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A LEAN PERSPECTIVE ON POST-DISASTER HOUSING RECONSTRUCTION IMPLEMENTATION IN CIANJUR

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Abstract

Post-disaster housing reconstruction is a critical recovery process that requires not only physical rebuilding but also effective coordination, administrative readiness, technical assistance, and community participation. However, reconstruction programmes often face delays, rework, quality problems, and low beneficiary satisfaction. This study aims to analyse the implementation of post-disaster housing reconstruction after the 2022 Cianjur earthquake from a Lean Construction perspective. A qualitative case study was conducted using institutional document analysis, semi-structured interviews, and field observations. The study involved 24 informants: 10 key informants from the central government, local government, technical actors, and local community leaders, and 14 beneficiary community members. The data were analysed through document review, thematic analysis, process analysis, and interpretation based on Lean Construction principles, including value, waste minimisation, flow, stakeholder coordination, and continuous improvement. The findings show that the reconstruction process in Cianjur was implemented through reimbursement, independent community-based reconstruction, and third-party implementation schemes. Four main implementation problems were identified: beneficiary data inconsistency, administrative complexity, limited technical knowledge and resources, and weak control of third-party implementation. From a lean perspective, these problems represent defects in information flow, overprocessing, resource bottlenecks, value leakage, and process interruptions that reduce value for beneficiaries. The study suggests that future post-disaster housing reconstruction should strengthen beneficiary data management, simplify administrative procedures, balance facilitator workloads, provide early technical education, and improve third-party monitoring to support more efficient, beneficiary-oriented reconstruction.

Keywords: Beneficiary Value; Cianjur Earthquake; Lean Construction; Post-Disaster Housing Reconstruction; Reconstruction Implementation.

INTRODUCTION

Post-disaster housing reconstruction is one of the most critical stages in disaster recovery because housing is directly related to safety, livelihood restoration, social stability, and community resilience. The success of housing reconstruction can indicate the effectiveness of broader post-disaster recovery efforts, particularly in restoring the living conditions of affected communities (Ophiyandri et al., 2020). However, housing reconstruction after disasters is often difficult to implement effectively. Previous studies have shown that post-disaster reconstruction frequently faces recurring problems, including damaged infrastructure, funding limitations, limited resources, weak stakeholder coordination, and community relocation resistance (Kermanshachi & Safapour, 2019; Rouhanizadeh & Kermanshachi, 2019; Rouhanizadeh et al., 2020; Vahdatmanesh et al., 2022). In the Indonesian context, low community satisfaction has also been reported in housing rehabilitation and reconstruction programmes after the 2009 West Sumatra earthquake (Ophiyandri et al., 2015). These problems are particularly challenging in developing countries, where reconstruction must be carried out under urgent conditions, with limited institutional capacity, and under strong pressure to deliver safe housing quickly. In this context, housing reconstruction is not merely a physical construction activity but also a complex implementation process involving multiple actors, including the central and local governments, technical teams, facilitators, contractors, non-governmental organisations, and beneficiary communities. The interaction among these actors influences how

reconstruction activities are planned, verified, funded, implemented, supervised, and handed over to affected households. The 2022 Cianjur earthquake in West Java, Indonesia, provides an important case for examining the implementation of post-disaster housing reconstruction. The earthquake caused extensive damage to the housing sector, with 98,390 damaged houses reported across 15 sub-districts (PUPR, 2022). The reconstruction programme involved several implementation schemes, including reimbursement, independent community-based reconstruction, and third-party reconstruction involving contractors, applicators, or other implementing actors. These schemes created different implementation processes and coordination challenges. Therefore, the Cianjur case provides a relevant empirical context for analysing how post-disaster housing reconstruction is implemented and how process-related problems emerge during implementation.

