Engineering Management Strategies for Optimizing FEMA-Funded School Reconstruction Programs in Puerto Rico

Christian J. Betancourt Cruz
Advisor: Prof. Hector J. Cruzado, PhD, PE
Graduate School

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Abstract

FEMA-funded school reconstruction programs in Puerto Rico face significant engineering management challenges related to schedule delays, cost variability, environmental reviews, procurement complexity, and stakeholder coordination. This study applied a structured engineering management approach using process mapping, schedule analysis, and performance indicators to evaluate reconstruction initiatives associated with Hurricane Maria, seismic retrofitting projects, and the INNOVA program. The analysis identified that INNOVA projects exhibited the highest average schedule delay at 28% and the highest average cost variance at 22%, while straight repair projects demonstrated more stable performance indicators. Procurement processes, environmental reviews, interagency coordination, and FEMA administrative requirements were identified as critical bottlenecks affecting schedule performance and project execution.

Introduction

Puerto Rico experienced severe damage to public school infrastructure following Hurricane Maria in 2017 and the 2020 earthquake sequence. FEMA-funded reconstruction initiatives now include straight repairs, seismic retrofitting projects, and major transformation projects under the INNOVA initiative. Managing these reconstruction programs requires coordination among government agencies, contractors, consultants, and school communities while complying with federal procurement, environmental, and administrative requirements.

Literature Review

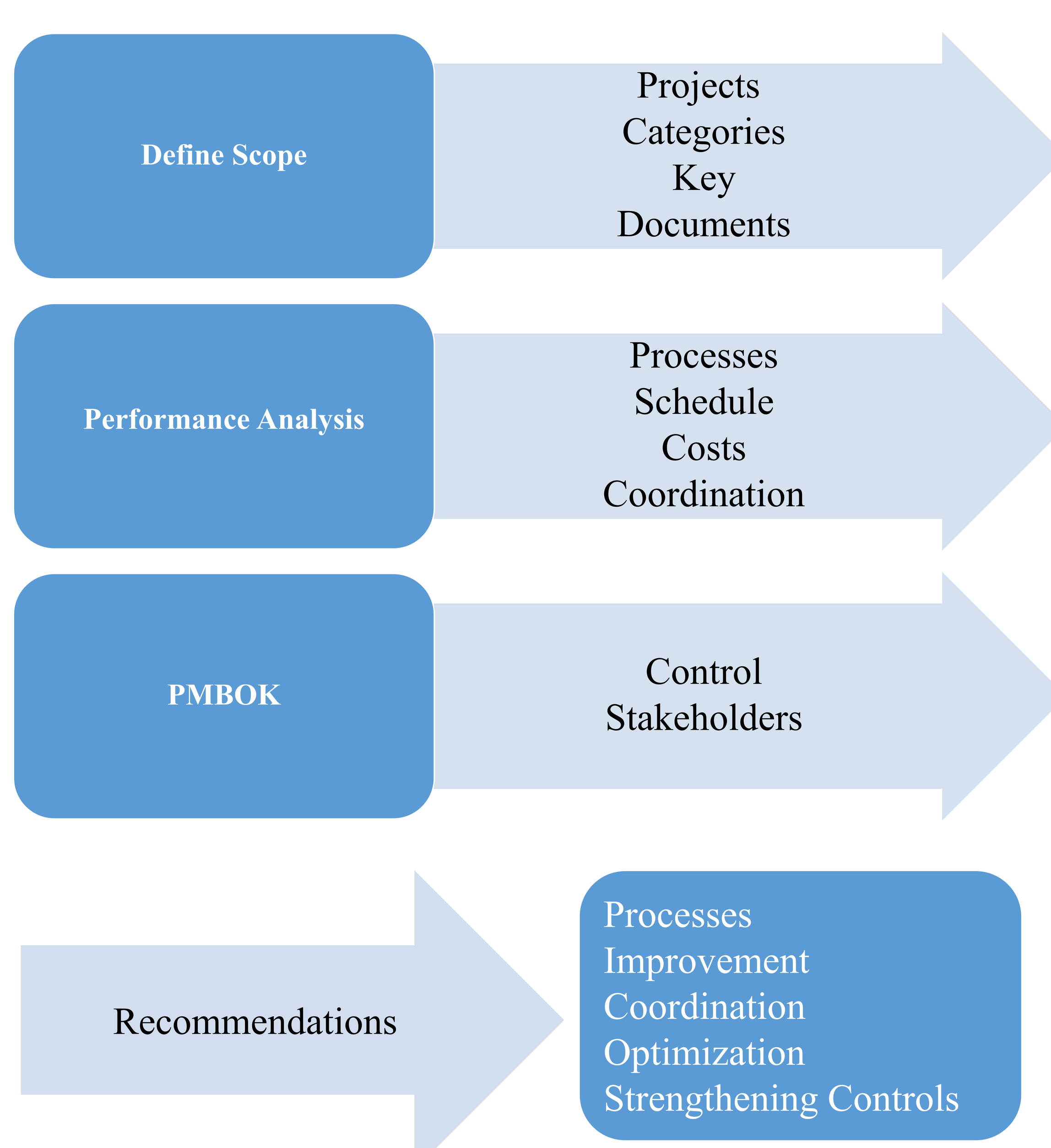
Large-scale infrastructure reconstruction programs require strong project management practices to control cost, schedule, scope, and stakeholder coordination. The PMBOK framework emphasizes structured planning, monitoring, and communication as essential elements for managing complex projects. Previous research indicates that cost overruns and schedule delays are common in public infrastructure programs, especially when projects involve regulatory requirements, multiple stakeholders, and changing scopes. FEMA-funded reconstruction projects add another layer of complexity because they must comply with procurement rules, eligibility documentation, environmental reviews, and federal reporting requirements.

