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Assessing The Environmental and Economic Benefits of Concreting National Route 79 (N79) and Lim-Siocon Road: Advancing Infrastructure Sustainability and Regional Growth

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ABSTRACT

This study examines the economic and environmental benefits of the concreting of National Route 79 (N79) and Lim-Siocon Road in the Philippines. It explores the impacts of improved road infrastructure on regional trade, market accessibility, job creation, and environmental sustainability. Using a descriptive-correlational research design, the study assesses how road quality, transportation efficiency, and drainage systems affect local economies and ecosystems. The findings reveal that the concreting of these roads has significantly enhanced economic accessibility, facilitated business growth, reduced transportation costs, and improved public safety. Environmentally, the project has reduced soil erosion, improved water quality, and decreased air pollution. Furthermore, the study highlights the importance of sustainable drainage systems in mitigating environmental degradation. The research emphasizes the need for infrastructure projects to integrate both economic and environmental goals for long-term, sustainable development. These insights contribute to the ongoing discourse on infrastructure's role in fostering regional growth and ecological balance.

Keywords: *National Route 79, Lim-Siocon Road, Road infrastructure, Economic Benefits, Environmental Sustainability, Market Accessibility, Job Creation, Drainage Systems*

INTRODUCTION

Infrastructure plays a critical role in economic development and environmental sustainability. The construction and maintenance of roads, particularly in developing regions, are vital for facilitating trade, reducing travel time, and improving overall connectivity. The concreting of National Route 79 (N79) and Lim-Siocon Road is a significant step toward enhancing infrastructure resilience and ensuring long-term economic benefits. These roads serve as major transportation arteries, connecting key economic hubs and rural communities, fostering better mobility, and reducing logistical challenges. Improved road quality not only ensures safer travel but also contributes to sustainable development by integrating modern engineering solutions that mitigate environmental degradation (Kumar & Patel, 2023).

Globally, infrastructure sustainability has become a primary concern in urban planning and regional development. Many countries have implemented road concreting projects to improve transportation efficiency and reduce maintenance costs associated with traditional asphalt roads. Studies show that well-constructed concrete roads have longer lifespans and require less frequent repairs, leading to lower overall carbon emissions from construction activities. Additionally, sustainable road projects emphasize the integration of eco-friendly materials and innovative drainage systems to minimize environmental impact. The use of permeable concrete, for instance, has been found to significantly reduce surface runoff and soil erosion, ensuring better water management in areas prone to flooding

(Li & Zhang, 2022).

Despite the known advantages of road concreting, there are still gaps in research concerning its localized environmental and economic impacts. Most studies focus on large-scale urban road projects, leaving rural and semi-urban infrastructure developments underexplored. The case of N79 and Lim-Siocon Road presents a unique opportunity to assess how such projects affect regional trade, accessibility, and environmental conditions. There is also a need to understand how improved road infrastructure can contribute to market expansion, increased employment opportunities, and a reduction in transportation costs. Addressing these gaps will provide valuable insights into the broader implications of infrastructure sustainability and regional growth (Fernandez & Torres, 2023).

From a legal perspective, road infrastructure development in the Philippines is governed by various regulations and policies. The Department of Public Works and Highways (DPWH) and the National Economic and Development Authority (NEDA) oversee major road projects to ensure compliance with environmental standards and sustainability principles. The Philippines' Build, Build, Build program has prioritized infrastructure investments to boost economic recovery and improve nationwide connectivity. However, there are concerns regarding the implementation and enforcement of environmental impact assessments (EIA) in road construction projects, particularly in rural areas. Strengthening legal frameworks and ensuring compliance with sustainability policies will be crucial in maximizing the benefits of concreting N79 and Lim-Siocon Road (Santos & Ramirez, 2022).

At the local level, the concreting of N79 and Lim-Siocon Road is expected to bring significant socio-economic improvements. The project will enhance accessibility for local businesses, reduce travel time for residents, and provide better transportation links to markets and industrial zones. Local government units (LGUs) and stakeholders are optimistic about the potential increase in trade and investment following the road's completion. However, concerns remain regarding land-use changes, potential displacement of communities, and long-term maintenance costs. A comprehensive evaluation of these factors will help determine the overall impact of this infrastructure development on local economic resilience and sustainability (Garcia & Cruz, 2023).

The actual situation in the region highlights the urgent need for improved road infrastructure. Many parts of N79 and Lim-Siocon Road remain underdeveloped, leading to inefficiencies in transportation and logistics. Poor road conditions contribute to higher vehicle maintenance costs, increased travel times, and safety hazards for commuters. Additionally, inadequate drainage systems exacerbate soil erosion and flooding during heavy rains, negatively affecting agricultural productivity and local biodiversity. By implementing sustainable concreting solutions, the region can address these challenges while promoting economic and environmental stability (Martinez & Ong, 2023).

One of the primary objectives of this study is to analyze the economic benefits of concreting N79 and Lim-Siocon Road. Improved road quality is expected to facilitate greater trade activities, enhance business operations, and boost employment opportunities. Increased accessibility to markets will enable local producers to expand their reach, fostering economic growth in rural communities. Understanding these economic implications will provide valuable insights for policymakers and stakeholders in planning future infrastructure projects (Lopez & Villanueva, 2022).

The second objective focuses on assessing the environmental benefits of road concreting. The project is expected to reduce soil erosion, mitigate air and water pollution, and contribute to biodiversity conservation. Sustainable drainage solutions incorporated into the road design will help regulate surface runoff and prevent further land degradation. Additionally, improved road surfaces can reduce dust pollution, benefiting both human health and local ecosystems. This assessment will provide critical data on how infrastructure improvements align with environmental sustainability goals (Reyes & Delgado, 2023).

The third objective is to evaluate the effectiveness of existing policies and regulations in ensuring sustainable road construction. By examining policy implementation, this study will identify challenges in compliance, monitoring, and enforcement of environmental and economic standards. Recommendations will be provided to enhance legal frameworks and promote best practices in infrastructure sustainability. Addressing policy gaps will be crucial in ensuring that future road projects balance economic growth with environmental conservation (Torres & Bautista, 2023).

LITERATURE REVIEW

The review of related literature explores the benefits of concreting National Route 79 (N79) and Lim-Siocon Road, particularly focusing on the environmental and economic impacts of road improvements. Concreting roads offers numerous advantages, particularly in enhancing infrastructure sustainability and fostering regional development. As infrastructure projects, such as the N79 and Lim-Siocon Road, improve road conditions, they reduce vehicle operating costs—fuel consumption and maintenance expenses—thereby enhancing business efficiency and commuter convenience (Fernandez & Lee, 2022). Moreover, these improvements significantly lower transportation costs, as better road conditions facilitate faster and more reliable movement of goods and services, directly benefiting businesses by enhancing supply chain efficiency (Lopez & Kim, 2022).

The economic benefits are further demonstrated by how better roads stimulate regional trade, create job opportunities, and improve market access for local producers. By enhancing road networks, businesses in previously underserved areas are better connected to urban markets, fostering the growth of trade and commerce. Research suggests that road improvements lead to increased business investments, particularly in agriculture, tourism, and retail sectors (Rodriguez & Santos, 2023). Small and medium-sized enterprises (SMEs) benefit significantly from these developments by expanding their reach and market access, thus contributing to regional economic resilience (Garcia & Patel, 2023). Additionally, improved road access reduces travel time, benefiting commuters and allowing businesses to operate more efficiently, thereby promoting economic growth (Lopez & Carter, 2022).

Job creation is another key benefit of road infrastructure projects. During the construction phase, both skilled and unskilled labor is employed, providing immediate economic relief to local communities (Kim & Gonzalez, 2021). Post-construction, road improvements continue to generate employment opportunities by facilitating growth in sectors such as logistics, retail, and tourism. Moreover, studies indicate that the long-term employment benefits are particularly notable in rural areas, where better roads help reduce the barriers to accessing formal job markets (Lopez & Wang, 2023). By improving labor force participation and creating new job opportunities, road concreting projects enhance the overall economic health of rural regions.

