



Community-Based Routine Road Maintenance as a Strategy to Mitigate Social Inequality in Provincial Road Networks

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Abstract

Background: Road infrastructure development plays a crucial role in fostering economic growth and improving interregional connectivity. However, uneven distribution of benefits can generate or intensify existing social disparities.

Objective: This study aims to analyze the role of community-based routine provincial road maintenance in mitigating social inequality by evaluating maintenance implementation and assessing community participation patterns.

Methods: This study employs a mixed-methods quantitative-evaluative design across 20 provincial road sections in nine districts of West Java Province. Data were collected from 89 respondents for the routine maintenance variable and 140 respondents for the community participation variable.

Results: The evaluation results indicate that all routine maintenance variables fall within moderate to excellent categories, except for the labor factor, which scored poorly (1.65) due to limited availability of certified skilled workers. For community participation, all variables scored moderate to excellent, except the willingness to contribute financially (1.83), largely influenced by low household income. SEM analysis identifies significant variables including shoulder damage level, labor factor, community attendance in meetings, and participatory contributions.

Conclusion: The study concludes that social disparities can be mitigated by increasing community income through operational cooperation between government and villages, enabling communities to participate in routine maintenance—particularly in simple tasks requiring trained local labor.

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INTRODUCTION

Road infrastructure development serves as a driver of economic growth and interregional connectivity (Siatan et al., 2024). Improving roads through road maintenance can boost economic growth and public welfare (Gertler et al., 2024). Road infrastructure also plays a significant role in attracting foreign investment (Bassem, 2025). Improved road connectivity in several countries has had a serious impact on social development, such as the reduction in population density in Canada Rabbi (2025), and the economic growth in China (Bluhm et al., 2025).

However, road construction not only generates economic benefits but also has the potential to create new social inequalities or exacerbate existing ones. These inequalities arise from the unequal distribution of development benefits and impacts among social groups (Junior et al., 2023). These impacts can include economic inequality, rising land values and gentrification, social and cultural change, interregional inequality, and environmental damage.

Road construction improves the mobility of goods and people, creating new economic opportunities for communities along road corridors. High-income communities, however, tend to be more effective in capitalizing on improved access—possessing greater skills, capital, and networks to translate connectivity into economic gain. In contrast, low-income communities living directly alongside provincial road infrastructure often remain marginalized, capturing fewer benefits while bearing a disproportionate share of displacement, environmental, and social disruption costs (Martínez-buelvas et al., 2022). Road construction projects must therefore be designed to be equitable and genuinely beneficial to adjacent communities, not merely to long-distance freight and commercial users (Jussila et al., 2025).

Furthermore, road construction often leads to an increase in land and property values. This situation is highly profitable for large landowners, but it becomes a burden for local communities, who cannot afford the increased taxes or rents. Ultimately, local communities sell their land and move to the outskirts, a phenomenon known as gentrification, where economically disadvantaged groups are displaced by more affluent groups. This phenomenon has occurred in several infrastructure projects around the world, such as the construction of high-speed rail in Japan Yoo (2024), urban development projects in Genoa, Italy Mendonça (2024), urban development projects in Genoa, Italy [9], and the creation of pedestrian areas in Barcelona (Carne & Oriol, 2025).

Road construction often requires large-scale land clearing, which impacts the environment and local livelihoods. Without fair compensation and participatory planning, some local communities may be adversely affected. Low-income residents, for example, are likely to be exposed to higher levels of NO₂ than those with higher incomes. Therefore, sustainable and equitable transportation planning must include reducing environmental impacts and protecting the community socially (Morgado-gamero et al., 2023). Creating new settlements, preventing the eviction of residents, and developing the rural economy are some possible approaches (Gocer et al., 2024). Furthermore, infrastructure development also has implications for political and state policies (Terrefe & Verhoeven, 2024).

The differential nature of these impacts is critical: while all roadside communities experience disruption from road construction and maintenance, the intensity and permanence of negative impacts are systematically concentrated among low-income households—those with fewer resources to relocate, fewer legal tools to claim compensation, and fewer alternative livelihood options. It is this asymmetric vulnerability, rather than community affectedness per se, that constitutes the social inequality problem this study addresses.

