SSRG International Journal of Civil Engineering
ISSN: 2348-8352/ https://doi.org/10.14445/23488352/IJCE-V13I7P104

Volume 13 Issue 7, 53-63, July 2026

Original Article

Integrating Socio-Cultural Factors into Construction Schedule Delay Analysis: A PLS-SEM Study on Public Housing Projects

Mardiaman[1], Minson Simatupang[2]

[1]*Department of Civil Engineering, Universitas Tama Jagakarsa, South Jakarta, Indonesia.*
[2]*Department of Civil Engineering, Halu Oleo University, Southeast Sulawesi, Indonesia.*

[1]*Corresponding Author : mardi240967@gmail.com*

Received: 07 February 2026 Revised: 25 March 2026 Accepted: 19 June 2026 Published: 29 July 2026

Abstract *- Schedule overruns represent a continuing problem in public housing construction, in which the performance of projects is determined not only by laboratory conditions determined in technical or management approaches but also by context-sensitive societal and other mores. Despite the fact that previous works mostly centre on operational and environmental aspects as explanatory variables of delay, very few quantitative models directly include socio-cultural factors. Notably, the collective effects of internal, external, managerial–administrative, and socio-cultural factors on construction schedule delays are tested in this study through the application of Partial Least Squares Structural Equation Modeling (PLS-SEM). Data were collected by 99 professionals involved in public housing projects. The measurement model assessment indicates satisfactory reliability and validity. Structural analysis reveals managerial and administrative factors having the greatest effect on schedule delays (β = 0.365, p = 0.001), with socio-cultural factors having the second highest relationship with system delay (β = 0.261, p < 0.001), followed by internal factors (β = 0.259, p = 035) and external factors (β = 0185, p=48). The model explains 27% of construction schedule delay variance (R^2 = 0.270), showing moderate explanatory capacity for socio-organization study contexts. The outcomes suggest that the schedule performance in public housing projects is more influenced by the quality of governance and community dynamics than technical or environmental aspects. This study extends delay analysis frameworks by proposing an explicit consideration of socio-cultural variables as a latent construct, which also provides useful insights for realistic approaches to involve stakeholders and strengthen the administration in schedule management activities.*

Keywords *- Construction delay, PLS-SEM, Project schedule performance, Public housing, Socio-cultural factors.*

1. Introduction

Schedule performance is a critical predictor of success in public housing construction projects. In publicly funded housing, delays often lead to cost escalation and contractual disputes, with direct implications for the timely provision of housing services to the community. Unlike commercial projects, public housing is closely tied to social welfare objectives; therefore, schedule delays can generate broader socio-economic consequences [1-4].

Most studies that have been done on the topic of construction delays currently concentrate on the role played by technical shortcomings, unavailability of resources, inefficiency in management, and others like weather conditions and governmental laws. These variables have been tested in depth utilizing both qualitative and quantitative approaches to determine their impact on the scheduling process [5-10]. However, in the context of public housing construction, which is highly community-oriented, existing may be insufficient to fully explain the causes of delay. Recent studies indicate that non-technical and sustainability-related factors play a crucial role in construction performance, yet their influence is often overlooked in many delay models [1, 11, 12].

Public housing constructions take place in a socially sensitive environment where issues of land ownership and community hostility arise. This reflects an ongoing trend to move by narrowly technical towards more integrated socio-organizational perspectives in the construction management research community. These conditions emphasize the growing impact of socio-cultural dynamics forces on construction project performance.

These socio-cultural conditions can impede site access, slow mobilization and extend negotiations among stakeholders and surrounding communities [13, 14]. While prior research acknowledges the highlighting of stakeholder

engagement and social acceptance in infrastructure development [15, 16], these factors are often not explicitly integrated into quantitative models of project delay. However, socio-cultural dimensions are frequently treated descriptively and rarely incorporated as explicit latent constructs in quantitative delay models.

Although there have been increasing calls for attention to the risks associated with stakeholders, past empirical work has tended to view socio-cultural issues as secondary or even qualitative elements rather than incorporate them into sound quantitative modeling approaches.

This points to a significant gap in the literature, aligned with public housing efforts that require considerable and inescapable engagement of communities. Furthermore, existing delay models are limited to technical and managerial domains and do not consider the socio-cultural aspects of public housing development.

In this regard, the current study proposes a conceptual model that integrates socio-cultural elements as one of the key variables used in estimating the impact of delays with the help of a PLS-SEM approach to empirically test its relative highlighting compared to conventional delay predictors. On the contrary to other former works, this investigation mainly proves the role of socio-cultural factors as significant constituents of project schedule behavior.

Such arising issues are specifically relevant in developing countries where land management rules, informal community systems, and socio-political struggle could affect construction project execution greatly. In the absence of formal modeling of these factors, traditional delay analysis models are likely to underestimate their impact on construction schedule delays.

Thereby, an integrated strategy will be required for analyzing the influence of these factors on construction project delays. In this connection, the joint effects of internal, external, managerial–administrative, and socio-cultural factors on delays in public housing construction projects are tested through the application of Partial Least Squares-Structural Equation Modeling (PLS-SEM). In this study, socio-cultural factors are explicitly defined as an independent latent variable, thereby contributing to the existing body of knowledge in delay analysis, which has traditionally been dominated by technical and managerial perspectives.

Objectives of the outcomes of this study attempt to add value to the field of construction management through insights by this empirical study on the highlighting of social-cultural variables compared to the conventional variables that cause delay. Practically, the outcomes provide valuable insights for policymakers, contractors, and project managers involved in public projects on how to incorporate social risk factors into schedule management.