Lean Construction offers a useful perspective for examining the implementation of post-disaster housing reconstruction by focusing on value creation, waste minimisation, process flow, stakeholder coordination, and continuous improvement. Originating from lean production, lean thinking emphasises the effective use of resources to reduce non-value-added activities and maximise value for users (Lean Construction Institute, 2019; Demirkesen, 2020). In the construction sector, Lean Construction has been applied to improve project performance, reduce waste, enhance productivity, and increase client value (Shastri et al., 2022). In the context of post-disaster reconstruction, lean principles can help identify implementation problems that create delays, rework, administrative burden, poor information flow, quality problems, and dissatisfaction among beneficiaries. Previous research has also indicated that Lean Construction principles have potential applications in post-disaster housing reconstruction by helping to identify implementation inefficiencies and opportunities for improvement in the reconstruction process (Octavia et al., 2023).

Several studies have discussed the relevance of lean principles to post-disaster management, shelter rehabilitation, infrastructure recovery, and humanitarian supply chains (Mojtahedi & Oo, 2012; El Jazzar & Hamzeh, 2015; Haarr & Drevland, 2016; Upadhyay et al., 2020; Rad et al., 2022; Gharib et al., 2022; Eranga et al., 2022). However, empirical studies examining post-disaster housing reconstruction implementation from a Lean Construction perspective remain limited. Most previous studies have focused on general construction projects, infrastructure recovery, humanitarian logistics, or shelter rehabilitation, whereas housing reconstruction, as a community-centred recovery process, has received less attention. This gap is important because housing reconstruction involves not only technical construction activities but also beneficiary verification, administrative preparation, funding mechanisms, community participation, technical facilitation, and implementation control.

This study aims to analyse the implementation of post-disaster housing reconstruction after the 2022 Cianjur earthquake from a Lean Construction perspective. Specifically, this study examines how the reconstruction process was implemented, what process-related problems emerged during implementation, and how these problems can be interpreted through lean principles to identify opportunities for improvement. The study is guided by the following research questions: (1) How was post-disaster housing reconstruction implemented in Cianjur after the 2022 earthquake? (2) What implementation problems emerged during the reconstruction process? and (3) How can these problems be interpreted from a Lean Construction perspective?

This study contributes to the literature and practice of post-disaster housing reconstruction in three ways. First, it provides an empirical description of post-disaster housing reconstruction implementation based on the 2022 Cianjur earthquake case. Second, it identifies key implementation problems in the reconstruction process, including beneficiary data issues, administrative complexity, limited technical resources, and third-party implementation problems. Third, it interprets these findings through Lean Construction principles, particularly value, flow, waste minimisation, stakeholder coordination, and continuous improvement. In practical terms, the findings provide directions for improvement for future post-disaster housing reconstruction programmes, including strengthening beneficiary data management, simplifying administrative procedures, improving technical facilitation, enhancing stakeholder coordination, and controlling third-party implementation to ensure that reconstruction activities deliver greater value to affected communities.

METHOD

This study employed a qualitative case study design to analyse the implementation of post-disaster housing reconstruction after the 2022 Cianjur earthquake from a Lean Construction perspective. A qualitative case study was considered appropriate because the research focused on understanding the reconstruction process, the actors involved, the problems that emerged during implementation, and the interpretation of these problems within their real-life institutional and community context.

The object of this study was the implementation process of post-disaster housing reconstruction in Cianjur Regency, West Java Province, Indonesia. Cianjur was selected as the case study area because the 2022 earthquake caused extensive damage to the housing sector. Based on official data, 98,390 damaged houses were reported across 15 sub-districts (PUPR, 2022). The scale of housing damage and the involvement of multiple implementation schemes made Cianjur a relevant case for analysing post-disaster housing reconstruction through a Lean Construction perspective. The study used several data sources to capture both formal procedures and actual implementation conditions, as summarised in Table 1.

