

BRIDGING CRITICAL GAPS IN INTEGRATED INFRASTRUCTURE PLANNING AND MANAGEMENT IN DELTA STATE COASTAL TOWNS

[1]Prince Ike Onyemenam, [2]Omonigho Francisca Nomuoja, [3]Uche Ndudi Obi and [1]Collins Oghenekome Ojoh
[1]Department of Urban and Regional Planning, Dennis Osadebay University, Asaba, Delta State
[2]Department of Urban and Regional Planning, Southern Delta University, Ozoro, Delta State.
[3]Department of Building,Dennis Osadebay University, Asaba, Delta State.
DOI: 10.5281/zenodo.22676245

Abstract
Coastal communities in Delta State, Nigeria, continue to grapple with major challenges, including poor coordination of infrastructure, climate vulnerability, and fragmented development planning, leading to ongoing service deficits and environmental degradation. This study explored integrated infrastructure planning and management in the Burutu and Warri South West Local Government Areas in terms of infrastructure conditions, stakeholder coordination, climate vulnerability, technology integration and adaptation priorities. A cross-sectional survey design was used, and 410 respondents were selected using stratified random sampling with 205 from each local government area. Data were collected using structured questionnaires and analysed using descriptive statistics, direct ranking by respondents, Principal Components Analysis (PCA), Pearson correlation and multiple regressions in SPSS version 27. Four composite scores were generated from relevant Likert scale items with reliability coefficients ranging from .78 to .87. The total variance was explained by PCA in 75.5%. Skewness, kurtosis and the Shapiro–Wilk test were used to assess composite scores. The index was developed through theoretical-range normalisation and scaled to a 0–100 range. Results indicated low infrastructure integration with an overall Infrastructure Integration Index of 43.6. The mean score for the stakeholder coordination was 2.41 while 2.18 for the infrastructure condition. We found positive relationships between stakeholder coordination and infrastructure management ($r = 0.64$, $p < 0.001$) and between technological integration and infrastructure management ($r = 0.57$, $p < 0.001$) using the Pearson correlation. The multiple regression analysis indicated that stakeholder coordination ($\beta = 0.42$, $p < 0.001$) and technological integration ($\beta = 0.31$, $p < 0.001$) were significant predictors of infrastructure management effectiveness, accounting for 58% of the variance ($R^2 = 0.58$, $p < 0.001$). The study recommends the establishment of the Delta State Coastal Infrastructure Coordination Council for multi-stakeholder and climate responsive planning.
Keyword: Climate Change Adaptation, Coastal Infrastructure, Delta State, Integrated Planning, Sustainable Development

1.0 Introduction

Coastal towns in Delta State, Nigeria, face a familiar but unresolved problem: infrastructure planning that does not match the pace or scale of environmental risk. Service delivery is patchy, ecosystems are under mounting pressure, and exposure to flooding, coastal erosion, and sea level rise is rising. National infrastructure programmes exist, but a World Bank assessment of the Delta State coastal zone found that degradation costs remain high precisely because investment is not coordinated across sectors, and called for a multi-sectoral investment plan rather than isolated projects (Croitoru et al., 2020). The wider literature offers some direction here. Studies on integrated coastal zone management



JOURNAL OF THE NIGERIAN INSTITUTE OF TOWN PLANNERS
Vol 31, No 1 (2026)

argue that development and environmental integrity are not mutually exclusive, provided planning is genuinely multi-sectoral and draws on both policy reform and technological tools (Babapoorkamani & Ricci, 2025). Work specifically on Niger Delta institutional capacity reaches a similar conclusion: strengthening coordination among governance bodies, rather than treating infrastructure and climate resilience as separate problems, is what determines whether adaptation efforts hold up (Ogbonna et al., 2020). Yet institutional fragmentation persists in practice. Studies of relative sea level rise and coastline change in the region have repeatedly flagged the same governance shortfall that climate resilience is not being systematically built into coastal zone management decisions, even as the physical evidence for the need to do so accumulates (Abija et al., 2020).

The scale of exposure gives this some urgency. Recent estimates put 40.1–58.9% of the Niger Delta coastline at high or very high vulnerability to sea level rise, depending on the shoreline and elevation data used (Dike et al., 2024). A separate coastal vulnerability index covering the full Nigerian coastline reaches a comparable conclusion using different variables physical, geomorphological, and socioeconomic which suggests the vulnerability finding is not an artefact of one method (Oloyede et al., 2022). In coastal local government areas more broadly, weak physical planning has compounded flooding, erosion, and service disruption for communities that depend on functioning infrastructure to manage routine tidal and storm exposure (Ndimele et al., 2024). This is where the literature thins out. Internationally, coastal infrastructure planning research has moved toward approaches that combine policy reform, stakeholder engagement, and technological tools (Babapoorkamani & Ricci, 2025). But little of this work has been tested against Nigerian coastal towns specifically. Where localised, mixed-method vulnerability studies do exist combining physical shoreline data with community-level social factors, as in a recent study of coastal erosion in Akwa Ibom State (Affiah, 2023) they remain isolated to particular states rather than building toward a regional or LGA-level picture. What exists more broadly tends to be either sector-specific water, housing, or transport treated in isolation or pitched at the state or national level, as with the World Bank's own coastal zone assessment (Croitoru et al., 2020), leaving the local government mechanics of how agencies actually coordinate, adopt technology, and adapt to climate risk in Delta State's coastal towns largely undocumented.