2. Literature Review and Hypotheses Development

This research takes an integrative approach that integrates both project management theory and social system theory to help comprehend the complex reality of construction delay, where project performance is not just about effectiveness but also about social processes and the institutional setting. by a project governance perspective, delays occur when coordination is insufficient to effectively align the interests and processes of the various parties involved.

Furthermore, based on the social system theory, construction projects should be regarded as an open system within a bigger socio-cultural environment. So community relations, culture and relationship among stakeholders become significant enough.

Integrating the theoretical lenses offers the fundamental insights required to consider socio-cultural context in delay analysis, particularly as community engagement is high among public housing projects.

2.1. Construction Schedule Delay

Delay in the construction schedule is defined as the inability to perform certain project tasks within the stipulated period according to the contractual agreement. In public-sector projects, delays often lead to cost escalations, contractual disputes, and inefficiencies in service delivery [1-4]. However, in the context of public housing, such delays have implications that extend beyond financial considerations alone.

In previous research on delay, a number of factors have been found to contribute to delay, and these have been broadly categorized into internal, external, and managerial factors [5, 8, 13]. While these factors are widely acknowledged, most empirical models remain dominated by operational and organizational variables.

Socially embedded factors, particularly those emerging by community interactions, are often discussed qualitatively but are less frequently operationalized and quantified as empirical constructs.

The execution of projects within the context of close cooperation with neighboring communities and socio-political systems results in a conceptual disconnect when analyzing public housing project delays. In order to bridge this conceptual disconnect, sociocultural factors need to be incorporated into thorough analytical methods.

Recent international research across Asia, Africa, and the Middle East indicates that socio-cultural and stakeholder-related factors are becoming increasingly important determinants of construction delays in developing countries.

2.2. Internal Factors

Internal factors represent project-specific conditions that are directly handled by the executing organization. These include design clarity, drawing changes, equipment readiness, labor adequacy, material availability and cost feasibility. Empirical research in popular forums regularly identifies shortcomings in these as a key driver of productivity loss, rework and hence schedule slippage.

Frequent iteration and changes in design, redesign issues disrupt workflow continuity and tend to require rework or corrective actions. Likewise, a shortage of skilled labor and delays in building material delivery impact operational efficiency and lengthen task durations. by a production and resource-based perspective, these elements are theoretically linked to schedule delays because they directly affect core project execution processes.

Accordingly, the following hypothesis is proposed:
H1: Internal factors significantly affect construction schedule delay.

2.3. External Factors

External variables include the factors that are not directly affected by project management. Such factors include weather conditions, soil types, government regulations, and accessibility of the site. In this vein, delays associated with weather conditions and ground characteristics have been suggested to contribute to setbacks in foundation and structural construction, particularly in housing and infrastructure projects [7, 13-16].

In addition to internal variables, external factors often necessitate the use of adaptive scheduling techniques rather than relying solely on managerial control. While contingency planning may mitigate some impacts, the uncertainty associated with environmental conditions continues to pose challenges to timely project delivery [19]. Therefore, external constraints remain a theoretically valid determinant of schedule delay.

The paraphrasing service ran into an issue twice, so I'll give you a clean, humanized version directly:

Based on this explanation, the second hypothesis is formulated as follows:

H2: External factors have a significant impact on construction schedule delays.

2.4. Managerial and Administrative Factors

Managerial and administrative factors encompass issues related to coordination, communication, control systems, decision-making, and payment processes. The project performance literature highlights that inadequate coordination among project participants can increase the likelihood of approval delays, scheduling errors, and ineffective resource management [17-19].

From an organizational theory perspective, managerial tools represent the integration structure that helps coordinate planning and implementation processes. Although the available technical resources might be adequate, improper management practices and administrative delays may outcome in a build-up of scheduling discrepancies. In public projects, in particular, administrative activities and hierarchy-based decision processes might influence delay rates [20-22].

Therefore, managerial and administrative effectiveness is expected to exert a significant influence on schedule performance.

H3: Managerial and administrative factors are significant in the delay of the construction schedule.

2.5. Socio-Cultural Factors

Socio-cultural factors refer to community-related and contextually embedded influences that affect project implementation. These include land ownership issues, traditional land claims, community opposition, safety concerns, and levels of community support. Infrastructure and housing projects developed in socio-culturally complex environments are particularly susceptible to delays arising from land disputes or resistance by local communities [23].

Studies on social license to operate have shown that project continuity hinges on stakeholder acceptance and trust [15]. Poor community support can cause construction work to stall due to protests, inaccessibility or prolonged negotiations. Although their highlighting has been established, these socio-cultural factors are sometimes dealt with descriptively and sometimes incorporated as separate latent variables in delay models.

In public housing projects, where programs directly affect the community, the influence of socio-cultural factors on delay outcomes may be as significant as technical or managerial factors. Modeling these as relations of variables in a structural equation model allows for a full assessment of how they interact to influence project delays. Accordingly, the final hypothesis is proposed:

H4: Socio-cultural factors significantly affect construction schedule delay.

3. Materials and Methods

3.1. Research Design

In this respect, a quantitative research design was taken to test the causal relationships among internal, external, managerial–administrative, and socio-cultural factors influencing construction schedule delays. Data were primarily gathered through a structured questionnaire.

In this connection, Partial Least Squares–Structural Equation Modeling (PLS-SEM) was selected as the analytical approach due to its predictive strength and its capacity to accommodate complex structural relationships and moderate sample sizes [41]. PLS-SEM is particularly well-suited for construction management research due to the theoretical development in the field being somewhat nascent, with the primary focus on this type of research being on estimating the strength and significance of relationships among latent constructs. In addition, because PLS-SEM can be applied for exploratory analysis with new constructs (such as socio-cultural variables) where theories are not strong (Chin, 2010), it appears to fit the adopted exploratory qualitative approach well. In addition, it accommodates non-normally distributed data and smaller samples that align with construction management research.