From an environmental perspective, the use of durable concrete in road construction has significant benefits. Concrete roads reduce the frequency of repairs, minimizing the extraction of raw materials and reducing overall construction-related carbon emissions (Garcia & Lopez, 2022). Furthermore, better-drained roads can help mitigate soil erosion and prevent flooding, protecting nearby ecosystems (Martinez & Carter, 2022). The environmental impact of improved roads extends beyond land conservation, as smoother surfaces lead to enhanced fuel efficiency, reducing vehicle emissions and contributing to better air quality (Chen & Torres, 2021). Road drainage systems integrated into concrete roads also improve water quality by controlling runoff and preventing sedimentation in water bodies (Huang & Patel, 2023).

Additionally, well-paved roads are linked to reduced transportation-related damages, leading to lower insurance and operational costs for logistics companies (Garcia & Patel, 2023). This is critical for the development of efficient transport networks that help businesses manage their supply chains more effectively. The efficiency of road networks also has broader social benefits, as improved transportation systems facilitate access to education, healthcare, and other essential services, thereby contributing to the overall quality of life in rural and urban areas alike (Garcia & Kim, 2023). Moreover, these infrastructural improvements support economic inclusivity by allowing more widespread participation in the national economy, particularly for rural populations previously cut off from larger markets (Lopez & Torres, 2022).

On a broader scale, the environmental benefits of concrete roads are not limited to transportation efficiency but also contribute to ecological preservation. Road projects that integrate wildlife corridors, buffer zones, and green infrastructure help preserve biodiversity and mitigate habitat fragmentation (Martinez & Lee, 2022). By designing roads to minimize disruption to natural habitats, infrastructure projects can coexist with conservation efforts, promoting both environmental and economic sustainability. Additionally, the durability of concrete roads contributes to long-term environmental stability by reducing the need for constant repairs, which can be resource-intensive and environmentally damaging (Garcia & Nguyen, 2023).

In terms of climate resilience, improved road surfaces lower carbon emissions by optimizing vehicle performance, particularly as smoother roads reduce vehicle fuel consumption and allow for more efficient transportation (Wang & Patel, 2023). Furthermore, these roads can support the adoption of greener transport solutions, such as electric vehicles, by providing more reliable and sustainable infrastructure for eco-friendly transportation (Lopez & Carter, 2022). Sustainable construction techniques, including the use of recycled materials, further reduce the environmental footprint of road projects, ensuring that infrastructure development aligns with climate goals.

Overall, the study highlights the significant role that improved infrastructure plays in both economic and environmental development. The concreting of National Route 79 (N79) and Lim-Siocon Road enhances not only regional connectivity and business growth but also contributes to environmental conservation by reducing pollution, improving water quality, and fostering sustainable land management. As road projects continue to evolve, integrating both economic and ecological considerations will be crucial for ensuring that infrastructure development supports long-term, sustainable growth. These findings align with previous research but offer localized insights into how road improvements can directly impact rural areas, highlighting the broader potential benefits of infrastructural investments in regional development (Garcia & Lopez, 2022).

MATERIALS AND METHODS

This study utilized a descriptive-correlational research design combined with regression analysis to evaluate the economic and environmental benefits of concreting National Route 79 (N79) and Lim-Siocon Road. The descriptive component aimed to provide an in-depth account of the effects of improved road infrastructure on factors such as transportation efficiency, economic accessibility, and environmental sustainability. The correlational aspect sought to establish relationships between these improvements and key outcomes, including trade growth, job creation, and reductions in logistics costs and environmental degradation. Regression analysis was employed to quantify the influence of road quality and transportation efficiency on economic variables, such as business expansion and trade flow, while also assessing the environmental benefits related to soil erosion reduction and biodiversity preservation.

The study was conducted in the region surrounding N79 and Lim-Siocon Road in the Philippines, which served as a vital transportation corridor linking agricultural, commercial, and industrial zones. This locale was particularly suited for analyzing the impact of road improvements on regional economic growth, given its diverse economic landscape and reliance on efficient infrastructure for market access. The research assessed the effects of the road concreting project on local businesses, logistics companies, and agricultural producers, focusing on evaluating changes in operational efficiency, trade accessibility, and environmental concerns such as soil erosion and pollution. The findings provided valuable insights into how infrastructure investments could support both economic development and environmental conservation in growing regions.

Stratified random sampling was used to select a diverse group of 150 respondents, ensuring proportional representation from key sectors, including business and logistics, agriculture, and environmental experts. This sampling method guaranteed a comprehensive analysis of how road improvements impacted various stakeholders. The data collection process involved structured questionnaires, semi-structured interviews, and document analysis, which provided both quantitative and qualitative insights into the benefits and challenges of the road development project. To ensure the validity and reliability of the findings, the study employed expert validation, pilot testing, and statistical techniques such as factor analysis and Cronbach's alpha to assess the accuracy and consistency of the research instruments.

RESULTS AND DISCUSSION

1. What is the demographic profile of respondents in terms of:
1.1 Sex;
1.2 Age;
1.3 Civil status; and
1.4 Education?

The demographic profile of the respondents provides valuable context to interpret the data on the environmental and economic benefits of the concreting of National Route 79 (N79) and Lim-Siocon Road. The gender distribution shows a predominance of female respondents (60%), reflecting the significant role women may play in the communities affected by infrastructure projects. This higher representation of women could indicate a greater involvement in household and community-based decision-making, where road improvements have a direct impact on daily life, especially in terms of safety, accessibility, and transportation convenience.

Table 1
Demographic Profile of the Respondents

Variable	Category	Frequency (n=150)	Percentage
Sex	Male	60	40.00%
	Female	90	60.00%
Age	18-21	-	-
	22-25	6	4.00%
	26-29	54	36.00%
	30 and above	90	60.00%
Civil Status	Single	54	36.00%
	Married	96	64.00%
Education	Elementary	-	-
	High school	6	4.00%
	College	78	52.00%
	Post Graduate	66	44.00%

The age distribution reveals that most respondents are mature individuals aged 30 and above (60%), followed by those aged 26-29 (36%) and a smaller portion in the 22-25 range (4%). This suggests that the individuals most affected by the infrastructural project are in their more stable years, likely having established careers, families, and long-term commitments. Older respondents may bring perspectives based on experience, such as concerns about family mobility, safety, and long-term economic opportunities, which are integral to assessing the broader societal impact of infrastructure projects. These mature individuals are likely to offer well-grounded insights into how improved road infrastructure influences their economic conditions and daily routines, particularly in rural and semi-urban areas where transportation issues may be more pronounced.

In terms of civil status, the data shows a higher percentage of married individuals (64%), implying that many respondents are invested in the long-term well-being of their families. This demographic is particularly relevant when evaluating how infrastructure projects influence household livelihoods, access to essential services, and long-term transportation safety. For married individuals, concerns regarding improved road safety, reduced travel time, and better access to health services and educational institutions are more pertinent. This group may also have a vested interest in job creation and economic development, seeing these changes as crucial for family stability and future opportunities.

Regarding educational attainment, the majority of respondents are college graduates (52%) or hold postgraduate degrees (44%), which suggests a highly informed and educated respondent pool. With such a well-educated demographic, the study benefits from perspectives that are both nuanced and critically informed. These individuals are likely to understand and articulate the long-term benefits and potential drawbacks of infrastructure projects. Their high level of education also enhances the credibility of the data, ensuring that the responses are based on informed perspectives. This demographic is likely to provide valuable feedback on how road improvements can affect both local economies and broader regional sustainability, particularly in areas such as business growth, education access, and environmental conservation.

Research on the impacts of road infrastructure improvements often highlights the importance of demographic factors in shaping the perceived benefits of such projects. Studies show that women, particularly in rural communities, tend to bear the brunt of transportation challenges, making them more likely to support and advocate for road improvements (Patel & Kim, 2022). The age profile of respondents in this study aligns with findings from similar research, indicating that older individuals, particularly those with established family responsibilities, are more invested in the long-term effects of infrastructure projects (Martinez & Lopez, 2023). These individuals often prioritize safety, accessibility, and sustainability, as road improvements directly impact their ability to support their families and engage in economic activities.

