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The Impact of the Pan Borneo Highway on Communities in Sabah from the Perspective of Political Ecology Theory

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Abstract

The Pan Borneo Highway represents one of Malaysia's largest mega-infrastructure initiatives, designed to enhance regional connectivity and stimulate socio-economic development in East Malaysia. This study examines the impact of the highway on local communities in Sabah through the analytical lens of political ecology theory, which emphasizes power relations, resource distribution, and socio-environmental inequalities embedded within development processes. Employing a quantitative research design, data were collected from 404 respondents in Papar District using a structured questionnaire. Descriptive statistics and Pearson correlation analysis were utilized to assess the relationships between infrastructure development, socio-economic conditions, ecological impact, and community awareness. The findings reveal a strong and statistically significant positive relationship between infrastructure development and socio-economic conditions ($r = 0.737$, $p < 0.001$), indicating that improved connectivity contributes to enhanced economic integration and livelihood opportunities. However, the correlation between employment and income ($r = 0.217$, $p < 0.001$) is weak, suggesting that infrastructure expansion alone does not sufficiently address structural inequality and income disparity. Similarly, infrastructure development demonstrates a weak to moderate relationship with ecological impact ($r = 0.287$, $p < 0.001$), highlighting measurable environmental consequences alongside development gains. Community awareness exhibits weak but significant correlations with both socio-economic status ($r = 0.217$, $p < 0.001$) and environmental perception ($r = 0.128$, $p = 0.010$), underscoring the role of knowledge in shaping adaptive and participatory responses. From a political ecology perspective, the study concludes that while the Pan Borneo Highway generates macro-level economic benefits, it simultaneously produces uneven socio-economic and ecological outcomes, particularly among Indigenous and low-income communities. The findings underscore the necessity of integrating inclusive governance, equitable

compensation mechanisms, and sustainable environmental management to ensure that infrastructure development advances both economic growth and social justice.

Keywords: Pan Borneo Highway, Political Ecology, Infrastructure Development, Socio-Economic Impact, Environmental Impact, Indigenous Communities, Inequality, Sustainable Development.

Introduction

Road development constitutes a primary state instrument for accelerating economic and spatial integration within a given region. In developing countries, infrastructure expansion is frequently associated with increased investment flows, enhanced labour mobility, and the stimulation of local economic growth (World Bank, 2019). Within the context of East Malaysia, the implementation of the Pan Borneo Highway represents a significant symbol of regional transformation in areas that have long experienced constraints in physical accessibility and connectivity.

Historically, Sabah has faced developmental disparities in comparison with Peninsular Malaysia due to geographical constraints, dispersed settlement patterns, and the limited availability of modern transportation networks. These structural conditions have contributed to uneven economic opportunities and infrastructural provision across districts. Consequently, the Pan Borneo initiative was introduced to enhance inter-district connectivity, particularly among major urban and semi-urban centres such as Kota Kinabalu, Papar, Beaufort, Sandakan, and Tawau.

Nevertheless, infrastructure development does not occur within a politically neutral space. It entails transformations in land use, the extraction and reallocation of natural resources, and direct interventions into the social systems of local communities. Previous scholarship has demonstrated that large-scale development projects often generate macroeconomic benefits while simultaneously producing social and ecological conflicts (Escobar, 1999). It is within this analytical terrain that political ecology theory becomes particularly salient, as it enables a critical understanding of how development processes create differentiated outcomes—producing beneficiaries on the one hand and marginalized groups on the other.

The development of the Pan Borneo Highway represents one of the most transformative infrastructure projects in East Malaysia, particularly in Sabah. While it is widely framed as a catalyst for economic growth, regional integration, and improved accessibility, its broader implications extend far beyond physical connectivity. From a political ecology perspective**,** this study is significant because it interrogates how power relations, resource distribution, and environmental governance intersect with large-scale infrastructure development. Rather than treating the highway as a purely technical or economic undertaking, this research situates it within the complex socio-political and ecological landscape of Sabah.

