

Original article

DEVELOPMENT AND VALIDATION OF AN ADAPTIVE STAKEHOLDERS' INTERFACE MANAGEMENT SYSTEM FOR UNIVERSITY INFRASTRUCTURE PROJECTS

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Abstract: This paper introduces the Adaptive Stakeholders' Interface Management System (ASIMS) for university infrastructure projects, employing a system-of-systems approach. A mixed-methods design - involving surveys, flowcharting, key informant discussions, descriptive and inferential analyses - was adopted. ASIMS targeted 412 project management professionals with ≥ 10 years' experience across 12 universities. These experts provided perspectives that informed ASIMS development. The system was then deployed in two ongoing projects at the Federal University of Technology Owerri (a hold-out sample) and validated through performance feedback from 10 experts. Findings reveal that ASIMS significantly improves project communication by increasing openness (19.1%), honesty (9.3%), inclusivity (5.3%), and transparency (3.5%). It also leads to reductions in: conflicts (17.2%), uncertainties (13.5%), cost overruns (11.2%), time overruns (10.6%), and quality compromises (7.8%). In conclusion, ASIMS promotes communication, inclusivity, collaboration, and conflict resolution. Adoption of Agile principles that emphasize continuous multi-level stakeholder engagement, communication, and accountability is recommended to optimise interface management.

Keywords: Adaptive; Stakeholder; Interface management; System-of-system; Infrastructure project; Agile principle; University.

1. INTRODUCTION

The availability of essential infrastructure is vital for effective teaching, research, and learning in higher education. In Nigerian public universities, however, dilapidated facilities resulting from poor maintenance pose significant challenges. A primary contributor to this issue is inadequate planning and execution of infrastructure projects. Currently, the Tertiary Education Trust Fund (TETFund) serves as the main funding source for these initiatives. Yet, TETFund projects frequently

encounter delays, cost overruns, time extensions, and even abandonment, often due to stakeholder conflicts arising from ineffective interface management. Consequently, the development of an adaptive stakeholders' interface management system (ASIMS) is essential for successful infrastructure delivery in the Nigerian university system.

A project stakeholder comprises any individual, group, or organisation whose actions or interests may influence - or be

influenced by - the project, thereby playing a pivotal role in its success or failure (Bourne, 2015; Loftus, 2021; Müller et al., 2023). Stakeholder interface management, as recognised in the Project Management Institute (2021), entails managing complex human and organisational relationships across the dynamic project lifecycle (Pirozzi, 2020). Recent research reinforces this perspective, portraying effective interface management as relational governance to address interdependencies (Zhang et al., 2023), informed by psychological factors influencing stakeholder behaviour (Khosravi et al., 2023) and adaptive strategies attuned to evolving relationships throughout project phases.

Stakeholders are classified as internal or external according to their roles, responsibilities, interests, and influence (Hawrysz & Maj, 2017). Contemporary studies refine this framework by incorporating attributes such as proximity to the project core (Yang et al., 2023) and mapping distinct influence networks for internal and external groups, even in digitally advanced settings (Olanrewaju et al., 2024).

The Interface Management System (IMS), a key component of systems management, follows five iterative steps: identification, documentation, transfer, communication, and closure of interfaces (Shokri et al., 2013). This process remains foundational for handling complexity in modern projects, as evidenced by studies on relational governance in megaprojects (Zhang et al., 2023) and systematic reviews (Papavasiliou & Gorod, 2022). Recent advancements, such as Digital Twin frameworks, enable real-time iteration (Chen et al., 2024), while communication remains the critical enabler of all steps (Khosravi & Rezvani, 2022).

In infrastructure projects, an interface denotes the connection between construction elements, phases, or stakeholders (Papavasiliou & Gorod, 2022). Poor stakeholder interface management frequently results in cost overruns, schedule delays, and quality deficits, undermining project outcomes (Shokri et al., 2012). Empirical evidence continues to link interface conflicts to escalating costs and delays (Matinheikki et al., 2022; Zhang et al., 2023), information flow failures to rework and

defects (Li et al., 2023), and overall interface mismanagement to project underperformance (Khosravi & Rezvani, 2022). A robust IMS thus clarifies stakeholder roles, responsibilities, interests, and influences, enhancing project coordination.

This paper addresses the pressing need for a sustainable, evidence-based system-of-systems approach to stakeholder interface management in Nigerian public universities. Drawing on these challenges, it proposes an integrative framework to identify, categorise, classify, engage, control, evaluate, and debrief key stakeholders through critical thinking and filtering methods. The framework bridges knowledge gaps in stakeholder drivers, team formation, and integration within a system-of-systems model - particularly amid limited transparency and information sharing, which breed mistrust and conflict. The resulting ASIMS is tailored to surmount unique barriers to infrastructure delivery, thereby fostering quality teaching, research, and learning. The paper comprises five sections: introduction, conceptual framework and theoretical foundations, methodology, results and discussion, and conclusion.