Routine road maintenance is part of road management that aims to maintain road conditions so that they continue to function according to service standards and their planned service life. In Indonesia, provincial road management is carried out by the Provincial Government through three programs: routine road maintenance, road rehabilitation, and road improvement. The routine provincial road maintenance program is implemented independently by the Provincial Government, enabling a social approach.

Routine road maintenance involves the maintenance and repair of roads in good and moderate condition (Regulation of the Minister of Public Works Number 13/PRT/M/2011 Concerning Road Maintenance Procedures, 2011). Road maintenance planning requires digital-

based data Moses (2024), including information on road conditions and financing Roma (2023), and road status Roma (2023), which is necessary to determine the authority for road management. Road infrastructure plays a role in supporting the community's economy and social activities. Therefore, roads play a strategic role in community mobility, distribution of goods, and access to public services, and thus require priority maintenance. The social aspect of routine maintenance implementation begins with the selection of methods and materials for road maintenance. The use of recycled materials Azam (2024) and cold mix asphalt Wang (2024) is one aspect that supports environmental sustainability and reduces disruption to social activities.

Routine road maintenance is carried out in stages, including road condition surveys, program determination, damage inventory, preparation of activity lists, determination of repair methods, and planning of material, tool, and labor requirements (Procedures for Road Maintenance and Inspection, 2011). The implementation of a social approach is carried out by involving local labor, using local materials, and maintaining comfort for road users.

