ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 7 (July 2026)

Integrating AI and IoT in Smart Classrooms: Stakeholder Perceptions and Strategic Framework for Educational Institutions

Marvin O. Mallari[1*] and Arden C. Cabugos[1]
[1]*Holy Cross Colleges, Inc., Sta. Ana, Pampanga, Philippines*
[*]*mallarimarvin022@gmail.com*

Date Submitted:
March 23, 2026

Date Accepted:
May 17, 2026

Date Published:
July 28, 2026

DOI:
10.5281/zenodo.21639198

ABSTRACT

Artificial intelligence (AI) and Internet of Things (IoT) technologies can transform conventional classrooms into connected, interactive, and data-informed learning environments, but their effective adoption depends on institutional readiness. This study assessed stakeholders' perceptions of the challenges and limitations associated with AI- and IoT-enabled smart classrooms and developed a strategic implementation framework for educational institutions. A quantitative descriptive design was employed with 30 respondents composed of students, faculty members, and administrators from a private higher educational institution in Pampanga, Philippines. Participants were selected through convenience sampling. Data were gathered using an adapted, expert-reviewed questionnaire and analyzed using weighted mean and standard deviation. The respondents agreed that institutions face substantial implementation barriers (overall M = 3.13). Inadequate teacher training emerged as the most strongly perceived concern (M = 3.23, SD = 0.73), followed by insufficient internet connectivity and technological infrastructure (M = 3.20, SD = 0.76). Unclear data privacy policies and resistance to innovation both obtained a mean of 3.03. Stakeholder feedback further emphasized human-capacity limitations, institutional readiness, and awareness gaps. Based on these findings, an iterative framework was developed around leadership and governance, smart infrastructure, human capability, operational support, data privacy and ethics, learning analytics, sustainability, equity and accessibility, and continuous improvement. The study concludes that AI and IoT adoption should be treated as an institution-wide transformation requiring phased investment, continuous capacity building, responsible data governance, and sustained administrative commitment.

Keywords: *artificial intelligence, Internet of Things, smart classrooms, stakeholder perceptions, higher education, digital transformation*

INTRODUCTION

Digital transformation is reshaping higher education by extending teaching and learning beyond conventional classroom arrangements. Smart classrooms represent one expression of this transformation because they combine connected devices, digital platforms, sensors, and intelligent applications to support instruction and institutional operations. Through IoT connectivity, devices can collect and exchange data, automate selected classroom functions, and support timely responses to educational needs (Ali et al., 2015). Smart classroom technologies may also strengthen interactivity and engagement when they are aligned with instructional purposes rather than introduced as isolated technological additions (Alshammari & Korr, 2022).

The integration of AI expands these capabilities by enabling adaptive learning, automated feedback, predictive analysis, and personalized support. AI- and IoT-enabled environments can generate real-time

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 7 (July 2026)

information about attendance, resource use, classroom conditions, and learning behaviors, allowing institutions to respond more efficiently and tailor learning experiences to students' needs (Huang & Lin, 2023). Large-scale educational data can likewise support evidence-based decision-making, provided that institutions possess the technical and organizational capacity to interpret the information responsibly (Kumar et al., 2020).

Smart technologies can also contribute to the broader management of educational institutions. Integrated systems may improve procurement, financial management, employee records, information flow, and reporting processes (Fernando et al., 2022). IoT-supported facility management can assist institutions in monitoring equipment and physical spaces, anticipating maintenance requirements, and generating more timely operational reports (Santos et al., 2025). AI-powered analytics can further connect classroom-level data with institutional planning, helping administrators identify patterns that may inform resource allocation and academic support (Delgado et al., 2023).

Despite these potential benefits, implementation is frequently constrained by unreliable connectivity, inadequate equipment, limited technical support, insufficient faculty preparation, cybersecurity risks, and concerns about the collection and use of personal data. A systematic review by Hossain and Cummings (2023) emphasized that smart classroom adoption requires more than technology procurement because user readiness, policy clarity, infrastructure quality, and sustained support strongly affect implementation. Teacher knowledge, confidence, beliefs, and organizational culture are also closely intertwined in technology-related change (Ertmer & Ottenbreit-Leftwich, 2010).

These concerns are especially relevant in higher educational institutions that must balance innovation with financial limitations, local infrastructure conditions, and ethical responsibilities. Although international research has examined AI, IoT, and smart learning environments, institution-specific evidence remains important because readiness and implementation conditions vary across settings. In the Philippine context, there is a continuing need for practical frameworks that translate broad digital-transformation goals into feasible actions for leadership, faculty development, infrastructure, governance, and student access.