Moreover, the use of PLS-SEM is well-suited to exploratory analysis with novel constructs, for example, socio-cultural factors, where the underlying theory is not well-established. Furthermore, it allows for the use of non-normally distributed data and smaller samples, which are well-suited to construction management research.

3.2. Population, Sampling, and Data Collection

The study targeted professionals directly involved in public housing construction projects. In that regard, purposive sampling was used to avoid the chance that respondents does not have relevant experience in project implementation and schedule maintenance.

Data was collected from January 2 to February 2, 2026. In total, 99 valid questionnaires were used in the response analysis. The sample size meets the minimal requirement for PLS-SEM analysis, that is, a sample size greater than ten-fold of the biggest number of structural paths directed at a latent development.

Table 1 presents the questionnaire indicators used in this study.

Table 1. Questionnaire indicators

A	**Internal Factor**
A1	Limited human resources (labor) are affecting project delays [24, 25].
A2	Lack of experience of the project team in apartment building construction [8, 22, 26]
A3	Delays in the procurement of building materials. [9, 27]
A4	Lack of coordination among project teams [18-20, 28]
A5	Limited construction tools and equipment [29, 30]
B	External Factors
B1	Extreme weather conditions in Papua affect project progress [13, 14, 16, 31].
B2	Limited modes of transportation for delivering materials to the project site outside the island. [32, 33].
B3	Delays in obtaining permits by government agencies [15].
B4	Social or cultural conflicts around the project site [23, 34-36]
B5	Increase in material prices due to Papua's geography [35].
C	Management and Administrative Factors
C1	Poor project planning [37, 38].
C2	Delays in payment by the employer [19].
C3	Lack of supervision and evaluation of project progress [33].
C4	Changes in design or project scope during implementation [39].
C5	Lack of communication among the project and government parties [25].
D	Social and Cultural Factors
D1	Social conditions [39].
D2	The existence of customary land rights protected by Special Operations [37, 40].
D3	The role of the tribal chief as an individual in a region [25].
D4	The existence of holidays is stipulated in Papua Governor Decree No. 140 of 2008 [37].
	Y = Project Delays
Y1	Project progress is in line with the planned time targets [41].
Y2	Deviations between planned and actual progress often occur [41, 42].
T3	Projects often require additional time beyond the contract schedule [43, 44].

3.3. Measurement of Variables

The research model consists of four exogenous latent constructs and one endogenous construct:

- Internal Factors
- External Factors
- Managerial–Administrative Factors
- Socio-Cultural Factors
- Construction Schedule Delay (endogenous)

Each construct was operationalized in a reflective manner and measured with multiple indicators based on the literature.

In this respect, responses were analyzed utilizing a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Higher scores were interpreted as indicating a greater level of agreement with statements related to potential causes of construction schedule delays.

3.4. Structural Model Specification

The structural relationship among variables is expressed as

$$Y=\beta_1 X_1+\beta_2 X_2+\beta_3 X_3+\ldots.+\xi$$

- Y = Construction Schedule Delay
- X_1 = Internal Factors
- X_2 = External Factors
- X_3 = Managerial–Administrative Factors
- X_4 = Socio-Cultural Factors
- β_1–β_4 = path coefficients
- ε= error term

3.5. Data Analysis Procedure

In this regard, data analysis was performed utilizing SmartPLS software and was carried out through a two-stage evaluation procedure:

3.5.1. Measurement Model Assessment

The conceptual research model is illustrated in Figure 1.

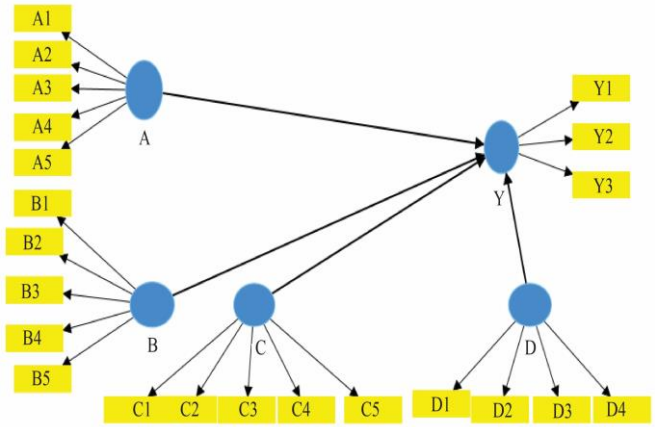

Fig. 1 Model of SEM

In this respect, the measurement model was assessed to verify the reliability and validity of the constructs, and the following criteria were taken:

- Indicator Reliability: Outer loadings ≥ 0.50
- Internal Consistency Reliability: Composite Reliability (CR) ≥ 0.70
- Convergent Validity: Average Variance Extracted (AVE) ≥ 0.50
- Discriminant Validity: Fornell–Larcker criterion

Composite Reliability (CR) was calculated as:

$$CR=\frac{(\Sigma\lambda_i)^2}{(\Sigma\lambda_i)^2+\Sigma\theta_i} \quad (1)$$

Average Variance Extracted (AVE) was calculated as:

$$AVE=\frac{\Sigma\lambda_I^2}{\Sigma\lambda_I^2+\Sigma\theta_I} \quad (2)$$

3.5.2. Structural Model Assessment

The structural model was analyzed utilizing:

- Path coefficients (β)
- Bootstrapped t-values
- p-values
- Coefficient of determination (R^2)
- Effect size (f^2)
- Predictive relevance (Q^2)

The coefficient of determination was calculated as

$$R^2=1-\frac{\Sigma(Y-\hat{Y})^2}{\Sigma(Y-\bar{Y})^2} \quad (3)$$

Effect size (f^2) was computed to determine the relative contribution of each exogenous construct:

$$f^2=\frac{R^2_{included}-R^2_{included}}{1-R^2_{included}} \quad (4)$$

In this regard, predictive relevance (Q^2) was analyzed through the blindfolding procedure. A Q^2 value exceeding zero was interpreted as proof that predictive relevance is exhibited by the model for the endogenous constructs.