Table 1. Data sources and their role in the analysis

Data source	Participants/Documents	Purpose in the analysis
Institutional documents	Action plans, technical guidelines, implementation instructions, implementation reports, beneficiary decrees, activity manager decrees, and related regulations	To identify formal procedures, implementation stages, institutional roles, and reconstruction schemes
Key informant interviews	Government agencies, disaster management agencies, technical teams, facilitators, local leaders, and other actors involved in reconstruction	To understand actual implementation, stakeholder roles, process problems, and solutions applied during reconstruction
Beneficiary interviews	14 community members receiving housing reconstruction assistance	To understand community experiences, involvement, perceived problems, and satisfaction with reconstruction implementation
Field observations	Post-disaster housing reconstruction locations in Cianjur	To verify implementation conditions and support interpretation of document and interview findings

The research informants consisted of stakeholders directly involved in the reconstruction process and community members who received housing reconstruction assistance. Informants were purposively selected for their involvement, knowledge, and role in the planning, coordination, implementation, supervision, or receipt of post-disaster housing reconstruction assistance. In total, this study involved 24 informants: 10 key informants and 14 beneficiary community members. The 10 key informants represented central government, local government, technical actors, and local community leaders. The 14 beneficiary community members were included to capture community experiences, participation, perceived problems, and satisfaction with the reconstruction process and results. The characteristics of the research informants are presented in Table 2.

Table 2. Characteristics of research informants

Informant group	Informant type	Role in reconstruction	Number of informants
Central government	Ministry of Public Works and Housing / National Disaster Management Agency	Policy direction, funding mechanism, technical regulation, and national coordination	3
Local government	Regional Disaster Management Agency and rehabilitation-reconstruction division	Local coordination, beneficiary verification, implementation control, and problem resolution	3
Technical Team	Technical team and facilitators	Damage verification, technical assistance, design support, supervision, and community facilitation	2
Local community leader	Hamlet/village-level representative	Local information, community coordination, and field-level reconstruction issues	2
Beneficiary community	Housing reconstruction beneficiaries	Reconstruction participants and recipients of housing assistance	14
Total			**24**

The operational concepts used in this study were derived from Lean Construction principles, particularly value, waste minimisation, flow, stakeholder coordination, and continuous improvement. In this study, value refers to reconstruction outputs and processes that meet beneficiary needs, improve housing safety, and support recovery. Waste refers to activities or conditions that do not add value to the reconstruction process, such as repeated verification, administrative complexity, waiting time, rework, poor information flow, resource bottlenecks, and quality problems. Flow refers to the smooth movement of information, decisions, funds, technical assistance, materials, and construction activities throughout the reconstruction process. Stakeholder coordination refers to the integration of roles and responsibilities among government agencies, technical teams, facilitators, third-party implementers, local leaders, and beneficiary communities. Data were collected through institutional document analysis, semi-structured interviews, and field observations. The institutional documents included action plans, technical guidelines, implementation instructions, implementation reports, decrees on beneficiary determination, decrees on activity managers, and other regulations related to post-disaster housing rehabilitation and reconstruction. These documents were used to identify the formal stages, procedures, requirements, institutional roles, and implementation schemes of housing reconstruction in Cianjur.

Semi-structured interviews were conducted to obtain deeper information about the actual implementation process. The interview questions focused on several themes: the stages of housing reconstruction implementation, the objectives of each stage, the actors involved and their roles, problems encountered during implementation, solutions applied by stakeholders, and community experiences as beneficiaries. This approach allowed the researchers to compare formal procedures described in institutional documents with actual implementation experiences reported by stakeholders and communities. Data analysis was conducted in several stages. First, institutional documents were reviewed to identify the formal reconstruction process, including data collection, beneficiary verification, administrative preparation, fund disbursement, construction implementation, supervision, and handover. Second, interview data were analysed using thematic analysis to identify recurring implementation problems and stakeholder experiences.

The coding process focused on issues related to data validity, administrative requirements, technical assistance, resource limitations, community participation, third-party implementation, construction quality, and beneficiary satisfaction. Third, the reconstruction process was analysed to describe the implementation flow and the various reconstruction schemes used in Cianjur, including reimbursement, independent community-based reconstruction, and third-party reconstruction. Fourth, the identified problems were interpreted using Lean Construction principles to assess their impact on value, flow, waste minimisation, stakeholder coordination, and continuous improvement. To improve the trustworthiness of the findings, this study used data triangulation by comparing information from institutional documents, key informant interviews, beneficiary interviews, and field observations. The triangulation process helped identify whether the problems reported by informants were consistent with formal procedures and field conditions. This approach strengthened the credibility of the analysis and reduced the risk of relying on a single source of information.