Accordingly, this study assessed how students, faculty members, and administrators perceived the challenges and limitations of implementing AI- and IoT-enabled smart classrooms in a private higher educational institution in Pampanga. It also developed a strategic framework intended to guide institutional planning and responsible adoption. Specifically, the study described stakeholder perceptions of implementation barriers and used the findings to recommend coordinated strategies for infrastructure development, capacity building, governance, sustainability, and continuous improvement.

Literature Review

AI and IoT in Smart Classroom Environments

Smart classrooms are technology-rich learning environments in which connected devices, digital interfaces, and software platforms support interaction, monitoring, and instructional delivery. IoT provides the connectivity layer that allows devices and sensors to communicate, while AI supports interpretation, automation, and adaptive responses. When these technologies are pedagogically aligned, they can support greater engagement, more immediate feedback, and personalized learning opportunities (Alshammari & Korr, 2022; Huang & Lin, 2023). Their educational value therefore depends on how well technical functions are connected to specific teaching and learning goals.

The use of AI and IoT also creates opportunities for data-informed educational management. Big-data applications can help institutions analyze patterns in learning, resource utilization, and operational performance (Kumar et al., 2020). AI-powered analytics may assist in identifying learners who need additional support, while connected facility systems can improve monitoring and maintenance (Delgado et al., 2023; Santos et al., 2025). Similarly, the integration of enterprise and information systems can reduce fragmented administrative processes and improve organizational responsiveness (Fernando et al., 2022).

Research on digital classroom transformation nevertheless cautions against equating the presence of technology with meaningful educational change. Gunasekaran et al. (2024) and Ve et al. (2024) emphasized that

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 7 (July 2026)

AI and IoT influence education through the combined effects of technology, pedagogy, users, and organizational systems. This view positions the smart classroom as an ecosystem rather than a collection of devices. Effective implementation therefore requires alignment among infrastructure, teacher practice, data use, technical support, and institutional goals.

Institutional Readiness and Stakeholder Capacity

Institutional readiness includes the availability of reliable infrastructure, adequate funding, technical personnel, appropriate policies, and stakeholders who are prepared to use emerging technologies. Connectivity and hardware are foundational, but they do not guarantee adoption when teachers and learners lack the confidence or competence to integrate the systems into daily practice. Ertmer and Ottenbreit-Leftwich (2010) explained that technology change is shaped by the interaction of knowledge, confidence, beliefs, and culture, indicating that faculty development must address both technical skills and pedagogical decision-making.

Smart classroom implementation also requires continuous support rather than one-time orientation. Faculty members need opportunities to practice using adaptive platforms, connected devices, dashboards, and digital classroom-management tools. Administrators and technical personnel must likewise understand how classroom data are generated, interpreted, protected, and translated into institutional decisions. The implementation challenges summarized by Hossain and Cummings (2023) show that inadequate training and weak infrastructure often reinforce one another: teachers may avoid technologies that are unreliable, while institutions may underinvest in systems that users are not prepared to adopt.

Stakeholder participation is therefore essential throughout planning, pilot implementation, evaluation, and expansion. Students can provide evidence about accessibility and learning experience; faculty members can identify pedagogical and operational constraints; administrators can align adoption with institutional goals and budgets; and technical personnel can assess interoperability, maintenance, and security. A stakeholder-centered approach reduces the risk of adopting technologies that are technically available but poorly suited to the actual educational environment.

Data Governance, Leadership, and Sustainable Implementation

AI- and IoT-enabled classrooms collect substantial amounts of data, including attendance information, device activity, environmental readings, and potentially learning-behavior data. Clear governance is therefore necessary to define authorized access, data retention, security controls, appropriate educational use, and accountability. Chan and Lee (2023) argued that comprehensive AI policy in higher education should integrate teaching, learning, ethics, and governance rather than treat these as separate concerns. Policy implementation should also remain adaptive because technological capabilities and institutional needs evolve over time (Viennet & Pont, 2017).

Leadership is a central coordinating force in this process. Leaders influence whether innovation is adequately resourced, communicated, and connected to institutional priorities. Studies of transformational and transactional leadership in educational and public-sector settings suggest that clear direction, collaboration, support, and responsiveness can strengthen participation in organizational initiatives (Domingo et al., 2025; Nilo et al., 2025). For smart classroom adoption, leadership must connect strategic vision with practical actions such as infrastructure planning, faculty development, technical support, and policy compliance.