3.6. Common Method Bias Assessment

In this respect, Harman's single-factor test was performed to evaluate the potential presence of common method bias. The outcomes revealed that less than 50% of the total variance was described by the first factor, referring that common method bias was not a substantial concern.

By the same token, collinearity was tested utilizing VIF values, which were found to be below 3.3, thereby confirming the absence of multicollinearity.

4. Results and Discussion

4.1. Results

4.1.1. Measurement Model Assessment

In this respect, the measurement model was assessed to verify indicator reliability, internal consistency reliability, convergent validity, and discriminant validity before the structural relationships were tested. All constructs were specified as reflective measures.

Indicator Reliability

Indicator reliability was assessed utilizing outer loadings, with a threshold of 0.50 adopted as the minimum acceptable value. Indicators with loadings below this threshold were removed to enhance construct reliability.

In this regard, the outer loading values of the measurement model are presented in Table 2.

Table 2. Outer loadings of measurement model indicators

Construct	Indicator	Outer Loading
Internal Factors	A1	0.685
	A2	0.882
	A3	0.742
	A4	0.828
External Factors	B2	0.413
	B3	0.550
	B4	0.803
Managerial & Administrative Factors	C2	0.695
	C3	0.665
	C4	0.714
	C5	0.781
Socio-Cultural Factors	D1	0.834
	D2	0.771
	D3	0.664
	D4	0.568
Schedule Delay	Y2	0.812

Indicators B2 (0.413), Y1 (0.455) and Y3 (0.412) were removed due to loading less than 0.50. Since their correlation coefficients are more than the minimum acceptable value, other indicators have good reliability.

Internal Consistency Reliability

In this respect, Composite Reliability (CR) was taken to assess the internal consistency reliability of the model. A CR value exceeding 0.70 was regarded as an indication of acceptable reliability.

Composite reliability is calculated as:

$$CR=\frac{(\Sigma\lambda_i)^2}{(\Sigma\lambda_i)^2+\Sigma\theta_i} \quad (5)$$

where $\lambda_i$represents standardized outer loadings.

All constructs achieved CR values above 0.70, confirming satisfactory internal consistency.

Convergent Validity

In this respect, convergent validity was assessed utilizing Average Variance Extracted (AVE). An AVE value of 0.50 or higher was determined, indicative of the proportion of variance in the indicators that is described by the construct.

AVE is computed as

$$AVE=\frac{\Sigma\lambda_I^2}{\Sigma\lambda_I^2+\Sigma\theta_I} \quad (6)$$

Table 3 summarizes the CR and AVE outcomes.

Table 3. Composite reliability and convergent validity

Construct	Composite Reliability	AVE
Internal Factors	0.86	0.56
External Factors	0.79	0.51
Managerial & Administrative Factors	0.88	0.59
Socio-Cultural Factors	0.90	0.64
Schedule Delay	0.81	0.54

In this respect, the recommended thresholds (CR ≥ 0.70 and AVE ≥ 0.50) were satisfied by all constructs, thereby confirming adequate convergent validity.

Discriminant Validity

In this respect, discriminant validity was assessed utilizing the Fornell–Larcker criterion. The square root of the Average Variance Extracted (AVE) for each construct was found to exceed its correlations with other constructs, thereby indicating that each construct is empirically distinct from the remaining latent variables. These outcomes revealed that there is enough discriminant validity in the measurement model to test the structural one.

Against this backdrop, the measurement model was found to exhibit adequate discriminant validity and was therefore determined suitable for testing the structural model.

4.1.2. Structural Model Assessment

In this respect, the structural model was analyzed by assessing path coefficients (β), t-values, and p-values to determine their significance, alongside the coefficient of determination (R^2), effect size (f^2), and predictive relevance (Q^2), after which the structural model was confirmed.

Path Coefficients and Hypothesis Testing

All the proposed links are positive and significantly associated with each other at the 5% significance level.

Managerial and administrative aspects, sociocultural aspects, internal aspects, and external aspects affect construction schedule delays with β = 0.365 > 0.261 > 0.259>0.185.

Table 4. Structural path coefficients

Hypo	Path	Path Coefficient	t-value	p-value	Outcome
H1	Internal Factors → Schedule Delay	0.259	2.11	0.035	Supported
H2	External Factors → Schedule Delay	0.185	1.98	0.048	Supported
H3	Managerial & Administrative Factors → Schedule Delay	0.365	3.42	0.001	Supported
H4	Socio-Cultural Factors → Schedule Delay	0.261	4.87	0.000	Supported

Coefficient of Determination (R^2)

Explanation strength of the model is measured through the R-squared value:

$$R^2=0.270$$

That is, 27% of the variation in construction schedule delay can be described by internal, external, managerial/administrative and socio-cultural factors (which the model doesn't consider as independent variables).

