

BARRIERS, STRATEGIES, AND MAINTENANCE PRACTICES OF ROAD WORKERS IN MAINTAINING THE PROVINCIAL ROADS OF CATANDUANES

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ABSTRACT

This study assessed the barriers, strategies, and maintenance practices of road workers in maintaining the provincial roads of Catanduanes. Employing a descriptive-correlational research design, the study aimed to identify the key challenges faced by road workers, examine the strategies employed to address these challenges, and determine how these factors relate to the perceived effectiveness of road maintenance practices. The descriptive component highlighted the major barriers and strategies implemented, while the correlational aspect examined their relationships with perceived maintenance effectiveness, informing the development of a strategic intervention plan for more sustainable road management. Findings revealed that road workers in Catanduanes encountered several significant barriers in maintaining provincial roads, with an overall weighted mean of 3.56, rated as very challenging. Key barriers included lack of equipment and materials (mean = 3.51), inadequate funding (mean = 3.60), unfavorable weather conditions (mean = 3.55), and manpower shortage (mean = 3.58). These challenges were compounded by issues such as outdated machinery, absence of spare parts, weather-related road damage, and declining interest among younger personnel in road maintenance work. To address these barriers, road workers implemented a range of strategies. Prioritization of critical areas, particularly severely damaged and high-traffic roads, received the highest mean of 3.66, while preventive maintenance planning achieved the highest indicator mean of 4.00, emphasizing scheduled inspections and predictive maintenance. Community involvement (mean = 3.41) and resource optimization (mean = 3.55) were also employed to maximize manpower, equipment, and budgetary resources efficiently. Regarding the perceived effectiveness of maintenance practices, respondents reported high effectiveness in regular grading and patching (mean = 3.54), drainage system maintenance (mean = 3.54), vegetation control (mean = 3.56), and signage installation and repair (mean = 3.55). Correlational analysis indicated a significant relationship between the barriers encountered and the perceived effectiveness of maintenance practices ($r = 4.922 > 0.444$, $p < 0.05$), as well as between strategies implemented and perceived effectiveness ($r = 0.667 > 0.444$, $p < 0.05$). Based on these findings, a strategic intervention plan was proposed, focusing on capacity building, community engagement, institutional partnerships, and climate-resilient practices to enhance the sustainability, efficiency, and overall effectiveness of road maintenance operations in Catanduanes.

Keywords: Road maintenance, barriers, strategies, effectiveness, Catanduanes

INTRODUCTION

Road maintenance is a critical factor in ensuring safe and sustainable transportation networks, which support economic growth, trade, and daily commuting (Buuveibaatar, Brilakis, Peck, Economides, & Lee, 2025). In the Philippines, well-maintained roads facilitate access to

essential services, boost productivity, and reduce transportation costs (Liu et al., 2021). This study focuses on the variables of barriers, strategies, and maintenance practices of road workers on provincial roads, aiming to examine the challenges these workers face. It also seeks to assess the strategies employed and evaluate maintenance practices for effectiveness in sustaining road infrastructure in Catanduanes (Mashwama, Mushatu, & Aigbavboa, 2018; Mishra & Magar, 2017). Understanding these aspects is crucial for developing context-specific interventions that enhance road longevity. By exploring these factors, the research provides a foundation for more efficient road management and worker support.

The legal basis for this study is grounded in Republic Act No. 8794, which imposes motor vehicle users' charges to fund road maintenance (Republic Act No. 8794, 2000). Additionally, the Philippine Development Plan (2023–2028) prioritizes infrastructure development, including provincial roads, to promote inclusive growth and disaster resilience. The Department of Public Works and Highways (DPWH) and Local Government Units (LGUs) are legally mandated to oversee road construction, maintenance, and rehabilitation, forming the institutional framework guiding road maintenance practices across the country (Buuveibaatar et al., 2025). These laws and plans establish the responsibilities of both national and local authorities in sustaining road infrastructure. They also provide mechanisms for allocating resources and ensuring accountability in maintenance projects. Consequently, these legal instruments serve as the foundation for this study's focus on provincial road workers and their practices.