Furthermore, the high educational attainment of the respondents in this study mirrors findings from other studies that suggest higher education levels are correlated with greater awareness of the long-term benefits of infrastructure development (Singh & Patel, 2021). Educated respondents are more likely to critically evaluate the potential environmental and economic impacts of road projects, providing more informed feedback that can guide policy decisions. This demographic is also more likely to understand the interconnection between transportation efficiency, economic growth, and environmental sustainability (Chen & Zhang, 2023).

Overall, the demographic profile of the respondents enhances the study's credibility, ensuring that the data gathered reflect a well-rounded understanding of the impacts of road infrastructure projects. These insights will be useful for policymakers, urban planners, and environmental advocates in designing infrastructure projects that promote both economic development and environmental sustainability.

2. How do local stakeholders assess the impact of the concreting of N79 and Lim-Siocon Road in terms of:
2.1 Infrastructure Development and Road Quality;
2.2 Sustainable Drainage and Erosion Control Measures;
2.3 Transportation Efficiency and Reduced Travel Time; and
2.4 Economic Accessibility and Market Expansion?

Table 2 describes the impact of the concreting of National Route 79 (N79) and Lim-Siocon Road in terms of infrastructure development and road quality. The table shows an overall mean of 3.82 (SD = 0.29), interpreted as Highly Effective. This result means that respondents strongly agreed that the project has brought significant positive improvements to road quality, durability, safety, and connectivity. The implication is that concreting the road provided sustainable infrastructure that reduces maintenance costs and supports economic growth. As Garcia and Lopez (2022) highlight, high-quality road infrastructure improves vehicle efficiency, reduces frequent repairs, and ensures safer mobility—findings consistent with the perceptions of respondents.

Table 2
Impact of the concreting of N79 and Lim-Siocon Road in terms of Infrastructure Development and Road Quality

Item	Mean	SD	Description
The concreting of N79 and Lim-Siocon Road has significantly improved road quality.	3.96	0.20	Highly Effective
The new infrastructure supports the durability and longevity of the roadway.	3.72	0.45	Highly Effective
The road construction materials used meet high-quality standards.	3.56	0.50	Highly Effective
The new road infrastructure ensures better safety for motorists and pedestrians.	3.88	0.33	Highly Effective
The project has improved connectivity between urban and rural areas.	4.00	0.00	Highly Effective
Overall Mean	**3.82**	**0.29**	**Highly Effective**

Legend: 1.00-1.75= Ineffective; 1.76-2.50= Moderately Effective; 2.51-3.25= Effective; 3.26-4.00= Highly Effective

The statement with the highest mean of 4.00 (SD = 0.00) is “The project has improved connectivity between urban and rural areas”, which is rated as Highly Effective. This indicates unanimous agreement among respondents that the road concreting greatly enhanced accessibility and linkages. The implication is that improved connectivity promotes trade, reduces travel time, and encourages investments in local communities. This aligns with Rodriguez and Santos (2023), who emphasize that road infrastructure strengthens economic integration and supports rural development by connecting producers and consumers more effectively.

The statement with the lowest mean of 3.56 (SD = 0.50) is “The road construction materials used meet high-quality standards”, though still rated Highly Effective. While respondents acknowledged effectiveness, the relatively lower score may suggest some concerns about material consistency or visible construction quality. The implication is that while the road is functional and beneficial, sustainability and quality assurance should remain priorities to ensure long-term durability. According to Carvalho, Martins, and Antunes (2021), sustainable road infrastructure requires the integration of high-quality materials to balance economic benefits with environmental protection, stressing the importance of continuous monitoring and quality control in projects like this.

Table 3 describes the impact of the concreting of N79 and Lim-Siocon Road in terms of sustainable drainage and erosion control measures. The overall mean of 3.69 (SD = 0.48) is interpreted as Highly Effective. This shows that respondents agreed the project successfully integrated proper drainage and erosion control measures that support long-term road quality and environmental protection. The implication is that the infrastructure does not only improve transportation but also considers ecological sustainability. As Hernandez and Lee (2022) noted, sustainable drainage systems in road construction enhance stormwater management and prevent flooding, which makes infrastructure more resilient to climate impacts.

Table 3
Impact of the concreting of N79 and Lim-Siocon Road in terms of Sustainable Drainage and Erosion Control Measures

Item	Mean	SD	Description
The project includes well-planned drainage systems to prevent flooding.	3.68	0.47	Highly Effective
Erosion control measures have been effectively implemented along the road.	3.68	0.55	Highly Effective
The road design integrates environmentally friendly drainage solutions.	3.68	0.47	Highly Effective
The drainage system helps maintain road quality during extreme weather.	3.64	0.48	Highly Effective
The project minimizes environmental degradation in surrounding areas.	3.76	0.43	Highly Effective
Overall Mean	3.69	0.48	Highly Effective

Legend: 1.00-1.75= Ineffective; 1.76-2.50= Moderately Effective; 2.51-3.25= Effective; 3.26-4.00= Highly Effective

The statement with the highest mean of 3.76 (SD = 0.43) is “The project minimizes environmental degradation in surrounding areas”, described as Highly Effective. This indicates that respondents strongly recognized the project’s role in reducing soil erosion and protecting nearby ecosystems. The implication is that by preventing land degradation, the road concreting contributes to agricultural stability and environmental conservation. Martinez and Carter (2022) emphasized that paved roads play a critical role in mitigating soil erosion and preserving soil structure, which supports both ecological balance and long-term productivity of adjacent lands.

The statement with the lowest mean of 3.64 (SD = 0.48) is “The drainage system helps maintain road quality during extreme weather”, though still rated Highly Effective. This suggests that while drainage systems were effective, some respondents may still have concerns about how well they perform under very heavy rainfall or severe weather conditions. The implication is that continuous monitoring and upgrading of drainage infrastructure are essential for climate resilience. According to Huang and Patel (2023), urban drainage systems face challenges under extreme weather, and innovative designs are needed to ensure durability and prevent road damage during floods.

Table 4 describes the impact of the concreting of N79 and Lim-Siocon Road in terms of transportation efficiency and reduced travel time. The overall mean of 3.98 (SD = 0.12) is interpreted as Highly Effective. This indicates that respondents strongly agreed that the project has significantly improved travel time, public transport efficiency, vehicle operating costs, and traffic flow. The implication is that the concreting project plays a vital role in enhancing mobility and transportation services in the area. As Lopez and Carter (2022) noted, concrete roads reduce travel delays, improve regional connectivity, and contribute to sustainable mobility by ensuring smoother traffic flow and reduced commuting time.

Table 4
Impact of the concreting of N79 and Lim-Siocon Road in terms of Transportation Efficiency and Reduced Travel Time

Item	Mean	SD	Description
The concreting of N79 and Lim-Siocon Road has reduced travel time.	4.00	0.00	Highly Effective
The road improvements have enhanced public transport efficiency.	4.00	0.00	Highly Effective
The project has led to faster and safer travel for commuters.	3.96	0.20	Highly Effective
The road improvements contribute to reduced vehicle operating costs.	3.96	0.20	Highly Effective
The project has minimized traffic congestion in the area.	3.96	0.20	Highly Effective
Overall Mean	3.98	0.12	Highly Effective

Legend: 1.00-1.75= Ineffective; 1.76-2.50= Moderately Effective; 2.51-3.25= Effective; 3.26-4.00= Highly Effective

The statements with the highest mean of 4.00 (SD = 0.00) are "The concreting of N79 and Lim-Siocon Road has reduced travel time" and "The road improvements have enhanced public transport efficiency", both described as Highly Effective. This suggests unanimous agreement among respondents that the project made transportation faster and improved the efficiency of public transport systems. The implication is that shorter travel time allows workers, students, and businesses to function more productively, while better public transport strengthens accessibility for more people. Garcia and Patel (2023) stressed that improved road infrastructure enhances transportation efficiency, reduces delays, and boosts economic activities, showing that infrastructure upgrades directly contribute to growth and productivity.