2. CONCEPTUAL FRAMEWORK AND THEORETICAL FOUNDATIONS

The conceptual framework of this paper draws on three foundational theories: Stakeholder Theory (Freeman, 1984), which positions stakeholders as central to value creation; Systems Thinking (Checkland, 1999), which advocates holistic analysis of interdependencies; and Agile Principles (Highsmith, 2009), which emphasise iterative adaptation, feedback loops, and emergent requirements. These theories are integrated into a cyclical process for stakeholder interface management, yielding a five-step adaptive information management framework: identification, engagement, control, relevance evaluation, and debriefing. This approach aligns with established adaptive management principles (Papavasiliou & Gorod, 2022; Pirozzi, 2020; Shokri et al., 2013).

The core components of the ASIMS - identification, categorization, classification, engagement, control, and debriefing - are robustly supported in the literature.

Contemporary research continues to validate and refine their application within management disciplines (Aapaoja & Haapasalo, 2014; Bourne, 2015). Recent studies advance dynamic models that integrate these elements to address evolving stakeholder relationships (Mok et al., 2023), alongside data-driven approaches for enhanced identification and classification (Olanrewaju et al., 2024). The

engagement phase is consistently emphasised as critical, necessitating differentiated strategies (Liu et al., 2022). Feedback loops underscore the need for continuous reassessment of stakeholders' relevance to project goals, while control and debriefing recognises the value of documenting lessons learnt for performance improvement (Khosravi & Rezvani, 2022).

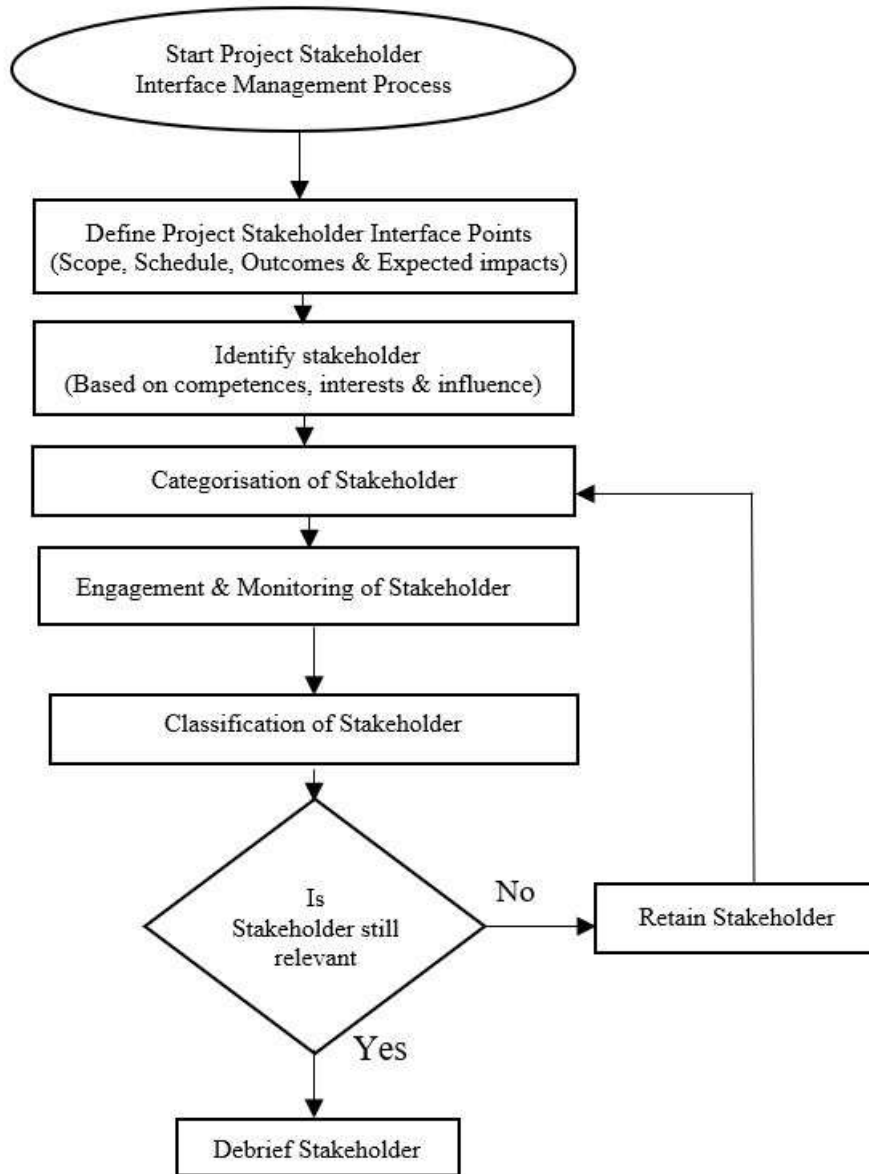


Figure 1: Agile interfacing in project stakeholder management process (Authors' conceptualization)

The innovation of the ASIMS resides in its explicit control and feedback mechanism - prompting the question, 'Is the stakeholder still relevant?' - which enables evidence-based decisions on stakeholder retention or disengagement throughout the project

lifecycle. This mechanism addresses the complexities and dynamic nature of human interactions in project systems, underscoring the necessity of effective interface management. Such challenges were highlighted by Maddaloni and Davis (2017)

and Khan et al. (2019), and they remain a focus of contemporary research. Recent studies advocate dynamic models for tracking and updating stakeholder salience (Mok et al., 2023) and robust frameworks for continual reassessment of stakeholder influence amid evolving project environments (Aaltonen & Kujala, 2022).

