

Strategies for Implementing Social Engineering in Self-Managed Village Infrastructure Construction Management

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ABSTRACT

This study analyzes the influence of socio-engineering on construction management effectiveness and formulates strategies for self-managed village infrastructure development in Morowali Regency using an explanatory sequential mixed-methods approach. The results show high levels of both socio-engineering (3.72) and construction management effectiveness (3.69). Statistical analysis reveals a very strong, significant relationship ($R^2 = 0.800$), indicating that socio-engineering contributes 80% to development effectiveness. Key strategies include strengthening community participation, optimizing village assemblies, improving communication, utilizing local resources, and capacity building. However, community participation remains predominantly operational rather than substantive in decision-making processes.

INTRODUCTION

Village infrastructure development is one of the key instruments for improving community welfare and strengthening regional connectivity. In its implementation, the government encourages the use of a self-management model that positions the community as the primary agent of development. This approach aims not only to improve the efficiency of village fund utilization but also to strengthen community empowerment and the sustainability of development outcomes. Theoretically, the self-management method is designed to cut through the bureaucratic chain of commercial procurement and minimize construction costs compared to conventional national standard contractual methods. The self-management model for rural infrastructure development is expected to serve as an effective alternative for supporting infrastructure development in rural areas at a more affordable cost (Praja et al., 2021).

Conventional construction management is often trapped in the pursuit of rigid indicators such as schedule adherence, budget efficiency, and material quality compliance (the triple constraints). This mechanistic approach tends to view local communities as passive objects of development. As a result, various substantive non-technical obstacles arise, such as land ownership boundary disputes, community resistance, and a low sense of ownership – all of which lead to the abandonment of public facilities after construction. Fundamentally, quality defects and physical failures in infrastructure of this kind rarely stem from a single factor but are deeply rooted in human behavior and stakeholder interactions that neglect non-technical risk mitigation aspects (Saeman et al., 2025). Therefore, modern project management in rural areas requires new proactive tools capable of simultaneously aligning technical and humanistic aspects to mitigate the potential for construction failures early on. From a modern development perspective, rural communities must be positioned as active agents of development with the autonomous capacity to determine the direction of meeting their own local needs. In line with this, various studies indicate that the success of rural infrastructure development is influenced not only by technical aspects of construction but also by social factors involving community participation, communication, transparency, and the capacity of village institutions. Conversely, failure to manage social aspects often leads to poor-quality development, conflicts of interest, and a lack of community ownership of development outcomes (Hendrawati & Pramudianti, 2020).

The complexity of construction management in rural areas requires special attention due to limited human resources with technical expertise, isolated locations, and unique on-site risk characteristics. These non-technical factors often create obstacles to achieving quality, cost, and time targets in public infrastructure projects (Anondho, 2019). Ideal rural infrastructure development requires a paradigm shift, in which local communities are no longer passively positioned as beneficiaries but act as active agents with full authority. Aligning engineering governance with the principles of people-centered and participatory development is the cornerstone for achieving local autonomy within a self-management framework (Nauli et al., 2025).

The concept of socio-engineering offers an approach that integrates social and technical aspects into the development process. Through this approach, communities are not merely the objects of development but also act as active participants in the planning, implementation, monitoring, and maintenance of infrastructure (Hafrida et al., 2023).

Morowali Regency is one of the regions actively implementing community-managed village infrastructure development. However, the social dynamics of a heterogeneous community, the development of industrial zones, and differences in village institutional capacity present unique challenges in the application of socio-engineering.

Based on the introduction above, this study aims to analyze how the application of socio-engineering influences the effectiveness of construction management for community-managed village infrastructure and to formulate effective strategies for applying socio-engineering in the construction management of community-managed village infrastructure.