Despite these policies, gaps remain in understanding the unique challenges faced by provincial road workers in Catanduanes, particularly in disaster-prone and geographically constrained areas. Previous studies largely focused on urban roads, funding issues, or general infrastructure policies, while insufficient attention has been given to the experiences, coping strategies, and practical methods employed by local road workers (Mashwama et al., 2018; Mishra & Magar, 2017). Factors such as budget limitations, insufficient training, climate vulnerability, and lack of standardized equipment highlight the need for a context-specific investigation. Examining these challenges allows for a more accurate identification of barriers that hinder road maintenance effectiveness. It also provides insights into how workers adapt to local conditions and resource constraints. This understanding is critical for developing practical solutions that address both operational and environmental challenges.

The significance of this study lies in its potential to provide evidence-based recommendations for improving road maintenance efficiency, enhancing worker safety, and ensuring the sustainability of provincial roads in Catanduanes. By examining barriers, evaluating strategies, and documenting best practices, the research addresses critical infrastructure challenges. It informs local policy-making and supports disaster-resilient development. The study also contributes to the optimization of resource allocation and prioritization of maintenance activities. In addition, it promotes knowledge sharing among road management stakeholders. Ultimately, the research aims to create safer and more reliable road networks, fostering economic growth and social well-being in the province.

LITERATURE REVIEW

Road maintenance is a vital aspect of transportation infrastructure that ensures road safety, durability, and efficient mobility. Well-maintained roads reduce vehicle wear, lower transportation costs, and support economic activity by facilitating trade and daily commuting (Han, Huang, Yang, Chen, & Chen, 2023). In rural and provincial settings, limited budgets

often hinder the implementation of comprehensive maintenance programs. Strategic planning is essential to prioritize road repairs, optimize available resources, and maintain the functionality of the road network. Research emphasizes that predictive maintenance models can enhance decision-making and extend pavement lifespan while reducing long-term costs (Pérez-Acebo, Linares-Unamunzaga, Rojí, & Gonzalo-Orden, 2020). These measures are particularly important in areas with frequent traffic and environmental stressors. Barriers to effective road maintenance often include insufficient equipment, lack of skilled personnel, and inadequate funding. Environmental conditions, such as heavy rainfall, flooding, and freezing-thawing cycles, accelerate pavement deterioration and complicate repair schedules (Li, Hu, Cheng, Wang, Ni, & Ye, 2024). Administrative challenges within local governments, including weak coordination and bureaucratic delays, further hinder timely maintenance, especially after disasters (Hayat & Amaratunga, 2017). The inability to perform preventive maintenance can result in higher operational risks and road accidents (Ma, Xu, Gao, Mu, E, & Gu, 2022). Additionally, rural municipalities often show disparities in infrastructure performance compared to metropolitan areas due to limited resources and technical support (Bikam & Chakwizira, 2021). These challenges highlight the need for targeted strategies and resource optimization to maintain provincial roads effectively.

Local governments play a central role in ensuring road infrastructure resilience through planning, budgeting, and oversight. Hayat and Amaratunga (2017) noted that effective post-disaster road reconstruction requires not only financial support but also skilled personnel and appropriate equipment. Budgetary constraints are a recurring issue, particularly in rural road networks, where maintenance must be prioritized to address the most critical road segments (Amir & Henry, 2023). Data-driven allocation of maintenance funds can optimize repair schedules and maximize the impact of limited resources. Advanced monitoring tools, such as predictive models and condition assessment indices, help identify roads in urgent need of repair. These approaches ensure that roads remain functional, safe, and accessible for local communities.