By incorporating control and feedback loops, ASIMS ensures flexibility and agility in stakeholder interface management process that fosters continuous organisational learning and improvement (He et al., 2023), while enabling responsiveness to project's dynamics (Khosravi & Rezvani, 2022). Consequently, the process is non-linear and adaptively responsive, facilitating continuous monitoring and evaluation of stakeholders' relevance and impact (Ibrahim, 2014; Loftus, 2021). This adaptability is particularly vital for successful infrastructure project implementation in complex environments such as the Nigerian public universities.

3. METHODOLOGY

This paper employs a mixed-methods approach, built on the system-of-systems (SoS) design framework, flow-charting, surveys, key informant discussions, descriptive and correlational analyses. Online surveys gathered expert opinions on university infrastructure project drivers and dependences from 412 project management professionals with at least ten years' experience in university infrastructure project management, across 12 Nigerian public universities. These respondents were serving either as internal staff, external consultants, or contractors within the Physical Planning and Development Units of the sampled institutions. Descriptive analysis of the survey data informed the inputs and relational structures for the agile SoS design framework and development algorithm of ASIMS. A prototype was then deployed to two ongoing infrastructure projects at the Federal University of Technology Owerri (a hold-out sample university), where 10 experienced practitioners provided independent expert assessments and feedbacks as to the operability, outcomes, and impacts of ASIMS. These assessment feedbacks were descriptively summarised and inferentially validated (Ezirim et al., 2004).

3.1 Flow-charting

Flow-charting employs standardised symbols (e.g., ovals for start/end points, rectangles for processes, diamonds for decisions) to visually map sequential workflows, decisions, and interactions (Keating & Bradley, 2015). For developing and validating ASIMS in university infrastructure projects, flowcharts illustrate interactions among constituent systems: Start → Stakeholder input (e.g., procurement/contractors) → Decision (budget approval?) → Adaptive feedback loop (real-time dashboard update) → Emergent validation (simulation metrics) → End.

3.2 System-of-systems model

The system-of-systems (SoS) model conceptualises complex endeavours as interoperable, independent systems that yield emergent capabilities surpassing individual components (Dahmann & Madni, 2016). In university infrastructure projects, it frames stakeholders (e.g., administrators, contractors) as autonomous constituent systems connected via adaptive interfaces. Grounded in systems thinking and modelling (ST&M) (Walker, 2014), the SoS approach mathematically simulates information flows and decision-making processes (Madni & Sievers, 2024). This is essential for analysing interrelationships across project networks (He et al., 2023; Papavasiliou & Gorod, 2022), with advancements like Digital Twins enabling dynamic, data-driven simulations for real-time decisions (Chen et al., 2024).

In this study, ST&M emphasised multiple stakeholder perspectives to achieve project objectives, treating each stakeholder as part of a larger system to balance diverse interests (Papavasiliou & Gorod, 2022). The SoS framework integrated process engineering (PE) and information systems management (ISM) across the project lifecycle (Kozma et al., 2021), analysing stakeholder interrelationships to enhance interface management. Practical applications include real-time dashboards for feedback loops - e.g., procurement (System 1) auto-adjusting contractor bids (System 2) in response to regulatory changes - and agent-based modelling for simulating negotiations (Keating & Bradley, 2015).

3.3 Analytical tools

Descriptive and inferential analytics were utilised. The power/predictability matrix classified stakeholders into four quadrants: powerful but predictable; powerful but unpredictable; predictable with low power; and unpredictable with low power. The study also drew on the power/interest matrix, classifying stakeholders by whether they are affected by project outcomes or control key resources (knowledge, political, financial), distinguishing influential (those who can

affect) from affected (those impacted by) groups.

Bourne (2015) advanced stakeholder salience assessment via a modified impact/probability matrix, substituting salience for impact on the Y-axis (see Table 1). This multi-attribute approach remains influential, with recent research developing dynamic models to track salience evolution over the project lifecycle (Mok et al., 2023) and data-driven methods like Social Network Analysis to quantify influence and urgency (Olanrewaju et al., 2024), as detailed in Equation 1.

$$Urgency = INT \left(\sqrt{\frac{Vested\ Stake * Importance\ To}{25}} * 5 \right) \dots (1)$$

Where:

- i) Vested Stake = Degree of stakeholder investment in the project (scale 1–10)
- ii) Importance To = Importance of the project to the stakeholder (scale 1–10)
- iii) INT = Integer function
- iv) Constants 25 and 5 are scaling factors derived from the salience matrix.

least two salience attributes (power, legitimacy, urgency) and thus qualify as primary team members. ‘Keep informed’ stakeholders, with higher potential impact than ‘keep satisfied’ ones, serve as key supporters, while those with a single attribute warrant ‘minimal effort’ as extended stakeholders. Values are computed using stakeholder salience attributes (power, legitimacy, urgency) and the probability of impact on project objectives.