The statements with the lowest mean of 3.96 (SD = 0.20) include "The project has led to faster and safer travel for commuters", "The road improvements contribute to reduced vehicle operating costs", and "The project has minimized traffic congestion in the area". Even though these are the lowest, they are still rated Highly Effective, meaning respondents consistently recognized their positive impact. The implication is that while road improvements reduce costs and congestion, there may still be minor challenges in sustaining these benefits over time, such as increased vehicle numbers or higher demand for road usage. According to Lopez and Kim (2022), improved infrastructure reduces transportation costs and congestion, but continuous planning and traffic management are necessary to maintain efficiency in the long run.

Table 5 describes the impact of the concreting of N79 and Lim-Siocon Road in terms of economic accessibility and market expansion. The overall mean of 3.94 (SD = 0.15) is interpreted as Highly Effective. This indicates that respondents strongly agreed that the road improvement boosted economic activity, increased business opportunities, and enhanced market accessibility in the area. The implication is that infrastructure development does not only improve mobility but also stimulates local and regional economies. As Garcia and Kim (2023) emphasized, well-constructed roads improve connectivity between rural and urban markets, fostering entrepreneurship, trade expansion, and economic inclusivity.

Table 5
Impact of the concreting of N79 and Lim-Siocon Road in terms of Economic Accessibility and Market Expansion

Item	Mean	SD	Description
The road improvement has boosted economic activity in the area.	4.00	0.00	Highly Effective
Businesses have experienced increased customer access due to better roads.	4.00	0.00	Highly Effective
The project has attracted new investments in the region.	3.80	0.40	Highly Effective
The road expansion has improved the distribution of goods and services.	4.00	0.00	Highly Effective
The new road has led to more employment opportunities.	3.88	0.33	Highly Effective
Overall Mean	3.94	0.15	Highly Effective

Legend: 1.00-1.75= Ineffective; 1.76-2.50= Moderately Effective; 2.51-3.25= Effective; 3.26-4.00= Highly Effective

The statements with the highest mean of 4.00 (SD = 0.00) are "The road improvement has boosted economic activity in the area", "Businesses have experienced increased customer access due to better roads", and "The road expansion has improved the distribution of goods and services", all described as Highly Effective. This shows unanimous agreement that the road concreting project has directly benefited local businesses by reducing logistical barriers and increasing consumer access. The implication is that roads act as catalysts for regional market expansion, improving trade efficiency and competitiveness. Rodriguez and Santos (2023) noted that enhanced road infrastructure stimulates commercial growth and investment by creating stronger economic linkages between urban and rural areas.

The statement with the lowest mean of 3.80 (SD = 0.40) is "The project has attracted new investments in the region", though still rated Highly Effective. While respondents agreed that investments have improved, the slightly lower score may reflect that attracting large-scale or long-term investors requires more time and additional supporting policies. The implication is that while infrastructure is a strong foundation for development, consistent promotion and supportive business environments are needed to sustain investor confidence. Chen and Zhang (2023) pointed out that infrastructure investment positively impacts growth, but complementary economic policies and governance frameworks are necessary to maximize its long-term effects.

3. How do local stakeholders evaluate the economic benefits of the concreting of N79 and Lim-Siocon Road in terms of:

3.1 Increase in trade and business growth;
3.2 Job creation and employment opportunities;
3.3 Reduction in transportation and logistics costs; and
3.4 Improved market access for local producers?

Table 6 describes the economic benefits of the concreting of N79 and Lim-Siocon Road in terms of increase in trade and business growth. The overall mean of 3.86 (SD = 0.32) is interpreted as Very High Benefit. This indicates that respondents strongly agreed that the project contributed to the growth of local businesses, improved accessibility, and facilitated trade activities. The implication is that the concreting project not only improved mobility but also served as a driver for regional economic expansion. As Fernandez and Lee (2022) pointed out, improved road infrastructure enhances trade efficiency and fosters business growth by reducing bottlenecks and expanding access to markets.

Table 6
Economic benefits of the concreting of N79 and Lim-Siocon Road in terms of an Increase in trade and business growth

Item	Mean	SD	Description
The road improvement has led to an increase in local business activities.	3.84	0.37	Very High Benefit
The newly concreted road has attracted more investors to the area.	3.72	0.45	Very High Benefit
Local businesses have expanded due to improved road accessibility.	3.96	0.20	Very High Benefit
The road has facilitated easier transportation of goods, boosting trade.	3.96	0.20	Very High Benefit
Commercial establishments have increased along the improved road.	3.84	0.37	Very High Benefit
Overall Mean	3.86	0.32	Very High Benefit

Legend: 1.00-1.75= Low Benefit; 1.76-2.50=Moderate Benefit; 2.51-3.25= High Benefit; 3.26-4.00= Very High Benefit

The statements with the highest mean of 3.96 (SD = 0.20) are "Local businesses have expanded due to improved road accessibility" and "The road has facilitated easier transportation of goods, boosting trade", both rated as Very High Benefit. This highlights that the most immediate effect of the project was on the growth of small and local businesses, which benefited from improved market access and reduced transportation challenges. The implication is that reliable road infrastructure enables micro, small, and medium enterprises (MSMEs) to thrive, supporting inclusive economic development. Torres and Kim (2022) emphasized that road improvements enhance agricultural and business productivity by reducing costs and improving the efficiency of goods distribution.

The statement with the lowest mean of 3.72 (SD = 0.45) is "The newly concreted road has attracted more investors to the area", still interpreted as Very High Benefit. While respondents acknowledged the role of the road in drawing investments, the slightly lower score suggests that full-scale investor confidence may take more time and requires complementary policies to maximize opportunities. The implication is that while infrastructure is a foundation for growth, government and community initiatives must also encourage and sustain investor participation. Chen and Zhang (2023) observed that infrastructure projects positively influence long-term economic growth, but their success in attracting investments depends on supportive policies and business-friendly environments.

Table 7 describes the economic benefits of the concreting of N79 and Lim-Siocon Road in terms of job creation and employment opportunities. The overall mean of 3.84 (SD = 0.35) is interpreted as Very High Benefit. This means respondents strongly agreed that the project created more jobs both directly in construction and indirectly through business growth and mobility improvements. The implication is that road infrastructure projects not only enhance transportation but also play a key role in generating sustainable employment opportunities for communities. As Kim and Gonzalez (2021) noted, infrastructure investments produce both immediate construction jobs and long-term employment in logistics, trade, and tourism.

Table 7
Economic benefits of the concreting of N79 and Lim-Siocon Road in terms of Job creation and employment opportunities

Item	Mean	SD	Description
The road improvement has generated job opportunities in the construction sector.	3.88	0.33	Very High Benefit
More employment opportunities have emerged due to increased business activities.	3.72	0.45	Very High Benefit
The improved road has encouraged the establishment of new businesses, creating jobs.	3.76	0.43	Very High Benefit
Local residents have better access to employment opportunities outside their communities.	3.92	0.27	Very High Benefit
The improved road has enhanced job mobility and workforce productivity.	3.92	0.27	Very High Benefit
Overall Mean	3.84	0.35	Very High Benefit

Legend: 1.00-1.75= Low Benefit; 1.76-2.50=Moderate Benefit; 2.51-3.25= High Benefit; 3.26-4.00= Very High Benefit

The statements with the highest mean of 3.92 (SD = 0.27) are “Local residents have better access to employment opportunities outside their communities” and “The improved road has enhanced job mobility and workforce productivity”, both described as Very High Benefit. This indicates that the greatest impact of the road concreting project lies in enabling residents to reach wider job markets and improving productivity by reducing travel barriers. The implication is that road projects expand labor force participation and enhance community livelihoods. Lopez and Wang (2023) emphasized that better mobility allows more people to access job opportunities, strengthening inclusive economic growth in rural and peri-urban areas.

The statement with the lowest mean of 3.72 (SD = 0.45) is “More employment opportunities have emerged due to increased business activities”, though still rated as Very High Benefit. This suggests that while the project has supported business-driven job creation, respondents may feel that the expansion of business employment is still gradual compared to direct construction and mobility-related benefits. The implication is that although roads facilitate trade and enterprise, business-driven employment growth may take longer to fully materialize. Garcia and Patel (2023) noted that while road improvements enhance supply chain efficiency and business competitiveness, the ripple effect on job creation often develops over time as markets expand and stabilize.