In PLS-SEM analysis, R^2 values of 0.25 can be deemed weak to moderate in the context of behavioral and socio-organizational studies according to existing guidelines [4]. As such, the model shows sufficient explanatory power given the complexity of construction project environments.

Effect Size (f^2)

The effect size (f^2) was determined to assess the relative impact of each external component on the endogenous variable.

$$f^2=\frac{R^2_{included}-R^2_{included}}{1-R^2_{included}}$$

Outcomes reveal that the managerial, administrative and socio-cultural variables demonstrate medium-sized effect sizes; however, internal and external variables show small effect sizes.

This implies that the incremental refinements in management coordination systems and a well-managed socio-cultural engagement corps are more apt to affect a bottleneck as opposed to a mere technical fix or environmental accommodation.

Predictive Relevance (Q^2)

Blindfolding was used to assess the predictive ability of the model. In this case, the Stone-Geisser Q^2 value obtained in terms of construction schedule delay was higher than zero, implying that the structural model has adequate predictive ability. By the same token, a Q^2 value above zero in relation to construction schedule delays was regarded as proof that the model exhibits predictive relevance.

To confirm the stability of the model, further sensitivity analysis was performed by evaluating changes in path coefficients across subsamples. The outcomes exhibit consistent relationships among constructs and confirm the validity of the estimate of models.

4.2. Discussion

The structural equation modeling outcomes reveal that the construction project schedule delay within the public housing construction project setting depends on both internal and external factors, in addition to managerial-administrative and socio-cultural variables. The four independent variables account for 27% of the variation in schedule delay, as per the coefficient of determination (R^2 = 0.270). Even though the amount of described variance may be deemed moderate, it is acceptable since the study deals with the behavioral and socio-organizational nature of construction management, where project outcomes depend on a number of interplays.

Compared to traditional delay models that primarily emphasize technical and managerial variables, the proposed model demonstrates enhanced explanatory relevance by incorporating socio-cultural constructs. Although previous studies tend to emphasize technical considerations as drivers, the outcomes of this research highlight that socio-cultural factors not only have similar effects with technical aspects but, in some cases, demonstrate stronger impacts, therefore showing us changes among detected causes of delay in public housing projects.

Of the constructs tested, the managerial and administrative factor has the highest standardized parameter estimate or path coefficient, with a β of 0.365; p-value 0.001.

This suggests that schedule compliance is driven by coordination efficiency, decision-making speed, monitoring practices, and administrative effectiveness. Poor communication among contractors, consultants and project owners may outcome in inefficiency in accommodating emerging problems and resource allocations, consequently leading to deviations from the schedule. These outcomes further validate empirical proof that managerial processes function as a key integrative mechanism linking technical planning with on-site implementation [17, 19].

The outcomes obtained by the present study support some of the outcomes of other international studies that emphasize the highlighting of socio-cultural factors in determining delays in project management. In contrast to earlier models on delays that emphasized the predominance of technical aspects, this study shows the dominance of socio-cultural factors in delaying the process of construction. This could probably be due to the distinctiveness of public housing development projects compared to other construction projects.

The outcomes additionally indicate that socio-cultural disruptions operate as systemic risks rather than merely isolated events, propagating across the different phases of project execution. This supports the view that strategies to mitigate delay should focus not only on technical plans but also on proactively engaging with stakeholders and devising holistic social risk management strategies. Socio-cultural dimensions are significant statistically in their effect on schedule delay (β=0.261, $p<0.001$), as well as being one of the most important factors in the model.

Socio-cultural factors show a statistically significant impact on schedule delay ($\beta = 0.261$, $p < 0.001$) and are one of the most important factors in the model. The significance of this coefficient clearly shows that the community-related problems of land, community opposition, and safety problems are not marginal events but represent structurally relevant determinants in influencing time performance in public housing projects.

In conclusion, property disputes and community opposition can hinder construction activities, restrict site access, and prolong negotiation processes. These outcomes provide quantitative support for arguments in the literature on social license and stakeholder conflict, underscoring the highlighting of securing community support for successful infrastructure delivery [18, 45].

Such outcomes have been confirmed by other studies emphasizing the highlighting of stakeholder involvement and alignment by a socio-cultural perspective in the achievement of project success, especially in government-funded projects [12].

The analysis of internal factors confirms a positive relationship among internal variables and schedule delays ($\beta = 0.259$, $p = 0.035$). Factors such as design changes, equipment availability, adequacy of labor supply, and the reliability of material delivery remain critical determinants of schedule performance. However, the slightly smaller coefficient magnitude compared to the managerial variables indicates that technical readiness by itself is not a sufficient condition for schedule stability. Excessive socio-cultural upheaval or inefficient coordination, such as might overcome internal efficiency gains, could be a barrier even if resources and technical plans are forthcoming.

External factors have the least impact, but they remain statistically significant as well ($\beta = 0.185$, $p = 0.048$). Factors including weather conditions, soil properties, site constraints, etc., can affect the construction progress; however, the effect of these factors seems to be relatively limited in this case. This is possibly due to the majority of environmental hazards being predicted at the planning stage and mitigation measures included as part of scheduling changes. However, their ongoing relevance shows that environmental factors are still key drivers of construction delays.

The effect size (f^2) analysis helps to better understand the relative highlighting of each construct. The managerial and socio-cultural constructs have a medium effect size, while the internal and external constructs have a small effect size. This indicates that improvements in the design of the managerial coordination system and effective strategies for socio-cultural engagement are more likely to offer significant improvements in schedule delays than technical or environmental interventions.