Sustainability further requires institutions to consider lifecycle costs, maintenance, energy efficiency, scalability, accessibility, and continuous evaluation. A phased approach allows institutions to test technologies, identify unintended effects, and refine policies before wider implementation. The literature consequently supports an iterative framework in which external requirements, leadership, infrastructure, human capability, operations, data ethics, analytics, sustainability, student equity, and feedback operate as interdependent components of digital transformation.

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 7 (July 2026)

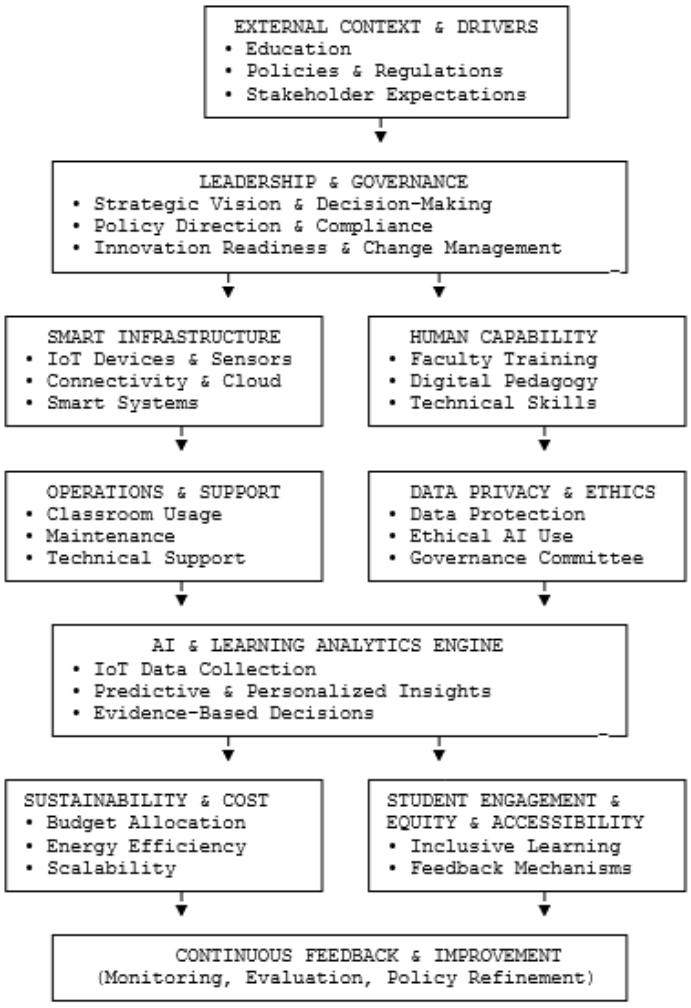


Figure 1. *AI- and IoT-Enabled Smart Classroom Implementation Framework*

METHODS

Research Design

The study employed a quantitative descriptive research design to determine stakeholders' perceptions of the challenges and limitations associated with AI- and IoT-enabled smart classrooms. The design was appropriate because the investigation focused on describing existing views and implementation conditions without manipulating the study environment.

Research Locale

The study was conducted in a private higher educational institution in Pampanga, Philippines. The institutional setting was selected because it included stakeholders with exposure to technology, engineering, digital systems, or smart classroom concepts and therefore provided an appropriate context for examining readiness for AI and IoT integration.

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 7 (July 2026)

Participants and Sampling Technique

The respondents consisted of 30 stakeholders composed of students, faculty members, and administrators. Convenience sampling was used to include participants who were available and who possessed relevant technical backgrounds, familiarity with smart classroom configurations, or experience related to the research topic. The inclusion of three stakeholder groups allowed the study to reflect instructional, learner, and administrative perspectives.

Research Instrument

Data were gathered using a survey questionnaire adapted from Gunasekaran et al. (2024). The instrument focused on perceived challenges and limitations in the implementation of AI- and IoT-based smart classrooms, including infrastructure, teacher preparedness, data privacy policy, and institutional openness to innovation. Its content was subjected to expert review before administration. Responses were measured through a four-point Likert scale ranging from 1 (Strongly Disagree) to 4 (Strongly Agree). The questionnaire also allowed respondents to provide feedback on implementation concerns that were not fully captured by the structured items.

Data Gathering Procedure

The questionnaire was administered to eligible students, faculty members, and administrators who met the study's familiarity or experience criteria. Completed responses were collected, checked for completeness, encoded, and consolidated for statistical analysis. The stakeholder comments were reviewed to identify recurring implementation concerns that could inform the proposed strategic framework.