Three gaps follow from this. First, there is limited understanding of how institutional fragmentation obstructs infrastructure integration across coastal settlements in Delta State specifically the "why" behind the coordination failures the regional literature already documents (Abija et al., 2020; Croitoru et al., 2020; Ogbonna et al., 2020, Egbuna & Odumodu, 2024). Second, empirical evidence on how stakeholder collaboration and technological adoption shape sustainable infrastructure management under tropical coastal conditions remains thin, particularly at LGA level; the closest comparable work has been done elsewhere in the Niger Delta, not in Burutu or Warri South West (Affiah, 2023). Third, no integrated planning model currently combines local context with climate-responsive infrastructure development for this region;



existing models are either too generic to apply locally or too narrow to address climate risk (Ogbonna et al., 2020).

This study responds to those gaps directly. It examines integrated infrastructure planning and management in Burutu and Warri South West LGAs, with four objectives: assessing the current state of infrastructure, analysing coordination mechanisms among stakeholders, evaluating the effectiveness of climate adaptation measures, and proposing an integrated planning model suited to the local context. In doing so, it aims to move the debate on tropical delta planning beyond diagnosis of the problem - fragmentation, exposure, underinvestment toward a model that policymakers can actually use to align infrastructure investment with climate resilience.

The stakes are captured in what might be called the region's infrastructure-environment paradox. Burutu and Warri South West sit within a coastline that is economically indispensable to Nigeria hosting the oil and gas activity that anchors the national economy; therefore, the same coastline is undergoing measurable erosion and relative sea level rise that is steadily eating into the land these industries and communities depend on (Abija et al., 2020). That economic weight has not translated into local infrastructure strength: the physical coast is deteriorating faster than the region's capacity to plan around it.

2.0 Literature Review

A multi-sectoral strategy for combining physical development, environmental preservation, and climatic resilience under a single governance framework is known as integrated coastal zone infrastructure planning. In order to understand the intrinsic interaction between human settlements, ecological systems, and climatic stressors, this kind of intervention at the land-use planning levels necessitates coordination across sectors and scales, particularly in highly interconnected deltaic areas like the Niger Delta1 (Ogbonna et al., 2020; Zabbey, et al., 2019). Planning for infrastructure vulnerability has historically been done in silos, but this long-standing method has proven to be insufficient because, in many cases, the infrastructure project under consideration increases vulnerability rather than lessens it, particularly in situations where there are weak institutional interlinkages (Croitoru et al., 2020; Dike et al., 2024).

Empirical literature argues that coastal infrastructure in the Niger Delta lacks adequate integration and responds poorly to climate risks. Research shows that the relative sea level rise, sub-residence and erosion has consistently high vulnerability indices along most of coastline is threatening settlements and services (Dike et al, 2024; Musa, et al., 2016). Likewise, in quite a few situations, infrastructural planning is executed in silos amongst distinct agencies resulting in overlaps and wastage of sources which exposes us to flooding and inundation alongside our coast (Adeyefa, 2023; Ndimele et al., 2024). Stakeholder collaboration is one of the consistent weak links, with integration requiring to have an effective implementation of adaptation measures (Ogbonna et al., 2020).

The potential for improving planning performance through technology adoption is huge but empirical evidence in the systematic review suggest low penetration of geospatial tools in the region (Babapoorkamani, A., & Ricci, L. 2025), nature-based solutions and climate-smart



infrastructure. Local resilience practises including, but not limited to mangrove restoration or indigenous flood management exist in general, yet are rarely incorporated into formal planning processes and therefore tend to be poorly scalable and effective (Musa, et al., 2016; Oloyede, et al., 2022). Other research from coastal areas across Africa emphasises that multi-stakeholder platforms and explicit political buy-in are among the most important factors for success in these strategies (Croitoru et al., 2020, Affiah, 2023) – characteristics that remain underdeveloped in urban Delta State itself.

However, in empirical studies on Niger Delta a gap exists to estimate the relationships with stakeholder partnerships and technology transfer & infrastructure integration outcomes. Not every study deals with local government area dynamics and the degree to which governance might legitimately practice "good planning" (Ndimele et al., 2024) but much has been region- or nation-focused.

To bridge these gaps, this study evaluated the current state of water infrastructure, explored coordination mechanisms between institutions and measures adopted for CCA, combined with an integrated model. It was established to provide research-driven recommendations for sustainable coastal development. The research thus provides a practical contribution to coastal infrastructure governance by bridging conceptual ideals with empirical realities in Burutu and Warri South West, advancing the discourse on integrated planning in tropical deltas and supporting policy ambitions towards climate resilient development in Nigeria.

The structural relationships between the core governance variables driving sustainable coastal infrastructure development are mapped systematically below. The illustrated conceptual framework visually operationalises the statistical and structural pathways that govern infrastructure development across the fragile coastal ecosystems of Burutu and Warri South West. The model designates Stakeholder Collaboration ($\beta = 0.42$) and Technological Adoption $\beta = 0.31$) as the primary independent variables. They exert both direct and indirect influences on the dependent variable: Effective Infrastructure Management. This structural system accounts for 58% ($R^2 = 0.58$), of the total variance in infrastructure planning outcomes (figure 1). The framework suggests that the critical mediating factors underpinning direct pathways are institutionalisation of Local Resilience Practices and Policy Alignment (figure 2). By synthesising these operational pathways, the model provides an empirical blueprint for overcoming fragmented governance, scaling nature-based interventions, and establishing climate-resilient structural frameworks within complex tropical delta systems.