From a theoretical perspective, the outcomes suggest that incorporating socio-cultural variables into a structural equation model enhances the understanding of construction delays. Traditional delay models have largely focused on technical inefficiencies and environmental constraints; however, recent outcomes indicate that socially embedded factors also exert a statistically significant influence on project schedules. In this regard, the study extends existing delay analysis frameworks by integrating socio-cultural dimensions in a manner that goes beyond purely operational considerations.

Therefore, from a practical perspective, benevolence about how this study is translated into practice suggests that integrated project managers should make a unique approach for improvisation in public housing projects to prevent delays, such as: encouraging co-creation with suppliers and careful monitoring of these creation days (such as two minutes) rather than weeks, can stop talented demand overruns. Besides the enhancement of planning, monitoring and management of resources, community engagement, conflict resolution and communication must be institutionalized by all stakeholders in the project. This will help decrease risks associated with land-related conflicts and the community, and hence will ensure that the reliability of the schedule is improved.

To sum up, the eyes of the conversation showed that public housing project cycles delay hotspots lie not only in technical inefficiencies, but in the dynamics among managerial capabilities and socio-cultural factors.

5. Practical and Policy Implications

The outcomes of this study have major implications not only for managers but also for policymakers. For managers, stakeholders must include socio-cultural risk assessment in the initial phases of project planning and scheduling. Community engagement, non-aggressive communication and conflict resolution capabilities will be key to minimize any possible disruptions while implementing projects.

On the policy side, governments would need to work on better stakeholder engagement mechanisms and more streamlined administrative processes. They would inevitably improve project readiness and mitigate the risk of delays in implementation, hence the need to include socio-cultural factors as part of feasibility studies.

6. Conclusion

By means of the Partial Least Squares Structural Equation Modelling (PLS-SEM) approach, the determinants of construction schedule delays in public housing projects were investigated through the integration of internal, external managerial-administrative, and socio-cultural factors. The empirical outcomes confirm that all four constructs significantly influence schedule performance. Schedule delays are more largely affected by managerial and administrative factors, socio-cultural, internal, and external factors. The fit among the structural model and schedule delay explains 27% of variance, revealing a moderate level of explanatory power in a socio-organizational project context.

The outcomes clearly indicate that technical factors appear less influential compared to managerial and socio-cultural factors of schedule delays in public housing projects. Instead, the level of governance, coordination, and the social context dynamics play a more important role in determining time performance. In particular, the role of management competence and stakeholder interaction mechanisms plays a crucial role in mitigating schedule risk.

Theoretical Contribution: Beyond conventional variables, the existing literature on construction delays is further enriched by the identification of socio-cultural factors as an independent latent construct. This multi-dimensional framework complements existing delay analysis models and has future applicability especially in social infrastructure projects.

Practically, based on this research some recommendations can be made to project managers and policy makers in order to decrease the problem of schedule delays in infrastructure projects. This study shows that the development of institutional capacity to implement progressive changes is more important than relying on incremental technical improvements. Improving responsiveness, coordination mechanisms, and community outreach (e.g. proactive engagement) are probably going to have greater effects on schedules than resource-based measures.

In the future studies, it may be meaningful to have a stronger conceptual framework including financial risks, political risks, contractual risks to enhance the prediction ability of model.

This study is determined a significant contribution to the literature; nonetheless, certain limitations are acknowledged. Of particular note, a fairly small sample size with a regional focus was taken. Future research might remedy this via larger samples or cross-country comparisons that boost generalizability. Moreover, the use of variables like financial and political risks may improve the model even more.

Funding Statement

Funding for this research was provided by Universitas Tama Jagakarsa. Notwithstanding this support, no role was played by the sponsor in the study design, data collection, analysis, interpretation, or manuscript submission.

References

[1] Aftab Hameed Memon et al., "Investigation of Project Delays: Towards a Sustainable Construction Industry," *Sustainability*, vol. 15, no. 2, pp. 1-17, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[2] Paul Terna Gbahabo, and Oluseye Samuel Ajuwon, "Effects of Project Cost Overruns and Schedule Delays in Sub-Saharan Africa," *European Journal of Interdisciplinary Studies*, vol. 3, no. 2, pp. 46-58, 2017. [Google Scholar]

[3] Raj Kapur Shah, "An Exploration of Causes for Delay and Cost Overruns in Construction Projects: Case Study of Australia, Malaysia & Ghana," *Journal of Advanced College of Engineering and Management*, vol. 2, pp. 41-55, 2016. [CrossRef] [Google Scholar] [Publisher Link]

[4] Philip Kofi Asiwome Segbedzi, "Investigation of Construction Cost Overrun Issues and Management: Evidence from a PublicUniversity in Ghana," *International Journal of Research and Innovation in Applied Science*, vol. 8, no. 7, pp. 76-81, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[5] Abenet Yohannes Hailu et al., "Construction Project Delay Factors of Public Universities in Ethiopia: A Structural Equation Modeling Approach," *Journal of Economics, Management and Trade*, vol. 29, no. 3, pp. 16-34, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[6] Mohammed Aldahash, and Othman Subhi Alshamrani, "Factors Affecting Construction Productivity for Steel Rebar Work in Hot Climate Country," *The Open Construction and Building Technology Journal*, vol. 16, pp. 1-14, 2022. [CrossRef] [Google Scholar] [Publisher Link]

[7] Ibrahim Mahamid, "Principal Factors Impacting Labor Productivity of Public Construction Projects in Palestine: Contractors' Perspective," *International Journal of Architecture, Engineering and Construction*, vol. 2, no. 3, pp. 194-202, 2013. [Google Scholar]