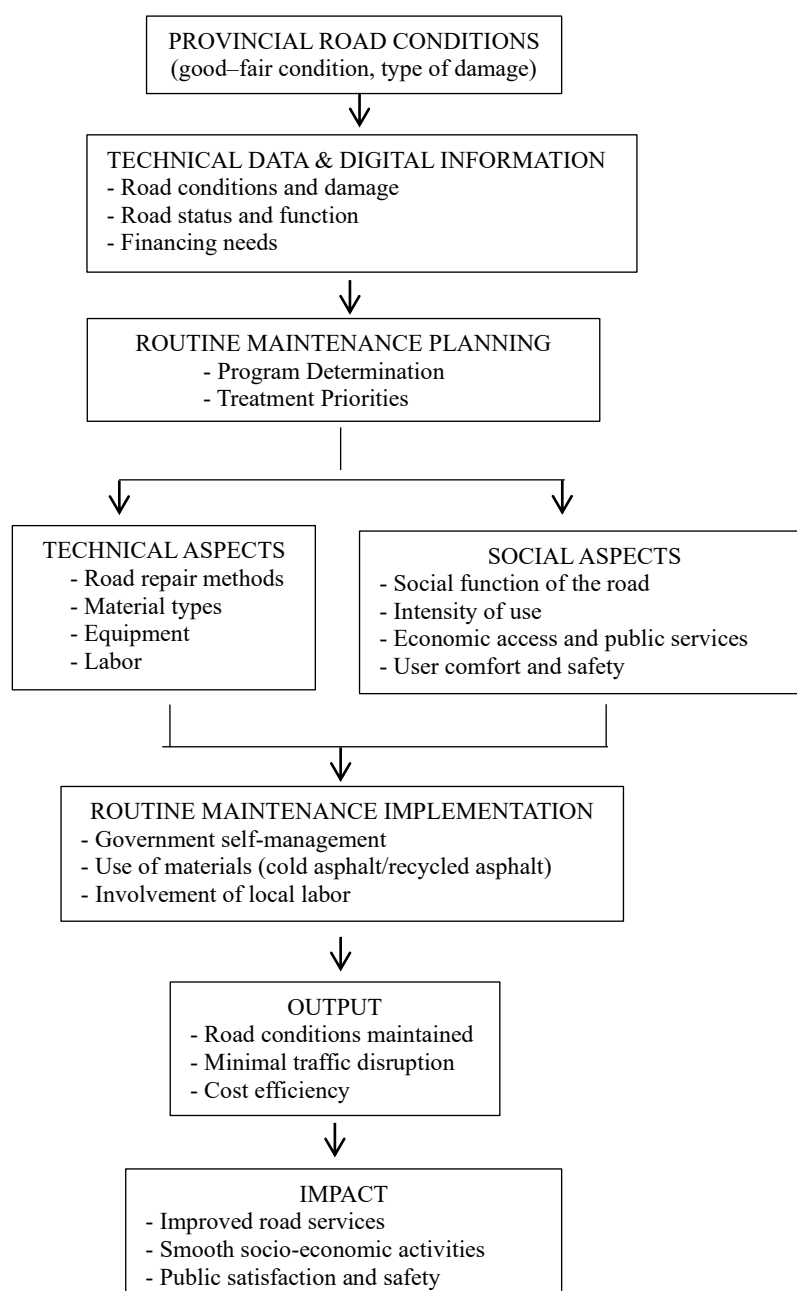


Figure 1. Conceptual Framework for Technical-Social Based Routine Road Maintenance

Community participation in road maintenance is the active involvement of the community in all or part of the road maintenance process. Communities can participate in road maintenance, from planning and budgeting to technical design and implementation ([Law Number 23 of 2014 Concerning Regional Government, 2014](#)). This activity is carried out through collaboration between the government and the community ([Regulation of the Government of the Republic of Indonesia Number 45 of 2017 Concerning Community Participation in the Implementation of Regional Government, 2017](#));([Government Regulation Number 34 of 2006 Concerning Roads, 2006](#)).

In addressing social disparities, community participation serves as an instrument for the equitable distribution of the benefits of road infrastructure as a government asset, ensuring that it is not enjoyed by only a select few but that it also improves the welfare of the wider community. Routine maintenance of provincial roads is carried out annually by the Provincial Government using a self-managed method, but it has not yet fully involved the community. Law of the Republic of Indonesia Number 38 of 2004 has provided opportunities for the community to play an active role in road maintenance ([Law Number 38 of 2004 Concerning Roads, 2004](#)).

This participation has been proven to improve the welfare of residents in Japan Koga ([2024](#)), strengthen community attitudes toward program acceptance, and simultaneously reduce social criticism of the government ([Versigghel et al., 2023](#)). Furthermore, road transportation has a significant impact on the realization of social justice Muhoza ([2023](#)) by opening access to economic, social, and public services. Therefore, community participation in road maintenance is an important part of regional governance, which aims to realize community welfare and reduce social disparities through inclusive and equitable infrastructure development.

Structural Equation Modeling (SEM) is a multivariate statistical analysis method used to analyze complex relationships among various variables. This research attempts to address social inequality by incorporating community participation as a crucial factor. SEM allows researchers to examine the relationships among observed variables, latent variables, and measurement models within a single, integrated model framework. Structural equation modeling, also known as causal modeling Lv ([2025](#)), is used to explore whether there are causal or structural relationships between social, economic, and participatory factors and their impact on social inequality.

The SEM approach is used to analyze the direct and indirect influences of the various factors studied Wang ([2025](#)), thus enabling a more comprehensive description of the mechanisms by which community participation influences efforts to reduce social inequality. While SEM does not always establish absolute causality, it emphasizes a comprehensive and integrated analysis of problems Sakulsriprasert ([2025](#)), considering the interrelationships between variables within a system. Thus, the application of structural equation models can reveal various factors that influence community preferences and behavior in supporting development programs Drechsel ([2025](#)), including in the management of road infrastructure, as well as how these factors contribute to achieving social justice and welfare.

Recent studies underscore how complex the relationship between infrastructure development and social inequality can be. A study by Yoo ([2024](#)) shows that, as seen with high-speed rail, the positive relationship between infrastructure development and regional economic value does not come without a cost—namely, higher land prices and gentrification affecting low-income communities due to displacement from areas experiencing new socioeconomic growth. Infrastructure development does not itself reduce inequality but can further strengthen the urban–rural divide; this is especially true in rapidly growing countries with comparatively underdeveloped rural areas ([Chotia & Rao, 2017](#)). These studies provide evidence that infrastructure alone is not a sufficient condition to ensure equitable welfare distribution and, therefore, requires purposeful social intervention.