4. RESULTS AND DISCUSSIONS

4.1 Results

The values in Table 1 were derived by applying weighted responses from 412 highly experienced infrastructure project professionals (over 10 years in practice) across 12 Nigerian universities to a survey instrument. The survey elicited their opinions on key stakeholder interface management issues in university infrastructure projects, adapted to the Bourne (2015) model as shown in Equation 1. Table 1 calibrates stakeholder positioning, emphasising that ‘key players’ must exhibit at

Table 1 also calibrates shifts in stakeholder positioning arising from active involvement. Stakeholder salience - the degree to which managers classify competing claims - is determined by three attributes: power, legitimacy, and urgency (Ebiringa, 2011). This matrix identifies stakeholders warranting the most attention, with salience varying by the number of attributes possessed and evolving as stakeholders seek to amplify their claims over the project lifecycle.

Table 1: Salience and probability/impact matrix (Modified probability/impact matrix)

Probability Matrix								
Urgency Score	Salience				Impact			
PTM (0.90)	0.09	0.18	0.36	0.72	0.72	0.36	0.18	0.09
KSP (0.70)	0.07	0.14	0.28	0.56	0.56	0.28	0.14	0.07
TS (0.50)		0.10	0.20	0.40	0.40	0.20	0.10	
ES (0.30)		0.06	0.12	0.24	0.24	0.12	0.06	
	key players (0.10)	keep informed (0.20)	keep satisfied (0.40)	Minimal effort (0.80)	Minimal effort (0.80)	keep satisfied (0.40)	keep informed (0.20)	key players (0.10)

Probability to Impact of the Stakeholders on an objective (e.g., cost, time, scope or quality). Each stakeholder is rated on his/her salience and probability to impact on the project objective if identified and prioritized.

Source: Authors' computations (2025)

Where: PTM = Primary Team Members, KSP = Key Supporting Participants, TS = Tertiary Stakeholders, ES = Extended Stakeholders.

Power denotes a stakeholder's ability to compel others to act against their initial intentions, derived from mobilising social/political forces or controlling resources. Government agencies and courts, for instance, wield formal power despite not initiating actions. Legitimacy reflects perceptions of a stakeholder's claims as appropriate within social norms; managers classify such claims, though those lacking power (e.g., external stakeholders without contracts) are often overlooked (Nworuh, et al. (2025)). Urgency gauges the immediacy of a claim, combining time sensitivity (unacceptability of delays) and criticality (importance to the stakeholder). In construction projects, potential negative impacts heighten urgency. While less potent than power or legitimacy, urgency influences salience dynamics. Stakeholders lacking all

three attributes are excluded from project consideration. Urgency levels were computed via Equation 1 based on the variables in Table 1, signalling the required intensity of interface management attention.

4.2 Development of ASIMS

Figure 2 operationalises the conceptual process from Figure 1 into the proposed ASIMS. The development followed system-of-systems (SoS) methodology (Papavasiliou & Gorod, 2022) and Agile principles, emphasising iterative process and responsiveness to change (Madni & Sievers, 2024). The SoS process commenced with defining the project brief - a foundational step in requirement engineering, affirmed as critical for success (Bourne, 2015; He et al., 2023; Pirozzi, 2020). Contemporary research highlights how inadequate initial requirements precipitate communication breakdowns and interface conflicts in later stages (Khosravi & Rezvani, 2022).

