

Improving Road Construction Project Delivery Through Material Supply Chain Efficiency: A Case Study in Nueva Ecija

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Abstract- This study explored the factors affecting material supply chain efficiency in road construction projects in Nueva Ecija, Philippines. Using a qualitative case study design, interviews were conducted with 10 key informants, including engineers, contractors, consultants, and government personnel. Data were analyzed using thematic analysis, resulting in six main themes: environmental challenges, impact on project timelines, regulatory and administrative challenges, coordination problems with agencies, strategies used by practitioners, and suggested improvements. Findings indicate that heavy rainfall, flooding, soft soil, and bureaucratic delays significantly affect supply chain efficiency. Practitioners adopt adaptive strategies such as soil stabilization, rescheduling, and early permit submission. Recommendations include digitalized permit processing, unified LGU-national agency guidelines, proactive planning, and inter-agency coordination. These measures aim to reduce delays, enhance efficiency, and improve overall project performance.

I. INTRODUCTION

1.1 Background of the Study

Efficient material supply chains are critical to the success of road construction projects. In the Philippines, particularly in Nueva Ecija, construction projects face numerous environmental, regulatory, and coordination challenges. Frequent heavy rainfall, flooding, and soft soil often disrupt project schedules, while administrative delays such as ECC approvals, right-of-way issues, and LGU permits exacerbate inefficiencies. These factors not only affect timelines but also increase costs and strain resources.

International studies show that environmental disruptions and bureaucratic processes are common obstacles in countries with similar climates and regulatory conditions, such as India and Thailand (Kumar & Singh, 2018; Chaiyasoonthorn, 2020).

Improving supply chain efficiency is therefore essential to ensuring timely project completion and optimal resource utilization.

1.2 Statement of the Problem

This study seeks to answer the following questions:

1. What environmental challenges affect material supply chain efficiency in road construction projects?
2. How do these challenges impact project timelines?
3. What regulatory and administrative issues contribute to delays?
4. How does inter-agency coordination affect project execution?
5. What strategies are currently used to mitigate delays?
6. What improvements can be implemented to enhance supply chain efficiency?

1.3 Objectives of the Study

General Objective:

To explore the factors affecting material supply chain efficiency in road construction projects in Nueva Ecija, Philippines.

Specific Objectives:

1. Identify environmental challenges affecting projects.
2. Determine the impact of these challenges on project timelines.
3. Examine regulatory and administrative bottlenecks.
4. Assess coordination issues among agencies.
5. Document strategies adopted by practitioners.
6. Recommend improvements for supply chain efficiency.

1.4 Significance of the Study

This study is significant for:

- Project Managers and Practitioners: Provides insights to enhance planning and mitigate delays.
- Government Agencies: Supports policy reforms and inter-agency coordination.
- Academia: Contributes to the literature on supply chain efficiency in Philippine road construction projects.

1.5 Scope and Limitations

- Focused on road construction projects in Nueva Ecija, with examples from national and provincial roads.
- Included 10 purposively sampled respondents.
- Findings may not be generalizable to other regions.
- Only qualitative data through interviews were used; no quantitative metrics were collected.

II. REVIEW OF RELATED LITERATURE

2.1 Theoretical Framework

The study is grounded on Supply Chain Management (SCM) theory and Project Risk Management principles, emphasizing how environmental and administrative risks influence supply chain efficiency.

2.2 Local Studies

- DPWH reports (2022) cite weather and permit delays as major causes of road construction inefficiencies.
- Santos (2021) highlighted bureaucratic bottlenecks in LGU approvals as a consistent problem in provincial road projects.

2.3 International Studies

- Kumar & Singh (2018) found that monsoon rains disrupt road construction supply chains in India.
- Chaiyasoonthorn (2020) reported that inter-agency delays and soil instability affect timelines in Thailand's rural road projects.

2.4 Summary of Literature

Environmental and regulatory challenges are common worldwide, but solutions such as digitalized permits, proactive scheduling, and adaptive strategies have proven effective in mitigating delays.