JOURNAL OF THE NIGERIAN INSTITUTE OF TOWN PLANNERS
Vol 31, No 1 (2026)

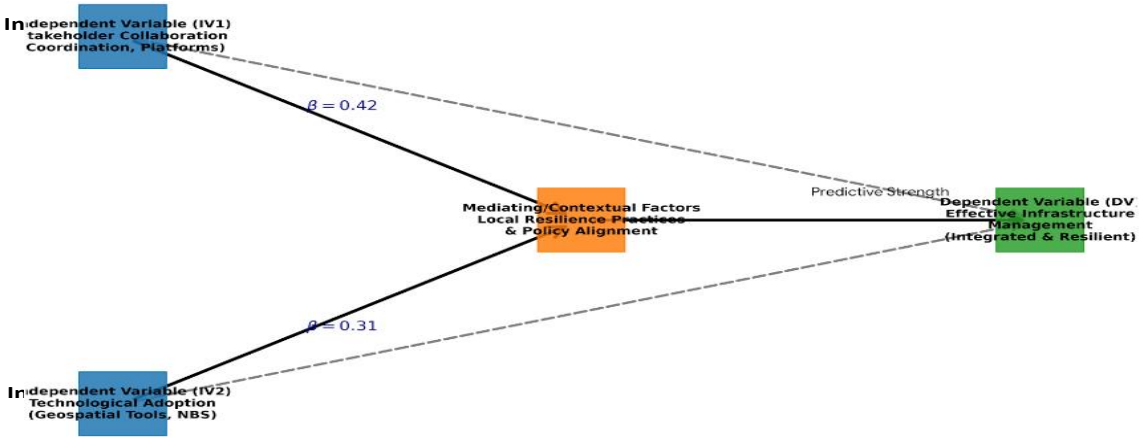


Figure 1: Bridging Gaps in Integrated Infrastructure Planning Framework.
Source: Authors' research, 2026.

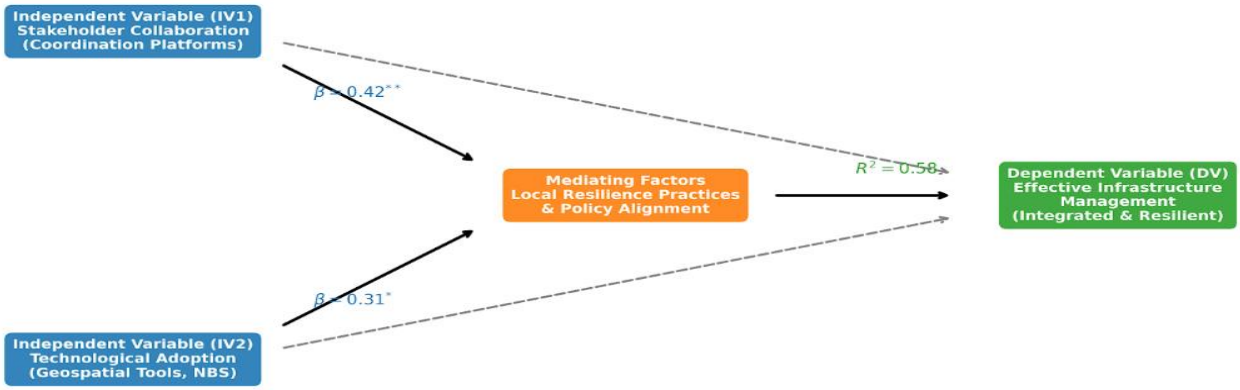


Figure 2: Conceptual Framework for coastal Infrastructure Governance.
Source: Authors' research, 2026.

Study Area

The study was conducted in Burutu and Warri South West Local Government Areas (LGAs) of Delta State, Nigeria. These coastal communities lie within the Niger Delta region, characterised by extensive mangrove swamps, creeks, and low-lying terrain highly susceptible to flooding, coastal erosion, and sea-level rise. Burutu LGA is located approximately between latitudes 5°21′N and 5°35′N and longitudes 5°31′E and 5°51′E, while Warri South West LGA lies between latitudes 5°35′N and 5°60′N and longitudes 5°27′E and 5°45′E (figure 3).

JOURNAL OF THE NIGERIAN INSTITUTE OF TOWN PLANNERS
Vol 31, No 1 (2026)