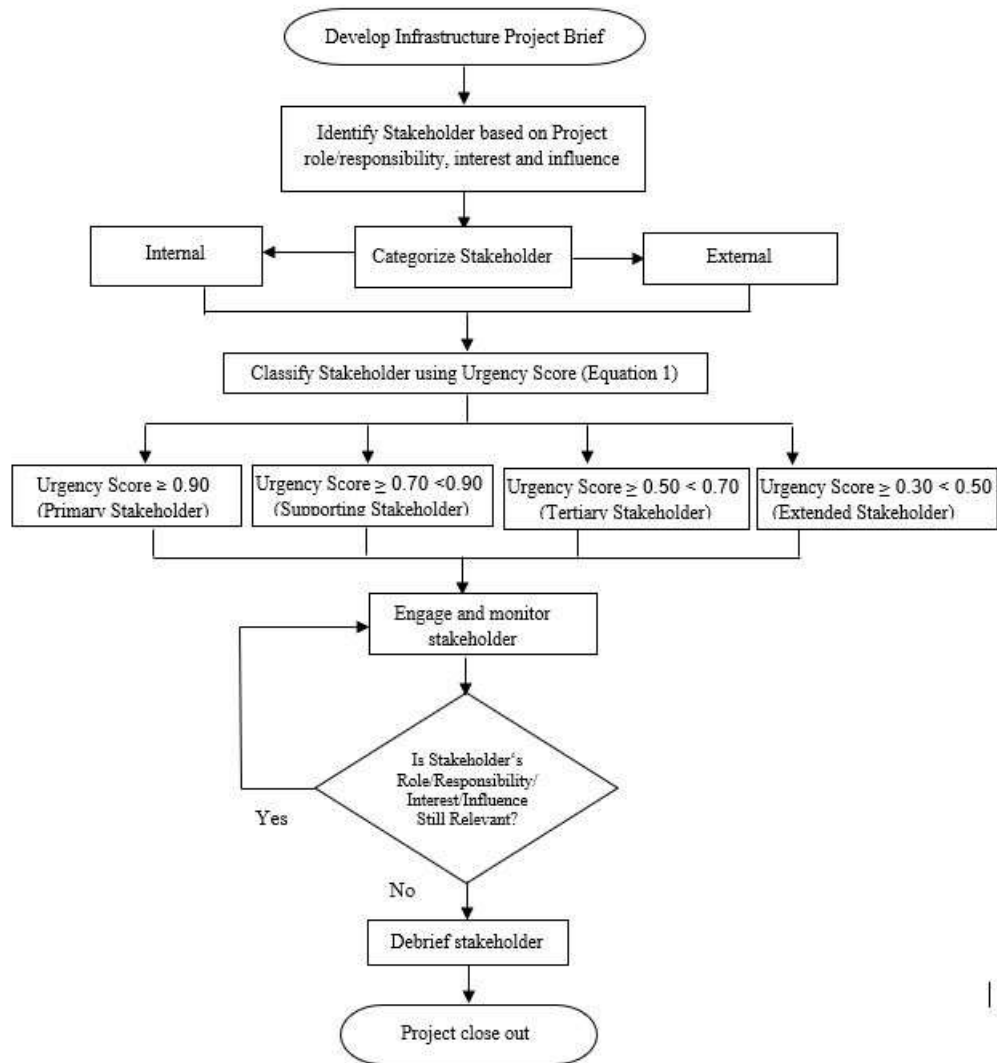


Figure 2: Adaptive ASIMS (Formulated by Authors, 2025)

The subsequent steps - categorization, classification, and engagement - draw from multi-attribute grids (Khan et al., 2019) and the salience model (power, legitimacy, urgency). Contemporary research reinforces their relevance, with dynamic frameworks tracking evolving influence in megaprojects (Mok et al., 2023) and data-driven methods like Social Network Analysis quantifying attributes such as influence (Olanrewaju et al., 2024).

The four-tier classification (Primary, Supporting, Tertiary, Extended), adapted from Roeder (2013), is validated by empirical network analyses revealing stakeholder clusters from core influencers to peripheral actors (Olanrewaju et al., 2024). Control and debriefing stages extend beyond planning to active management and learning, aligning with calls for dynamic frameworks (Loftus, 2021).

ASIMS’s principal contribution is integrating these steps into a cohesive, user-friendly flowchart with a control point (e.g., ‘Is the stakeholder’s role still relevant?’).

4.3 ASIMS deployment and validation

ASIMS was deployed to two ongoing infrastructure projects at the Federal University of Technology Owerri (hold-out sample) and evaluated by 10 practitioners via:

- Baseline assessment of pre-ASIMS issues (e.g., communication gaps, role conflicts, engagement inconsistencies);
- Implementation applying the framework for stakeholder identification, categorization and classification;
- Post-implementation review using surveys and key informant discussions across nine performance indicators.

4.3.1 CASE 1 (SICT building project)

Experts identified 11 stakeholder groups and roles (see Table 2). ASIMS elevated end-users to Primary Team Members (previously

overlooked), yielding focused engagement, 19% improved requirement clarity, fewer late-stage changes, and 10.6% reduced time overruns.

Table 2: Summary of expert assessment feedback on application of ASIMS on case project 1

Stakeholder group	Role
Customer	Local physical planning unit: project oversight, purpose definition, constraints.
End Users	Teaching/non-teaching staff, students.
Main Contractor	Oversees all construction activities.
Sub-contractors	Handle outsourced smaller tasks.
Side-contractors	Directly contracted by customer for specialised functions (e.g., ventilation, electricity, and plumbing).
Main Designer (Architect)	Leads overall design, integrates other contributions.
Other Designers	Specific subsystems (e.g., structural, electrical).
Public Authorities	Local government: regulates construction, planning, fire safety, health.
Material Suppliers	Provide concrete, windows, furnishings, instruments.
Local Residents/Neighbours	Raise project-related concerns.
Council and Management	Final decision-makers, approve project/funding.

Source: Authors' Fieldwork (2025)

4.3.2 Case 2 (Perimeter fencing of teaching hospital site)

This anti-encroachment project garnered strong support, particularly from end-users and

the Imo State Government, which recognises the hospital's healthcare value. Experts identified 12 stakeholder groups and roles (see Table 3).

Table 3: Summary of expert assessment feedback on ASIMS application in case project 2

Stakeholder Group	Role
Customer	Council and Management: final decisions.
End-Users	Teaching/non-teaching staff, students, future patients.
Main Contractor	Executes design implementation.
Sub-contractors	Specific tasks under main contractor.
Property Management	Coordinates stakeholders, handles information/issues.
Main Designer (Architect)	Leads design, integrates contributions.
Other Designers	Discrete functions.
Public Authorities	Local government: supervision, constraints.
Material Suppliers	Provide materials.
Local Residents/Neighbours	Raise concerns/requests.
Construction Consultant	Provides expertise where customer lacks knowledge.
Project Sponsor	No direct requirements/interest.