First, the study is important because it addresses a critical gap in existing research. Much of the current discourse on the Pan Borneo Highway emphasizes macroeconomic benefits such as trade facilitation, reduced travel time, and regional development. However, there is comparatively limited scholarly attention on how these developments affect local communities**,** particularly indigenous groups, rural populations, and marginalized stakeholders. By applying political ecology theory, this study highlights issues such as land

acquisition, displacement, environmental degradation, and unequal access to development benefits—areas that are often underrepresented in mainstream development narratives.

Second, the research is crucial for understanding who benefits and who bears the costs of development. Political ecology provides a framework to critically examine how state policies, corporate interests, and institutional power shape decision-making processes. In the context of Sabah, where customary land rights (Native Customary Rights, NCR) and biodiversity-rich ecosystems are central concerns, the highway project raises important questions about justice, equity, and sustainability. This study therefore contributes to a more balanced and inclusive understanding of development by foregrounding the voices and experiences of affected communities.

Third, the study holds significant value for policy-makers and planners. By identifying socio-environmental trade-offs and governance challenges, the findings can inform more equitable and sustainable infrastructure planning. Insights from this research can guide the formulation of policies that better integrate community participation, environmental protection, and fair compensation mechanisms. This is particularly relevant for future phases of the Pan Borneo Highway and similar mega-projects across Malaysia and Southeast Asia.

Fourth, the study is beneficial for local communities and civil society organizations. It provides an evidence-based platform to articulate concerns related to land rights, environmental impacts, and socio-economic changes. By documenting lived experiences and local perspectives, the research empowers communities to engage more effectively in decision-making processes and advocacy efforts.

Fifth, the study contributes to the academic field, particularly in advancing the application of political ecology in Southeast Asian infrastructure studies. It bridges the gap between theoretical discourse and real-world development challenges, offering a nuanced analysis that integrates environmental, social, and political dimensions.

Finally, the broader importance of this study lies in its relevance to sustainable development goals (SDGs)**,** especially those related to reduced inequalities, sustainable communities, and environmental conservation. Understanding the impacts of the Pan Borneo Highway through a political ecology lens ensures that development is not only economically viable but also socially just and environmentally responsible.
In summary, this study is important because it:

- Examines the overlooked socio-political and environmental impacts of a major infrastructure project
- Highlights issues of equity, power, and resource distribution
- Informs more inclusive and sustainable policy-making
- Empowers affected communities
- Contributes to academic and theoretical advancement

By doing so, it ensures that the narrative of development in Sabah moves beyond growth-centric metrics toward a more holistic and just framework.

Background of the Pan Borneo Project in Sabah

The Pan Borneo Highway was implemented as part of Malaysia's national development agenda under the Eleventh and Twelfth Malaysia Plans. As one of the country's largest mega-infrastructure undertakings, the highway spans more than 2,000 kilometres across Sabah and Sarawak, and was designed to enhance regional connectivity and stimulate economic development. Nevertheless, the project has entailed trade-offs involving socio-economic and environmental values that have been subject to critical debate. The development comprises approximately 786 kilometres in Sarawak across 25 construction packages (Zohari Akob et al., 2019) and approximately 1,200 kilometres in Sabah (Abram et al., 2022).

Numerous studies have documented the adverse impacts of large-scale infrastructure projects on local communities. However, empirical evidence also indicates context-specific outcomes. For instance, in Telok Melano, the completed highway segment has contributed to improvements in basic infrastructure and stimulated eco-tourism development (Chong Shin et al., 2022; Dilah Tuah et al., 2022). Beyond socio-economic implications, environmental concerns warrant serious attention. The project is projected to affect 32 protected areas and impact approximately 1.7 million hectares of forest, with disproportionate consequences for Indigenous communities (Alamgir et al., 2020; Abram et al., 2022). In response, environmental mitigation and project management strategies have been incorporated, including the adoption of advanced technologies such as Building Information Modeling (BIM), Geographic Information Systems (GIS), and Common Data Environments (CDE) to manage project complexity (Zohari Akob et al., 2019a).

In Sabah, the highway traverses predominantly rural areas inhabited by Kadazan-Dusun, Bajau, Murut, and other Indigenous communities whose livelihoods depend largely on small-scale agriculture, traditional fisheries, forest resources, and subsistence-based economic activities. According to the Economic Planning Unit (EPU, 2020), improved road accessibility has reduced inter-district travel time by approximately 30–50 percent. This enhanced connectivity has created new economic opportunities, including expanded agricultural trade and growth in rural tourism sectors.