THEORETICAL REVIEW

This study builds upon the academic foundation of a number of previous studies focusing on the socio-technical aspects of construction management, community participation, and the dynamics of rural community development. A review of this literature is essential for mapping out methodologies and key findings, as well as identifying research gaps to be addressed. Thematically, the interrelationship between rural development, technical efficiency, and social approaches has been widely debated in the literature. Firman (2021) asserts that the key to rural development lies in a human-centered, participatory approach that prioritizes local wisdom. Such community-based empowerment not only stimulates economic aspects but also strengthens social, political, and cultural structures by reviving the values of deliberation and mutual cooperation. In this context, the government's role has shifted from that of a primary actor to that of a facilitator, while community-led self-management serves as the driving force behind development.

The argument regarding the advantages of this self-managed model is empirically supported by Praja et al. (2021) through a cost-effectiveness evaluation study of village road projects. Through technical comparisons, it was found that self-managed infrastructure development proved to result in lower costs compared to conventional methods, although the application of technical standards such as SNI remains crucial to ensure efficiency and accountability in the management of village funds. However, on-the-ground realities show that a purely technical approach often fails when it neglects the social dimension. Suryadi et al. (2021) identified that the greatest risk of infrastructure failure actually stems from non-technical or social aspects, such as low-quality human resources, weak oversight, and a work culture that disregards quality specifications. A solution to these socio-technical problems is offered by Saeman et al. (2025), who state that socio-engineering is an integral part of the socio-technical system of construction projects. This approach encompasses interventions targeting worker behavior, organizational culture, communication structures

among stakeholders, and adaptation to external environmental influences so that projects can respond more effectively to the complexities of local dynamics.

In implementing such social engineering at the village government level, transparent governance and effective communication play a central role. Hendrawati and Pramudianti (2020) explain that the principles of participation, transparency, and accountability are the main foundations for fostering social trust in village development. They emphasize that participation in social engineering is not merely the physical presence of community members in deliberations, but rather their emotional engagement, input, and involvement in decision-making throughout all stages of the project. To ensure this meaningful participation can be realized, Permadi and Muis (2021) detail the importance of planning an effective development communication strategy through three adaptive approaches: the use of modern digital media such as WhatsApp groups to accelerate the flow of information; a direct, family-oriented approach using the local language; and structured participatory communication within formal development planning deliberation forums.

Although stakeholder interactions in infrastructure projects have been extensively studied—such as in Lalan’s (2022) research on large-scale projects highlighting conflicts arising from communication gaps—these studies generally still focus on national strategic projects and overlook the unique characteristics of community-managed projects at the rural level. In general, the existing literature has provided valuable insights that a multidimensional approach integrating local actors, technical aspects, and institutions can enhance project sustainability. However, there remains a significant research gap regarding how the dynamics of socio-economic and local legal interactions influence the application of construction technologies in villages. This study aims to fill this gap by focusing on community-managed infrastructure construction management in rural areas. Through a socio-engineering lens, this study will conduct an in-depth analysis of the direct impacts of stakeholder interactions, ranging from the initial land acquisition process and sustainable project management to legal mitigation measures in the event of construction failures.

METHODOLOGY

This study employs a mixed-methods approach using a sequential explanatory design. The mixed-methods approach was adopted to sequentially validate quantitative statistical data with an in-depth understanding of social reality in the field. The combination of these two approaches operationally implements a sequential explanatory design. The selection of this structure is based on the rationale that quantitative statistical findings in the initial phase provide a general overview of the problem but require the support of expanded qualitative data in the subsequent phase to elucidate the existence of the phenomenon in a comprehensive, in-depth, and credible manner. Through this model, the analysis results reflect the validity of the duality of parameters—namely, the generalizability of quantitative data substantiated by the depth of qualitative field data (Justan & Aziz, 2024).