As described above, road construction can drive economic growth and improve interregional connectivity, but it can create social imbalances for surrounding communities. To address this gap, a study was conducted on provincial roads in the region of West Java, Indonesia. The objective of this study was to identify how participation in provincial road maintenance programs can increase community income and thus address social inequality.

Second, while transportation infrastructure planning is not new in any country or region, one of the novel aspects of this research project is its approach of integrating routine provincial road maintenance and community income improvement as a direct means to tackle social inequality, a linkage that has hardly been addressed thus far.

METHOD

This study employed a mixed-method quantitative-evaluative design across 20 provincial road sections in nine districts of West Java Province. The research was conducted at 20 provincial road sections namely nine districts at the province of West Java, Indonesia (Refer to Figure 2). We chose West Java for the research context, as it is one of Indonesia's most populated and economically active provinces, consisting of a provincial road network going through urban-peripheral and rural-agricultural communities. The range of community characteristics, road maintenance challenges and patterns of participation within districts in the sample (namely highland, lowland, and coastal zones) provide context for variability among findings that can generalized to similar provincial road contexts across Indonesia.

Figure 2 shows the research locations. The research was conducted on 20 road sections spread across 9 districts in West Java Province, Indonesia (Geocurrents, 2025).



Figure 2. Map of Indonesia

Research Variables

Tables 1 and 2 present the variables and indicators of the research variables. The independent variable is the implementation of routine provincial road maintenance. The dependent.

Table 1. Variables of Road Routine Maintenance

Variables	Indicator Variables
Traffic factors (LL)	1. Traffic volume (LL1) 2. Road capacity (LL2) 3. Heavy vehicle mix (LL3)
Road condition (KJ)	1. Pavement condition (KJ1) 2. Shoulder condition (KJ2) 3. Drainage condition (KJ3) 4. Road slope condition (KJ4)
Implementation method (MP)	1. Pavement maintenance implementation method (MP1) 2. Road shoulder maintenance implementation method (MP2) 3. Road drainage maintenance implementation method (MP3) 4. Road slope maintenance implementation method (MP4)
Maintenance material (MT)	1. Type of material according to needs (MT1) 2. Material volume according to needs (MT2) 3. 3. Material quality according to specifications (MT3)

Variables	Indicator Variables
Road maintenance equipment (PA)	<ol style="list-style-type: none"> 1. Type of road maintenance equipment (PA1) 2. Capacity of road maintenance equipment (PA2) 3. Number of road maintenance equipment (PA3)
Power Workforce (UT)	<ol style="list-style-type: none"> 1. Number of workers (UT1) 2. Workforce certification (UT2) 3. Workforce experience (UT3)
Budget allocation (AA)	<ol style="list-style-type: none"> 1. Availability of sufficient budget road maintenance (AA1) 2. Accuracy of budget disbursement (AA2)

Table 2. Variables of Community Participation

Variables	Indicator Variables
Community participation level (PM)	<ol style="list-style-type: none"> 1. Community presence in village planning meetings (PM1) 2. Community presence in implementation (PM2) 3. Community presence in maintenance (PM3)
Contribution of manpower and materials (AM)	<ol style="list-style-type: none"> 1. Contribution of manpower or materials in village planning meetings (AM1) 2. Contribution of manpower or materials in implementation (AM2) 3. Contribution of manpower or materials in maintenance (AM3)
Willingness to participate in road maintenance (KT)	<ol style="list-style-type: none"> 1. Willingness to participate by reporting road damage (KT1) 2. Willingness to help fund road maintenance (KT2) 3. Willingness to participate in implementing road maintenance (KT3)
Community Institutions (KM)	<ol style="list-style-type: none"> 1. Cooperation contract between the Government and the Village (KM1) 2. Cooperation contract between the Government and community organizations (KM2) 3. Cooperation contract between the Government and community groups (KM3)

Data Collection and Analysis

Secondary data were accessed from three provincial-level government agencies, including the West Java Provincial Public Works and Spatial Planning Office (Dinas PUPR), the Provincial Transportation Office, and the Regional Finance Agency for 2022–2024. Road condition records (damage inventory reports), routine maintenance budget allocations, and community workforce participation records were treated as secondary data that further validated or contextualized primary survey findings and that also facilitated the assignment of scores for each maintenance variable according to objective institutional benchmarks.