Table 8 describes the economic benefits of the concreting of N79 and Lim-Siocon Road in terms of reduction in transportation and logistics costs. The overall mean of 3.94 (SD = 0.23) is interpreted as Very High Benefit. This shows that respondents strongly agreed that the road improvements significantly reduced costs related to transportation, logistics, and supply chain operations. The implication is that smoother and more durable roads make mobility more efficient, reducing operational expenses for both businesses and commuters. According to Lopez and Kim (2022), well-constructed road infrastructure lowers transportation costs by reducing travel delays, fuel consumption, and inefficiencies in logistics operations.

Table 8
Economic benefits of the concreting of N79 and Lim-Siocon Road in terms of Reduction in transportation and logistics costs

Item	Mean	SD	Description
The road improvement has reduced fuel consumption for transport vehicles.	3.92	0.27	Very High Benefit
Logistics and delivery costs have decreased due to smoother roads.	3.92	0.27	Very High Benefit
The improved road has minimized vehicle maintenance and repair costs.	3.96	0.20	Very High Benefit
Businesses now experience faster and more cost-effective supply chain operations.	3.96	0.20	Very High Benefit
The transportation of goods and services has become more efficient.	3.96	0.20	Very High Benefit
Overall Mean	3.94	0.23	Very High Benefit

Legend: 1.00-1.75= Low Benefit; 1.76-2.50=Moderate Benefit; 2.51-3.25= High Benefit; 3.26-4.00= Very High Benefit

The statements with the highest mean of 3.96 (SD = 0.20) are “The improved road has minimized vehicle maintenance and repair costs”, “Businesses now experience faster and more cost-effective supply chain operations”, and “The transportation of goods and services has become more efficient”, all rated as Very High Benefit. This indicates that respondents viewed the most important benefit of road concreting as the reduced wear and tear on vehicles, improved efficiency in moving goods, and faster business operations. The implication is that lower repair and delivery costs directly contribute to profitability and competitiveness. Garcia and Patel (2023) supported this, noting that sustainable roads enhance supply chain performance and lower freight costs, which helps businesses maximize trade opportunities.

The statements with the lowest mean of 3.92 (SD = 0.27) are “The road improvement has reduced fuel consumption for transport vehicles” and “Logistics and delivery costs have decreased due to smoother roads”, though still rated as Very High Benefit. This suggests that while the reduction in fuel and delivery costs is widely acknowledged, these benefits may be slightly less visible compared to the savings from reduced maintenance and supply chain efficiency. The implication is that while fuel efficiency is an important outcome, businesses feel stronger impacts from reduced mechanical costs and faster operations. Lopez and Carter (2022) emphasized that smoother roads improve fuel efficiency and reduce congestion, but their most significant long-term value lies in lowering total logistics costs.

Table 9 describes the economic benefits of the concreting of N79 and Lim-Siocon Road in terms of improved market access for local producers. The overall mean of 3.98 (SD = 0.08) is interpreted as Very High Benefit. This indicates that respondents strongly agreed the road project enhanced the ability of farmers and small-scale producers to access markets and distribute their products efficiently. The implication is that infrastructure development plays a critical role in strengthening agricultural trade and rural entrepreneurship. Torres and Kim (2022) noted that improved road access reduces transportation costs, minimizes post-harvest losses, and boosts productivity, especially for perishable goods.

The statements with the highest mean of 4.00 (SD = 0.00) are “Local farmers and producers now have better access to major markets”, “The road has improved the efficiency of transporting perishable goods”, and “Producers now experience faster and more reliable distribution of their products”, all rated as Very High Benefit. This shows unanimous agreement that the most significant contribution of the project was providing reliable, cost-effective, and efficient transport for producers. The implication is that farmers and producers are now better integrated into the supply chain, reaching larger markets and ensuring product freshness. Garcia and Patel (2023) emphasized that better logistics through road concreting directly strengthens agricultural competitiveness and improves rural incomes

Table 9
Economic benefits of the concreting of N79 and Lim-Siocon Road in terms of Improved market access for local producers

Item	Mean	SD	Description
Local farmers and producers now have better access to major markets.	4.00	0.00	Very High Benefit
The road has improved the efficiency of transporting perishable goods.	4.00	0.00	Very High Benefit
Producers now experience faster and more reliable distribution of their products.	4.00	0.00	Very High Benefit
The road improvement has expanded trade opportunities for local businesses.	3.96	0.20	Very High Benefit
Farmers and small-scale entrepreneurs now reach a wider customer base.	3.96	0.20	Very High Benefit
Overall Mean	3.98	0.08	Very High Benefit

Legend: 1.00-1.75= Low Benefit; 1.76-2.50=Moderate Benefit; 2.51-3.25= High Benefit; 3.26-4.00= Very High Benefit

The statements with the lowest mean of 3.96 (SD = 0.20) are “The road improvement has expanded trade opportunities for local businesses” and “Farmers and small-scale entrepreneurs now reach a wider customer base,” although they are still rated Very High Benefit. This suggests that while trade expansion and broader customer reach have improved, these benefits are still in progress and may continue to grow over time. The implication is that sustained business development and market linkages are required to maximize the potential of the new road. Rodriguez and Santos (2023) highlighted that road improvements create economic linkages between rural and urban markets, but the full benefits often unfold gradually as businesses adjust and markets expand.

4. How do local stakeholders assess the environmental benefits of road concreting in terms of:
4.1 Reduction in soil erosion and land degradation;
4.2 Decreased air and water pollution from improved road surfaces;
4.3 Preservation of natural habitats and biodiversity; and
4.4 Lower carbon footprint due to efficient transportation?

Table 10 describes the environmental benefits of the concreting of N79 and Lim-Siocon Road in terms of reduction in soil erosion and land degradation. The overall mean of 3.60 (SD = 0.40) is interpreted as Very Good Impact. This indicates that respondents agreed the project was effective in minimizing soil erosion, reducing dust, stabilizing slopes, and preventing land degradation. The implication is that the concreting project not only improved transportation but also provided environmental protection, particularly in areas prone to erosion and landslides. Martinez and Carter (2022) noted that paved roads significantly help mitigate soil erosion by stabilizing surfaces and reducing sedimentation in waterways, which aligns with these findings.

The statement with the highest mean of 4.00 (SD = 0.00) is “The project has helped stabilize slopes and prevent landslides”, described as Very Good Impact. This shows that respondents unanimously recognized the project’s strongest environmental contribution was in stabilizing terrain and ensuring slope protection. The implication is that the project enhanced community safety by reducing the risk of landslides, especially in areas exposed to heavy rains. Huang and Patel (2023) emphasized that slope stabilization and modern drainage systems are crucial in preventing land degradation and ensuring long-term road durability, which validates the positive impact perceived by respondents.

Table 10
Environmental benefits of the concreting of N79 and Lim-Siocon Road in terms of Reduction in soil erosion and land degradation

Item	Mean	SD	Description
The road improvement has helped control soil erosion along the route.	3.48	0.50	Very Good Impact
The use of proper drainage systems has minimized land degradation.	3.56	0.50	Very Good Impact
The project has helped stabilize slopes and prevent landslides.	4.00	0.00	Very Good Impact
Vegetative cover and erosion control measures have been effectively implemented.	3.48	0.50	Very Good Impact
The concreting of the road has reduced dust-related soil erosion.	3.48	0.50	Very Good Impact
Overall Mean	3.60	0.40	Very Good Impact

Legend: 1.00-1.75= Poor Impact; 1.76-2.50= Moderate Impact; 2.51-3.25= Good Impact; 3.26-4.00= Very Good Impact

The statement with the highest mean of 4.00 (SD = 0.00) is “The project has helped stabilize slopes and prevent landslides”, described as Very Good Impact. This shows that respondents unanimously recognized the project’s strongest environmental contribution was in stabilizing terrain and ensuring slope protection. The implication is that the project enhanced community safety by reducing the risk of landslides, especially in areas exposed to heavy rains. Huang and Patel (2023) emphasized that slope stabilization and modern drainage systems are crucial in preventing land degradation and ensuring long-term road durability, which validates the positive impact perceived by respondents.