Source: Authors' fieldwork (2025)

ASIMS clarified Project Sponsor and Customer roles, averting authority conflicts. Early classification of local residents as Extended Stakeholders enabled proactive

communication, preventing disputes (see Table 4) and achieving 17.2% conflict reduction (see Table 5).

Table 4: Summary of ASIMS Application and Key Outcomes in Case Projects

Project component	SICT building project	Perimeter fencing project
Key Stakeholder Highlight	End-users (Staff & Students) formally included as PTMs.	Local Residents classified as Extended Stakeholders
Pre-ASIMS Issue	Unclear requirements leading to rework.	Potential for community encroachment and disputes.
ASIMS-Driven Action	Structured requirement engineering sessions with end-users.	Proactive information sharing and grievance management.
Observed Outcome	Reduced change requests; better alignment with user needs.	Smoothed project execution; minimal external conflict.

Source: Authors' fieldwork (2025)

Table 4 presents a comparative summary of how the ASIMS was applied across two distinct infrastructure projects—a SICT building project and a perimeter fencing project at the Federal University of Technology, Owerri—and the key outcomes achieved. The table highlights the role of stakeholder integration in improving project delivery performance and minimizing risks. At the project component level, the two cases differ in nature: one is an internal institutional development (SICT building), while the other involves external boundary control (perimeter fencing). This distinction is important because it shapes the type and influence of stakeholders involved. Regarding key stakeholder highlights, the SICT building project demonstrates a progressive stakeholder engagement approach by formally integrating end-users (staff and students) as Project Team Members (PTMs). This reflects a participatory model where users directly influence project design and implementation. In contrast, the perimeter fencing project identifies local residents as extended stakeholders, acknowledging their indirect but significant impact on project success due to their proximity and potential for interference.

The pre-ASIMS issues in both projects reveal typical challenges associated with insufficient stakeholder engagement. In the SICT building project, unclear requirements led to frequent rework, indicating a gap in early-stage requirement elicitation. Meanwhile, the perimeter fencing project faced risks of community encroachment and disputes, highlighting the absence of proactive community relations and communication strategies. The ASIMS-driven actions illustrate how structured stakeholder integration

addressed these challenges. For the SICT building project, the introduction of systematic requirement engineering sessions with end-users ensured that their needs were clearly defined and incorporated from the outset. In the perimeter fencing project, proactive information dissemination and grievance management mechanisms helped to build trust and reduce tensions with local residents.

Finally, the observed outcomes confirm the effectiveness of ASIMS. In the SICT building project, there was a notable reduction in change requests and improved alignment between the delivered facility and user expectations - indicating enhanced efficiency and quality. In the perimeter fencing project, smoother execution and minimal external conflict were achieved, demonstrating the value of early stakeholder identification and continuous engagement in mitigating social risks. Overall, Table 4 underscores that ASIMS enhances project performance by institutionalizing stakeholder inclusion, improving communication, and proactively managing potential conflicts. It also illustrates that stakeholder strategies must be context-specific - tailored to whether stakeholders are internal users or external community actors - to achieve optimal results.

4.4 ASIMS impact assessment

ASIMS impact was assessed via pre- and post-implementation comparative analysis of project performance. Data were analysed using descriptive statistics and Pearson correlation, with significance tested via two-tailed t-tests ($p < 0.05$) as summarized in Table 5.

Table 5: Correlation Coefficients of ASIMS with Project Systems Performance

Indicators	Openness	Conflict reduction	Uncertainty	Cost effectiveness	Time effectiveness	Honesty & Accountability	Quality & Reliability	Inclusivity	Buy in/ decision support
Coefficient	0.191	0.172	0.135	0.112	0.106	0.093	0.078	0.053	0.035
Sig	0.041	0.038	0.022	0.039	0.014	0.025	0.036	0.048	0.031

Source: Authors' computations from survey data, 2025

Table 5 presents the correlation coefficients between ASIMS and various dimensions of project systems performance. The table provides both the strength of relationships (coefficients) and their statistical significance (Sig values), offering insight into how ASIMS influences different performance indicators. Overall, the coefficients are positive across all indicators, which implies that ASIMS has a direct (though moderate) positive relationship with all aspects of project performance considered. This suggests that increased adoption or effectiveness of ASIMS is associated with improvements in openness, conflict reduction, uncertainty management, and other performance outcomes.

Starting with the strongest relationships, *openness* (0.191, $p = 0.041$) and *conflict reduction* (0.172, $p = 0.038$) show the highest correlation coefficients. This indicates that ASIMS is particularly effective in promoting transparency and reducing disputes among stakeholders. These findings align with the core premise of ASIMS, which emphasizes structured stakeholder engagement and communication. The next set of indicators—*uncertainty* (0.135, $p = 0.022$), *cost effectiveness* (0.112, $p = 0.039$), and *time effectiveness* (0.106, $p = 0.014$)—demonstrate moderate but statistically significant relationships. These results suggest that ASIMS contributes to better predictability and efficiency in project delivery, likely through improved information flow and early identification of risks.