[8] Stephanie Day, and Lynda Corner, "Outcomes from a Digital Literacy Project," *2014: ASCILITE 2014 Conference Proceedings. Rhetoric and Reality: Critical Perspectives on Educational Technology*, pp. 140-149, 2014. [CrossRef] [Google Scholar] [Publisher Link]

[9] Faham Tahmasebinia, and Vicheth Song, "Significant Factors Causing Delay in the Cambodian Construction Industry," *Sustainability*, vol. 14, no. 6, pp. 1-24, 2022. [CrossRef] [Google Scholar] [Publisher Link]

[10] Nesru Serani Dusso, "The Causes and Effects of Delay of Building Construction in Ethiopia, Southern Nation Nationalities of People Region in Gurage Zone (Case of Wolkite Town)," *Civil and Environmental Research*, vol. 12, no. 1, pp. 12-21, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[11] Youcef J.T. Zidane, and Nils O.E. Olsson, "Defining Project Efficiency, Effectiveness and Efficacy," *International Journal of Managing Projects in Business*, vol. 10, no. 3, pp. 621-641, 2017. [CrossRef] [Google Scholar] [Publisher Link]

[12] Saidat Damola Olanrewaju, and Olabode Emmanuel Ogunmakinde, "Waste Minimisation Strategies at the Design Phase: Architects' Response," *Waste Management*, vol. 118, pp. 323-330, 2024. [CrossRef] [Google Scholar] [Publisher Link]

[13] Steven J. Schuldt et al., "Weather-Related Construction Delays in a Changing Climate: A Systematic State-of-the-Art Review," *Sustainability*, vol. 13, no. 5, pp. 1-25, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[14] Chetlapally Balakrishna et al., "Schedule Delay Analysis of a Multi-Storied Residential Project using Primavera," *IOP Conference Series: Materials Science and Engineering: 3rd International Conference on Inventive Research in Material Science and Technology (ICIRMCT 2021)*, Coimbatore, India, vol. 1091, pp. 1-9, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[15] Shabir Hussain Khahro et al., "Delay in Decision-Making Affecting Construction Projects: A Sustainable Decision-Making Model for Mega Projects," *Sustainability*, vol. 15, no. 7, pp. 1-22, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[16] Yukio Nakata et al., "Effect of Drainage and Saturation on Undrained Shear Strength for Compacted Sandy Soils," *E3s Web of Conferences: 7th International Symposium on Deformation Characteristics of Geomaterials*, vol. 92, pp. 1-6, 2019. [CrossRef] [Google Scholar] [Publisher Link]

[17] Noppadon Jokkaw, and Tanit Tongthong, "Factors Influencing O N Safety Management Status and Evaluation of Safety Management Status in Construction Projects in Cambodia," *ASEAN Engineering Journal*, vol. 5, no. 1, pp. 34-48, 2016. [CrossRef] [Google Scholar] [Publisher Link]

[18] Viet T. Nguyen et al., "An Analysis of Construction Failure Factors to Stakeholder Coordinating Performance in the Finishing Phase of High-Rise Building Projects," *Advances Civil Engineering*, vol. 2020, no. 1, pp. 1-14, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[19] João Raimundo, Budi Witjaksana, and Jaka Purnama, "Analyzing the Impact of Contract Value, Project Duration, and Number of Floors on Human Resource Costs in the Agenci Dejenvolvementu Nacional Office Construction Project in Dili Using Multiple Regression," *Asian Journal of Social and Humanities*, vol. 3, no. 6, pp. 1245-1262, 2025. [CrossRef] [Google Scholar] [Publisher Link]

[20] Joy Aṅụrị Okereke, "*Effects of Teamwork in Building Construction Project in Enugu State*," Thesis, Enugu State University of Science and Technology (ESUT), pp. 1-101, 2023. [Publisher Link]

[21] Akanbi Toyin Ibrahim, Abdulrashid Sirajo, and Aliyu Hassan Ibrahim, "The Effects of Delay and Time Management Building Construction: A Review," *International Journal of Scientific Advances (IJSCIA)*, vol. 3, no. 4, pp. 628-632, 2022. [Google Scholar] [Publisher Link]

[22] Nawaf K. Alsohiman, Wael Alattyih, and Husnain Haider, "Ranking of Variation Orders Caused by the Owners of Construction Projects in Saudi Arabia Using Statistical and Fuzzy-Based Methods," *Civileng*, vol. 4, no. 4, pp. 1121-1142, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[23] Zemra Rachid, and Ouafa Saighi, "Measures to Mitigate the Main Causes of Social Housing Delays in Algeria," *Civil and Environmental Engineering Reports*, vol. 33, no. 2, pp. 13-33, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[24] Saidatul Alfena Putri Asyari, and I Nyoman Dita Pahang Putra, "Analysis of Project Delay Using the Fault Tree Analysis (FTA) Method in Rising Building Projects," *CIVED (Journal of Civil Engineering and Vocational Education)*, vol. 10, no. 3, pp. 846-853, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[25] Citra Pradipta Hudoyo, Iwan Rustendi, and Ika Handayani, "Risk Analysis of Pemalang District Road and Bridge Construction Delays," *Applied Research on Civil Engineering and Environment (ARCEE)*, vol. 4, no. 2, pp. 84-94, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[26] Ali Hussien Mohammad, "Enhancing Labor Productivity to Mitigate Time and Cost Overruns in Construction Projects," *International Journal of Environmental Research and Earth Science*, vol. 8, no. 4, pp. 225-235, 2025. [CrossRef] [Google Scholar] [Publisher Link]