Structured Likert-scale (1–5) questionnaires were used for collecting primary data on the routine maintenance variables from 89 respondents and community participation variables from 140 respondents. Using a purposive sampling technique, respondents were categorized into four stakeholder groups: government agency officials (B), local village representatives (C), road maintenance practitioners (D), and community empowerment organization representatives, represented by members from two target organizations, namely MBO and public organizations.

The measuring instrument was a Likert scale with gradations from 1 to 5. Data were analyzed using the Structural Equation Modeling (SEM) method with the Partial Least Squares (PLS) technique. The statistical model consisted of Construct Validity Testing (convergent validity), Discriminant Validity Testing (discriminant validity), Construct Reliability Testing (composite reliability), and Structural Model Evaluation. The logic of the links between variables in the study is also theoretically grounded: routine provincial road maintenance (X_1) generates demand for local labor and materials, which, when procurement is designed as a community-based activity, creates income for households living along roadsides.

This income-generation pathway is mediated in turn by community participation (X_2):

when communities are involved in planning meetings (AM1, PM1) and provide labor and non-financial resources (TK2, KJ2), maintenance benefits are distributed more equitably, thereby increasing community income (Y). The hypothesized structural model thus places community participation as a mediator between the quality of maintenance implementation and equity-level mitigation outcomes.

RESULTS AND DISCUSSION

Results

Routine Road Maintenance Evaluation

Routine road maintenance assessment generated scores across all seven latent variables that constitute the study's road maintenance implementation construct. The subsequent section outlines selected findings, especially for variables that diverged substantially from the range of moderate-to-excellent performance that most indicators reflected.

Assessment of routine road maintenance evaluates the accomplishment of regular maintenance tasks on provincial roads using various relevant variables. Evaluation data were collected through questionnaires and interviews directed towards respondents actively or passively involved in routine provincial road maintenance. These variables, listed in Table 1, combine not only technical factors but also social ones by measuring how fairly the benefits are shared among the community.

Results of the evaluation showed that implementation of road maintenance in provincial roads is categorized into moderate, good, and excellent levels. These results serve as evidence that upkeep was performed per technical standards and in aid of public access and mobility. Maintaining road access contributes to the reduction of social disparities for communities with low transportation access and in rural areas. These scores from moderate-to-excellent levels suggest that the infrastructure management maintenance program is functioning adequately as an operational compliance-based mechanism against the prescribed technical maintenance standards across most variables. The analysis of participation and the results of the SEM-PLS model presented in the following sections answer this question, namely whether this quality of maintenance translates into better community welfare and lower social inequality.

By contrast, Paralimni scored low on TK2—the certified workforce indicator—with 1.65 (the lowest of all indicators). This score also reflects the overall small number of workers with recognized skilled labor certificates within the study area, suggesting a structural competency gap in the maintenance workforce. This is notable, because TK2 subsequently turned out to be one of the significant predictors ($t = 2.076$, $p = 0.038$) in the SEM-PLS model, and confirmed that quality of workforce tracks with structural measures of effectiveness for community-based maintenance rather than just being a technical matter.

The EU approach to social sustainability makes clear that the transport worker must decarbonize as well as be made socially sustainable (Mejía & Allen, 2024). It means improving communication, training of workers and strengthening good work organization (Kerzhner, 2023). A skilful workforce brings efficiency in the function and decreases road maintenance cost Moses (2024) while also creating space for reliable job opportunities, rise in income levels, and eliminates social disparities among regions.

Hence, upgrading not only the skill level of routine maintenance workers at the provincial level but also creating a system of certification positions road maintenance not merely as a mundane technical operation, but as an effective tool for inclusive social development.

Community Participation Evaluation

Community involvement was measured along four main clusters of variables: planning participation, material contribution, organizational commitment, and financial willingness. The following summarizes some of the key patterns from the evaluation scores (Table 2).