The research locations were purposively selected in five villages in the Bungku Tengah Subdistrict, Morowali Regency, Central Sulawesi, namely

Bahomoleo, Bahontobungku, Bente, Puungkoilu, and Sakita. Data collection in this study employed a mixed-methods approach, beginning with a quantitative phase in which a Likert-scale questionnaire was distributed to 126 respondents, including village officials, community group members, community leaders, and local residents. After undergoing internal validity and reliability testing, the inferential data were analyzed using simple linear regression to test the causal relationship model among variables (Nugraha et al., 2024). To verify these numerical findings, the study proceeded to the qualitative phase through interviews and five separate Focus Group Discussion (FGD) sessions in each village, exploring nine clusters of core questions related to stakeholder engagement, the utilization of local resources, and budget transparency. All narrative data obtained were then analyzed using an interactive method through thematic coding and the tabulation of comparative matrices across villages to produce comprehensive conclusions.

The population in this study was determined through purposive sampling, based on the researchers' judgment regarding which samples were appropriate, useful, and considered representative of the population (Jailani & Jeka, 2023). The respondents consisted of village government officials, members of the Activity Implementation Team (TPK), community leaders, and community members involved in village infrastructure development, totaling 126 people. The informants in this study consisted of village government officials, the Village Consultative Body, the Activity Implementation Team (TPK), community leaders, youth representatives, women's representatives, community group representatives (POKMAS), and village facilitators.

RESULTS AND DISCUSSION

Quantitative Analysis Results

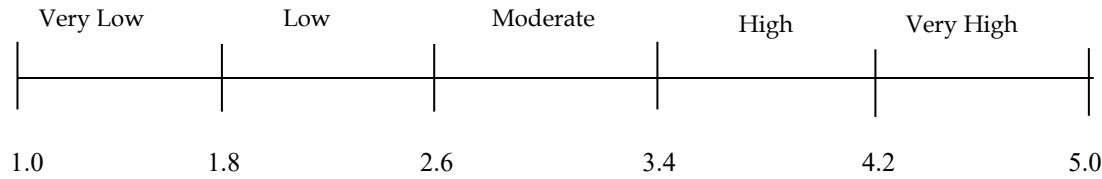
Validity and Reliability of Measurements

Before conducting the simple linear regression test, the research instrument was validated to ensure measurement accuracy. All items in the socio-engineering strategy (X) and construction management effectiveness (Y) variables were confirmed to be valid because the calculated r-values consistently exceeded the critical table value of 0.1466 ($n=126$, $\alpha=0.05$). Reliability testing of the instruments also revealed very strong reliability, with Cronbach's Alpha values of 0.931 for variable X and 0.945 for variable Y. These figures are well above the safe threshold for scientific reporting (0.60), indicating that the quantitative data in this study are free from random measurement error. The acceptable threshold for Cronbach's Alpha in scientific reporting may vary depending on the context of use. Values below 0.60 indicate low reliability, above 0.70 indicate adequate reliability, and above 0.90 indicate very high reliability (Thamrin et al., 2023; Hussey et al., 2020, in Kurniawan et al., 2025).

Mathematical Modeling of the Impact of Socio-Engineering

The descriptive analysis indicates a high level of appreciation among respondents in the five sample villages in Bungku Tengah Subdistrict. The socio-engineering strategy variable (X) recorded a mean value of 3.72, consistent with

the high mean value for construction management effectiveness (Y), which stood at 3.69. The interpretation of mean values in variable frequencies can be based on the following interval and categorical scales:



The relationship between the variables is very strong, as indicated by a correlation coefficient (r) of 0.894.

Through linear regression analysis, the structural equation for the impact was formulated as follows:

$$Y=1,651+0,946X$$

A constant value of 1.651 indicates the baseline level of project management effectiveness when social engineering factors are disregarded. Meanwhile, the regression coefficient of 0.946 demonstrates a massive empirical impact: for every one-unit increase in social intervention, the technical effectiveness of construction management (cost, quality, time) will increase by 0.946 units.

Simultaneously, the coefficient of determination (R^2) obtained is 0.800. These quantitative findings confirm that 80% of the success in the effectiveness of community road, farm road, and drainage construction at the study site is determined by the success of socio-engineering strategies, while the remaining 20% is influenced by technical variables outside the scope of the model. This causal relationship was found to be highly significant, with a Sig. value of 0.000 ($p < 0.05$). This aligns with the theory that the success of construction projects is achieved through joint optimization—that is, the simultaneous integration of social and technical factors. This approach demonstrates that improvements in project productivity, safety, quality, and effectiveness are strongly influenced by an organization’s ability to manage people, technology, and work processes in an integrated manner (Walker et al., 2024). This concept aligns with the socio-engineering approach, which positions social aspects as an integral part of construction management.