Technological innovations have greatly enhanced road maintenance practices in recent years. Automatic detection and classification systems allow for the identification of road defects at a global scale, improving the speed and accuracy of inspections (Kaya & Codur, 2025). Deep learning models and roadside camera systems provide real-time data on pavement conditions and weather impacts, enabling proactive repairs (Carrillo, Crowley, Pan, & Fu, 2020). Predictive analytics and decision tree methods can guide budget allocation and prioritize interventions based on road criticality (Amir & Henry, 2023). These technological strategies reduce human error, lower maintenance costs, and enhance operational efficiency. By integrating advanced tools with traditional practices, road workers can maintain higher standards of road quality.

Routine maintenance practices remain fundamental to road sustainability and safety. Regular inspection, pothole repair, resurfacing, and rehabilitation are core tasks performed by road workers to maintain functional roads (Pérez-Acebo, Linares-Unamunzaga, Rojí, & Gonzalo-Orden, 2020). Preventive maintenance, including the use of resilient construction materials and traffic monitoring, minimizes the frequency and severity of road failures (Li, Hu, Cheng, Wang, Ni, & Ye, 2024). Road maintenance operations must also consider traffic volume, road type, and environmental conditions to ensure targeted interventions. Efficient municipal asset management practices enhance the reliability of maintenance operations and improve public satisfaction (Bikam & Chakwizira, 2021). Overall, these practices are critical to sustaining road networks and supporting economic and social activities.

Despite technological advancements and strategic planning, road maintenance in provincial areas continues to face significant challenges. Resource constraints, environmental hazards, and administrative inefficiencies contribute to the vulnerability of roads, particularly in disaster-prone regions (Hayat & Amaratunga, 2017). Integrating modern monitoring tools with traditional maintenance techniques can help address these challenges and optimize road performance (Kaya & Codur, 2025). Collaboration between local governments, road authorities, and communities is essential for effective maintenance. Strategic planning, adequate funding, and skilled personnel allocation remain key to overcoming barriers. Ultimately, a combination of preventive, corrective, and data-driven practices ensures safe, reliable, and sustainable provincial road networks.

METHODOLOGY

This study employed a descriptive correlational design to examine the barriers, strategies, and maintenance practices of road workers in Catanduanes. Surveys and observations were used to collect data on challenges such as equipment, funding, manpower, and weather conditions, as well as the effectiveness of maintenance strategies. The design described current practices and explored how barriers influenced strategy success. Findings provided insights for improving road maintenance, optimizing resources, and enhancing infrastructure resilience.

Respondents of the Study

The population of the study consisted of 49 road workers involved in the maintenance of provincial roads in Catanduanes. Using Slovin's formula with a 5% margin of error, a sample size of 44 respondents was determined. The respondents were selected through simple random sampling to ensure unbiased representation of the road workers in the study. Only road workers were included in the final sample, as the focus of the research was specific to their roles and experiences in road maintenance.

Instrumentation

A self-made questionnaire was used to collect data on the barriers, strategies, and effectiveness of road maintenance practices in Catanduanes. It had three sections: Part 1 addressed barriers such as lack of equipment, funding, manpower, and unfavorable weather; Part 2 explored strategies like prioritizing critical areas, community involvement, preventive maintenance, and resource optimization; Part 3 assessed the perceived effectiveness of maintenance practices including grading, drainage upkeep, vegetation control, and signage repair. The questionnaire was validated by a panel of two foremen and two experts for clarity and relevance, and refined based on their feedback. A pre-test with a small group of road workers ensured clarity and consistency. Internal consistency was tested using Pearson's r , resulting in 0.887, indicating the instrument was reliable for data collection.

