Beyond Community Welfare: The Moderating Role of Institutions In Sustainable Slum Management In Bengkalis, Indonesia

Imran[1]*, Zulkarnain[2], Suwondo[3], Reni Suryanita[4]

[1]Student Doctoral Program in Environmental Sciences, Universitas Riau, Pekanbaru, Indonesia.
[2,3,4]Lecturer Program in Environmental Sciences, Universitas Riau, Pekanbaru, Indonesia
Coresponden author:
Email: imran.lst79@gmail.com

Abstract.
Sustainable slum management requires an integrated approach that considers community welfare and institutional support. However, the extent to which institutional factors strengthen the relationship between community quality of life and sustainable slum management remains insufficiently clarified in the context of local settlement governance. This study examines the moderating role of institutional factors in the relationship between community quality of life and sustainable slum management in Bengkalis Regency, Riau, Indonesia. A quantitative explanatory design was employed using questionnaire data collected from 86 household heads residing in designated slum areas across 21 villages. The data were analyzed using partial least squares structural equation modeling (PLS-SEM) with SmartPLS 4.0. The results indicate that community quality of life is positively associated with sustainable slum management ($\beta = 0.269$, $t = 3.142$, $p = 0.002$). Institutional factors also exhibit a positive and statistically significant moderating effect on this relationship ($\beta = 0.195$, $t = 3.420$, $p = 0.001$). However, the interaction effect size is small ($f^2 = 0.086$), suggesting that the additional explanatory contribution of institutional factors is limited. These findings indicate that institutional support may strengthen the association between community quality of life and sustainable slum management, although it should not be regarded as a standalone determinant of sustainability. The study highlights the importance of combining community welfare improvements with effective institutional coordination, accountability, and continuity in local settlement-management programs. Given the cross-sectional design and geographically limited sample, the findings should be interpreted cautiously and further examined in other settlement contexts.

Keywords: *community quality of life; institutional factors; slum management; sustainability and PLS-SEM.*

I. INTRODUCTION

Slum settlements remain a persistent challenge to inclusive and sustainable urban development. Inadequate housing, sanitation, drainage, access to safe water, and neighborhood infrastructure can expose residents to overlapping environmental and socioeconomic disadvantages. Indonesian studies have identified settlement density, uneven infrastructure provision, and socioeconomic constraints as important features of urban slum formation [1–5]. International urban-development reporting likewise emphasizes that upgrading underserved settlements involves more than isolated physical improvements [10]. Sustainable slum management, as examined here, concerns the continued functioning and maintenance of settlement improvements alongside residents' well-being and the governance arrangements supporting them. This distinction matters because improvements in the built environment may not be sustained when community needs and implementation capacity are insufficiently integrated.

Community quality of life represents a potentially important social dimension of sustainable slum management. More favorable living conditions may coincide with greater capacity to engage in neighborhood maintenance and support collective settlement initiatives. Yet the association need not be uniform across governance settings: similar levels of community welfare may be linked to different management outcomes depending on coordination, institutional continuity, and implementation support. Integrated planning research reinforces the importance of aligning activities across organizational and sectoral boundaries [6]. Accordingly, the question is not only whether community quality of life is associated with sustainable slum management, but also under what institutional conditions that association is stronger.

Institutional factors refer in this study to the institutional conditions captured by the survey construct, rather than to a direct experimental measure of any single governance reform. Institutional arrangements may

shape responsibilities, coordination, accountability, and opportunities for community participation. Research on community governance in Indonesian slum upgrading highlights the relevance of governance arrangements to the implementation of settlement programs [12]. Evidence on institutionalizing participatory slum upgrading also indicates that participation and public-sector processes need to be considered together [13]. These studies motivate a conditional argument: when institutional conditions are more supportive, community quality of life may exhibit a stronger positive association with sustainable slum management. The empirical implication is a positive interaction between the two constructs, not merely a positive independent association between institutions and management outcomes.