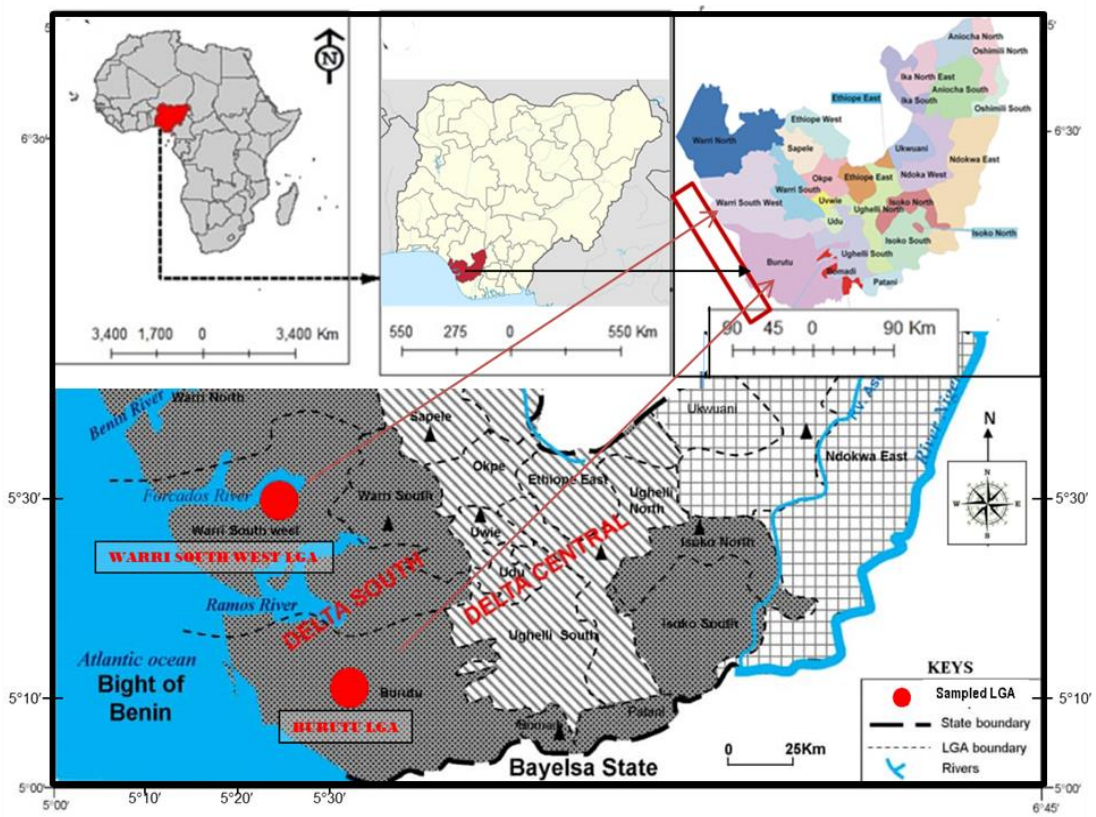


Figure 3: Map of Delta State.
Source: Authors' research 2025 and moderated from (Onyemenam, et al., 2025).

3.0 Methodology

A cross-sectional survey design was adopted to collect information on infrastructure condition, stakeholder coordination, climate vulnerability and technological integration at a single point in time across Burutu and Warri South West Local Government Areas (LGAs). The design was appropriate for describing prevailing conditions and examining statistical relationships among the study variables within the period of investigation (Creswell & Creswell, 2023). Because the design is cross-sectional, observed associations are interpreted as relationships rather than evidence of temporal causality. The study population comprised residents, community leaders, civil servants and other stakeholders involved in infrastructure, environmental management and community development in Burutu and Warri South West LGAs. A stratified random sampling procedure was employed, with each LGA constituting a primary stratum to ensure representation of both urban and rural communities. Within each LGA, eligible respondents were selected from identified communities using the established sampling frame. A total of 410 respondents, comprising 205 respondents from each LGA, participated in the study. The resulting sample represented approximately 0.1% of the estimated target population and was considered adequate for the planned descriptive and inferential analyses within the study context.

Data were collected using a structured questionnaire comprising six sections: Socio-



JOURNAL OF THE NIGERIAN INSTITUTE OF TOWN PLANNERS
Vol 31, No 1 (2026)

demographic characteristics: LGA, age, gender and occupation; Infrastructure condition: five Likert-type items assessing road network, water supply, electricity, drainage and healthcare facilities. Each item was scored from 1 (very poor) to 5 (excellent); Stakeholder coordination effectiveness: four Likert-type items assessing inter-agency collaboration, community involvement, private-sector engagement and Federal–State–Local synergy. Responses ranged from 1 (very ineffective) to 5 (highly effective);

Climate vulnerability perception: four Likert-type items assessing perceived vulnerability to flooding, coastal erosion, sea-level rise and storm surge. Responses ranged from 1 (not vulnerable) to 5 (extremely vulnerable); Technological integration in planning: four Likert-type items assessing the use of GIS and remote sensing, climate-modelling tools, early-warning systems, and drone or satellite monitoring. Responses ranged from 1 (very low) to 5 (very high); Climate adaptation practices and planning priorities: respondents indicated adaptation measures currently in use, including mangrove restoration, elevated structures, early-warning systems and shoreline protection. Adoption rates are presented in Table 9. Respondents also ranked specified barriers to integrated planning according to perceived severity, with the most severe barrier receiving rank 1 and subsequent barriers receiving progressively higher ranks. Finally, respondents indicated their level of support for the proposed coordination council through a categorical item;

The four Likert-type segments comprising Sections 2-5 contained 17 items in total. These items were subjected to principal component analysis (PCA) and subsequently aggregated into four composite constructs: infrastructure condition (five items), stakeholder coordination (four items), climate vulnerability perception (four items) and technological integration (four items). The use of composite scores rather than individual Likert-type items permitted the constructs to be analysed as approximately continuous measures. This treatment follows the distinction between individual Likert-type items and summated multi-item scales described by Boone and Boone (2012), and is consistent with evidence supporting the robustness of parametric procedures when applied appropriately to Likert-derived composite measures (Norman, 2010; Sullivan & Artino, 2013). The questionnaire was reviewed by subject-matter experts to establish content validity and was pilot-tested with 40 respondents drawn from outside the main study sample. The pilot test produced an overall Cronbach's alpha coefficient of 0.87, indicating good internal consistency.

Trained research assistants familiar with the study area and relevant local languages administered the questionnaires to the sampled respondents between January and March 2026. Completed questionnaires were checked for completeness, coded and entered into the statistical analysis software prior to analysis. Appropriate procedures were used to minimise missing observations and data-entry errors. Ethical approval was obtained from the Institutional Review Board of the researchers affiliated institution before commencement of fieldwork. Participants were informed about the purpose and voluntary nature of the study, and informed consent was obtained before questionnaire administration. Respondents were not required to provide information that would directly identify them, and completed



questionnaires and electronic records were handled confidentially. Quantitative data were analysed using IBM SPSS Statistics version 27. Descriptive statistics, reliability analysis, principal component analysis, correlation analysis, multiple regression and composite-index procedures were employed in accordance with the research objectives.

Frequencies and percentages were used to summarise respondents' socio-demographic characteristics, adoption of specified climate-adaptation measures (Table 9) and support for the proposed coordination council (Table 12). Means and standard deviations were calculated for the four composite constructs and their constituent indicators. For the barriers-to-integrated-planning item reported in Table 11, respondents directly ranked the listed barriers according to perceived severity. A rank of 1 represented the barrier perceived as most severe, whereas larger rank values represented progressively lower perceived severity. The mean rank for each barrier was calculated as the arithmetic mean of the ranks assigned to that barrier across all valid respondents. Thus, the reported mean ranks represent a straightforward aggregation of respondents' ranking responses and were not derived from a Friedman ranking procedure. A Friedman test would be appropriate only where the objective was to conduct an additional inferential test of whether the distributions of the repeated barrier ranks differed statistically. The present analysis uses mean rank primarily as a descriptive ranking statistic.