RESULTS

Table 1
Composite Table on Barriers in Maintaining the Provincial Roads

Variable	Weighted Mean	Verbal Interpretation	Rank
Lack of Equipment and Materials	3.51	Strongly Agree/Very Challenging	4
Inadequate Funding	3.60	Strongly Agree/Very Challenging	1
Unfavorable Weather Conditions	3.55	Strongly Agree/Very Challenging	3

Manpower Shortage	3.58	Strongly Agree/Very Challenging	2
Overall weighted mean	3.56	Strongly Agree/Very Challenging	

The composite table shows that road workers in Catanduanes encounter multiple significant barriers in maintaining provincial roads. Among the identified challenges, inadequate funding (WM = 3.60) is perceived as the most critical, followed closely by manpower shortage (WM = 3.58), unfavorable weather conditions (WM = 3.55), and lack of equipment and materials (WM = 3.51). The overall weighted mean of 3.56 indicates that respondents strongly agree that these factors present very challenging obstacles to road maintenance. These results suggest that both resource limitations and environmental conditions critically affect the ability of road workers to perform timely and effective maintenance activities.

The findings also emphasize that environmental stressors such as frequent rain, typhoons, and extreme weather events exacerbate the difficulty of maintaining provincial roads. Predictive maintenance and resource prioritization are recommended to extend road lifespan and improve efficiency despite these challenges (Pérez-Acebo, Linares-Unamunzaga, Rojí, & Gonzalo-Orden, 2020). The strong agreement across all variables underscores the interconnectedness of funding, manpower, equipment availability, and weather conditions as barriers that require integrated solutions. Road maintenance is thus not only a technical task but also a complex operational challenge shaped by both human and structural factors. The results align with literature indicating that well-maintained roads reduce vehicle wear, lower transportation costs, and support economic activity by facilitating trade and daily commuting (Han et al., 2023). Consequently, addressing these barriers is essential to sustain safe and functional transportation networks in Catanduanes.

Table 2
Composite Table on Strategies in Maintaining the Provincial Roads

Variable	Weighted mean	Verbal Interpretation	Rank
Prioritization of Critical Areas	3.52	Strongly Agree /Highly Effective	3
Community Involvement	3.41	Strongly Agree /Highly Effective	4
Preventive Maintenance Planning	3.55	Strongly Agree /Highly Effective	1.5
Resource Optimization	3.55	Strongly Agree /Highly Effective	1.5
Overall weighted mean	3.51	Strongly Agree /Highly Effective	

The composite table reveals that road workers in Catanduanes employ several effective strategies to maintain provincial roads despite the challenges they face. Among these strategies, preventive maintenance planning and resource optimization (WM = 3.55) are tied as the most highly effective approaches, followed by prioritization of critical areas (WM = 3.52) and community involvement (WM = 3.41). The overall weighted mean of 3.51 indicates that respondents strongly agree that these strategies are highly effective in sustaining road functionality. These results suggest that road maintenance is most successful when efforts are carefully planned, resources are maximized, and critical areas receive focused attention.

The findings also emphasize the importance of community involvement and preventive measures in reducing operational risks and extending pavement lifespan. Environmental conditions like heavy rainfall, flooding, and freeze-thaw cycles accelerate pavement deterioration, making preventive and prioritized maintenance essential (Ma, Xu, Gao, Mu, E, & Gu, 2022). Administrative challenges, including weak coordination and bureaucratic delays, further underscore the need for structured strategies and clear task allocation (Hayat

& Amaratunga, 2017). In rural municipalities with limited technical support and resources, targeted approaches such as resource optimization and community engagement are particularly crucial to maintaining road quality (Bikam & Chakwizira, 2021). These results highlight that integrating strategic planning, preventive practices, and collaborative approaches can enhance the effectiveness of road maintenance programs. Overall, the strategies identified provide a roadmap for improving operational efficiency, minimizing infrastructure deterioration, and sustaining safe transportation networks in provincial settings.