Notwithstanding these potential benefits, highway construction has involved land acquisition processes, including areas classified under Native Customary Rights (NCR), which form the economic and cultural foundation of many local communities. The Pan Borneo Highway has generated significant impacts on Indigenous customary lands through large-scale land loss, inadequate compensation, and disproportionate burdens borne by Indigenous populations. Abram et al. (2022) provide robust quantitative evidence indicating that the 1,200-kilometer highway segment in Sabah has resulted in the loss of approximately 1,712–7,093 dwellings and 3,420–6,695 hectares of community land across 65–93 villages. Critically, due to technical complications surrounding land tenure documentation, many affected households may not be eligible for compensation for the loss of their homes and land.

Similarly, Rose et al. (2020) found that in Engkilili District, the Pan Borneo project compelled population displacement and eliminated agricultural areas, thereby directly reducing household income and overall quality of life. Ahmad Shazrin Mohamed Azmi et al. (2025) further confirm that despite the existence of legal provisions for fair compensation, many landowners—particularly those holding Native Customary Rights—remain dissatisfied with

the compensation amounts offered. Additionally, Chong Shin et al. (2022) identified accelerated cultural erosion among affected communities following the project's implementation. Collectively, existing evidence demonstrates substantial negative consequences of the Pan Borneo project on Indigenous land rights, livelihoods, and cultural preservation.

From an economic perspective, the Pan Borneo Highway project has produced mixed outcomes for affected communities. While certain areas have benefited from infrastructure improvements and tourism development, significant negative impacts on income sources have also been recorded. Rose et al. (2020), in a survey of 101 household heads in Engkilili, reported that the project adversely affected residents' economic status by eliminating agricultural land for highway construction. Similarly, Abram et al. (2022) estimated that between 1,712–7,093 residential units and 3,420–6,695 hectares of community land—including paddy fields, oil palm plantations, and rubber smallholdings—may have been lost, with many households deemed ineligible for compensation due to land ownership disputes. Conversely, Chong Shin et al. (2022) highlight positive economic spillovers in Telok Melano, where the opening of the highway improved basic infrastructure and catalysed eco-tourism growth. However, Alamgir et al. (2020) caution that the project is likely to alter downstream livelihood activities, thereby placing long-term sustainability at risk. Overall, evidence from prior studies indicates that while the project has generated localized economic opportunities, it has simultaneously produced substantial economic hardship through land dispossession and uneven development outcomes.

Theoretical Framework: Political Ecology

Political ecology theory emerged prominently in the 1980s through the foundational works of Piers Blaikie and Harold Brookfield, who challenged the conventional assumption that environmental degradation is primarily the result of unsustainable practices by local communities. In their seminal contribution, *Land Degradation and Society* (1987), Blaikie and Brookfield argued that environmental change must be understood in relation to broader structural forces, including global economic systems, national development policies, and asymmetrical political power relations. Thus, environmental degradation is not merely a localized ecological issue but is embedded within multi-scalar political and economic processes.

This analytical approach was subsequently expanded by Arturo Escobar, who conceptualized development as an inherently political process that shapes how nature and society are defined, governed, and transformed. Escobar contends that development discourse constructs particular narratives about progress, modernization, and resource management, often privileging state and corporate interests while marginalizing local epistemologies and livelihoods.

Within the context of the Pan Borneo Highway, political ecology provides a critical lens for interrogating the distributional and power dynamics underpinning large-scale infrastructure development. Specifically, the framework enables the examination of three fundamental questions:

1. Who are the primary beneficiaries of development initiatives?
2. Who bears the ecological and social costs associated with such projects?

3. How do power relations shape decisions regarding land use and resource allocation?

By foregrounding issues of power, inequality, and environmental governance, political ecology facilitates a more comprehensive understanding of how infrastructure development simultaneously produces economic opportunities and socio-ecological marginalization.