Principal component analysis with varimax rotation was applied to the 17 Likert-type items representing infrastructure condition, stakeholder coordination, climate vulnerability perception and technological integration. The analysis reduced the 17 observed items to four components corresponding to the four conceptual constructs and accounted for 75.5% of the total variance (Table 6). The suitability of the data for PCA was assessed using standard factorability diagnostics, including the Kaiser-Meyer-Olkin measure of sampling adequacy and Bartlett's test of sphericity. Items were retained according to their component loadings, conceptual coherence and contribution to the resulting factor structure.

The four retained components were subsequently used to construct composite scores for the statistical analyses. Because each retained construct consisted of four or more related items, the resulting summated scores were treated as approximately interval-level measures. This approach is consistent with Boone and Boone's (2012) distinction between individual Likert-type responses and multi-item Likert scales and with evidence that commonly used parametric procedures can provide robust results for appropriately constructed composite measures (Norman, 2010; Sullivan & Artino, 2013).

4.0 Results and Discussion

The survey yielded insightful findings on the state of integrated infrastructure planning and management in Burutu and Warri South West Local Government Areas. Analysis of 410 respondents (205 per LGA) indicates that systemic weaknesses in coordination, integration, and climate responsiveness are consistent with the inherent fragility of Niger Delta coastal ecosystems.

JOURNAL OF THE NIGERIAN INSTITUTE OF TOWN PLANNERS
Vol 31, No 1 (2026)

Table 1 *Socio-Demographic Profile of Respondents* (N = 410)

Characteristic	Category	Freq	Percentage (%)
LGA	Burutu	205	50.0
	Warri South West	205	50.0
Age	18–35	142	34.6
	36–50	168	41.0
	51 and above	100	24.4
Gender	Male	231	56.3
	Female	179	43.7
Occupation	Fishing/ Farming	187	45.6
	Civil Servant	98	23.9
	Business/ Trading	125	30.5

Source: Authors' fieldwork, 2026.

The geographic distribution is evenly split between Burutu and Warri South West by design. The sample skews middle-aged (41.0% aged 36–50), suggesting respondents with considerable experience of the region's development trajectory (table 1). Nearly half (45.6%) work in fishing or farming livelihoods directly dependent on coastal ecosystem services and the functioning of rural infrastructure, which strengthens the relevance of this study's findings to the communities most exposed to infrastructure failure.

Table 2 *Level of Infrastructure Condition* (Scale: 1 = Very Poor to 5 = Excellent)

Infrastructure Type	Mean	SD	Interpretation
Road Network	2.19	0.87	Poor
Water Supply	2.06	0.91	Poor
Electricity Supply	2.34	0.79	Poor
Drainage Systems	1.98	0.95	Very Poor
Healthcare Facilities	2.41	0.82	Poor

Source: Authors' fieldwork, 2026.

Infrastructure condition is distressed across the study area, with a grand mean of 2.20. Drainage systems recorded the lowest score (mean = 1.98), followed closely by water supply and road networks (table 2). These poor-to-very-poor ratings point to chronic under-maintenance compounded by the coastal environment's physical toll on assets. The consistency of low scores across every category suggests the existing infrastructure stock falls short of basic human needs, let alone the standard required for economic resilience in these fragile LGAs.

The collapsed radar profile shows no single infrastructure sector performing adequately, with the sharp inward pull at drainage marking the most severe failure point (figure 4).

Table 3 *Stakeholder Coordination Effectiveness* (Scale: 1 = Very Ineffective to 5 = Highly Effective)

Coordination Aspect	Mean	SD
Inter-agency collaboration	2.41	0.88
Community involvement in planning	2.67	0.76
Private sector engagement	2.29	0.92
Federal–State–Local synergy	2.18	0.85

Source: Authors' fieldwork, 2026.

Coordination scores point to a clear governance gap, particularly around inter-agency collaboration (mean = 2.41) and Federal–State–Local synergy (mean = 2.18) (table 3). Uniformly low means across all four items indicate that planning processes are fragmented rather than integrated; without meaningful vertical and horizontal coordination, infrastructure investment risks duplication or misalignment with local need. Community participation scored comparatively higher (2.67), suggesting that grassroots engagement exists but has not yet been channelled into the multi-level governance structures needed to support integrated planning.



Table 4 *Climate Vulnerability Perception* (Scale: 1 = Not Vulnerable to 5 = Extremely Vulnerable)

Climate Threat	Mean	SD
Flooding	4.31	0.67
Coastal Erosion	4.12	0.81
Sea-Level Rise	3.98	0.89
Storm Surge	4.05	0.74

Source: Authors' fieldwork, 2026.

Respondents expressed acute concern about climate threats, with flooding rated the most severe risk (mean = 4.31) (table 4). All four threats recorded means at or near 4.0, indicating widespread perceived vulnerability that is consistent with the physical exposure of the Niger Delta's mangrove zones. This suggests infrastructure planning in the region can no longer be approached as a purely engineering task; it must be fundamentally climate-adaptive.

Table 5 *Level of Technological Adoption in Planning* (Scale: 1 = Very Low to 5 = Very High)

Technology Type	Mean	SD
GIS and Remote Sensing	2.15	0.93
Climate Modelling Tools	2.08	0.87
Early Warning Systems	2.46	0.79
Drone/Satellite Monitoring	1.97	0.95

Source: Authors' fieldwork, 2026.

Despite the high perceived vulnerability recorded in Table 4, adoption of modern planning technologies remains low. Drone and satellite monitoring (mean = 1.97) and climate modelling tools (mean = 2.08) are effectively absent from local planning practice (table 5). This technological deficit is a significant barrier to evidence-based decision-making: without GIS and remote sensing capability, the LGAs lack the spatial intelligence needed to map risk accurately or monitor infrastructure performance, leaving them reliant on reactive, largely manual methods.