RESULT AND DISCUSSION

Characteristics of Data Sources and Research Informants

The findings of this study were derived from institutional documents, interviews, and field observations related to post-disaster housing reconstruction after the 2022 Cianjur earthquake. Institutional documents were used to identify the formal procedures, implementation stages, funding mechanisms, technical requirements, and institutional roles in the reconstruction programme. Interviews were used to understand the actual implementation process, problems encountered in the field, and the experiences of both implementing actors and beneficiary communities.

This study involved 24 informants, comprising 10 key informants and 14 beneficiary community members. The key informants represented central government institutions, local government institutions, technical actors, and local community leaders. Central government informants provided information on policy direction, funding mechanisms, technical regulations, and national coordination. Local government informants explained local coordination, beneficiary verification, implementation control, and problem resolution. Technical actors described damage verification, design assistance, supervision, and community facilitation. Local community leaders provided information on community coordination and field-level reconstruction issues. Beneficiary community members described their experiences as both participants in and recipients of housing reconstruction assistance.

The combination of institutional documents, key informant interviews, beneficiary interviews, and field observations enabled the study to compare formal reconstruction procedures with actual implementation conditions. This triangulation was important because post-disaster housing reconstruction involves not only written regulations and technical procedures, but also field-level coordination, administrative readiness, community participation, resource availability, and implementation control.

Implementation Process of Post-Disaster Housing Reconstruction in Cianjur

The post-disaster housing reconstruction process in Cianjur involved several sequential and interrelated stages. Based on institutional documents and interview findings, the process began with data collection and damage assessment of affected houses. This stage was important because the data became the basis for determining beneficiary eligibility, damage categories, and the amount of reconstruction assistance. The verification process involved government institutions, technical actors, and local-level information to ensure that the assistance was distributed to eligible households. After the data collection and verification stage, the process continued with administrative preparation. Beneficiaries were required to complete several documents related to their eligibility, housing condition, proposed reconstruction plan, and technical requirements. These documents were needed to support the disbursement of funds and to ensure that reconstruction activities complied with the required earthquake-resistant housing standards. Technical teams and facilitators assisted the community in preparing the required documents and understanding the technical requirements.

The next stage was the disbursement of funds and the implementation of housing reconstruction. The disbursement process depended on the reconstruction scheme selected or applied by the beneficiary community. In general, the reconstruction programme in Cianjur comprised three implementation schemes: reimbursement, independent community-based reconstruction, and third-party reconstruction. Each scheme had different implications for community participation, technical assistance, construction control, fund utilisation, and supervision. The final stages involved supervision, reporting, and handover. Supervision was conducted to ensure that housing reconstruction followed technical standards, particularly earthquake-resistant construction principles. Reporting was required to document progress and support accountability in the use of reconstruction assistance. The handover stage marked the completion of reconstruction assistance and the beneficiary community's use of the reconstructed house. From a Lean Construction perspective, this process can be understood as a flow of information, decisions, administrative documents, funds, technical assistance, labour, materials, construction activities, and accountability mechanisms. When one stage experienced problems, the flow of subsequent stages was affected. Therefore, delays, repeated verification, administrative complexity, limited technical assistance, and weak implementation control can be interpreted as process disruptions that reduce efficiency and value for beneficiaries.

Implementation Schemes of Housing Reconstruction

The implementation of housing reconstruction in Cianjur was carried out through three main schemes: reimbursement, independent community-based reconstruction, and third-party reconstruction. These schemes provided flexibility for beneficiaries and implementing actors, but they also posed distinct challenges for coordination, supervision, and quality control. The reimbursement scheme was applied to beneficiaries who had already rebuilt or repaired their houses using their own resources before receiving reconstruction assistance. In this scheme, the main processes involved the verification of eligibility, the validation of completed work, administrative checks, and the reimbursement of eligible reconstruction costs. This scheme provided flexibility for households that could act quickly after the disaster. However, it also required careful verification to ensure that the completed reconstruction met the required criteria and technical standards.