Methodology

This project applied a structured engineering management approach to evaluate FEMA-funded school reconstruction programs in Puerto Rico and identify opportunities for program optimization. The first phase consisted of defining the scope of the reconstruction program under analysis. This included identifying major project categories, such as straight repairs, seismic retrofitting, and major transformation projects under the INNOVA initiative. Project schedules, cost reports, procurement documentation, and program status reports were reviewed to establish the operational structure of the reconstruction efforts.

The second phase focused on performance analysis, using engineering management tools and quantitative metrics. Process mapping techniques were applied to identify inefficiencies in workflows for procurement, permitting, and project execution. Schedule analysis was conducted to evaluate project timelines, milestone completion rates, and delays across different project types. Performance indicators such as schedule variance and milestone completion rates were used to assess execution efficiency. Cost performance was evaluated using metrics such as cost variance, change orders, and budget deviations across projects. Stakeholder coordination was assessed through the analysis of communication flows, decision-making structures, and interagency coordination processes. Coordination efficiency was evaluated by identifying delays or bottlenecks associated with stakeholder interactions.

The third phase compared current program management practices with established engineering management principles described in the PMBOK framework [1]. This comparison identified gaps in governance, cost monitoring, schedule control, and stakeholder management.



Results and Discussion

The analysis identified significant performance differences among FEMA-funded reconstruction initiatives. INNOVA projects exhibited the highest average schedule delay at 28% and the highest average cost variance at 22%, while straight repair projects demonstrated more stable performance indicators, with an average schedule delay of 12% and cost variance of 8%. Seismic retrofitting projects experienced intermediate performance levels due to permitting requirements, environmental reviews, and structural design revisions.

Table 1
Comparative Program Schedule Performance

Project Type	Estimated Program Cost	Avg. Schedule Delay	Milestone Completion Rate
Straight Repairs (4339 SR)	$236M	12%	78%
Seismic Retrofitting	$394M	18%	64%
INNOVA	$1.07B	28%	51%

Table 2
Comparative Program Budget Deviations

Project Type	Avg. Cost Variance	Avg. Change Orders	Avg. Budget Deviation
Straight Repairs (4339 SR)	8%	3	6%
Seismic Retrofitting	14%	5	11%
INNOVA	22%	8	19%

Procurement delays, environmental compliance reviews, interagency coordination, and FEMA administrative requirements were identified as the principal operational bottlenecks affecting project execution. These factors contributed to schedule extensions, budget deviations, milestone completion delays, and increased change orders across multiple reconstruction initiatives.