The statements with the lowest mean of 3.48 (SD = 0.50) are “The road improvement has helped control soil erosion along the route”, “Vegetative cover and erosion control measures have been effectively implemented”, and “The concreting of the road has reduced dust-related soil erosion”. While still rated as Very Good Impact, these lower ratings suggest that respondents may have observed that erosion control measures were present but not fully optimized or consistent throughout the entire stretch of the road. The implication is that while erosion and dust issues have been reduced, continued maintenance and additional vegetation or green engineering solutions may be necessary to maximize environmental protection. Chen and Torres (2021) highlighted that while concreting roads reduces dust and erosion, supplementary eco-friendly strategies such as vegetative buffers are essential for lasting environmental benefits.

Table 11
Environmental benefits of the concreting of N79 and Lim-Siocon Road in terms of Decreased air and water pollution from improved road surfaces

Item	Mean	SD	Description
The road concreting has reduced dust pollution, improving air quality.	3.92	0.27	Very Good Impact
Paved surfaces have minimized mud and dirt accumulation on roads.	3.92	0.27	Very Good Impact
The project has helped lower vehicle emissions due to smoother roads.	3.88	0.33	Very Good Impact
Proper drainage systems have reduced water pollution from road runoff.	3.88	0.33	Very Good Impact
The improved road has decreased standing water, reducing mosquito breeding grounds.	3.88	0.33	Very Good Impact
Overall Mean	3.90	0.30	Very Good Impact

Legend: 1.00-1.75= Poor Impact; 1.76-2.50= Moderate Impact; 2.51-3.25= Good Impact; 3.26-4.00= Very Good Impact

Table 11 describes the environmental benefits of the concreting of N79 and Lim-Siocon Road in terms of decreased air and water pollution from improved road surfaces. The overall mean of 3.90 (SD = 0.30) is interpreted as Very Good Impact. This shows that respondents agreed the project successfully reduced dust, mud, water runoff, and pollution, while also improving air quality and public health. The implication is that paved and well-drained road surfaces contribute not only to mobility but also to environmental protection and community well-being. Chen and Torres (2021) emphasized that paved roads reduce dust particles and improve air quality, lowering health risks in nearby communities.

The statements with the highest mean of 3.92 (SD = 0.27) are "The road concreting has reduced dust pollution, improving air quality" and "Paved surfaces have minimized mud and dirt accumulation on roads", both described as Very Good Impact. This indicates that the most visible improvements of the project were cleaner and safer road conditions with reduced dust and dirt. The implication is that the project has direct positive effects on residents' health and environmental cleanliness. Wang and Kim (2023) highlighted that road concreting prevents loose soil erosion and waterborne pollutants from entering streams, thus protecting both air and water quality.

The statements with the lowest mean of 3.88 (SD = 0.33) include "The project has helped lower vehicle emissions due to smoother roads", "Proper drainage systems have reduced water pollution from road runoff", and "The improved road has decreased standing water, reducing mosquito breeding grounds". Though still rated as Very Good Impact, these slightly lower scores suggest that while respondents recognized these benefits, their impacts may be less directly visible compared to dust reduction. The implication is that the long-term sustainability of these benefits will depend on proper road maintenance and effective drainage management. Lopez and Wang (2023) stressed that sustainable infrastructure plays a key role in reducing emissions and maintaining healthy ecosystems, but continuous investment is required to sustain these impacts.

Table 12 describes the environmental benefits of the concreting of N79 and Lim-Siocon Road in terms of the preservation of natural habitats and biodiversity. The overall mean of 3.68 (SD = 0.46) is interpreted as Very Good Impact. This indicates that respondents agreed the project contributed positively to environmental sustainability by reducing deforestation, protecting ecosystems, and considering wildlife in road design. The implication is that road development can be environmentally sensitive when complemented by sustainable planning measures. Martinez and Lee (2022) stressed that integrating wildlife crossings and conservation measures in infrastructure projects reduces habitat disruption and supports biodiversity conservation.

Table 12
Environmental benefits of the concreting of N79 and Lim-Siocon Road in terms of Preservation of natural habitats and biodiversity

Item	Mean	SD	Description
The project has minimized deforestation and land clearing in surrounding areas.	3.76	0.43	Very Good Impact
Road design has considered wildlife corridors and safe crossings.	3.68	0.47	Very Good Impact
The construction project has preserved nearby water bodies and ecosystems.	3.68	0.47	Very Good Impact
The project has avoided disrupting natural habitats and wildlife populations.	3.68	0.47	Very Good Impact
Reforestation and vegetation restoration efforts have been part of the project.	3.60	0.49	Very Good Impact
Overall Mean	3.68	0.46	Very Good Impact

Legend: 1.00-1.75= Poor Impact; 1.76-2.50= Moderate Impact; 2.51-3.25= Good Impact; 3.26-4.00= Very Good Impact

The statement with the highest mean of 3.76 (SD = 0.43) is "The project has minimized deforestation and land clearing in surrounding areas", rated as Very Good Impact. This suggests that respondents saw reduced environmental damage in terms of forest clearing compared to typical construction projects. The implication is that infrastructure development can coexist with environmental conservation when careful land management is applied. Garcia and Nguyen (2023) emphasized that responsible planning in road projects helps control deforestation and strengthens ecosystem resilience.

The statement with the lowest mean of 3.60 (SD = 0.49) is "Reforestation and vegetation restoration efforts have been part of the project", though still rated as Very Good Impact. This shows that while vegetation initiatives were recognized, respondents perceived them as less strongly implemented compared to other aspects. The implication is that while reforestation adds value, it may need more extensive or visible application to maximize ecological benefits. Chen, Wu, and Zhao (2023) pointed out that reforestation and restoration are essential in balancing development with environmental protection, ensuring long-term ecological sustainability.

Table 13 describes the environmental benefits of the concreting of N79 and Lim-Siocon Road in terms of lowering carbon footprint due to efficient transportation. The overall mean of 3.81 (SD = 0.37) is interpreted as Very Good Impact. This indicates that respondents agreed the project significantly reduced traffic congestion, improved fuel efficiency, and encouraged more sustainable transport practices. The implication is that road concreting not only enhanced mobility but also supported environmental sustainability by lowering greenhouse gas emissions. Lopez and Carter (2022) highlighted that efficient, well-paved roads minimize congestion and idling, thus reducing carbon emissions and promoting sustainable mobility.

Table 13
Environmental benefits of the concreting of N79 and Lim-Siocon Road in terms of Lower carbon footprint due to efficient transportation

Item	Mean	SD	Description
The improved road has reduced traffic congestion, leading to lower fuel consumption.	3.88	0.33	Very Good Impact
The project has facilitated the use of energy-efficient public transportation.	3.88	0.33	Very Good Impact
Smoother roads have led to improved vehicle fuel efficiency.	3.76	0.43	Very Good Impact
The road has helped reduce unnecessary detours and long travel routes.	3.92	0.27	Very Good Impact
The project has contributed to the promotion of eco-friendly transport options.	3.60	0.49	Very Good Impact
Overall Mean	3.81	0.37	Very Good Impact

Legend: 1.00-1.75= Poor Impact; 1.76-2.50= Moderate Impact; 2.51-3.25= Good Impact; 3.26-4.00= Very Good Impact

The statement with the highest mean of 3.92 (SD = 0.27) is "The road has helped reduce unnecessary detours and long travel routes", rated as Very Good Impact. This shows that respondents recognized shorter, more direct routes as the most significant contribution of the project to environmental sustainability. The implication is that by eliminating detours, the project saves fuel, lowers emissions, and improves travel efficiency. Wang and Patel (2023) supported this, noting that efficient road networks directly contribute to reducing carbon footprints by optimizing transportation systems.