The independent community-based reconstruction scheme allowed beneficiaries to manage their own reconstruction process with assistance from technical teams or facilitators. This scheme was consistent with community participation because beneficiaries were directly involved in planning and implementing the reconstruction of their houses. However, this scheme also required sufficient technical knowledge, access to skilled workers, and continuous facilitation. Without adequate support, beneficiaries could experience difficulties in preparing technical documents, understanding earthquake-resistant construction standards, managing construction activities, and ensuring quality. The third-party implementation scheme involved external implementing actors, such as contractors, applicators, or other parties, in the construction process. This scheme could help accelerate reconstruction for beneficiaries who lacked the capacity, time, or resources to manage construction independently. However, interviews and field findings indicated that this scheme also created several problems, including

competition among applicators, the emergence of intermediaries, reduced control over fund utilisation, and potential decline in construction quality. These problems affected beneficiary satisfaction and created additional intervention needs from local disaster management authorities. The existence of these three schemes shows that the reconstruction programme attempted to accommodate different beneficiary conditions. From a Lean Construction perspective, this flexibility can support value creation when beneficiaries can choose a scheme that fits their needs and capacity. However, flexibility without strong information flow, technical control, and stakeholder coordination may also lead to process variation, rework, delays, and quality problems.

Implementation Problems in the Reconstruction Process

The findings show that several implementation problems emerged during the post-disaster housing reconstruction process in Cianjur. These problems were found at different stages of the reconstruction process and affected the programme's smoothness, efficiency, and perceived value. The first problem concerned beneficiary data collection and verification. The reconstruction process encountered difficulties due to invalid or inconsistent data, including duplicate national identity numbers, mismatches between proposed beneficiary data and population data, and multiple family cards for a single household. These data issues resulted in repeated verification and delayed the subsequent reconstruction process. They also created confusion and dissatisfaction among community members, particularly when households initially expected assistance but were later found ineligible.

The second problem was administrative complexity. Beneficiaries were required to prepare various administrative and technical documents, including documents related to earthquake-resistant housing concepts, house design, implementation plans, and construction schedules. Although technical teams and facilitators assisted in preparing these documents, the number of facilitators was limited compared with the number of damaged houses. As a result, administrative preparation became time-consuming, delaying the start of reconstruction for some beneficiaries. For disaster-affected communities living in temporary shelters or emergency conditions, complex administrative requirements created an additional burden.

The third problem was limited technical knowledge and limited human resources. Community-based reconstruction required beneficiaries to understand earthquake-resistant housing principles and to manage construction activities properly. This finding is consistent with Shaikh et al. (2022), who emphasised the role of disaster knowledge management in improving post-disaster housing reconstruction outcomes. However, not all beneficiaries had sufficient technical knowledge or construction management capacity. At the same time, the availability of facilitators, technical teams, skilled workers, and builders was limited compared with the scale of housing damage. This condition created a bottleneck in technical assistance, slowed the reconstruction process, and increased the risk of quality problems.

The fourth problem concerned third-party implementation. In schemes involving applicators, contractors, or other implementing parties, competition among third-party actors sometimes led to problematic practices, including the involvement of intermediaries. This condition reduced the effectiveness of fund utilisation and weakened control over construction quality. In some cases, third-party implementation issues required direct intervention by the local Disaster Management Agency, further delaying the completion of reconstruction. These problems also reduced community satisfaction and weakened the achievement of the post-disaster reconstruction goal of building back better. Overall, these problems indicate that the implementation challenges in Cianjur were not only technical construction issues, but also process-related problems involving data flow, administrative procedures, technical facilitation, stakeholder coordination, and implementation control. From a Lean Construction perspective, these problems can be interpreted as disruptions in the reconstruction flow and as forms of non-value-added activities that reduce efficiency and beneficiary value.