Further, *honesty and accountability* (0.093, $p = 0.025$) and *quality and reliability* (0.078, $p = 0.036$) also show positive correlations, though slightly weaker. This implies that while

ASIMS supports ethical practices and quality outcomes, its influence in these areas may be more indirect or mediated through other factors such as governance structures and technical capacity. The weakest correlations are observed in *inclusivity* (0.053, $p = 0.048$) and *buy-in/decision support* (0.035, $p = 0.031$). Despite their low magnitude, these relationships remain statistically significant, indicating that ASIMS still has a measurable, albeit limited, effect on stakeholder inclusiveness and decision acceptance. This may suggest that while stakeholders are engaged, deeper levels of empowerment and consensus-building may require additional mechanisms beyond ASIMS. Importantly, all Sig values are below 0.05, confirming that the relationships are statistically significant at the 5% level. This strengthens confidence in the reliability of the findings and suggests that the observed correlations are unlikely to have occurred by chance. In summary, Table 5 indicates that ASIMS positively influences multiple dimensions of project systems performance, with the strongest effects on openness and conflict reduction, and more modest effects on inclusivity and decision support. The findings reinforce the value of ASIMS as a tool for enhancing stakeholder management and improving overall project outcomes, while also pointing to areas where its impact could be further strengthened.

Further, Figure 3 presents modified ASIMS for stakeholder classification and team formation structure based on feedbacks obtained from the application of ASIMS to the case projects. The decision node 'Is the identified stakeholder still relevant to achieving project goals?' serves as a critical control/filter based on assessed salience.

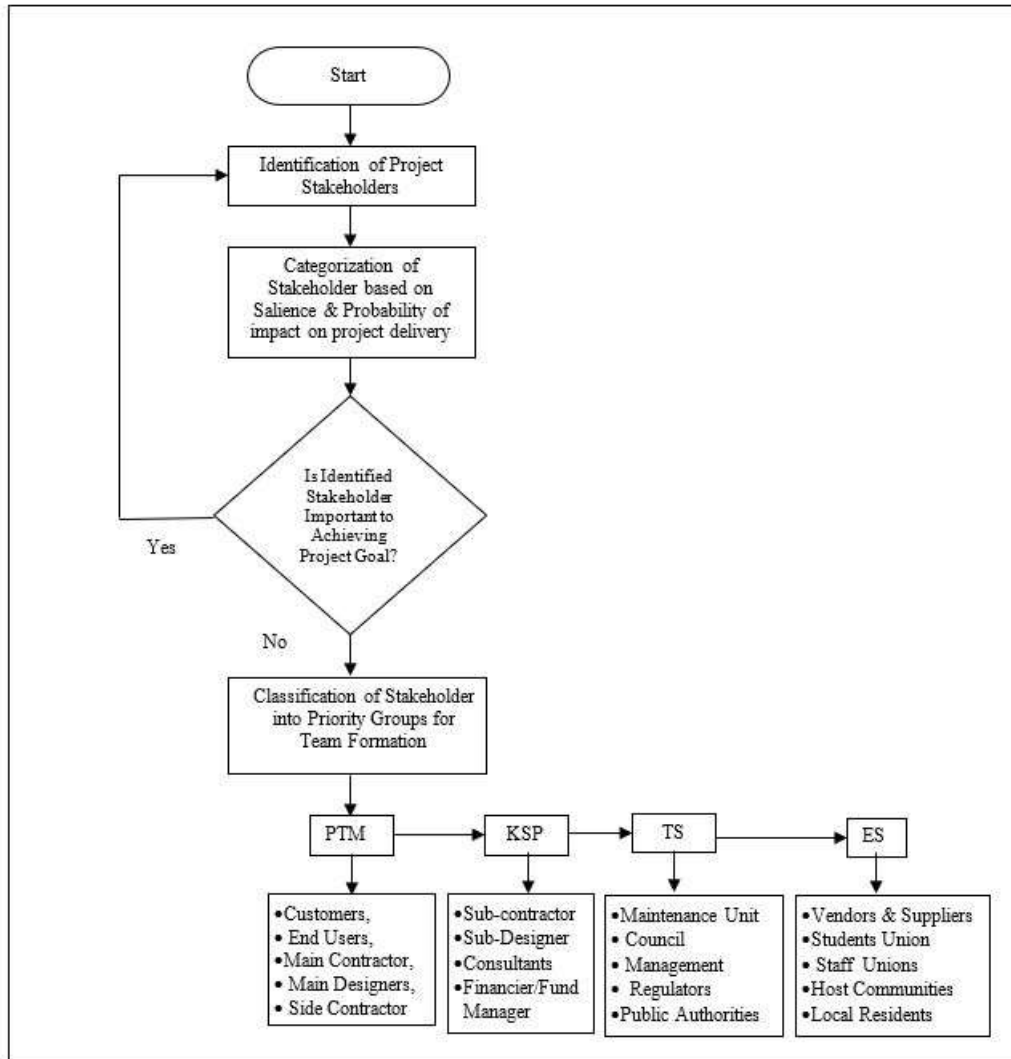


Figure 3: Modified of ASIMS

A stakeholder qualifies as ‘important’ if possessing at least one salience attribute (power, legitimacy, urgency), as earlier defined in the Salience and Probability/Impact Matrix (Table 1; Equation 1). Those failing this threshold receive no classified engagement in core project teams.

