficial to the environment and the economy. Nevertheless, policymakers should not forget how important governance and maintenance reforms really are, since they support and sustain all the planned actions in this key framework.

5. Implementation Recommendations for Sustainable Limited Rural Connectivity in Sabah

For rural communities in Sabah to experience steady growth in connectivity, it's important to use a wide approach that addresses several areas related to this topic. In the beginning, governmental entities should make sure existing basic roads are maintained and boosted by their reliable support, since all further projects depend on this. For this reason, we need to concentrate on improving important infrastructure and set up regular maintenance schedules to guarantee area reliability in places where flooding is common and the land is challenging. Also, promoting public-private partnerships is necessary, since this way, the right resources and important knowledge can be obtained for managing and maintaining rural roads. At the same time, embracing and using modern solutions such as GPS, apps for mobile devices, and digital platforms greatly benefits transport services, routes, and makes traveling in remote places easier. It is also important that people from the community are closely involved in every part of the implementation process, since this can help them feel responsible, answer to their needs more quickly, and promote the project's stability. Providing training and developing abilities for people should come first, as it will help them handle and support transport projects for many years. To face Sabah's special geographical issues effectively, a transport system should connect roads, rivers, and alternate ways, granting easy navigation and solutions suitable for the various rural parts of the area. Because of this, all infrastructure plans should include practices that improve climate resilience, especially to guard rural regions against future complications from harsh weather. When looking at governance, it matters to ensure that various government bodies cooperate well so that policies do not conflict and everyday work gets more efficient. It is also important to build transparent systems for monitoring and checking results, since these help find progress, spot forthcoming problems, and allow flexible solutions. One more step is to promote economic growth in rural areas, and this task can be achieved by developing access to important markets, schools, and health clinics. All the recommendations included in this plan blend together to make sure there is equal, sustainable, and dependable internet in Sabah's rural areas, leading to everyone's development and raising life standards.

6. Conclusion.

It is necessary to put together a detailed and effective plan so that rural areas in Sabah have better connections by integrating infrastructure upgrades, innovations in technology, and close involvement by people living there. It is vital to give attention to road maintenance, work closely with different levels of government, and establish positive partnerships with companies, as these factors play a central role in progress that lasts in the region. Also, making sure to develop innovative multimodal plans and focus on climate resilience can help rural areas deal with their varying and regular environmental problems. To make sure these initiatives work well and adapt to new circumstances, solid rules for governance and regular checking must always be

applied and quickly changed when required. When basic services, infrastructure, and job chances are all enhanced, these dedicated actions can help reverse mass migrations from the rural areas and encourage development across the whole country. All in all, this joint approach works to improve living standards in these rural areas and to help these communities stay safe from damage in the future. Through involvement in these initiatives, it is believed that more people in the area will live in fairness and prosperity in the future.

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