Qualitative Analysis Results

Data analysis techniques in qualitative research largely draw on the methods pioneered by Miles and Huberman, known as the interactive data analysis method. Qualitative data analysis involves three stages: data reduction, data presentation, and drawing conclusions (Saleh, 2017, in Qomaruddin & Sa’diyah, 2024).

Data Reduction

The data reduction phase involved selecting, summarizing, and simplifying key information from the interviews and focus group discussions, then grouping it into analytical codes to make it more organized, as shown in **Table 1** below:

Table 1. Thematic Analysis Code

Code	Theme	Meaning
USM	Understanding Self-Management	Public perception of self-management
CP	Community Participation	Community involvement in development
VD	Village Deliberation	Decision-making process
VC	Village Communication	Relationship between the village government and the community
LL	Local Labor	Use of village workers
LM	Local Materials	Use of local resources
LW	Local Wisdom	Cultural values and mutual cooperation
HRC	Human Resource Capacity	Technical capacity of implementers
PA	Project Administration	Project reporting and governance
TRN	Transparency	Transparency of budget information
CON	Conflict	Disagreements within the project
DB	Development Benefits	Socioeconomic impacts of development

Based on the coding process described above, several main themes emerged that help explain how socio-engineering strategies were applied in the construction management of self-managed village infrastructure projects in the five villages that were the focus of this study.

Data Presentation

Public Understanding of Self-Management

The interview results show that most informants understand that self-managed development is a development process carried out independently by the village government, involving the community and utilizing local labor and resources. However, this level of understanding is not uniform across all villages. The villages of Bahomoleo, Puungkoilu, and Sakita demonstrated a relatively good understanding of the concept of self-management as a development process that involves the community from the planning stage through maintenance. In contrast, in Bente Village, the understanding of self-managed development—particularly among village officials—remains limited to the mere execution of physical work. This indicates that the quality of self-managed development implementation is heavily influenced by the level of understanding that village officials and the community have of the concept.

Forms of Social Engineering Implementation

The application of socio-engineering in community-managed village infrastructure development is carried out through various social approaches, such as involving the community, community leaders, and youth and women's

groups in village deliberations, utilizing local labor, and fostering a culture of mutual cooperation. These approaches aim to increase community participation while fostering a sense of ownership over the results of development. This strategy is most evident in the villages of Bahomoleo and Puungkoilu, where the community is actively involved in various stages of the project, from the planning and implementation phases to the maintenance of infrastructure..

The Role of Deliberation in Decision-Making

Village deliberations serve as the primary mechanism in the village development decision-making process, enabling village governments and communities to set development priorities, resolve conflicts, evaluate project implementation, and formulate solutions to the challenges they face (Lase et al., 2025). This deliberation practice is more active in the villages of Bahomoleo and Puungkoilu than in other areas; conversely, the implementation of deliberations in Bente Village has not been optimal, resulting in limited community participation in the decision-making process.

Barriers to the Implementation of Socio-Engineering

The results of interviews and focus group discussions (FGDs) indicate that the implementation of community-managed village infrastructure development still faces several major barriers, such as a shortage of skilled labor due to a lack of technical construction skills among the community, as well as a limited understanding among some village officials and residents regarding the community-managed mechanism itself. In addition, project administration has not been running optimally due to difficulties in preparing financial reports and reports on the physical progress of the project. These challenges are further exacerbated by limited communication between the village government and the community, where such ineffective interaction has the potential to trigger misunderstandings and reduce the level of community participation in development (Nainggolan & Helmi, 2025).