This assessment of community participation in road maintenance measures the level of community involvement using specific variables. Evaluation data are gathered by observing the magnitude of community engagement in road maintenance activities, which we summarize in Table 2. The significance of community participation in the management of road maintenance is

that it provides an opportunity for social empowerment and guarantees equitable distribution of the benefits of infrastructure development to all sections of underserved groups in terms of access to infrastructure and resources.

Based on the assessment results, the level of community participation in road maintenance received moderate, good, and excellent evaluation categories. This usually means the community has been engaged in road works through direct and indirect participation. Such is the context in which this participation plays a key role in narrowing social inequalities, helping to create a sense of identity and ownership for local communities, as well as bolstering the relationship between citizens and road administrators, especially where there are high levels of dependence on road infrastructure.

However, the indicator measuring the variable of willingness to participate in road management received a low score of 1.83 for willingness to help fund road maintenance. The overall low income of the community leads to their being unable to contribute financially. This reality is indicative of economic cleavages that shape the modalities of public engagement. These limitations must be framed not as low levels of public awareness, but as society's limited financial capacity, which curtails the space for meaningful economic participation.

Public participation can still be increased through non-financial contributions that have a positive impact Harris (2025), such as involvement in supervision, light maintenance, and the expression of aspirations. Furthermore, the delivery of government information through social media has been shown to significantly influence public willingness to participate Pai (2025), as it can reach various social strata more evenly. Support for technological capabilities also has the potential to attract broader stakeholder participation Li (2025), including previously less engaged community groups. Furthermore, the establishment of community forums can be an effective collaborative platform to increase public participation Boyle (2025), while simultaneously reducing social disparities by providing a space for dialogue and equal involvement for all community groups.

Structural Equation Model Analysis

Figures 3 and 4 present the structural equation models for provincial road routine maintenance implementation and community participation, respectively. The study on provincial road routine maintenance incorporates seven latent variables, namely road damage (KJ), implementation methods (MP), road materials (MJ), maintenance equipment (AJ), maintenance workforce (TK), traffic factors (LL), and budget allocation (AA). Each latent variable is represented by a different number of indicators.

The research model was developed based on the workflow and stages of provincial road routine maintenance activities, integrating all relevant variables and their associated activities. The model was subsequently analyzed using a component-based Structural Equation Modeling (SEM) approach with SmartPLS software (Partial Least Squares). The analysis revealed varying factor loading (FL) values for the relationships between latent variables and their indicators.