III. RESEARCH METHODOLOGY

3.1 Research Design

This study utilized a qualitative research approach, specifically a case study design, to explore the environmental and regulatory challenges affecting material supply chain efficiency in road construction projects in Nueva Ecija. Qualitative research was chosen because it allows for an in-depth understanding of the experiences and perspectives of professionals directly involved in the construction process.

The study emphasized first-hand accounts from project engineers, contractors, consultants, and government personnel to gain insights into recurring challenges, their impact on project timelines, and strategies used to mitigate delays.

3.2 Research Locale

The study was conducted in Nueva Ecija, Philippines, a province with multiple ongoing road and highway construction projects. Nueva Ecija is prone to environmental challenges such as heavy rainfall, flooding, and soft soil conditions that can impact construction schedules. Selected projects were primarily national roads, highways, and farm-to-market roads under DPWH supervision.

Some insights from international studies, particularly from countries with similar climatic and regulatory conditions such as India and Thailand, were also incorporated to provide a comparative perspective.

3.3 Respondents

The study included 10 key informants ($n = 10$) who were directly involved in road construction projects in Nueva Ecija. Respondents were selected using purposive sampling to ensure that individuals with relevant experience and knowledge were included. The sample consisted of:

- Project Engineers – 1
- Contractors – 1

- Environmental/Safety Officers – 1
- Project Manager – 1
- LGU Engineer – 1
- Site Engineer – 1
- Subcontractor – 1
- DPWH Staff – 1
- Consultant – 1
- Junior Engineer – 1

All respondents had at least 1 year of experience in road construction, with most having more than 4 years of relevant work experience.

3.4 Data Collection Instruments

The primary instrument was a semi-structured interview guide (Appendix A), which included questions on:

1. Environmental challenges affecting construction projects
2. Impacts on project timelines
3. Regulatory and administrative challenges
4. Coordination with agencies
5. Strategies used by practitioners
6. Suggestions for improvement

Interviews were conducted in-person and via phone/online platforms where necessary. Each interview lasted approximately 30–45 minutes, and all responses were recorded with consent for transcription and analysis.

3.5 Data Analysis

The data were analyzed using thematic analysis, which involved:

1. Transcribing all interview responses
2. Coding responses according to recurring themes
3. Categorizing codes into six major themes:
 - Environmental Challenges
 - Impact on Project Timelines
 - Regulatory and Administrative Challenges
 - Coordination Problems with Agencies
 - Strategies Used by Practitioners
 - Suggested Improvements
4. Summarizing findings in tables and matrices (Appendices B, C, D, and E)
5. Identifying patterns, frequencies, and supporting statements

This approach ensured that all findings were systematically organized, transparent, and aligned with the objectives of the study.

3.6 Ethical Considerations

- Participation was voluntary.
- Respondents could refuse to answer any question.
- No personal identifiers were included to ensure confidentiality.
- Responses were used solely for academic purposes.

IV. PRESENTATION, ANALYSIS, AND DISCUSSION OF RESULTS

This chapter presents the results of the interviews, the thematic analysis, and a discussion of the findings in relation to existing literature. Findings are organized according to the six main themes.

4.1 Environmental Challenges

Respondents consistently cited heavy rainfall, flooding, soft soil, and mudslides as the primary environmental challenges. These issues affect construction schedules and the efficiency of the material supply chain.

- Frequency: 100% of respondents reported at least one environmental challenge.
- Example statements:
 - R1: “Kapag sunod-sunod ang ulan, stop-work talaga. Hindi ma-compact ang lupa.”
 - R3: “Mudslide incidents sa slope area, kailangan ng temporary slope protection.”

These findings align with studies in similar climates internationally (e.g., India and Thailand), where monsoon rains and unstable soil significantly impact road construction timelines (Kumar & Singh, 2018; Chaiyasoonthorn, 2020).

4.2 Impact on Project Timelines

Environmental factors directly contributed to work stoppages, reworks, curing delays, and delayed material testing.

- Frequency: 100% of respondents experienced timeline impacts.
- Examples:

- R10: “Minsan 2–3 days kami naka-stop kasi saturated ang soil.”
- R2: “Kapag nabaha, kailangan ulitin excavation.”