The statement with the lowest mean of 3.60 (SD = 0.49) is "The project has contributed to the promotion of eco-friendly transport options", though still rated Very Good Impact. This suggests that while respondents saw potential for eco-friendly transport (e.g., bicycles, energy-efficient vehicles), the benefit is less visible compared to immediate fuel savings and reduced congestion. The implication is that while infrastructure provides a foundation for green transport, additional policies and incentives are needed to encourage widespread adoption. Lopez and Torres (2022) emphasized that infrastructure improvements create opportunities for sustainable transport, but complementary initiatives such as public awareness and investment in eco-friendly systems are necessary to maximize their impact.

5. Is there a significant difference in how respondents evaluate the economic and environmental benefits of road concreting when grouped according to their demographic profile?

Economic Benefits

Table 14 illustrates the test of significant difference in how respondents evaluate the economic benefits of road concreting when grouped according to sex. Both male and female respondents reported the same mean score of 3.91. However, the test statistic yielded a p-value of 0.000, which is less than the alpha level of 0.05. Because the p-value is below the threshold, the null hypothesis (Ho1) was rejected. This means that there is a statistically significant difference in how respondents evaluate the economic benefits of road concreting when grouped by sex.

Table 14
Test of the significant difference in how respondents evaluate the economic benefits of Road Concreting when grouped according to sex

Category	Mean	Test statistic	p-value	Decision	Interpretation
Male	3.91	16.658	0.000	Reject Ho1	Significant
Female	3.91				

Although the mean values appear equal, the test result indicates a difference in how male and female respondents perceive the benefits at a deeper statistical level. This suggests that gender plays a role in how economic impacts are understood or prioritized. For instance, men may focus on business growth and logistics, while women may value accessibility and household-level benefits. The implication is that infrastructure projects like the concreting of N79 and Lim-Siocon Road should consider gender-sensitive planning to address the unique concerns of different stakeholder groups. As noted by Fernandez and Lee (2022), improved infrastructure fosters trade diversification and resilience, but the perception of benefits may vary across social groups, reinforcing the need for inclusive development strategies

Table 15 illustrates the test of significant difference in how respondents evaluate the economic benefits of road concreting when grouped according to age. The results show that respondents aged 22–25 had a mean of 3.75, those aged 26–29 had 3.90, and those aged 30 and above had 3.92. The p-value is 0.000, which is less than the alpha level of 0.05, leading to the rejection of the null hypothesis. This means there is a statistically significant difference in perceptions across age groups.

Table 15
Test of the significant difference in how respondents evaluate the economic benefits of Road Concreting when grouped according to age

Category	Mean	Test statistic	p-value	Decision	Interpretation
22-25	3.75	13.843	0.000	Reject Ho1	Significant
26-29	3.90				
30 and above	3.92				

The implication is that older respondents (30 and above) tend to recognize more strongly the economic benefits of road concreting compared to younger respondents, perhaps due to their direct involvement in business, employment, or family responsibilities. Rodriguez and Santos (2023) explained that road infrastructure enhances economic integration and market access, but its perceived benefits can vary depending on age-related experiences with mobility and livelihood opportunities.

Table 16 illustrates the test of significant difference in how respondents evaluate the economic benefits of road concreting when grouped according to civil status. Single respondents had a mean of 3.94, while married respondents had 3.89. The p-value is 0.284, which is greater than the alpha level of 0.05, so the null hypothesis was not rejected. This means there is no significant difference between single and married respondents.

Table 16
Test of the significant difference in how respondents evaluate the economic benefits of Road concreting when grouped according to civil status

Category	Mean	Test statistic	p-value	Decision	Interpretation
Single	3.94	1.157	0.284	Do not reject Ho1	Not Significant
Married	3.89				

The implication is that both groups share a similar perception of the road concreting project's economic benefits, showing that civil status does not strongly influence how individuals evaluate infrastructure improvements. As Garcia and Kim (2023) emphasized, improved road accessibility benefits both households and businesses alike, suggesting that the advantages are widely felt regardless of personal or family circumstances.

Table 17 illustrates the test of significant difference in how respondents evaluate the economic benefits of road concreting when grouped according to education. Respondents with high school education had a mean of 3.90, those with college education had 3.93, and postgraduates had 3.89. The p-value is 0.017, which is less than the alpha level of 0.05, so the null hypothesis was rejected. This means there is a statistically significant difference in perceptions when grouped according to education.

Table 17
Test of the significant difference in how respondents evaluate the economic benefits of Road Concreting when grouped according to education

Category	Mean	Test statistic	p-value	Decision	Interpretation
High school	3.90	4.180	0.017	Reject Ho1	Significant
College	3.93				
Post Graduate	3.89				

The implication is that educational background affects how people assess infrastructure projects, with college-educated respondents rating the benefits slightly higher. This suggests that higher educational attainment may be linked to greater awareness of the economic value of infrastructure development. Chen and Lee (2023) highlighted that infrastructure quality is closely tied to economic growth and development, and individuals with higher education may better understand these connections.

Environmental Benefits

Table 18 illustrates the test of significant difference in how respondents evaluate the environmental benefits of road concreting when grouped according to sex. Male respondents had a mean of 3.74, while female respondents had a mean of 3.75. The p-value is 0.027, which is less than the alpha level of 0.05. Therefore, the null hypothesis was rejected, and the result is significant. This means that there is a difference between male and female respondents in evaluating environmental benefits.

Table 18
Test of the significant difference in how respondents evaluate the environmental benefits of Road Concreting when grouped according to sex

Category	Mean	Test statistic	p-value	Decision	Interpretation
Male	3.74	5.013	0.027	Reject Ho1	Significant
Female	3.75				

The implication is that perceptions of environmental impact may differ by gender, possibly because men and women prioritize different aspects of environmental quality. Chen and Torres (2021) explained that road concreting reduces dust and improves air quality, but gender-based perceptions of such benefits may vary depending on roles in the household or community.

Table 29 illustrates the test of significant difference in how respondents evaluate the environmental benefits of road concreting when grouped according to age. Respondents aged 22–25 had a mean of 3.90, those aged 26–29 had 3.73, and those aged 30 and above had 3.74. The p-value is 0.000, which is less than 0.05. Thus, the null hypothesis was rejected, showing a significant difference among age groups.

Table 19
Test of the significant difference in how respondents evaluate the environmental benefits of Road Concreting when grouped according to age

Category	Mean	Test statistic	p-value	Decision	Interpretation
22-25	3.90	12.867	0.000	Reject Ho1	Significant
26-29	3.73				
30 and above	3.74				

This suggests that younger respondents (22–25) perceive stronger environmental benefits than older groups, possibly due to higher awareness of issues like air pollution and sustainability. Martinez and Lee (2022) highlighted that younger generations tend to be more environmentally conscious, which could explain why they rated the benefits higher.

Table 20 illustrates the test of significant difference in how respondents evaluate the environmental benefits of road concreting when grouped according to civil status. Single respondents had a mean of 3.81, while married respondents had 3.71. The p-value is 0.000, which is below 0.05. Hence, the null hypothesis was rejected, indicating a significant difference. This shows that single respondents viewed environmental benefits more positively than married respondents.

Table 20
Test of the significant difference in how respondents evaluate the environmental benefits of Road Concreting when grouped according to civil status

Category	Mean	Test statistic	p-value	Decision	Interpretation
Single	3.81	34.677	0.000	Reject Ho1	Significant
Married	3.71				

The implication is that family responsibilities might influence married individuals to prioritize economic and practical benefits over environmental aspects. Garcia and Nguyen (2023) noted that biodiversity and environmental preservation are valued differently depending on community priorities, which may explain the divergence in perceptions.

Table 21 illustrates the test of significant difference in how respondents evaluate the environmental benefits of road concreting when grouped according to education. High school graduates had a mean of 3.80, college respondents 3.75, and postgraduates 3.73. The p-value is 0.073, which is greater than 0.05. Therefore, the null hypothesis was not rejected, and the result is not significant. This indicates that educational attainment does not substantially affect how respondents view the environmental benefits of the road concreting project.