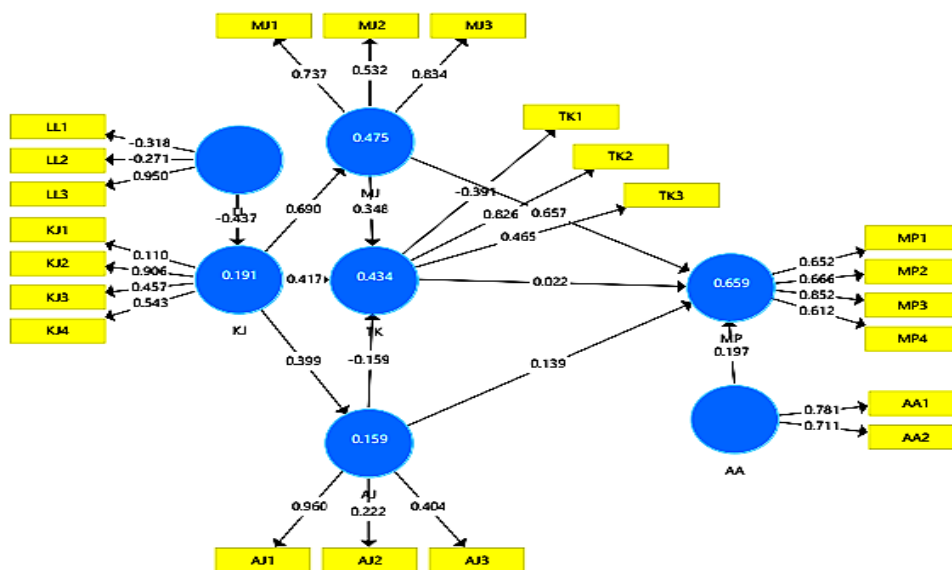


Figure 3. Research Model of Routine Road Maintenance

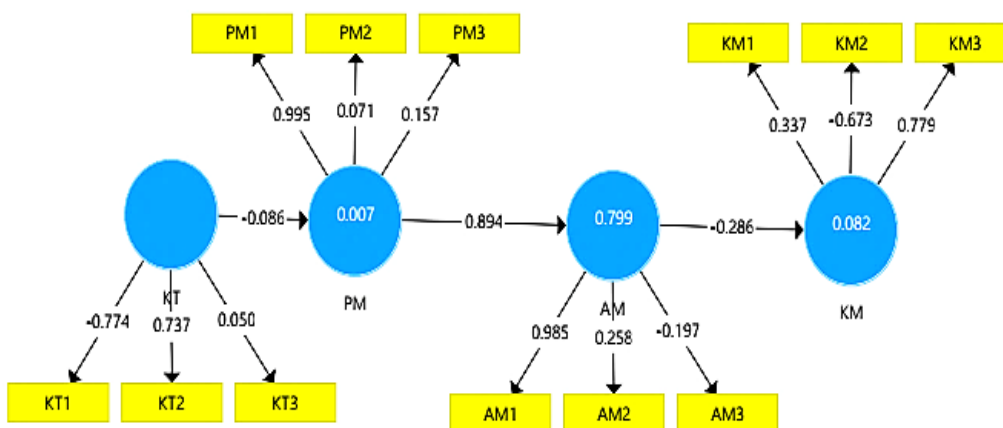


Figure 4. Research Model of Community Participation

Indicator validity was assessed based on factor loading values, where indicators with FL values below 0.50 were excluded from the model. As a result, the initial research models presented in Figures 3 and 4 were modified. Furthermore, the significance of the relationships among latent variables was evaluated through a bootstrapping procedure by examining the T-statistics and p-values, leading to further refinement of the research model.

Data analysis proceeded with an evaluation of the measurement model (outer model), including assessments of convergent validity, discriminant validity, and construct reliability, followed by evaluation of the structural model (inner model). The results indicate that several variables achieved statistical significance, with T-statistics exceeding 1.96 and p-values below 0.05.

Table 3 summarizes the analysis results for variables related to provincial road routine maintenance implementation, while Table 4 presents the results for community participation variables. At a confidence level exceeding 95% and a significance threshold of 5%, the significant indicators identified in the road maintenance model were the level of road shoulder damage (KJ2) and the workforce factor (TK2). In the community participation model, the significant indicators were community attendance in planning deliberations (AM1) and community contribution participation (PM1).

Table 3. Results of Routine Road Maintenance Variable Analysis

Variabel	Original Sample	Sample Mean	Standard Deviation	T Statistic	P Values
KJ2←KJ	0,909	0,690	0,418	2,173	0,030
KJ3←KJ	0,303	0,201	0,439	0,691	0,490
KJ4←KJ	0,862	0,480	0,593	1,455	0,146
TK1←TK	-0,196	-0,099	0,452	0,435	0,664
TK2←TK	0,994	0,627	0,479	2,076	0,038
TK3←TK	-0,174	0,124	0,646	0,269	0,788

Table 4. Results of Community Participation Variable Analysis

Variabel	Original Sample	Sample Mean	Deviasi Standard	T Statistic	P Values
AM ₁ ←AM	0,993	0,951	0,101	9,832	0,000
AM ₂ ←AM	0,219	0,204	0,198	1,103	0,271
AM ₃ ←AM	-0,170	-0,159	0,339	0,501	0,616
PM ₁ ←PM	0,992	0,947	0,102	9,732	0,000
PM ₂ ←PM	0,080	0,061	0,240	0,334	0,739
PM ₃ ←PM	0,181	0,149	0,326	0,555	0,579

Discussion

Cooperation in Routine Road Maintenance

Indonesian citizens have equal opportunities to participate in the management of government assets, including provincial roads, which are government assets that must be maintained sustainably ([Regulation of the Government of the Republic of Indonesia Number 45 of 2017 Concerning Community Participation in the Implementation of Regional Government, 2017](#)). Therefore, community involvement in routine road maintenance not only aims to increase the effectiveness of road maintenance but also plays a crucial role in reducing social disparities through community empowerment and equitable distribution of development outcomes.