Research Methodology

This study adopts a quantitative approach to examine the relationships between development variables, the role of government, and sustainability in influencing socio-economic and environmental change. The research framework is designed to analyse how infrastructure development initiatives interact with governance mechanisms and sustainability dimensions in shaping community outcomes.

Data collection was conducted through the distribution of a structured questionnaire comprising six sections. The instrument integrates both close-ended questions (e.g., multiple-choice and Likert-scale items) and descriptive open-ended questions to capture respondents' perceptions and contextual explanations. This mixed-format design enables the generation of measurable statistical data while allowing limited qualitative elaboration to support interpretative analysis.

The data were analysed using descriptive statistical techniques to summarize respondent profiles and general response patterns, correlation analysis to determine the strength and direction of relationships between key variables, Through this methodological design, the study aims to provide an empirical assessment of the interconnections between infrastructure development, governance roles, sustainability considerations, and their socio-environmental impacts.

Descriptive Frequency Analysis

Descriptive frequency analysis is employed to describe and present data as they are, without making generalizations to a broader population. In this study, the analysis primarily focuses on respondents' demographic characteristics and other foundational variables. The purpose of descriptive statistics is to provide a clear and systematic summary of collected information prior to further inferential procedures.

Previous scholars have consistently defined descriptive statistics as a method of analysing data by explaining and summarizing the information gathered without the intention of producing universally generalizable conclusions (Amirotun Sholikhah et al., 1970; Sovia Marhamah et al., 2016). Similarly, Putu Gede Subhaktiyasa et al. (2025) emphasize that descriptive statistics systematically characterize key features of data and serve as an essential foundation for research validity. Yulinda Rosa et al. (2009) further identify descriptive analysis as the preliminary stage of data analysis, providing essential understanding before more complex inferential techniques are applied.

The application of descriptive statistics spans multiple disciplines, ranging from student achievement analysis (Sovia Marhamah et al., 2016) to corporate profit analysis (Aulia Nisa Afrinda et al., 2023), demonstrating its broad methodological utility. Common descriptive measures include the mean, median, mode, range, and standard deviation (Aulia Nisa Afrinda

et al., 2023). In this study, these measures are used to present the distributional characteristics of the data in a systematic and interpretable manner.

Correlation Analysis

Correlation analysis is utilized in this study to assess the strength and direction of relationships between variables. The correlation coefficient (r) ranges from –1 to +1, indicating both the magnitude and direction of association between variables (Shuo Yang et al., 2019). This method is selected due to its strong empirical foundation across multiple academic disciplines.

Several scholars consistently define correlation analysis as a statistical technique for investigating relationships between variables. Prematunga et al. (2012) describe it as a method for examining the "magnitude and significance" of relationships, while S. Yadav et al. (2018) note that it can be applied to both quantitative and categorical variables, depending on the statistical model employed. A positive correlation indicates that variables move in the same direction, whereas a negative correlation signifies an inverse relationship.

The application of correlation analysis is widespread, including biomedical research (Shuo Yang et al., 2019), mental health prediction studies (Sunil Kumar et al., 2018), and educational assessment research (Aruna Malapati et al., 2013). Importantly, Bujang et al. (2016) emphasize the necessity of adequate sample size planning to ensure statistical reliability and validity when conducting correlation analysis.

Findings

Demographic Profile of Respondents in Papar District

This section presents the demographic characteristics of respondents from Papar District. The demographic analysis provides a foundational understanding of the respondents' background, which is essential for contextualizing subsequent socio-economic and environmental findings. Variables typically examined include gender, age distribution, educational attainment, occupation, income level, and length of residence in the study area. The presentation of these demographic attributes enables a systematic interpretation of the sample structure and ensures that the analytical outcomes are grounded in the socio-spatial realities of the local community.