Benefits of Implementing Socio-Engineering

Despite various challenges, the implementation of socio-engineering strategies in village infrastructure development has proven to provide a range of significant benefits to the community, such as increasing residents' active participation, fostering a sense of ownership of the infrastructure built, and creating new job opportunities for the local workforce. Furthermore, this approach helps foster transparency and accountability in the governance of village development. Through this intensive community involvement, the entire development process can proceed more effectively, be better targeted, and be more responsive to the actual needs of the local community.

Inter-Village Thematic Analysis Matrix

Although the mathematical results indicate a dominant contribution of up to 80%, the qualitative picture emerging from the focus group discussions (FGDs) reveals variations in the depth of social engineering implementation at the

grassroots level. A comparison of sociological indicators across villages is presented in **Table 2** below.

Table 2. Comparison Matrix of Qualitative Findings on Self-Managed Development Across Villages

Theme of Findings	Bahomoleo Village	Bahontobungku Village	Bente Village	Puungkoilu Village	Sakita Village
Understanding Self-Management	Good	Fairly good	Limited	Good	Good
Community Participation	Active	Fair	Limited	Active	Fairly active
Village Deliberation	Active	Fair	Insufficient	Active	Fair
Local Workforce	Dominant	Dominant	Dominant	Dominant	Dominant
Project Transparency	Fair	Fair	Low	Fairly good	Fair
Major Obstacles	Technical staff	Labor	Communication	Comprehension	Capacity of the Civil Service

Source: Primary Data Processed by the Researcher (2026)

The results in Table 2 show that in the five study villages, the local labor indicator exhibited a consistent level of dominance. These findings reinforce the results of the quantitative analysis, which indicate a strong relationship between mutual aid practices and budget efficiency. The involvement of local labor in village infrastructure development reduces spending on outside labor, thereby making construction costs more efficient (Praja et al., 2021). However, the effectiveness of implementation in some villages is still affected by poor communication, which is one of the factors hindering the coordination and execution of activities.

Bente Village is the most critical area due to limited understanding, a lack of consultation, and low budget transparency. This confirms the fundamental principle that bottlenecks in information flow and a lack of understanding of the project's administrative system result in suboptimal effectiveness of physical construction on-site. This lack of transparency can be proactively addressed by adopting physical information dissemination models, such as creating transparency banners in public areas and installing technical information boards at each construction site (Hendrawati & Pramudianti, 2020). On the other hand, the villages of Bahomoleo and Sakita have a conducive social climate (active participation), but face major obstacles in the form of limited administrative capacity and a shortage of skilled technical personnel to execute construction blueprints. This phenomenon reinforces the findings of empirical studies that technical efficiency in village self-management schemes absolutely requires support from a supply of trained labor (Juwita et al., 2025).

Qualitative Conclusions

Based on the results of the qualitative data analysis, it can be concluded that socio-engineering has been applied in self-managed village infrastructure development across all study villages, though the level of implementation varies. The villages of Bahomoleo and Puungkoilu demonstrated relatively better levels of implementation because community participation, village communication, and deliberation were more active. Meanwhile, Bente Village showed a relatively weaker application of socio-engineering due to limited communication and understanding of the self-management concept.

The results of this study indicate that the success of community-managed village development is influenced not only by technical aspects of construction but also significantly by social factors such as community participation, village communication, participatory leadership, and the utilization of local resources (Salsabila & Rodiyah, 2026).

Integration of Quantitative and Qualitative Results

The results of the quantitative data analysis and the results of the qualitative data analysis are integrated as shown in **Table 3** below:

Table 3. Integration of Quantitative and Qualitative Findings

Quantitative Findings	Qualitative Findings	Interpretation
High level of social engineering	The community is involved in deliberations and project work	Community participation has been quite good
Highest indicator for local workforce	Project workers are drawn from the village community	Community-managed projects support community empowerment
Lowest indicator for communication forums	Communication by the village government is not yet optimal	Communication mechanisms need to be strengthened
High satisfaction with development outcomes	The community is reaping the benefits of development	Community-managed projects have a positive impact

Based on the results of the integrated quantitative and qualitative data analysis, the questionnaire results are supported by the findings from interviews and focus group discussions (FGDs); thus, it can be concluded that the implementation of socio-engineering strategies plays a significant role in enhancing the effectiveness of self-managed village infrastructure construction management

Although the quantitative analysis results indicate that the effectiveness of construction management falls into the high category, data triangulation through interviews and FGDs reveals the phenomenon of “elite-driven participation” – a condition in which the success of community-managed projects is determined more by the village elite than by the participation of the community as a whole.