[27] Farida Rachmawati, Herdira Dita Ramadhani, and Aulia Shofi Nurhidayah, "Project Delay Risk Assessment," *IPTEK The Journal for Technology Science*, vol. 34, no. 1, pp. 60-71, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[28] Emmanuel Tayo Adu, and Akintayo Opawole, "Assessment of Performance of Teamwork in Construction Projects Delivery in South-Southern Nigeria," *Journal of Engineering, Design and Technology*, vol. 18, no. 1, pp. 230-250, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[29] Pittayaporn Gomarn, and Jakrapong Pongpeng, "Causes of Construction Delay from Contractors and Suppliers in Thailand's Oil and Gas Platform Projects," *MATEC Web Conference*, vol. 192, pp. 1-4, 2018. [CrossRef] [Google Scholar] [Publisher Link]

[30] Mey Midina Suta, and Irfan Prasetia, "Analysis of Delay in Implementation of Work on Road Projects in Highways Division of Katingan Regency," *Technium: Romanian Journal of Applied Sciences and Technology*, vol. 19, pp. 40-49, 2024. [CrossRef] [Google Scholar] [Publisher Link]

[31] Ishwar Adhikari, Soo-yong Kim, and Young-dai Leec, "Selection of Appropriate Schedule Delay Analysis Method: Analytical Hierarchy Process (AHP)," *2006 Technology Management for the Global Future - PICMET 2006 Conference*, Istanbul, Turkey, pp. 483-488, 2006. [CrossRef] [Google Scholar] [Publisher Link]

[32] I. C. Osuizugbo, "Financial Instruments Used in the Financing Construction Project in Nigeria," *Journal of Engineering Research and Reports*, vol. 18, no. 3, pp. 24-35, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[33] Renny Juniati Saktina, and Khoirunnurrofik Khoirunnurrofik, "The Effect of Geographical Conditions on the Role of the Special Autonomy Fund for the Availability of Road Infrastructure in Papua," *Civil Service Development Journal*, vol. 14, no. 1, pp. 111-122, 2022. [CrossRef] [Google Scholar] [Publisher Link]

[34] Guangxi Wu, "Settlement Control Technology of High Filled Soil-Rock Embankment in Alpine and High-Altitude Areas," *Journal of World Architecture*, vol. 7, no. 4, pp. 75-81, 2023. [CrossRef] [Publisher Link]

[35] Ida Samuelsson, Johan Spross, and Stefan Larsson, "Assessment of Climate Impact and Costs Comparing Two Railway Embankment Fill Methods," *5th International Conference on New Developments in Soil Mechanics and Geotechnical Engineering*, pp. 181-189, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[36] Tamoor Azam et al., "An Analysis of Causes of Delay and Cost Overrun in Construction of Hydropower Project," *Journal of Public Affairs*, vol. 22, no. 3, 2022. [CrossRef] [Google Scholar] [Publisher Link]

[37] Ahmad Rayhan, Winda Talita Putri, and Farhan Ardhi Nugroho, "The Urgency of Special Legislation for Indigenous Peoples in Indonesia Strengthening Legal Protection and Cultural Heritage," *Indigenous Southeast Asian Ethnic Studies*, vol. 1, no. 1, pp. 1-16, 2025. [CrossRef] [Google Scholar] [Publisher Link]

[38] Madeline R. Shelton et al., "Critical Social Perspectives in Forest and Landscape Restoration – A Systematic Review," *Frontiers in Environmental Science*, vol. 12, pp. 1-14, 2024. [CrossRef] [Google Scholar] [Publisher Link]

[39] Yara Mattar et al., "The Impact of Change Orders Caused by Legislative Changes on Program Management in the UAE Construction Industry," *Buildings*, vol. 14, no. 5, pp. 1-25, 2024. [CrossRef] [Google Scholar] [Publisher Link]

[40] Feny Fathuri Yan Putri, "Legal Certainty of Indigenous People's Land Rights of Former Customary Land Ownership Evidence After Its Validity Period Expires," *International Journal of Law Dynamics Review*, vol. 3, no. 1, pp. 30-38, 2025. [CrossRef] [Google Scholar] [Publisher Link]

[41] Krystyna Araszkiewicz, and Magdalena Bochenek, "Control of Construction Projects using the Earned Value Method - Case Study," *Open Engineering*, vol. 9, no. 1, pp. 186-195, 2019. [CrossRef] [Google Scholar] [Publisher Link]

[42] Haruhiko Suwa, and Daisuke Morita, "Reactive Project Scheduling Method to Enhance Project Progress Under Uncertainty," *Journal of Advanced Mechanical Design, Systems, and Manufacturing*, vol. 10, no. 3, pp. 1-8, 2016. [CrossRef] [Google Scholar] [Publisher Link]

[43] Ahmed Rasul Hussein, and Sina Fard Moradinia, "Time and Cost Management in Water Resources Projects Utilizing the Earned Value Method," *Journal of Studies in Science and Engineering*, vol. 4, no. 1, pp. 91-111, 2024. [CrossRef] [Google Scholar] [Publisher Link]

[44] Murat Ruhlusaraç, and Filiz Çalişkan, "A Dynamic Multimodal Resource-Constrained Multi-Project Scheduling Problem with Weighted Early and Late Completion: A Real-Life Boutique Furniture Application," *Business & Management Studies: An International Journal*, vol. 10, no. 3, pp. 1095-1117, 2022. [CrossRef] [Google Scholar] [Publisher Link]

[45] Junaid Tariq, and S. Shujaa Safdar Gardezi, "Study the Delays and Conflicts for Construction Projects and their Mutual Relationship: A Review," *Ain Shams Engineering Journal*, vol. 14, no. 1, pp. 1-14, 2023. [CrossRef] [Google Scholar] [Publisher Link]