Lean Perspective on Housing Reconstruction Implementation

The implementation problems identified in Cianjur can be interpreted through the lens of Lean Construction principles, as they affected value delivery, process flow, waste minimisation, stakeholder coordination, and continuous improvement. From a lean perspective, post-disaster housing reconstruction is not only a construction activity but also a process system that depends on the smooth flow of information, decisions, funds, technical assistance, materials, labour, and community participation. When one element of this process is disrupted, subsequent activities are delayed or become less effective.

The reconstruction process in Cianjur revealed that several problems led to non-value-added activities. Data inconsistency, for example, caused repeated verification and delayed the determination of eligible beneficiaries. Administrative complexity imposed additional burdens on disaster-affected communities and slowed

the preparation for the disbursement of funds. Limited facilitators and technical actors created bottlenecks in technical assistance, while limited community knowledge of earthquake-resistant housing increased the risk of construction errors. Problems in third-party implementation reduced process control and affected construction quality. These findings indicate that lean principles can be used to explain how implementation problems reduce value for beneficiaries and interrupt the reconstruction flow. Table 3 presents the interpretation of the main implementation problems from a Lean Construction perspective. The table links each reconstruction stage to empirical problems, lean interpretations, related lean principles, and possible directions for improvement.

Table 3. Lean interpretation of implementation problems in post-disaster housing reconstruction

Reconstruction stage	Implementation problem	Lean interpretation	Related lean principle	Improvement direction
Beneficiary data collection and verification	Duplicate identity numbers, inconsistent beneficiary data, and repeated verification	Defective information flow that creates rework and waiting time	Waste minimisation and flow	Develop an integrated and updated beneficiary database supported by participatory verification
Administrative preparation	Complex documents required for housing assistance, including design, implementation plan, and schedule	Overprocessing that increases the burden on beneficiaries and delays fund disbursement	Value and waste minimisation	Simplify administrative procedures and provide standardised templates supported by facilitators
Technical assistance and facilitation	Limited number of technical teams and facilitators compared with the number of damaged houses	Resource bottleneck that interrupts process flow and slows decision-making	Flow and stakeholder coordination	Balance facilitator workload and strengthen technical support capacity
Community-based reconstruction	Limited community knowledge of earthquake-resistant housing principles	Capability gap that may reduce construction quality and beneficiary value	Value and continuous improvement	Provide early technical education, practical guidelines, and continuous field supervision
Third-party implementation	Competition among applicators, involvement of intermediaries, weak control of fund utilisation, and quality problems	Value leakage and weak process control that reduce quality and satisfaction	Stakeholder coordination and waste minimisation	Strengthen transparent third-party selection, monitoring, and performance evaluation
Supervision and reporting	Need for repeated checking and intervention when implementation problems occur	Interrupted feedback flow and delayed corrective action	Continuous improvement and flow	Use digital reporting and structured problem escalation mechanisms

The lean interpretation shows that the main challenge in Cianjur was not only the physical construction of houses but also the management of process flow. Beneficiary data, administrative requirements, technical facilitation, fund disbursement, construction implementation, supervision, and reporting were interdependent stages. When beneficiary data were inaccurate, the verification process had to be repeated. When administrative requirements were difficult to complete, fund disbursement was delayed. When technical assistance was limited, beneficiaries had difficulty preparing and implementing reconstruction plans. When third-party implementation was weakly controlled, the quality and completion of housing reconstruction were affected. These findings support the argument that Lean Construction can provide an analytical perspective on the implementation of post-disaster housing reconstruction. In conventional reconstruction management, delays and quality problems are often treated

as isolated technical or administrative issues. From a lean perspective, however, these problems are part of a wider process system. Data problems are not merely administrative errors; they are defects in information flow. Complex requirements are not merely procedural obligations; they may become overprocessing if they do not directly support value creation. Limited facilitation is not only a staffing issue; it becomes a bottleneck that interrupts the reconstruction flow. Third-party implementation problems are not only contractual issues; they represent weak stakeholder coordination and value leakage.