Bengkalis Regency in Riau Province provides a setting for examining this conditional relationship across designated slum settlement locations. The Indonesian regulatory framework identifies dimensions of settlement inadequacy relevant to planning and upgrading, including buildings, roads, water supply, drainage, wastewater, solid waste, and fire protection [11]. Nevertheless, these regulatory dimensions are criteria for identifying and addressing settlement conditions; they should not be confused with the three latent variables measured in this study. The local context is analytically useful because community welfare and institutional support must be considered within the same settlement-management setting, although a single-regency study cannot establish the generality of the relationship elsewhere.

Existing studies cited above provide valuable explanations of slum conditions and strategies for upgrading [1–6], while governance-oriented research emphasizes participation and institutional arrangements [12], [13]. What remains insufficiently tested in the present study setting is whether institutional factors condition the association between community quality of life and sustainable slum management. This is a narrower and more testable gap than a claim that institutions have never been studied in slum upgrading. The proposed contribution is therefore an empirical test of institutional moderation in Bengkalis, accompanied by an assessment of the magnitude, not only the statistical significance, of that interaction. This contribution should be interpreted as context-specific evidence rather than a new universal theory of settlement governance.

This study addresses two research questions: (1) Is community quality of life positively associated with sustainable slum management in Bengkalis Regency? (2) Do institutional factors positively moderate that association? Correspondingly, H1 proposes a positive relationship between community quality of life and sustainable slum management, and H2 proposes a positive interaction between community quality of life and institutional factors in explaining sustainable slum management. The hypotheses were examined using questionnaire responses and partial least squares structural equation modeling (PLS-SEM).

II. METHODS

Research Design and Study Setting

This study employed a quantitative explanatory design to examine the relationship between community quality of life and sustainable slum management and to assess the moderating role of institutional factors. The study was conducted in designated slum settlement areas in Bengkalis Regency, Riau Province, Indonesia. The study locations comprised 21 villages designated as slum areas under the relevant decrees of the Regent of Bengkalis. Data collection took place from October 2024 to February 2025, followed by data testing and analysis from February to June 2025.

Population, Sample, and Data Collection

The target population consisted of household heads residing in designated slum settlement areas in Bengkalis Regency, Indonesia. The study included 86 household heads from 21 villages. Data were collected using a structured questionnaire measuring community quality of life, institutional factors, and sustainable slum management. The original study reported the use of the Dixon and Leach approach for sample-size determination and disproportionate stratified random sampling for respondent selection. However, detailed information on the population frame, stratum sizes, sample allocation, random-selection procedures, and sample-size calculations was not available for verification. Therefore, the sampling procedure and the extent to which the sample represents the target population should be interpreted with caution.

Research Constructs and Measurement

The analytical model comprised three latent constructs, each measured using four questionnaire indicators: community quality of life (CQL1–CQL4), institutional factors (IF1–IF4), and sustainable slum management (SSM1–SSM4). Institutional factors were modeled as a moderator of the relationship between community quality of life and sustainable slum management. The seven regulatory aspects specified in Regulation No. 02/PRT/M/2016 were used to contextualize the designated slum areas rather than as additional indicators of the three latent constructs [11]. The full wording of the indicators, response scales, and details of instrument adaptation should be provided to facilitate replication.

Data Analysis

Data were analyzed using PLS-SEM in SmartPLS 4.0. Measurement-model evaluation covered outer loadings, Cronbach's alpha, composite reliability, average variance extracted (AVE), and discriminant validity. Structural-model evaluation examined path coefficients, bootstrapped test statistics, R^2, and f^2. H1 was assessed through the CQL → SSM path, whereas H2 was assessed through the IF × CQL → SSM interaction term. Statistical significance was interpreted at $p < 0.05$, while the substantive magnitude of each association was assessed separately. These reporting choices follow methodological guidance for PLS-SEM [7–9], [15]. For complete reproducibility, the final submission should also specify the interaction-term estimation approach, bootstrap resamples, confidence intervals, and collinearity diagnostics as shown in the original SmartPLS output; these details cannot be reconstructed from the summary tables.