The willingness of the community to participate in routine road maintenance activities was obtained from the results of a respondent survey. A total of 67% of respondents agreed, and 22% strongly agreed to play a role in routine provincial road maintenance. This high level of public interest demonstrates the strong potential for participation. On the other hand, respondents expressed a reluctance to provide financial assistance, and community participation was preferred in non-financial roles, such as reporting road damage. This reflects the community's limited economic capacity, making roles in the form of labor assistance and activity supervision a more acceptable alternative for reducing social disparities.

Among the 89 maintenance respondents and 140 community participation respondents, a substantial majority expressed willingness to engage in routine road maintenance activities: 67% agreed and 22% strongly agreed to participate in provincial road maintenance roles.

Community participation in routine road maintenance can be realized through collaboration between the government and the community. Based on the survey results, 89% of respondents agreed that collaboration between the government and villages is the primary form of community participation. However, 49% of respondents preferred cooperation between the government and community groups, while 7% approved of cooperation contracts between the government and community organizations. This community opinion indicates that village-level institutions and community groups are considered the most effective and reliable in bridging the gap between government program implementation and community aspirations, as well as expanding community access to development benefits.

Implementation of government infrastructure development in Indonesia must be carried out through the procurement of goods and services. This procurement can be carried out through self-management or service provider methods ([Presidential Regulation Number 16 of 2018 Concerning Procurement of Government Goods/Services, 2018](#)). One form of self-management

relevant to community participation is type IV self-management, in which planning is carried out by the government, while implementation and supervision are carried out by community groups. This method also allows communities to play a direct role in land management and compartmentalization Pugsley (2025), while still adhering to government programs and technical design standards (Eze et al., 2024). This approach has the potential to create a more equitable distribution of employment opportunities and increase the capacity of local communities.

SEM-PLS analysis identifies cooperation between government and villages as the participation model with the highest stakeholder endorsement—89% of respondents indicated it as their preferred arrangement. From a structural standpoint, the significant indicators identified in the model (KJ2: shoulder damage level, $t = 2.173$; TK2: certified workforce, $t = 2.076$; AM1: community contribution to planning meetings, $t = 9.832$; PM1: community attendance at planning meetings, $t = 9.732$) collectively suggest that community-government collaboration in road shoulder maintenance and planning participation are the most structurally coherent pathways for translating routine maintenance into community-level income opportunities. The evidence supports, rather than proves, that government-village cooperation is an effective implementation model—further confirmation would require longitudinal income data from participating communities.

CONCLUSION

The results of this study provide important evidence suggesting that community-based routine provincial road maintenance is a viable option to address structural social inequality in West Java through income generation from labor participation, framed within government-community collaboration. Results suggest moderate to high maintenance performance, but certification of the workforce limits potential quality and local employment opportunities; in addition, community willingness to participate—especially non-financially—contrasts with low financial contributions.

The SEM-PLS analysis reveals that quality of workforce and participation in planning processes are the two most significant attributes driving maintenance efficiency and community engagement, suggesting that equitable distribution of benefits is better achieved through competency development and participatory governance than infrastructure investment alone. This study was restricted by proxy measures of inequality, cross-sectional design, and regional scope, which suggests that generalizability and policy impact should be improved in future studies through the use of longitudinal income and wealth data across multiple geographical regions, as well as a more developed understanding of how workforce certification systems work.

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AUTHOR CONTRIBUTION STATEMENT

Yudi Sekaryadi conceptualized the research, designed the methodology, and led the overall study. Wimpy Santosa and Caroline Sutandi contributed to the development of the theoretical framework and data analysis using Structural Equation Modeling (SEM-PLS). An Anisarida and Ida Farida were responsible for data collection, field surveys, and questionnaire distribution. All authors contributed to data interpretation, manuscript writing, and final approval of the published version.

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