4.5 Discussion of findings

The results confirm a statistically significant positive correlation between ASIMS deployment and key performance metrics, examined here against the reviewed literature. The largest gain - openness (19.1%) - aligns with principles positing transparent communication as essential for mitigating conflicts (Pirozzi, 2020). This validates communication’s role as the enabler of Interface Management System (IMS)

processes (Khosravi & Rezvani, 2022; Shokri et al., 2013). Reductions in conflicts (17.2%) and uncertainties (13.5%) stem directly from ASIMS’s systematic identification, categorization and classification, supporting Maddaloni and Davis (2017) on inclusive mapping’s risk-reduction benefits and Matinheikki et al. (2022) on poor interface management’s consequences.

Notable declines in cost overruns (11.2%) and time overruns (10.6%) corroborate Papavasiliou and Gorod (2022) on interface management’s role in complex system-of-systems projects. ASIMS clarifies roles early (Bourne, 2015), averting rework from miscommunication (Li et al., 2023) and realising IMS benefits (Shokri et al., 2013). The modest quality improvement (7.8%) indicates ASIMS’s structural benefits,

tempered by technical/execution factors, echoing Khan et al. (2019) and Nworuh, et al. (2025) that stakeholder management is necessary but insufficient alone. ASIMS's adaptability across diverse cases (SICT building; perimeter fencing) highlights its strength: salience-based classification accommodates project-specific needs, per Pirozzi (2020) and Mok et al. (2023). Dynamic contractor reclassification and the 'Is stakeholder still relevant?' loop enable continuous reassessment and control (Aaltonen & Kujala, 2022), fostering organisational learning and performance improvement (He et al., 2023).

5. SUMMARY, CONCLUSION, AND RECOMMENDATIONS

5.1 Summary

This paper develops an integrated system classifying stakeholders into four groups - Primary Team Members (PTM), Key Supporting Participants (KSP), Tertiary Stakeholders (TS), and Extended Stakeholders (ES) - to optimise engagement timing, methods, and resource allocation (Table 1). This informed the ASIMS framework (Figure 2: development; Figure 3: classification and team formation), underpinning the continuous stakeholder control step via salience and relevance analysis.

Key outcomes include enhanced communication and reduced conflict: elevating end-users to PTM (SICT project) and classification of residents as ES (fencing project) improved openness, minimising conflicts/uncertainties (Table 3). A mixed-methods approach (qualitative insights, quantitative scoring) establishes evidence-based interface management, validated by descriptive/correlational analyses (Table 3; Table 4). ASIMS further enables dynamic classification as projects evolve, via its adaptive, feedback-driven loop ('Is stakeholder still relevant?' Figure 1) for continual reassessment.

5.2 Conclusion

Effective stakeholder identification, classification, and evaluation are crucial for accurate requirement handling; errors here precipitate project failure. ASIMS provides a

systematic approach grounded in functional roles, salience, and impact/contribution potential, prioritising early-phase value creation and success.

Benefiting all parties - especially in unique projects - ASIMS maintains trajectory, averts costly changes/rework, and prevents conflicts through early goal/constraint alignment. It advances theory on classification and team formation, enabling managers to harness expertise while treating stakeholders heterogeneously by roles/responsibilities.

User-friendly with clear criteria, ASIMS enhances requirement accuracy, reduces waste, and boosts value. It highlights needs for further salience-change research. Though demanding resources in fragmented sectors, its feasibility across cases confirms benefits outweigh costs long-term.

5.3 Recommendations

The following recommendations derive from this study:

- i) Universities should adopt adaptive systems like ASIMS to bolster communication, inclusivity, and collaboration, yielding improved outcomes as evidenced in the cases.
- ii) Implement systematic identification, categorization, classification based on responsibilities, interests, and influence for lifecycle engagement.
- iii) Establish regulatory frameworks mandating transparency, honesty, and openness to curb conflicts, uncertainties, cost/time overruns.
- iv) Integrate continuous monitoring, evaluation, control, and debriefing into project systems for adaptive learning.
- v) Promote Agile methodologies in policies for flexibility and responsiveness.
- vi) Foster seamless coordination among stakeholders to counter fragmentation and align project objectives.
- vii) Embed formal review, learning, and data-driven adjustment in university infrastructure development policies for resilience.
- viii) Support integrated project management systems enhancing information flow, risk control, and efficiency.

These align with adaptive policy principles - multi-perspective deliberation, engagement, integrated control, self-organisation, subsidiarity - for effective stakeholders interface management.

DISCLAIMER

Artificial intelligence (AI) tools were used in the preparation of this manuscript solely for grammar checking, language refinement, and clarity of expression. The core ideas, analysis, interpretations, and conclusions presented in this work are entirely those of the authors.

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