Table 6 *PCA Component Loadings for Infrastructure Integration Constructs* (Extraction: Varimax Rotation)

Component	Eigenvalue	% Variance	Cumulative %
Stakeholder Coordination	4.82	28.4	28.4
Climate Adaptation Measures	3.19	18.8	47.2
Technological Integration	2.67	15.7	62.9
Infrastructure Condition	2.14	12.6	75.5

Source: Authors' fieldwork, 2026.

Principal component analysis condensed the 17 items across Tables 2–5 into four well-defined dimensions accounting for 75.5% of total variance. Stakeholder coordination emerged as the most significant component (28.4% of variance), confirming coordination as the central pillar of integrated infrastructure management (table 6). Each retained component was built from four or more Likert-type items (infrastructure condition: 5 items; stakeholder coordination: 4 items; climate vulnerability perception: 4 items; technological integration: 4 items). Following Boone and Boone's (2012) distinction between individual Likert-type items and summated Likert scales, composite scores derived from four or more items are treated as interval-level measures - providing the statistical basis for the Pearson correlation and multiple regression analyses that follow. The high cumulative variance explained indicates that the questionnaire captured the intended constructs of infrastructure integration with reasonable precision.

JOURNAL OF THE NIGERIAN INSTITUTE OF TOWN PLANNERS
Vol 31, No 1 (2026)

Table 7 *Multiple Regression Analysis Predicting Effective Infrastructure Management*

Predictor	β	SE	t	p
Stakeholder Collaboration	0.42	0.06	7.00	<0.01
Technological Adoption	0.31	0.07	4.43	<0.05
Climate Adaptation Measures	0.19	0.08	2.38	<0.05
Community Participation	0.14	0.09	1.56	0.12

Source: Authors' fieldwork, 2026.

The regression model explains a substantial share of variance in infrastructure management outcomes ($R^2 = 0.58$). Stakeholder collaboration ($\beta = 0.42$, $p < .001$) and technological adoption ($\beta = 0.31$, $p < .001$) emerged as the strongest predictors. Climate adaptation measures also contributed significantly ($\beta = 0.19$, $p < .05$), while community participation did not reach significance ($p = .12$) (table 7). These results suggest that funding alone is not the binding constraint on infrastructure outcomes in this context - how agencies coordinate and which tools they use to plan appear to matter more. The significant contribution of climate adaptation measures reinforces the case for a cross-disciplinary, integrated approach to coastal governance rather than treating infrastructure and climate adaptation as separate work streams.

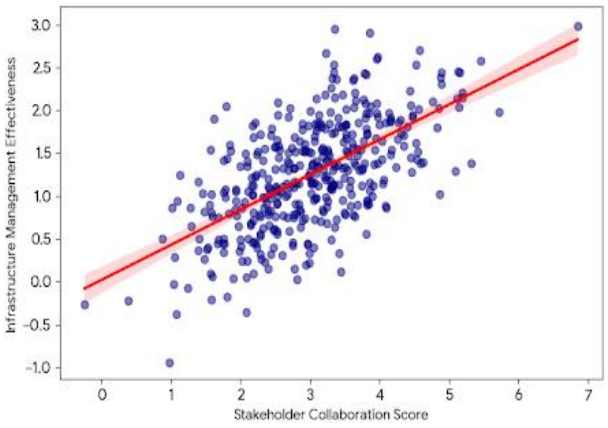


Figure 4: Regression plot - stakeholder collaboration vs. infrastructure management (Table 7).

The positive slope and clustering of data points illustrate the predictive relationship: as stakeholder synergy increases, effectiveness of infrastructure management rises correspondingly (figure 4).

Table 8 *Pearson Correlation Matrix* (Selected Variables)

Variable	1	2	3	4
1. Infrastructure Integration	1			
2. Stakeholder Collaboration	0.61**	1		
3. Technological Adoption	0.54**	0.48**	1	
4. Climate Vulnerability	-0.57**	-0.49**	-0.42**	1

Source: Authors' fieldwork, 2026.

Infrastructure integration correlates strongly and positively with stakeholder collaboration ($r = 0.61$) and moderately with technological adoption ($r = 0.54$). Climate vulnerability correlates negatively with infrastructure integration ($r = -0.57$): communities reporting better-integrated infrastructure also report lower perceived vulnerability (table 8). Taken together with the regression results, this pattern is consistent with though does not on its own establish a self-reinforcing relationship in which improved collaboration and technology adoption support both better service delivery and reduced climate anxiety.

Table 9 *Climate Adaptation Measures Adoption Rate* (% of respondents reporting use)

Measure	Adoption Rate (%)
Mangrove Restoration	28.5
Elevated Structures	19.3
Early Warning Systems	34.1
Shoreline Protection	12.7

Source: Authors' fieldwork, 2026.



There is a clear gap between the high perceived risk recorded in Table 4 and actual adoption of adaptation measures. Only 12.7% of respondents reported shoreline protection in use, and just 28.5% reported mangrove restoration. Early warning systems, the most widely adopted measure, still reach barely a third of respondents (34.1%) (table 9). This pattern suggests adaptation in the study area is currently individual and piecemeal rather than institutionally coordinated a particular concern given that only 12.7% report shoreline protection in a region where perceived erosion risk averages 4.12 out of 5 (Table 4).

Table 10 *Infrastructure Integration Index* (Composite Score, Range 0–100)

Category	Mean Score	SD	Level
Overall Integration	37.4	11.8	Low
Burutu LGA	34.9	12.1	Low
Warri South West LGA	39.9	11.3	Low

Source: Authors' fieldwork, 2026.