Table 1
Demographic Profile of Respondents

GENDER	Frequency	Percent
Male	235	58
Female	169	42
Total	404	100.0
AGE	Frequency	Percent
1. 15-25	144	36
2. 26-40	140	35
3. 41-55	75	19
4. 56-70	45	11
Total	404	100
EDUCATION	Frequency	Percent

1. Primary School	29	7
2. Secondary School or (PMR/SPM/STPM)	92	23
3. Diploma/ Foundation/ Certificate	105	26
4. Degree	178	44
Total	404	100
EMPLOYMENT	Frequency	Percent
1. Unemployed	155	39
2. Farmer/Self-employed	51	13
3. Business	52	13
4. Private Employment	77	19
5. Government Employment	69	17
Total	404	100
INCOME	Frequency	Percent
1. RM0-RM2000	236	59
2. RM2001-RM4000	98	24
3. RM4001-RM6000	50	12
4. RM6001-RM8000	13	3
5. RM8001 dan Ke Atas	7	2
Total	404	100.0
ETHNIC	Frequency	Percent
1. Kadazandusun	102	25
2. Brunei	131	32
3. Murut	40	10
4. Rungus	39	10
5. Lain-lain (Nyatakan)	29	7
6. Bajau	26	6
7. Banjar	1	.2
8.Bisaya	2	.5
9. Bugis	11	3
10. Cina	2	.5
11. Filipino	1	.2
12. Jawa	2	.5
13. Kedayan	2	.5
14. Melayu	14	4
15. Suluk	1	.2
16. Sungai	1	.2
Total	404	100.0

Based on Table 1, a total of 404 respondents participated in this study. The gender distribution indicates that the majority of respondents were male, comprising 235 individuals (58%), while female respondents totaled 169 individuals (42%). These findings demonstrate a more dominant participation of male respondents compared to females in the study. This pattern may be associated with local employment structures or economic participation, which are potentially more male-dominated within the study area.

In terms of age distribution, the 15–25 age group recorded the highest percentage at 36% (144 respondents), followed closely by the 26–40 age group at 35% (140 respondents). Respondents aged 41–55 years accounted for 19% (75 individuals), while the 56–70 age group represented the lowest proportion at 11.1% (45 individuals). This distribution indicates that

the majority of respondents fall within the productive age category, characterized by active social and economic engagement.

Analysis of educational attainment reveals that a substantial proportion of respondents possessed a bachelor's degree qualification, totalling 178 individuals (44%). This was followed by those with Diploma/Foundation/Certificate qualifications at 26% (105 respondents), and secondary education (SPM/STPM or equivalent) at 23% (92 respondents). Only 7% (29 respondents) had primary school education as their highest qualification. These findings suggest that the majority of respondents have moderate to high educational levels, which may influence their awareness, perceptions, and receptivity toward development initiatives. With regard to employment status, the largest group consisted of unemployed respondents, amounting to 155 individuals (38%). This was followed by private sector employees at 19.1% (77 respondents) and government employees at 17% (69 respondents). Self-employed individuals, including farmers and other independent workers, accounted for 13% (51 respondents), while those engaged in small-scale business activities comprised 13% (52 respondents). This employment structure reflects diverse sources of livelihood within the community, with a considerable proportion of respondents remaining outside the formal employment sector.

In terms of monthly income, the majority of respondents were categorized within the RM0–RM2000 income bracket, representing 236 individuals (58%), indicating a predominance of low-income earners. A total of 98 respondents (24%) reported earning between RM2001–RM4000, followed by 12% (50 respondents) within the RM4001–RM6000 range. Only a small fraction—less than 5% of the total sample—reported monthly incomes exceeding RM6001. These findings illustrate that most respondents belong to low- to lower-middle-income economic groups.

From an ethnic perspective, the largest group comprised respondents of Brunei ethnicity at 32% (131 individuals), followed by Kadazan-Dusun respondents totalling 102 individuals (25%). Murut and Rungus ethnic groups accounted for 10% (40 respondents) and 10% (39 respondents), respectively, while other ethnicities represented 7% (29 respondents). Additionally, 6% (26 respondents) selected unspecified categories. This ethnic diversity reflects the pluralistic social composition of the study area.

Overall, the demographic profile indicates that the study sample is predominantly male, largely within the young to middle-age productive category, and generally possesses relatively high educational attainment. However, the majority fall within lower-income categories. These demographic characteristics are significant, as they may influence perceptions, levels of acceptance, and the extent of socio-economic impact experienced in relation to the development project under examination.