From the perspective of Robert Chambers' Empowerment Theory, community participation cannot be assessed solely based on attendance at deliberative meetings or the fulfillment of administrative requirements. Participation that is merely a formality (tokenism) does not reflect a genuine empowerment process because the community does not yet have equal opportunities in decision-making or in the implementation of development (Nauli et al., 2025). Full community involvement in all stages of development is still dominated by village officials and certain groups, while youth groups have not been given adequate space to participate in the technical aspects of development (Peran et al., 2021). Youth representatives confirmed these structural barriers:

"We have not been involved in the infrastructure development process, because the village government has focused more on sports activities and youth development programs. Our involvement is limited to participating in village meetings and oversight, but only on general matters."

Similar discriminatory conditions affect gender representation in rural areas. Women's involvement is systematically suppressed during the initial planning phase, and they are denied access to the managerial implementation phase of village infrastructure development. This was stated explicitly by the Women's Representative:

"Women's involvement is limited to village planning meetings; during the implementation of the project, they are not sufficiently empowered."

Meanwhile, communal balancing elements such as community leaders are assigned a limited oversight role without any technical bargaining power. Community leaders express:

"We were involved in supervising the work, but only in an observational capacity."

This phenomenon of marginalization reveals that the mobilization of mutual aid in the research location is still exploited merely as a means of mobilizing specific labor, without addressing the essence of an inclusive division of labor and an equitable sharing of power. The neglect of formal organizational aspects and the absence of clear job descriptions often lead to overlapping responsibilities and low productivity in the field. If this elite bias is allowed to persist without further social engineering, the community's collective commitment to maintaining and ensuring the long-term physical sustainability of infrastructure post-construction is certain to be fragile. The long-term sustainability of village infrastructure development assets depends heavily on the effectiveness of community-based asset management and a sense of communal ownership that grows from the inclusion of youth and women from the very beginning of the project (Peran et al., 2021).

CONCLUSIONS AND RECOMMENDATIONS

The application of socio-engineering in construction management has been shown to have a very strong and significant impact on the effectiveness of community-managed rural infrastructure development, as indicated by a correlation coefficient of 0.894 and a coefficient of determination ($R^2 = 0.800$), which confirms an 80% contribution. These findings indicate that the effectiveness of development—which encompasses the quality of results, timeliness, cost

efficiency, and community satisfaction – is largely determined by the quality of the implementation of social engineering through strategies that integrate social factors into all stages of the project. This effective strategy is realized through strengthening community participation from the planning and decision-making stages onward; optimizing village deliberations as the primary forum for setting priorities and resolving conflicts; enhancing transparent and inclusive village communication; utilizing local labor and resources to ensure sustainability; strengthening human resource capacity in both technical construction and project administration, and integrating local wisdom values such as mutual cooperation (gotong royong) as the primary social capital for self-managed implementation.

To optimize the success of development efforts, synergy among various stakeholders must be fostered through integrated strategic measures. Village governments are directed to improve the quality of public communication by holding more participatory village deliberations and strengthening the transparency of budget management, in line with expectations that village communities will expand their substantive involvement in planning and oversight, rather than merely acting as operational labor. To support this ecosystem, local governments play a crucial role in providing intensive guidance and periodic training to village officials and Activity Implementation Teams (TPK) to boost the capacity for self-managed construction management at the site level.

FURTHER STUDY

Future research could develop a more comprehensive socio-engineering model by involving more villages and examining other factors that influence the effectiveness of self-managed village development.

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