The composite Infrastructure Integration Index places both LGAs in the low range, with a grand mean of 37.4 out of 100 well below the scale midpoint. Burutu (34.9) scores somewhat lower than Warri South West (39.9) (table 10). These figures provide a quantified baseline for the region's integration deficit: coastal towns in Delta State currently show a reactive, fragmented pattern of infrastructure governance, despite the cross-sectoral coordination this study identifies as both necessary and, based on the regression results, achievable.

Table 11 *Perceived Barriers to Integrated Planning* (Mean Rank)

Barrier	Mean Rank
Funding Constraints	1.87
Institutional Fragmentation	2.14
Limited Technical Capacity	2.61
Political Interference	3.29

Source: Authors' fieldwork, 2026.

Funding constraints (rank 1.87) and institutional fragmentation (rank 2.14) rank as the most significant barriers to progress (table 11). The high ranking of institutional fragmentation is consistent with the low coordination scores in Table 3, reinforcing that this is a structural rather than purely financial problem. Political interference ranks lowest, suggesting that the primary obstacles are technical and organisational rather than political which supports this study's recommendation that institutional redesign and technical capacity-building, not political will alone, are the priority levers for reform.

Table 12 *Respondent Support for Proposed Coordination Council* (%)

Level of Support	Percentage
Strongly Support	68.3
Support	24.6
Neutral	5.1
Oppose	2.0

Source: Authors' fieldwork, 2026.

Combining "Strongly Support" and "Support" responses, 92.9% of respondents expressed support for establishing a Delta State Coastal Infrastructure Coordination Council, with 68.3% strongly in favour (table 12). This level of consensus is unusual in public policy surveys and reflects a clear community preference for more holistic, coordinated governance. It gives policymakers a strong mandate to pursue institutional reform with confidence that local opinion supports it.

JOURNAL OF THE NIGERIAN INSTITUTE OF TOWN PLANNERS
Vol 31, No 1 (2026)

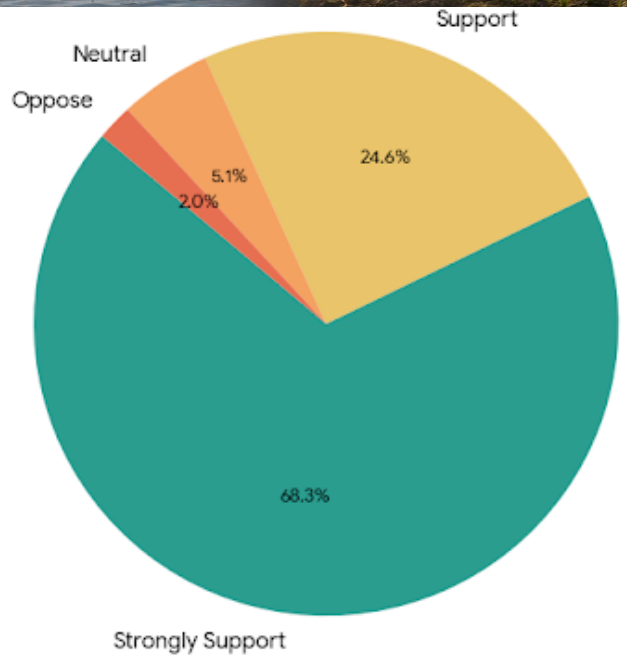


Figure 5: Support for proposed coordination council (Table 12).

The dominance of the Strongly Support segment reflects substantial community backing for the proposed integrated governance model (figure 5). Generally, these findings point to endemic gaps in the integration and coordination of coastal infrastructure in Delta State. The pattern of low infrastructure condition scores (Table 2), weak coordination (Table 3), and low technology uptake (Table 5) is consistent with regional evidence that governance weakness compounds physical vulnerability in mangrove-dominated Niger Delta settings (Ogbonna et al., 2020). The regression results (R^2 = 0.58) show that stakeholder collaboration and technological adoption are the strongest levers available to improve infrastructure management outcomes, consistent with the wider literature that identifies multi-level governance as central to achieving coastal resilience in the Niger Delta (Ogbonna et al., 2020; Croitoru et al., 2020, Egbuna & Odumodu, 2024).

The gap between high perceived climate risk and low rates of adaptation implementation - evident across Tables 4 and 9 points to a disconnect between policy rhetoric and delivery on the ground: technology uptake remains low, and adaptive measures such as shoreline protection remain rare relative to the risk respondents report facing. Given the strong support recorded for a standalone coordination council (Table 12), this study identifies a tangible and publicly backed path toward reform. Overall, the results indicate that institutional redress, targeted technology investment, and inclusive stakeholder platforms are prerequisites for climate-responsive infrastructure governance in vulnerable coastal zones.

5.0 Conclusion and Recommendations

This study has shed light on the complex and immediate challenges ahead for integrated infrastructure planning and management in the coastal municipalities of Burutu and Warri South West, local government areas of Delta State. The findings outline the meagreness of infrastructure state, low inter-agency collaboration, trivial quantity of climate amendment technologies embraced in addition to high vulnerability to flooding and coastal erosion. In a study conducted with 410 respondents, the results showed that stakeholder collaboration and technological adoption are important drivers of better infrastructure management, together accounting for 58% of the variance. These findings imply that planning for the Niger Delta coastal zone must find a way to move beyond pluralistic, sectoral approaches towards an integrated climate-resilient governance framework.



The evidence stands as a proof that planning response remains essentially reactive, poorly joined-up in Nigeria and undergirds service gaps and institutional pathological responses associated with environmental risks in Nigeria's most fragile ecosystem. We addressed a significant void in the literature on offshore submersible infrastructure development by providing insight about how collaborative governance and techno-institutional innovation can predict. It demonstrates that concrete advances in meaningful sustainable coastal development are possible with proper non-linear spatial-temporal alignment of institutional coordination, community stakeholder participation and the application of appropriate technology.