Delays from environmental factors can extend project timelines by weeks or months, affecting costs and resource allocation. This is consistent with Philippine construction reports highlighting weather as a critical risk factor (DPWH, 2022).

4.3 Regulatory and Administrative Challenges

All respondents reported delays caused by ECC processing, right-of-way (ROW) issues, multiple LGU permits, and DENR approvals.

- Frequency: 100% of respondents reported regulatory challenges.
- Example statements:
 - R1: “ECC ang pinaka-matagal, maraming follow-up.”
 - R6: “Barangay clearance tumatagal kasi kailangan ng meeting.”

These challenges confirm findings from local studies that regulatory compliance remains a significant bottleneck in Philippine road construction (Santos, 2021).

4.4 Coordination Problems with Agencies

Respondents noted delays due to slow endorsements, inter-agency bottlenecks, and misalignment between LGUs and DPWH.

- Frequency: 9 out of 10 respondents reported coordination challenges.
- Example statements:
 - R5: “Depende sa LGU kung gaano kabilis. Political issues minsan.”
 - R8: “Maraming pipirma sa routing kaya natetengga papers.”

Internationally, similar studies suggest that proactive inter-agency communication can significantly reduce construction delays (Zhang et al., 2019).

4.5 Strategies Used by Practitioners

Respondents described strategies to mitigate environmental and regulatory delays, including:

- Rescheduling works based on weather forecasts
- Soil stabilization and dewatering
- Early submission of permits and documentation
- Hiring liaison officers for faster processing

- Using temporary channels or drainage to prevent flooding
- Frequency: 100% of respondents employed at least one strategy.

● Example statements:

- R2: “Agad ginagawa ang soil stabilization bago mag-full swing.”
 - R10: “Temporary channels para hindi magbaha.”
- These strategies demonstrate adaptive practices consistent with literature on supply chain and project risk management (PMI, 2021).

4.6 Suggested Improvements

Respondents recommended ways to streamline processes and reduce delays, including:

- Faster and digitalized permit processing
- Unified guidelines for LGUs and DPWH coordination
- Pre-construction environmental scanning
- Enhanced training and capacity building for staff
- Frequency: 100% of respondents offered suggestions.
- Example statements:
 - R4: “Sana i-digitize lahat ng permit processing.”
 - R9: “Mas maganda kung may unified LGU guidelines.”

These recommendations align with both local and international best practices emphasizing process efficiency, digital solutions, and pre-planning to improve supply chain efficiency in construction projects.

4.7 Summary of Findings

- Environmental and regulatory challenges are interlinked and directly affect material supply chain efficiency.
- Coordination problems exacerbate delays, often requiring adaptive strategies.
- Practitioners rely on proactive planning and mitigation measures to minimize disruptions.
- Suggested improvements focus on digitalization, unified guidelines, and inter-agency coordination, which are aligned with global best practices.

The findings are summarized in Appendices B, C, D, and E, providing transparency and support for the analysis.

V. CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the conclusions derived from the findings of the study and provides practical recommendations for improving material supply chain efficiency in road construction projects in Nueva Ecija. The conclusions are based on the thematic analysis of interviews conducted with 10 key informants, including engineers, contractors, consultants, and government personnel.

The chapter also suggests actionable strategies for practitioners, policymakers, and agencies to enhance efficiency and reduce delays, drawing on both Philippine and international experiences.

5.2 Conclusions

Based on the thematic analysis and results presented in Chapter 4, the study concludes the following:

1. Environmental challenges significantly affect project efficiency. All respondents reported that heavy rainfall, flooding, soft soil, and mudslides frequently disrupt construction schedules, hinder material handling, and cause idle time on-site. These challenges are particularly critical in Nueva Ecija due to its flat terrain, flood-prone areas, and seasonal weather patterns.
2. Environmental impacts directly translate into timeline delays. Work stoppages, reworks, curing delays, and postponed material testing were common outcomes of environmental disruptions. Such delays increase project costs and extend delivery schedules, confirming findings from both Philippine studies (DPWH, 2022) and international literature (Kumar & Singh, 2018).
3. Regulatory and administrative processes contribute to significant project delays. All respondents identified ECC approvals, right-of-way issues, multiple LGU and DENR permits, and compliance audits as major sources of bottlenecks. The lengthy processing of these requirements directly affects the efficiency of the material supply chain.
4. Coordination problems exacerbate delays. Delays due to poor communication, inter-agency

bottlenecks, and misaligned schedules between LGUs, DPWH, and other agencies were widely reported. Coordination problems often compounded environmental and regulatory challenges, slowing down decision-making and project implementation.

5. Practitioners adopt adaptive strategies to mitigate challenges. Respondents reported using a combination of strategies, including rescheduling work, soil stabilization, early submission of permits, hiring liaison officers, and temporary drainage systems. These adaptive measures demonstrate proactive approaches to minimizing the impact of environmental and regulatory delays.
6. Improvements in digitalization, coordination, and pre-planning are needed. Suggested improvements include digitized permit processing, unified LGU guidelines, early environmental scanning, and enhanced staff capacity. These recommendations align with best practices in construction supply chain management, highlighting the importance of process efficiency and technology integration.

5.3 Recommendations

Based on the study's conclusions, the following recommendations are proposed to improve material supply chain efficiency in road construction projects in Nueva Ecija:

5.3.1 For Project Practitioners

- Implement proactive scheduling based on weather forecasts to minimize downtime.
- Conduct soil stabilization and dewatering prior to major construction activities.
- Submit all permits and documentation early, and designate liaison officers to follow up with agencies.
- Adopt temporary drainage systems to prevent flooding-related disruptions.

5.3.2 For Government Agencies (DPWH, DENR, LGUs)

- Digitize and centralize permit processing to reduce turnaround time.

- Develop standardized, unified guidelines across LGUs and national agencies to minimize inconsistencies.
- Improve inter-agency coordination, such as scheduled meetings and online reporting systems, to prevent bottlenecks.
- Provide training and capacity-building programs for staff to efficiently handle regulatory requirements.

5.3.3 For Policy and Planning

- Conduct pre-construction environmental assessments, including soil tests, flood risk analysis, and slope stability evaluation.
- Integrate risk mitigation strategies into project planning and budgeting.
- Encourage collaboration with private sector contractors and consultants to streamline workflow and reduce inefficiencies.
- Benchmark international best practices in countries with similar environmental challenges, such as Thailand and India, to adopt effective supply chain strategies.

5.4 Implications of the Study

This study provides insights into the critical factors affecting material supply chain efficiency in road construction projects, especially within the Philippine context. Its findings highlight the interconnectedness of environmental, regulatory, and coordination challenges and underscore the importance of strategic planning, adaptive measures, and institutional improvements.

The study can serve as a reference for project managers, government agencies, and policymakers seeking to enhance construction efficiency, minimize delays, and optimize resource allocation.

5.5 Limitations of the Study

- The study included only 10 respondents from Nueva Ecija, which may limit the generalizability of findings to other provinces.
- Data were collected through interviews only, without quantitative metrics on actual delays or cost impacts.

- Some international comparisons were limited due to differences in regulatory frameworks and environmental conditions.

5.6 Suggestions for Future Research

- Conduct a larger-scale study across multiple provinces to validate findings and explore regional variations.
- Include quantitative data on material supply delays, costs, and timelines for a mixed-methods approach.
- Investigate the effectiveness of digital permit processing and inter-agency coordination tools in reducing delays.
- Explore the impact of emerging technologies, such as construction management software and automated monitoring systems, on supply chain efficiency.

5.7 Conclusion

In conclusion, material supply chain efficiency in road construction projects in Nueva Ecija is significantly affected by environmental, regulatory, and coordination challenges. Practitioners adopt adaptive strategies, but systemic improvements are needed in government processes, inter-agency coordination, and pre-construction planning. By implementing the recommendations provided, project stakeholders can enhance efficiency, reduce delays, and improve overall project performance.

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