The Cianjur case also shows that flexibility in implementation schemes can create both value and risk. Reimbursement, independent reconstruction, and third-party implementation provided options for beneficiaries with different capacities and conditions. This flexibility is consistent with the lean principle of delivering value in line with user needs. However, flexibility must be supported by clear information flow, technical standards, effective coordination, and strong monitoring. Without these supports, different implementation schemes may lead to variation, delays, rework, and quality problems.

Therefore, applying a lean perspective to post-disaster housing reconstruction requires more than adopting lean tools from ordinary construction projects. It requires adapting lean principles to the specific conditions of disaster recovery, where communities face emergencies, institutions operate under time pressure, and reconstruction involves both technical and social processes. In this context, Lean Construction can support post-disaster housing reconstruction by helping stakeholders identify non-value-added activities, improve coordination, reduce process interruptions, and strengthen value delivery for affected communities.

Discussion with Previous Studies and Practical Implications

The findings of this study confirm that post-disaster housing reconstruction is a complex process involving technical, administrative, institutional, and community-related dimensions. This is consistent with previous studies showing that post-disaster reconstruction is often constrained by limited resources, damaged infrastructure, funding limitations, coordination problems, and community-related challenges (Kermanshachi & Safapour, 2019; Rouhanizadeh et al., 2020; Rouhanizadeh & Kermanshachi, 2019; Vahdatmanesh et al, 2022). However, this study extends previous findings by interpreting these implementation problems from a Lean Construction perspective. Rather than viewing these problems only as administrative or technical constraints, this study shows how they function as process interruptions that reduce flow, create non-value-added activities, and weaken value delivery to beneficiaries.

The beneficiary data problem found in Cianjur illustrates how poor information quality can disrupt the entire reconstruction process. Duplicate identity numbers, inconsistent beneficiary data, and repeated verification delayed the determination of eligible households and affected the subsequent stages of administrative preparation and fund disbursement. This finding supports the importance of accurate beneficiary identification and stakeholder coordination in post-disaster recovery. From a lean perspective, poor data quality can be interpreted as a defect in information flow because it creates rework, waiting time, and uncertainty for affected communities.

The administrative complexity found in this study also reflects a common challenge in post-disaster housing reconstruction. Reconstruction programmes require accountability, technical compliance, and transparent distribution of funds. However, when administrative requirements become too complex for affected communities, they may lead to overprocessing and delay the delivery of value. This finding is consistent with studies emphasising the importance of community participation and beneficiary involvement in reconstruction planning (Rasadi et al., 2020; Rasadi et al., 2021). In the Cianjur case, administrative requirements were necessary to ensure technical and financial accountability, but they also created additional burdens for households living in post-disaster conditions. Therefore, administrative procedures should be designed to balance accountability with simplicity and accessibility for beneficiaries.

The limited number of facilitators, technical actors, and skilled workers also shows that human resource capacity is a critical factor in housing reconstruction. Previous studies have identified resource limitations as a major cause of reconstruction delays and project complexity (Kermanshachi & Safapour, 2019; Rouhanizadeh et al., 2020). This study adds that, from a lean perspective, limited technical assistance creates a bottleneck in the reconstruction flow. When the number of facilitators is insufficient relative to the number of damaged houses, beneficiaries may experience delays in document preparation, design support, construction guidance, and supervision. This condition may reduce the quality of reconstruction and undermine efforts to build back better. The third-party implementation problems found in Cianjur show the importance of stakeholder coordination and process control. The involvement of applicators, contractors, or other implementing actors can accelerate reconstruction, particularly for beneficiaries who lack technical capacity. However, weak control over third-party