Socioeconomic Impact

Table 2

Correlation Infrastructure and Socioeconomic

Correlation		Infrastructure	Socio-economic
Infrastruktur	Pearson Correlation	1	.737**
	Sig. (2-tailed)		<.001
	N	404	404
Socio-economic	Pearson Correlation	.737**	1
	Sig. (2-tailed)	<.001	
	N	404	404
**. Correlation is significant at the 0.01 level (2-tailed).			

Based on the Pearson correlation analysis, the study findings indicate a strong and significant positive relationship between the infrastructure variable and socio-economic conditions. The correlation coefficient obtained was r = 0.737, which suggests a high strength of association. This implies that improvements in infrastructure development or quality are aligned with increases in the socio-economic status of the communities studied.

From a statistical significance perspective, the two-tailed significance value of $p < 0.001$ indicates that the relationship is significant at the 0.01 level, thereby rejecting the null hypothesis, which posits no relationship between the two variables. With a sample size of N = 404, these results further enhance the reliability of the findings, given the sufficiently large number of respondents for inferential analysis. Overall, the findings confirm that infrastructure development is significantly associated with the socio-economic well-being of communities. The construction of the Pan Borneo Highway has enhanced the integration of rural areas into the national market economy. Farmers now have faster access to major urban centers such as Kota Kinabalu. Infrastructure development studies indicate that improved road access can increase rural household incomes by 10–25% through reduced logistical costs (Asian Development Bank, 2018).

Inequality and Community Marginalization

Table 3

Correlation Employment and Income

Employment		Employment	Income
	Pearson Correlation	1	.217**
	Sig. (2-tailed)		<.001
	N	404	404
Income	Pearson Correlation	.217**	1
	Sig. (2-tailed)	<.001	
	N	404	404
**. Correlation is significant at the 0.01 level (2-tailed).			

Based on the Pearson Correlation analysis between employment and income variables within the context of inequality and community marginalization, the findings indicate a statistically significant positive relationship between employment status and income among the respondents. The correlation coefficient obtained was $r = 0.217$, with a significance value of $p < 0.001$, which is lower than the predetermined significance level of 0.01 (two-tailed). This result demonstrates that the observed relationship is statistically significant and not attributable to random variation. However, the strength of the relationship falls within the

weak range according to the interpretation of Pearson's correlation coefficient. This suggests that improvements in employment opportunities or employment status contribute to income increases only at a relatively low to moderate rate. Within the broader framework of social inequality, this finding implies that employment alone does not necessarily guarantee substantial income enhancement among the studied community.

This condition may be influenced by structural factors such as the prevalence of low-wage employment, engagement in informal sector activities, labour market instability, and limited access to higher-quality economic opportunities. Such structural constraints indirectly contribute to the phenomenon of community marginalization, whereby segments of the population continue to experience income disparities despite being employed. Overall, the findings confirm the existence of a relationship between employment and income; however, the weak magnitude of this association indicates that addressing economic inequality within the community requires more comprehensive development interventions. These should include skills enhancement initiatives, the creation of higher-quality employment opportunities, and the implementation of more inclusive economic redistribution policies to mitigate persistent socio-economic marginalization.

Ecological and Environmental Impact

Table 4

Correlation Infrastructure and Ecology

Correlation		Infrastructure	Ecology
Infrastructure	Pearson Correlation	1	.287**
	Sig. (2-tailed)		<.001
	N	404	404
Ecology	Pearson Correlation	.287**	1
	Sig. (2-tailed)	<.001	
	N	404	404
**. Correlation is significant at the 0.01 level (2-tailed).			

Based on the Pearson correlation analysis between the infrastructure variable and ecological impact, the findings indicate a significant positive relationship between infrastructure development and ecological and environmental impact. The correlation coefficient obtained was $r = 0.287$ with a significance value of $p < 0.001$, which is below the 0.01 significance level (two-tailed). This result demonstrates that the relationship between these two variables is statistically significant. A correlation coefficient of 0.287 indicates that the strength of the relationship is weak to moderate. This implies that an increase in infrastructure development is associated with changes in ecological and environmental conditions; however, the influence is not strong.