Table 3
Composite Table on Effectiveness of Maintenance Practices in Maintaining the Provincial Roads

Variable	Weighted mean	Verbal Interpretation	Rank
Regular Grading and Patching	3.54	Strongly Agree / Highly Effective	3.5
Drainage System Maintenance	3.54	Strongly Agree / Highly Effective	3.5
Vegetation Control	3.56	Strongly Agree / Highly Effective	1
Signage Installation And Repair	3.55	Strongly Agree / Highly Effective	2
Overall weighted mean	3.55	Strongly Agree / Highly Effective	

The composite table indicates that the maintenance practices employed by road workers in Catanduanes are perceived as highly effective in sustaining provincial road conditions. Among the identified practices, vegetation control (WM = 3.56) is considered the most effective, followed by signage installation and repair (WM = 3.55), and regular grading and patching along with drainage system maintenance (WM = 3.54). The overall weighted mean of 3.55 suggests strong agreement among respondents that these practices contribute significantly to road functionality. These results highlight that routine and targeted maintenance activities are critical in preserving the safety, accessibility, and longevity of provincial roads. Local governments play a central role in this process by planning, budgeting, and overseeing road infrastructure resilience.

The findings also underscore the importance of integrating skilled personnel, proper equipment, and regular monitoring to ensure effective maintenance. Advanced tools such as predictive models and condition assessment indices allow road managers to identify roads that require urgent repair, facilitating timely intervention and reducing long-term deterioration. Effective post-disaster reconstruction and routine maintenance depend on coordinated planning, adequate funding, and the strategic deployment of manpower and equipment (Hayat & Amaratunga, 2017). The results show that combining routine practices such as grading, patching, and vegetation control with preventive measures like proper drainage and signage repair ensures road safety and operational reliability. These practices not only reduce maintenance costs over time but also enhance mobility, lower vehicle wear, and support economic activity by keeping roads functional for local communities. Overall, the study emphasizes that systematic, evidence-based maintenance practices are essential for sustaining provincial road networks in resource-constrained settings.

Table 4
Relationship between the Barriers Encountered in Maintaining the Provincial Roads and Perceived Effectiveness of Maintenance Practices

Variables	Statistical Test	Computed Value	Critical-Value @ .05	Decision	Interpretation
Barriers Encountered in Maintaining the Provincial Roads VS Perceived Effectiveness of	Person r	4.922	.304	Reject Ho	Significant Relationship

Maintenance Practices					
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The results reveal a significant relationship between the barriers encountered in maintaining the provincial roads and the perceived effectiveness of maintenance practices ($r = 4.922$, critical value = .304, $p < .05$). The rejection of the null hypothesis indicates that the challenges faced by road workers, such as lack of equipment, insufficient funding, manpower shortages, and environmental stressors, directly influence how effective maintenance practices are perceived to be.

This suggests that addressing these barriers is essential for optimizing the impact of maintenance activities. Technological innovations, including automatic detection systems, deep learning models, and roadside cameras, can help mitigate the effects of these barriers by providing real-time data on road conditions and weather impacts, enabling proactive and targeted repairs (Kaya & Codur, 2025; Carrillo, Crowley, Pan, & Fu, 2020). Additionally, predictive analytics and decision tree methods allow for strategic allocation of limited budgets and prioritization of critical road segments, enhancing operational efficiency (Amir & Henry, 2023).

Table 5
Relationship between the Strategies Implemented to Address the Identified Barriers and the Perceived Effectiveness of Maintenance Practices

Variables	Statistical Test	Computed Value	Critical-Value @ .05	Decision	Interpretation
Strategies Implemented to Address the Identified Barriers and the Perceived Effectiveness of Maintenance Practices	Person r	0.667	.304	Reject Ho	Significant Relationship

The results reveal a significant relationship between the strategies implemented to address the identified barriers and the perceived effectiveness of maintenance practices ($r = 0.667$, critical value = .304, $p < .05$). The rejection of the null hypothesis indicates that the effectiveness of road maintenance is strongly influenced by the strategies employed to overcome challenges such as limited equipment, manpower shortages, insufficient funding, and adverse environmental conditions.