III. RESULTS AND DISCUSSION

Measurement Model Assessment

The measurement model was assessed to evaluate indicator reliability, internal consistency reliability, and convergent validity. Indicator reliability was examined through outer loadings, while Cronbach's alpha and composite reliability (CR) were used to assess internal consistency. Convergent validity was evaluated using the average variance extracted (AVE). The recommended thresholds were 0.70 for outer loadings, 0.70 for internal consistency reliability, and 0.50 for AVE. Indicators with loadings slightly below 0.70 may be retained when supported by theoretical considerations and satisfactory construct-level reliability and validity.

Table 1. Outer Loadings of the Measurement Model

Construct	Indicator	Outer loading
Community quality of life	CQL1	0.876
Community quality of life	CQL2	0.822
Community quality of life	CQL3	0.723
Community quality of life	CQL4	0.847
Institutional factors	IF1	0.832
Institutional factors	IF2	0.797
Institutional factors	IF3	0.866
Institutional factors	IF4	0.792
Sustainable slum management	SSM1	0.773
Sustainable slum management	SSM2	0.822
Sustainable slum management	SSM3	0.814
Sustainable slum management	SSM4	0.747

Source: Data analysis using SmartPLS 4.0.

As shown in Table 1, the outer loadings range from 0.723 to 0.876. All indicators exceed the minimum reference value of 0.70, indicating that each indicator has an acceptable relationship with its respective construct. The results provide preliminary support for retaining all twelve indicators in the measurement model.

Table 2. Construct Reliability and Convergent Validity

Construct	Cronbach's alpha	Composite reliability	AVE
Community quality of life	0.837	0.890	0.671
Institutional factors	0.840	0.893	0.676

Sustainable slum management	0.799	0.869	0.623

Source: Data analysis using SmartPLS 4.0.

Table 2 shows that Cronbach's alpha values range from 0.799 to 0.840, while composite reliability values range from 0.869 to 0.893. These results exceed the commonly used threshold of 0.70 and indicate satisfactory internal consistency. The AVE values range from 0.623 to 0.676, exceeding the minimum threshold of 0.50. Therefore, each construct explains more than half of the variance in its indicators on average, supporting convergent validity. Taken together, the outer loadings, reliability coefficients, and AVE values indicate that the measurement model demonstrates acceptable indicator reliability, internal consistency, and convergent validity. These results provide a basis for proceeding to structural model assessment. However, they do not independently establish discriminant validity; that property must be evaluated separately.

Discriminant Validity and Structural Model Assessment

Discriminant validity was assessed using the Fornell–Larcker criterion. Under this criterion, the square root of a construct's AVE should exceed its correlations with other constructs in the model. The diagonal values in Table 3 represent the square roots of AVE, whereas the off-diagonal values represent correlations between constructs.

Table 3. Fornell–Larcker Criterion

Construct	**Community quality of life**	**Institutional factors**	**Sustainable slum management**
Community quality of life	**0.819**	0.414	0.456
Institutional factors	0.414	**0.822**	0.604
Sustainable slum management	0.456	0.604	**0.789**

Source: Data analysis using SmartPLS 4.0.

The diagonal values exceed the corresponding interconstruct correlations. For community quality of life, the square root of AVE is 0.819, compared with correlations of 0.414 with institutional factors and 0.456 with sustainable slum management. For institutional factors, the square root of AVE is 0.822, exceeding its correlation of 0.604 with sustainable slum management. Similarly, the square root of AVE for sustainable slum management is 0.789, greater than its correlations with the other two constructs. These comparisons support discriminant validity according to the Fornell–Larcker criterion.