Table 3
Operational Bottlenecks

Procurement and Contracts		
Program	Type of Procurement	Avg. Days
INNOVA	RFP / RFQ / IFB	180 days
Seismic	RFP + Task Orders	90 days
Straight Repair	IFB	45 days
Environmental		
Program	Level of Review	Avg. Days
INNOVA	Environmental assessment	365 days
Seismic	Categorical Exclusion with Extraordinary Circumstances	180 days
Straight Repair	Categorical Exclusion	90 days
Interagency Coordination		
Program	Level of Integration	Avg. Days
INNOVA	High (More than 5 agencies)	120 days
Seismic	Medium (Less than 5 agencies)	30 days
Straight Repair	Low	30 days
FEMA Requirements		
Program	Additional Steps	Avg. Days
INNOVA	Cost Realignment Project formulation to address cost increases. It may also affect the environmental review level.	180 days
Seismic	Cost Realignment	180 days
Straight Repair	Cost Realignment	180 days

Conclusions

This study evaluated FEMA-funded school reconstruction programs in Puerto Rico using a structured engineering management approach. The analysis identified key challenges affecting program performance, particularly in schedule delays, cost variability, and stakeholder coordination.
The findings demonstrated that project complexity significantly impacts both schedule and cost performance. In addition, inefficiencies in procurement, permitting, and interagency coordination processes contribute to delays and inconsistencies across projects.

The application of engineering management tools, including process mapping, schedule analysis, and performance indicators, enabled a systematic evaluation of program operations and supported the identification of operational inefficiencies affecting reconstruction performance.

Based on the results, the study supports the implementation of standardized monitoring systems, improved governance structures, and enhanced coordination mechanisms among stakeholders. These strategies can improve program efficiency, reduce delays, and strengthen compliance with federal requirements in large-scale public infrastructure reconstruction programs.
The findings of this study contribute to the development of more effective engineering management practices for FEMA-funded reconstruction efforts and support the acceleration of school recovery initiatives in Puerto Rico.

References

[1] Project Management Institute (PMI), A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 7th ed. Newtown Square, PA: Project Management Institute, 2021.
[2] H. Kerzner, Project Management: A Systems Approach to Planning, Scheduling, and Controlling, 12th ed. Hoboken, NJ: John Wiley & Sons, 2017.
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[6] Federal Emergency Management Agency (FEMA), Public Assistance Program and Policy Guide (PAPPG), Version 4, Washington, DC: U.S. Department of Homeland Security, 2020.
[7] A. Rezvani, R. Khosravi, and N. Ashkanasy, "Examining the interdependencies among emotional intelligence, trust, and performance in infrastructure projects," International Journal of Project Management, vol. 36, no. 7, pp. 1034–1046, 2018.

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- This study applied a structured engineering management approach using process mapping, schedule analysis, and performance indicators to evaluate reconstruction initiatives associated with Hurricane Maria, seismic retrofitting projects, and the INNOVA program.

- The analysis identified that INNOVA projects exhibited the highest average schedule delay at 28% and the highest average cost variance at 22%, while straight repair projects demonstrated more stable performance indicators.

- Procurement processes, environmental reviews, interagency coordination, and FEMA administrative requirements were identified as critical bottlenecks affecting schedule performance and project execution.

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- The PMBOK framework emphasizes structured planning, monitoring, and communication as essential elements for managing complex projects.

- Previous research indicates that cost overruns and schedule delays are common in public infrastructure programs, especially when projects involve regulatory requirements, multiple stakeholders, and changing scopes.

- FEMA-funded reconstruction projects add another layer of complexity because they must comply with procurement rules, eligibility documentation, environmental reviews, and federal reporting requirements.

Methodology

- This project applied a structured engineering management approach to evaluate FEMA-funded school reconstruction programs in Puerto Rico and identify opportunities for program optimization.

- The first phase consisted of defining the scope of the reconstruction program under analysis. This included identifying major project categories, such as straight repairs, seismic retrofitting, and major transformation projects under the INNOVA initiative.

- Project schedules, cost reports, procurement documentation, and program status reports were reviewed to establish the operational structure of the reconstruction efforts.

Methodology (continued)

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- Performance indicators such as schedule variance and milestone completion rates were used to assess execution efficiency. Cost performance was evaluated using metrics such as cost variance, change orders, and budget deviations across projects. Stakeholder coordination was assessed through the analysis of communication flows, decision-making structures, and interagency coordination processes.

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Results and Discussion

- The analysis identified significant performance differences among FEMA-funded reconstruction initiatives.
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(continued)

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Conclusions (continued)

- Based on the results, the study supports the implementation of standardized monitoring systems, improved governance structures, and enhanced coordination mechanisms among stakeholders.

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Q&A

Session

Thank You

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