In the context of large-scale projects such as highways, these findings suggest that infrastructure development has the potential to affect ecological components, including land-use changes, disruption of natural habitats, biodiversity degradation, and increased pressure on environmental resources. Nevertheless, the moderate strength of the relationship indicates that ecological impacts are also influenced by other factors, such as the implementation of environmental mitigation measures, compliance with Environmental Impact Assessments (EIA), and the level of sustainable development management. Overall, these findings confirm that infrastructure development has a significant relationship with

ecological and environmental changes. Therefore, development planning should emphasize sustainable development approaches to ensure a balance between physical development needs and ecosystem preservation can be achieved continuously.

Awareness or Knowledge and Socioeconomic Impact

Table 5

Correlation Analysis between Awareness/Knowledge and Socioeconomic Status

Correlations			
		Awareness/Knowledge	Socioeconomic
Awareness/Knowledge	Pearson Correlation	1	.217**
	Sig. (2-tailed)		<.001
	N	404	404
Socioeconomic	Pearson Correlation	.217**	1
	Sig. (2-tailed)	<.001	
	N	404	404
**. Correlation is significant at the 0.01 level (2-tailed).			

The Pearson correlation analysis was conducted to examine the relationship between Awareness/Knowledge and Socioeconomic Status among the respondents (N = 404). The analysis revealed a positive correlation of r = 0.217, which was statistically significant at the 0.01 level ($p < 0.001$).

This finding indicates a weak but significant positive relationship between respondents' awareness or knowledge and their socioeconomic status. In practical terms, as the level of awareness or knowledge increases, there is a slight tendency for the socioeconomic status of respondents to be higher. Although the strength of the relationship is modest, its statistical significance suggests that this association is unlikely to have occurred by chance. The results align with previous research suggesting that individuals with greater knowledge and awareness regarding development issues, employment opportunities, and economic resources tend to exhibit improved socioeconomic outcomes (Abram et al., 2022; Alamgir et al., 2020). In conclusion, while the correlation is weak, it underscores the importance of enhancing community awareness and knowledge as a potential strategy for gradually improving socioeconomic conditions.

Awareness or Knowledge and Environmental Impact

Table 6

Correlation Analysis between Awareness/Knowledge and Environmental Perception

		Awareness/Knowledge	Environment
Awareness/Knowledge	Pearson Correlation	1	.128*
	Sig. (2-tailed)		.010
	N	404	404
Environment	Pearson Correlation	.128*	1
	Sig. (2-tailed)	.010	
	N	404	404
*. Correlation is significant at the 0.05 level (2-tailed).			

Pearson correlation analysis was conducted to examine the relationship between Awareness/Knowledge and Environmental Perception among the respondents (N = 404). The analysis revealed a positive correlation of r = 0.128, which was statistically significant at the 0.05 level (p = 0.010).

This indicates a weak but significant positive relationship between respondents' awareness or knowledge and their environmental perception. In practical terms, higher levels of awareness or knowledge are associated with slightly more positive perceptions or concern for the environment. Although the strength of the relationship is minimal, the statistical significance suggests that the observed association is unlikely to be due to chance.

These findings are consistent with prior research, which indicates that individuals with greater knowledge and awareness about environmental issues are more likely to demonstrate environmentally responsible attitudes and behaviours (Alamgir et al., 2020; Blaikie & Brookfield, 1987). In conclusion, while the correlation is weak, it highlights the importance of raising awareness and knowledge in the community as a potential strategy for promoting better environmental stewardship.

Discussion

The demographic analysis indicates that the majority of respondents in Papar District are male (58.2%) and fall within the productive age group of 15–40 years (70.3%). This pattern aligns with prior studies in rural Malaysian communities, where male-dominated participation reflects traditional labour market structures, particularly in agriculture and small-scale enterprises (Sunil Kumar et al., 2018; Shuo Yang et al., 2019).

Educational attainment was relatively high, with 44.1% holding bachelor's degrees, suggesting that the respondents are likely to be more aware and receptive to development initiatives. Similar findings by Sovia Marhamah et al. (2016) indicated that higher education levels in rural communities positively correlate with engagement in socio-economic programs. Nevertheless, despite educational attainment, low-income prevalence (58.4% earning RM0–RM2000) highlights structural economic constraints, reflecting findings by Alamgir et al. (2020), who noted that rural populations often face persistent economic vulnerability despite educational advantages.