actors may lead to value leakage, quality issues, and dissatisfaction among beneficiaries. This finding is relevant to previous studies on lean and post-disaster reconstruction, which highlight the need for better coordination, planning, and integration among reconstruction actors (Mojtahedi & Oo, 2012; Haarr & Drevland, 2016; Rad et al., 2022; Gharib et al., 2022). In the Cianjur case, third-party involvement was not inherently problematic, but it required transparent selection, clear responsibilities, performance monitoring, and stronger supervision. The study also contributes to the discussion on the relationship between Lean Construction and post-disaster reconstruction. Previous studies have explored lean principles in shelter rehabilitation, infrastructure recovery, humanitarian supply chains, and post-disaster management processes (El Jazzar & Hamzeh, 2015; Haarr & Drevland, 2016; Upadhyay et al., 2020; Demirkesen, 2020; Rad et al., 2022). However, the application of lean principles to post-disaster housing reconstruction remains limited. This study shows that Lean Construction can serve as an analytical perspective for identifying implementation inefficiencies in housing reconstruction, particularly those related to information flow, administrative procedures, technical support, stakeholder coordination, and quality control.

The practical implication of this study is that post-disaster housing reconstruction should be managed as an integrated process flow rather than as a series of separate administrative and construction activities. First, beneficiary data management should be improved through an integrated, up-to-date database that connects population data, damage assessment, beneficiary eligibility, and field verification. Second, administrative requirements should be simplified through standardised templates and stronger facilitator support so that accountability can be maintained without overburdening beneficiaries. Third, the allocation and workload of facilitators should be planned according to the number of damaged houses and the complexity of community needs. Fourth, technical education on earthquake-resistant housing should be provided early to beneficiaries involved in community-based reconstruction. Fifth, third-party implementation should be controlled through transparent selection, clear contractual responsibilities, digital progress reporting, and performance evaluation. These implications suggest that a lean perspective can support future post-disaster housing reconstruction programmes by helping stakeholders identify where process flow is interrupted, where waste occurs, and where value for beneficiaries is reduced. In this sense, Lean Construction should not be understood only as a set of construction tools, but as a management perspective for improving coordination, reducing non-value-added activities, and strengthening beneficiary-oriented recovery.

CONCLUSION

The study found four main implementation problems in the Cianjur reconstruction process. First, beneficiary data problems, such as duplicate identity numbers and inconsistent data, caused repeated verification and delayed subsequent stages. Second, complex administrative requirements imposed additional burdens on disaster-affected communities and delayed the disbursement of funds. Third, limited technical knowledge among facilitators and skilled workers created bottlenecks in technical assistance and construction implementation. Fourth, problems in third-party implementation, including applicator competition, intermediary involvement, weak fund control, and quality issues, reduced beneficiary satisfaction and undermined efforts to build back better.

From a Lean Construction perspective, these problems can be interpreted as process interruptions that reduce value, disrupt flow, create non-value-added activities, and weaken stakeholder coordination. Data problems represent defects in information flow; administrative complexity reflects overprocessing; limited facilitation creates resource bottlenecks; and weak third-party control creates value leakage and quality risks. Therefore, the implementation of post-disaster housing reconstruction should not be viewed only as a construction activity, but as an integrated process that requires smooth information flow, effective coordination, technical support, and continuous improvement. The practical implication of this study is that future post-disaster housing reconstruction programmes should strengthen beneficiary data management, simplify administrative procedures, balance facilitator workload, provide early technical education on earthquake-resistant housing, and improve monitoring of third-party implementation. These improvements can help reduce delays, minimise non-value-added activities, improve construction quality, and increase the value received by beneficiary communities.

This study has several limitations. First, it focused on a single case study, namely post-disaster housing reconstruction after the 2022 Cianjur earthquake, so the findings may not fully represent all reconstruction contexts in Indonesia. Second, the study used qualitative data from institutional documents, interviews, and field observations; therefore, it did not quantitatively measure the duration, cost, or productivity impacts of each implementation problem. Third, the study interpreted implementation problems through the lens of Lean Construction principles, but it did not test or validate a complete Lean Reconstruction model.

Future research should compare post-disaster housing reconstruction implementation across different disaster cases to identify common and context-specific lean-related problems. Further studies can also develop and validate a Lean Reconstruction framework or model using expert validation, stakeholder assessment, or quantitative performance indicators. In addition, future research may measure the impact of lean-based improvements on reconstruction time, cost, quality, beneficiary satisfaction, and community resilience.

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