The correlation of 0.604 between institutional factors and sustainable slum management is nevertheless higher than the other reported interconstruct correlations. Although it remains below the relevant diagonal values, the relatively strong association warrants careful interpretation because the constructs are related conceptually. The Fornell–Larcker results should ideally be complemented by the heterotrait–monotrait ratio (HTMT), if the necessary output is available. The structural model was subsequently assessed to examine the explanatory power of the model and the hypothesized relationships. The coefficient of determination (R^2) indicates the proportion of variance in an endogenous construct explained by its predictors. The adjusted (R^2) accounts for the number of predictors included in the model.

Table 4. Coefficient of Determination

Endogenous construct	**R^2**	**Adjusted R^2**
Sustainable slum management	0.462	0.445

Source: Data analysis using SmartPLS 4.0.

The (R^2) value of 0.462 indicates that the predictors in the structural model account for 46.2% of the variance in sustainable slum management. The adjusted (R^2) of 0.445 indicates that the model explains 44.5% of the variance after adjustment for the number of predictors. The remaining variance reflects factors not captured by the model and unexplained variation. These values indicate a meaningful degree of explanatory capacity, but they do not establish predictive accuracy or causal validity. The results should therefore be interpreted as evidence of the model's explanatory performance within the observed sample rather than proof that the included constructs fully determine sustainable slum management.

Direct Effect of Community Quality of Life on Sustainable Slum Management

The direct relationship between community quality of life and sustainable slum management was examined using the bootstrapped path coefficient. The estimated coefficient was positive and statistically significant ((\beta = 0.269), (t = 3.142), (p = 0.002)). This result indicates that higher community quality of life is associated with higher levels of sustainable slum management in the estimated model.

Table 5. Structural Path and Moderation Test Results

Relationship	β	t-statistic	p-value	Conclusion
Community quality of life → Sustainable slum management	0.269	3.142	0.002	Positive and statistically significant
Institutional factors × Community quality of life → Sustainable slum management	0.195	3.420	0.001	Positive and statistically significant moderation

Source: Data analysis using SmartPLS 4.0.

As reported in Table 5, the positive coefficient for community quality of life supports the proposed relationship. The result suggests that the welfare-related conditions experienced by residents are relevant to sustainable slum management. In practical terms, settlement management may be more closely associated with sustainability when it is considered alongside the quality of life of the communities concerned, rather than being approached exclusively as a physical-infrastructure issue. One possible interpretation is that better living conditions may support residents' capacity and willingness to participate in maintaining their settlement environment. However, this mechanism was not directly tested by the reported path coefficient and should therefore be treated as an interpretation rather than an established empirical finding. The result also needs to be understood within the study's methodological boundaries. The data were collected through a quantitative, cross-sectional survey of 86 household heads in 21 villages in Bengkalis Regency. Consequently, the estimated association does not establish temporal precedence or prove that improvements in quality of life cause improvements in sustainable slum management. Reverse relationships and other unmeasured influences cannot be excluded.

Moderating Role of Institutional Factors

The moderating role of institutional factors was examined through the interaction between institutional factors and community quality of life. The interaction coefficient was positive and statistically significant ((\beta = 0.195), (t = 3.420), (p = 0.001)). Thus, the moderation hypothesis was supported. The positive interaction indicates that the association between community quality of life and sustainable slum management becomes stronger as institutional factors increase, assuming that the variables were coded in the expected direction and the interaction was specified as reported. This finding suggests that the relationship between community welfare and sustainable settlement management is not independent of the institutional context.

Table 6. Effect Size of the Structural Relationships

Relationship	f^2	Effect-size interpretation
Community quality of life → Sustainable slum management	0.110	Small
Institutional factors × Community quality of life → Sustainable slum management	0.086	Small

Source: Data analysis using SmartPLS 4.0.