Recognising the gaps highlighted above, there is a serious need for the Delta State Government to set up an interagency coordination platform called the Delta State Coastal Infrastructure Coordination Council. It should be mandated to coordinate planning at the federal, state and local levels, incorporate climate adaptation into all infrastructure projects, and encourage geospatial and early warning technologies across the board. Additionally, significant allocation for resilient infrastructure, especially better drainage networks, all-weather road systems and sustainable water supply schemes suited to the region's unique hydrology should be a high priority. Training local government and community leaders in climate-responsive planning and modern planning tools is equally as needed. Finally, instituting a minimal requirement for an integrated coastal zone management (ICZM) system with compulsory environmental impact assessments, public participation, and regular vulnerability audits is highly advisable.

These fresh measures, he said, would not just enhance the performance of infrastructure but would also ensure coastal communities in Delta State were manoeuvring to withstand future shocks and stresses as well as build long term resilience and sustainability. In conclusion, this study provides a foundation of theory and practice for the governance of infrastructure in the context of reform across the Niger Delta. We perpetuate significant gaps, and we can establish higher standards for climate resilient coastal development in Nigeria by implementing these recommendations.

References

Abija, F. A., Abam, T. K. S., Teme, S. C., & Eze, C. L. (2020). Relative sea level rise, coastline variability and coastal erosion in the Niger Delta, Nigeria: Implications for climate change adaptation and coastal zone management. *Earth Science, Climatic Change, 11*, 9.

Adeyefa, A. O., Odekunle, T. O., & Adesina, F. A. (2023). Assessing the physical vulnerability of the coastal area of Nigeria to climate change. *Journal of Atmosphere, Oceanography and Environment, 11*(1).

Affiah, U. E. (2023). *Vulnerability of the Nigerian coast and communities to climate change-induced coastal erosion* [Doctoral dissertation, University of Glasgow]. Enlighten Theses. https://theses.gla.ac.uk/83408

Babapoorkamani, A., & Ricci, L. (2025). Decision-making strategies for climate change adaptation in coastal regions of Africa. *Environmental Development, 55*, 101196. https://doi.org/10.1016/j.envdev.2025.101196

Boone, H. N., & Boone, D. A. (2012). Analyzing Likert data. *Journal of Extension, 50*(2), Article 48. https://doi.org/10.34068/joe.50.02.48



Creswell, J. W., & Creswell, J. D. (2023). *Research design: Qualitative, quantitative, and mixed methods approaches* (6th ed.). SAGE.

Croitoru, L., Miranda, J. J., Khattabi, A., & Lee, J. J. (2020). *The cost of coastal zone degradation in Nigeria: Cross River, Delta and Lagos States*. World Bank.

Dike, E. C., Amaechi, C. V., Beddu, S. B., Weje, I. I., Ameme, B. G., Efeovbokhan, O., & Oyetunji, A. K. (2024). Coastal vulnerability index sensitivity to shoreline position and coastal elevation parameters in the Niger Delta region, Nigeria. *Science of the Total Environment, 919*, 170830. https://doi.org/10.1016/j.scitotenv.2024.170830

Egbuna, O. K., & Odumodu, U. J. (2024). Urban growth and flood vulnerability in Asaba, Delta State. *International Journal of Climate Change and Environmental Sustainability, 1*(2), 1–16.

Hirose, M., & Creswell, J. W. (2023). Applying core quality criteria of mixed methods research to an empirical study. *Journal of Mixed Methods Research, 17*(1), 12–28.

Hoff, R. M. (2023). *A proposal for infrastructure adaptation and cascading failures for black swans*. Arizona State University.

Hurlimann, A., Barnett, J., Fincher, R., Osbaldiston, N., Mortreux, C., & Graham, S. (2014). Urban planning and sustainable adaptation to sea-level rise. *Landscape and Urban Planning, 126*, 84–93.

Musa, Z. N., Popescu, I., & Mynett, A. (2016). Assessing the sustainability of local resilience practices against sea-level rise impacts on the lower Niger Delta. *Ocean & Coastal Management, 130*, 221–228.

Ndimele, P. E., Ojewole, A. E., Mekuleyi, G. O., et al. (2024). Vulnerability, resilience, and adaptation of Lagos coastal communities to flooding. *Earth Science, Systems and Society, 4*, Article 10087.

Norman, G. (2010). Likert scales, levels of measurement and the "laws" of statistics. *Advances in Health Sciences Education, 15*(5), 625–632. https://doi.org/10.1007/s10459-010-9222-y

Ogbonna, C., Albrecht, E., Ugochukwu, C., Nwajiuba, C., & Onyeneke, R. (2020). Climate resilience in African coastal areas: Scaling up institutional capabilities in the Niger Delta region. In W. Leal Filho (Ed.), *Handbook of climate change resilience*. Springer.

Oloyede, M. O., Williams, A. B., Ode, G. O., & Benson, N. U. (2022). Coastal vulnerability assessment: A case study of the Nigerian coastline. *Sustainability, 14*(4), 2097. https://doi.org/10.3390/su14042097

Onyemenam, P. I., Nomuoja, O. F., Adeleye, B. M., Ojoh, C. O., & Eyetan, T. E. (2025). Impact of infrastructure deficit on youth rural-urban migration and agricultural productivity in Delta State. *Impact International Journals and Publications, 1*(4), 615–630.

Sullivan, G. M., & Artino, A. R., Jr. (2013). Analyzing and interpreting data from Likert-type scales. *Journal of Graduate Medical Education, 5*(4), 541–542. https://doi.org/10.4300/JGME-5-4-18

Zabbey, N., Giadom, F. D., & Babatunde, B. B. (2019). Nigerian coastal environments. In *World seas: An environmental evaluation* (pp. 835–854). Academic Press.