Table 21
Test of the significant difference in how respondents evaluate the environmental benefits of Road Concreting when grouped according to education

Category	Mean	Test statistic	p-value	Decision	Interpretation
High school	3.80	2.662	0.073	Do not reject Ho1	Not Significant
College	3.75				
Post Graduate	3.73				

The implication is that environmental improvements such as cleaner air, reduced dust, and better drainage are visible and equally appreciated across all education levels. As Liu, Wang, and Zhao (2022) emphasized, sustainable road development creates benefits that are universally experienced, regardless of academic background.

6. Is there a significant relationship between road concreting (infrastructure development, drainage and erosion control, transportation efficiency, and market expansion) and its economic and environmental benefits?

Table 22 shows the test of significant relationship between road concreting and its economic benefits. The results indicate that infrastructure development and road quality has an r-value of .176 with a p-value of 0.031, which is less than 0.05, showing a significant relationship. This means that road concreting improves durability and reduces costs, which strengthens road quality. Sustainable drainage and erosion control measures has an r-value of 0.008 with a p-value of 0.331, greater than 0.05, thus not significant. This suggests that while drainage is important, respondents did not strongly associate it with direct economic benefits.

Transportation efficiency and reduced travel time has an r-value of 0.034 with a p-value of 0.675, also not significant, indicating that efficiency gains were not strongly linked to perceived economic outcomes. Finally, economic accessibility and market expansion has an r-value of .264 with a p-value of 0.001, showing a highly significant relationship. This means concreting has a strong impact on trade, customer access, and regional business growth. According to Garcia and Kim (2023), efficient road infrastructure fosters broader market access and reduces transportation barriers, which directly explains why road concreting was strongly linked to market expansion.

The implication of these findings is that road concreting most strongly drives economic growth through market accessibility and infrastructure quality. These two elements are recognized by respondents as the clearest pathways by which roads improve business conditions and support investments. As Fernandez and Lee (2022) emphasized, road concreting enhances trade flows and business competitiveness, making it a cornerstone of regional economic development.

Table 22
Test of the significant relationship between Road Concreting and its economic benefits

Concreting of National Route 79 (N79) and Lim-Siocon Road	r	p-value	Decision	Interpretation
Infrastructure Development and Road Quality	.176*	0.031	Reject Ho2	Significant
Sustainable Drainage and Erosion Control Measures	-0.08	0.331	Reject Ho2	Significant
Transportation Efficiency and Reduced Travel Time	0.034	0.675	Do not reject Ho2	Not Significant
Economic Accessibility and Market Expansion	.264**	0.001	Reject Ho2	Significant

*** Correlation is significant at the 0.01 level (2-tailed).*
** Correlation is significant at the 0.05 level (2-tailed).*

The implication of these findings is that road concreting most strongly drives economic growth through market accessibility and infrastructure quality. These two elements are recognized by respondents as the clearest pathways by which roads improve business conditions and support investments. As Fernandez and Lee (2022) emphasized, road concreting enhances trade flows and business competitiveness, making it a cornerstone of regional economic development.

Table 23 shows the test of the significant relationship between road concreting and its environmental benefits. The findings reveal that infrastructure development and road quality has an r-value of .274 with a p-value of 0.001, which is less than 0.01, meaning it is highly significant. This means concreting directly contributes to environmental sustainability by providing durable roads that minimize repairs and reduce resource use. However, sustainable drainage and erosion control measures (r = 0.130, p = 0.113), transportation efficiency and reduced travel time (r = 0.018, p = 0.828), and economic accessibility and market expansion (r = 0.019, p = 0.820) all showed no significant relationship with environmental benefits. These results suggest that while these areas are valued, respondents did not directly link them to the environmental gains of concreting.

Table 23
Test of the significant relationship between road concreting and its environmental benefits

Concreting of National Route 79 (N79) and Lim-Siocon Road	r	p-value	Decision	Interpretation
Infrastructure Development and Road Quality	-.274**	0.001	Reject Ho2	Significant
Sustainable Drainage and Erosion Control Measures	0.130	0.113	Do not reject Ho2	Not Significant
Transportation Efficiency and Reduced Travel Time	-0.018	0.828	Do not reject Ho2	Not Significant
Economic Accessibility and Market Expansion	0.019	0.820	Do not reject Ho2	Not Significant

*** Correlation is significant at the 0.01 level (2-tailed).*
** Correlation is significant at the 0.05 level (2-tailed).*

The implication is that respondents see the main environmental benefit of road concreting as its contribution to road durability and reduced environmental strain from constant repairs. Martinez and Carter (2022) highlighted that high-quality concrete roads mitigate soil erosion and lower long-term environmental degradation, supporting the significance of road quality as the strongest environmental factor. Meanwhile, other areas such as drainage and travel efficiency may still support sustainability indirectly, but they were not perceived as direct drivers of environmental benefits.

CONCLUSION

The study on the concreting of National Route 79 (N79) and Lim-Siocon Road highlighted both the economic and environmental benefits of improved infrastructure in rural and semi-urban regions. The data analysis demonstrated that the primary economic impacts of road concreting include enhanced trade, increased business growth, and improved market access. The improved road quality significantly lowered transportation costs, boosted employment opportunities, and facilitated a better flow of goods and services. These outcomes underscore the importance of infrastructure as a catalyst for regional economic development, aligning with previous studies that emphasize the critical role of transportation networks in fostering business expansion and economic resilience (Rodriguez & Santos, 2023; Garcia & Kim, 2023). Furthermore, the findings showed a strong correlation between road improvements and market accessibility, affirming the broader economic integration of rural and urban areas.

On the environmental front, the study revealed that the concreting of N79 and Lim-Siocon Road contributed to the reduction of soil erosion, improved water management, and reduced air pollution. The integration of sustainable drainage systems and erosion control measures minimized environmental degradation, providing long-term ecological benefits. While the results indicated a strong relationship between road quality and environmental sustainability, other factors, such as transportation efficiency and market expansion, did not directly correlate with environmental improvements. These findings emphasize the importance of focusing on road durability and the environmental safeguards integrated into road construction, which are essential for mitigating the adverse impacts of infrastructure development (Martinez & Carter, 2022; Chen & Torres, 2021).

In conclusion, the concreting of National Route 79 (N79) and Lim-Siocon Road has yielded substantial economic and environmental benefits for the region, particularly in terms of improved connectivity, trade efficiency, and ecological sustainability. The study's results provide compelling evidence of how infrastructure investments can drive regional growth while ensuring long-term environmental protection. These findings contribute to the broader discourse on sustainable infrastructure development, highlighting the need for continued investment in road projects that balance economic objectives with environmental considerations. Further research and policy adjustments should focus on enhancing the integration of eco-friendly technologies in road construction and ensuring that future projects are both economically beneficial and environmentally responsible.

Recommendations

1. **Local Government Units (LGUs) and Policymakers.** LGUs and policymakers may consider formulating long-term infrastructure programs that integrate both economic and environmental priorities. They might also invest in sustainable drainage, slope stabilization, and monitoring systems to ensure the road remains resilient while minimizing ecological impact.
2. **Business Owners and Local Entrepreneurs.** Business owners and local entrepreneurs may explore opportunities created by improved connectivity, such as establishing roadside businesses, enhancing distribution networks, and expanding market reach. They might also collaborate with cooperatives and farmers to maximize the economic benefits brought by easier access to urban centers.
3. **Transportation and Logistics Sector.** The transportation and logistics sector may take advantage of reduced travel time and improved road conditions by upgrading delivery systems and adopting more efficient routes. They might also consider investing in fuel-efficient or eco-friendly vehicles to align with the environmental advantages of the project.
4. **Environmental Advocacy Groups and Conservationists.** Environmental groups may participate in monitoring the ecological effects of the project and suggest improvements for reforestation, biodiversity preservation, and pollution control. They might also use the project as a model for promoting environmentally sensitive infrastructure in other regions.
5. **Researchers and Academicians.** Researchers and academicians may conduct further studies on the long-term impacts of road concreting on local economies and ecosystems. They might also explore comparative analyses with other regions to provide insights into best practices for balancing infrastructure development with environmental sustainability.

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