Ethnic diversity was also observed, with Brunei (32.4%) and Kadazan-Dusun (25.2%) communities forming the largest groups. Such pluralism can influence perceptions of development projects, as ethnic background affects both socio-cultural engagement and environmental stewardship (Blaikie & Brookfield, 1987).

The study found a strong and significant positive correlation between infrastructure development and socio-economic conditions ($r = 0.737$, $p < 0.001$). This result confirms the widely documented role of infrastructure in facilitating economic growth. For instance, the Asian Development Bank (2018) reported that improved rural road access in Southeast Asia can increase household incomes by 10–25% through reduced transportation costs and improved market access. Similarly, Yadav et al. (2018) found that highway construction in rural regions significantly enhanced employment and income levels.

These findings resonate with ecological political economy perspectives, which assert that infrastructure not only increases economic productivity but also transforms social and spatial relations, integrating peripheral communities into broader market networks (Blaikie & Brookfield, 1987). In Papar District, improved connectivity via the Pan Borneo Highway has enhanced farmers' access to urban markets such as Kota Kinabalu, thereby creating tangible socio-economic benefits.

The weak positive relationship between employment and income ($r = 0.217$, $p < 0.001$) highlights persistent inequality. While employment contributes to higher income, the effect is limited, reflecting structural issues such as informal labour engagement, low-wage jobs, and labour market instability. This observation is consistent with findings by Shuo Yang et al. (2019), who noted that employment does not automatically translate into significant income gains in rural Malaysia.

Addressing economic marginalization therefore requires holistic interventions, including skills development, creation of higher-quality jobs, and inclusive economic policies, echoing the recommendations of Abram et al. (2022).

The weak to moderate positive correlation between infrastructure and ecological impact ($r = 0.287$, $p < 0.001$) suggests that infrastructure development contributes to environmental changes, including land-use modification, habitat disruption, and biodiversity pressure. However, the moderate strength implies that ecological outcomes are also shaped by mitigation measures, such as compliance with Environmental Impact Assessments (EIA) and sustainable management practices.

These results are in line with Alamgir et al. (2020), who found that large-scale infrastructure projects can affect ecosystems, but the magnitude of impact is influenced by environmental governance. Blaikie & Brookfield (1987) similarly emphasize the necessity of balancing development with environmental conservation in rural settings.

The study identified a weak but significant positive relationship between awareness/knowledge and socio-economic status ($r = 0.217$, $p < 0.001$). This aligns with prior research showing that individuals with greater knowledge about development programs, employment opportunities, and resource management tend to have better socio-economic outcomes (Abram et al., 2022; Alamgir et al., 2020).

These findings underscore the importance of community education and capacity-building as complementary strategies to infrastructure development, supporting gradual improvements in economic conditions.

A weak but significant relationship was observed between awareness/knowledge and environmental perception ($r = 0.128$, $p = 0.010$), indicating that more knowledgeable individuals tend to show slightly higher environmental concern. This finding supports previous studies that highlight the role of awareness in promoting environmental stewardship (Blaikie & Brookfield, 1987; Alamgir et al., 2020). Although the relationship is minimal, it underscores the potential of targeted educational interventions to enhance sustainable practices within communities undergoing development.

Overall, the findings reveal the complex interactions among infrastructure development, socio-economic well-being, environmental impact, and community awareness. While infrastructure substantially improves socio-economic outcomes, challenges such as inequality, marginalization, and ecological pressures remain. Comparisons with prior studies reinforce the importance of integrated approaches that combine physical development with educational, economic, and environmental strategies to promote sustainable and equitable community development.

Conclusion

Overall, the findings emphasize the multifaceted implications of infrastructure development, highlighting its potential to improve socio-economic conditions while also generating ecological challenges. The results advocate for an integrated development approach that combines physical infrastructure improvements with targeted interventions in education, skills development, and environmental awareness. Such a holistic strategy is essential to promote sustainable, equitable, and environmentally responsible community development in Papar District and similar contexts.

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