Table 6 provides an additional perspective on the magnitude of the estimated relationships. The (f^2) value for the direct effect of community quality of life is 0.110, while the interaction effect has an (f^2) value of 0.086. Both are below the conventional reference value of 0.15 for a medium effect and are therefore interpreted as small under the commonly used Cohen guidelines. The distinction between statistical significance and effect size is important. The significant interaction indicates that the estimated moderation differs from zero under the model assumptions, whereas the small (f^2) value indicates that the interaction makes a relatively limited incremental contribution to explaining sustainable slum management. The finding therefore supports the relevance of institutional conditions without justifying the claim that institutional factors alone determine sustainability.

The result has practical implications for local settlement governance. Institutional support may help strengthen the relationship between community welfare and sustainable management when it provides

consistent coordination, clear responsibilities, accountable implementation, and continuity in settlement programs. These are potential policy mechanisms consistent with the interpretation of institutional moderation; they were not separately tested as individual causal mechanisms in the reported model. The analysis would be strengthened by presenting a simple-slope analysis or interaction plot showing the relationship between community quality of life and sustainable slum management at relatively low and high levels of institutional factors. Such an analysis would make the direction of the interaction easier to interpret. Because those estimates are not reported here, no numerical simple slopes or conditional effects are claimed.

Integrated Discussion and Implications

Two results emerge from the reported structural paths. Community quality of life is positively associated with sustainable slum management, and the interaction between institutional factors and community quality of life is positive. The first result supports the relevance of residents' welfare-related circumstances in understanding settlement-management outcomes. The second is consistent with a conditional association: the CQL–SSM relationship is stronger at higher values of institutional factors, assuming that higher construct scores represent more favorable institutional conditions. This is the specific empirical contribution of the study. It does not establish that particular institutional reforms cause better outcomes, nor does it identify which individual governance practices account for the interaction. Governance studies in Indonesia and other upgrading contexts provide a useful interpretive comparison because they emphasize community–institution relationships [12], [13].

The magnitude of the moderation must nonetheless remain central to interpretation. Although statistically significant, the reported interaction effect size is small ($f^2 = 0.086$); statistical significance should not be mistaken for a large policy effect. A recent Indonesian settlement-upgrading case study likewise underscores the interconnected social, environmental, and economic dimensions of sustainability [14], but it does not independently validate the mechanism estimated here. Policy implications are therefore appropriately cautious: settlement programs may benefit from coordinating community-welfare objectives with institutional accountability, continuity, and participation, but the present data do not test the effectiveness of these interventions. A plotted interaction and conditional simple slopes would help readers assess whether the substantive difference across institutional conditions is meaningful.

Several limitations constrain interpretation. The cross-sectional survey supports associations rather than causal claims; the 86 respondents across 21 villages limit precision and external validity; and the measurement indicators are not described in sufficient detail to permit independent assessment of construct content. In addition, the Fornell–Larcker statistics and R^2 values in Tables 3 and 4 must be checked against the SmartPLS output for the exact three-construct moderation model reported in this article, rather than assumed to transfer from a larger dissertation model. Future work should examine multiple regions, report conditional effects and confidence intervals, assess discriminant validity with HTMT, and explore institutional mechanisms through longitudinal or mixed-method designs. Until the model-output checks are completed, interpretations of Tables 3 and 4 should be treated as provisional.

IV. CONCLUSION

Community quality of life is positively associated with sustainable slum management in the Bengkalis sample, and the reported interaction indicates that this association is stronger under more favorable institutional conditions. The study's contribution is the explicit assessment of institutional moderation rather than another descriptive account of slum conditions. Nevertheless, the interaction is small, and neither the cross-sectional design nor the geographically limited sample warrants causal or broadly generalizable conclusions. Settlement-management practice should therefore consider community welfare together with institutional coordination and continuity, while further studies test the mechanisms and robustness of these relationships. The final statistical interpretation remains conditional on verification that all reported model-fit and validity summaries correspond to the article's specified model.

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