This suggests that targeted and well-planned strategies are essential for maximizing the efficiency and impact of maintenance practices. Preventive maintenance measures, including the use of resilient construction materials and traffic monitoring, reduce the frequency and severity of road failures, ensuring safer and more durable roads (Li, Hu, Cheng, Wang, Ni, & Ye, 2024). Efficient municipal asset management and strategic resource allocation enhance operational reliability and public satisfaction, particularly in rural and resource-constrained settings (Bikam & Chakwizira, 2021).

PROPOSED STRATEGIC INTERVENTION PLAN FOR PROVINCIAL ROAD MAINTENANCE

Key Challenge	Objective	Intervention Strategies	Persons Involved	Time Frame	Expected Outcomes
Inadequate funding (Rank 1, WM=3.60)	Establish a sustainable maintenance framework	- Organize Provincial Road Maintenance Council (PRMC) with LGUs, NGOs,	Governor's Office, Sangguniang Panlalawigan,	Annually	Institutionalized and shared funding support for road maintenance; regular

	through inter-agency coordination and PPPs	business sector - Draft and sign MOUs for PPPs in road rehab and maintenance - Allocate budgetary support for joint projects (e.g., periodic grading, bridge repairs) - Conduct annual review and planning sessions	PEO, DPWH, NGOs, Business Sector		review ensures adaptive strategies
Manpower shortage (Rank 2, WM=3.58)	Strengthen technical competencies of road maintenance workers	- Conduct modular training on asphalt/concrete patching, drainage clearing, grading - Introduce disaster-resilient techniques and materials - Partner with TESDA for certification - Provide practical field simulations	PEO, TESDA, DPWH trainers, LGUs, Maintenance Workers	Quarterly	Increased number of certified and skilled workers capable of modern maintenance practices
Unfavorable weather conditions (Rank 3, WM=3.55)	Implement preventive and climate-resilient maintenance strategies	- Regular pre-typhoon inspection and clearing of drainage systems - Construct slope protection, culverts, gabion walls in landslide-prone areas - Apply seal coating and crack-sealing techniques - Preposition materials and equipment - Develop and distribute Road Maintenance Emergency Protocols (RMEP)	PEO, Civil Engineers, MDRRMCs, Equipment Operators, LGUs	Before and during typhoon season	Reduced impact of typhoons and floods; extended road service life
Lack of equipment and materials (Rank 4, WM=3.51)	Enhance community participation and resource leverage	- Launch "Adopt-a-Road" program involving barangay residents - Conduct workshops on pothole patching, vegetation control - Provide starter kits for volunteers - Set up barangay-based reporting system (hotline/app)	Barangay Officials, LGU Engineers, Community Leaders, CSOs, Youth Groups	Biannually	Increased grassroots participation; faster detection and reporting of road issues; partial offset of equipment shortages

The proposed strategic intervention plan for provincial road maintenance in Catanduanes offers a comprehensive approach to address the key barriers identified in the study. In

response to inadequate funding, the plan emphasizes establishing a Provincial Road Maintenance Council (PRMC) with LGUs, NGOs, and the business sector, drafting MOUs for public-private partnerships, allocating joint budgets for essential repairs, and conducting annual review sessions to ensure sustainable and adaptive funding. To mitigate manpower shortages, modular training programs on asphalt and concrete patching, drainage clearing, grading, and disaster-resilient techniques are proposed, complemented by TESDA certification and practical field simulations. These initiatives aim to develop a skilled workforce capable of performing modern, effective maintenance practices.

Unfavorable weather conditions are addressed through preventive and climate-resilient strategies such as pre-typhoon inspections, clearing drainage systems, constructing slope protections and culverts, applying seal coating and crack-sealing, repositioning materials and equipment, and distributing Road Maintenance Emergency Protocols (RMEP). The lack of equipment and materials is tackled by promoting community participation through an “Adopt-a-Road” program, workshops for volunteers, starter kits, and barangay-based reporting systems. Collectively, these strategies integrate funding, technical capacity, climate resilience, and community engagement to ensure safe, reliable, and sustainable provincial road networks, reduce damage from natural hazards, and improve response and maintenance efficiency across Catanduanes.

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