Data Analysis

Descriptive statistics were used to analyze the data. Weighted mean determined the general level of agreement with each implementation challenge, while standard deviation described the variability of the respondents' answers. The written feedback was organized into recurring themes concerning human capacity, institutional readiness, infrastructure, and awareness. The quantitative and thematic findings served as the basis for developing the AI- and IoT-enabled smart classroom implementation framework.

Ethical Considerations

The findings were reported in aggregate form so that no individual respondent could be identified in the presentation of results. The source manuscript did not specify an institutional ethics-review number; consequently, no approval number is reported in this article. Only information relevant to the stated research objectives was included in the analysis.

RESULTS AND DISCUSSION

Perceived Challenges and Limitations

Table 1 presents the respondents' assessment of the major challenges and limitations in implementing AI- and IoT-enabled smart classrooms. The overall mean of 3.13 indicated agreement that the institution encountered meaningful barriers to implementation. The results show that the perceived obstacles were not confined to technology alone but also included human capability, policy, and organizational readiness.

Table 1. *Challenges and Limitations in Implementing AI- and IoT-Based Smart Classrooms*

Indicator	SD	Mean	Verbal Description
The school lacks sufficient internet connectivity and technological infrastructure to support AI- and IoT-based smart classrooms.	0.76	3.20	Strongly Agree
Teachers are not adequately trained to implement AI and IoT technologies in the classroom.	0.73	3.23	Strongly Agree

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 7 (July 2026)

The school does not have clear policies addressing data privacy and protection when using AI and IoT technologies.	0.81	3.03	Agree
The school is resistant to innovation and slow to adopt new technologies such as AI and IoT.	0.85	3.03	Agree
Overall		3.13	Agree

Inadequate teacher training obtained the highest mean (M = 3.23, SD = 0.73), showing that respondents regarded human capability as the most immediate implementation concern. Insufficient internet connectivity and technological infrastructure followed closely (M = 3.20, SD = 0.76). The two highest-rated items were both interpreted as Strongly Agree, indicating that stakeholders viewed faculty preparedness and infrastructure as closely connected requirements. This pattern is consistent with research showing that technology adoption is weakened when teachers lack confidence, pedagogical preparation, or reliable systems with which to work (Ertmer & Ottenbreit-Leftwich, 2010; Hossain & Cummings, 2023).

Unclear data privacy policies and resistance to innovation each obtained a mean of 3.03, interpreted as Agree. Although these concerns were rated slightly lower than training and infrastructure, they remain important because AI and IoT systems depend on continuous data collection and organizational cooperation. Policy ambiguity can reduce trust, while weak change management can limit use even when equipment is available. The findings support the view that responsible implementation must combine technical investment with governance, communication, and stakeholder participation (Chan & Lee, 2023; Viennet & Pont, 2017).

Stakeholder Feedback and Implementation Readiness

The respondents' written feedback revealed three recurring themes that extended the structured survey results. These themes were human capacity and technical competence, institutional readiness and infrastructure limitations, and awareness and knowledge gaps. Together, they show that stakeholders were concerned not only about the availability of technology but also about whether users understood its purpose, possessed the required skills, and received adequate organizational support.

Table 2. *Themes Identified from Stakeholder Feedback*

Theme	Stakeholder Concern	Institutional Implication
Human capacity and technical competence	Limited technical skills among personnel and students, including uncertainty about when and how AI and IoT should be used.	Continuous training and technical mentoring
Institutional readiness and infrastructure	Insufficient resources, unreliable connectivity, limited equipment, and weak readiness for full implementation.	Phased investment and readiness assessment
Awareness and knowledge gaps	Limited understanding of the purposes, risks, and educational benefits of smart classroom technologies.	Orientation, communication, and stakeholder engagement

The themes reinforce the quantitative results. Training was not viewed simply as learning how to operate devices; it also involved digital pedagogy, responsible data use, troubleshooting, and informed decision-making. Infrastructure readiness likewise included maintenance, technical support, interoperability, and long-term cost requirements. These concerns suggest that institutions should conduct readiness assessments before large-scale procurement and should align technology choices with users' actual capabilities and educational needs.

Strategic Framework for AI and IoT Adoption

The proposed framework treats smart classroom implementation as a continuous and iterative institutional process. External drivers such as education priorities, policies, regulations, and stakeholder expectations shape the overall direction. Leadership and governance then coordinate strategic decision-making, policy development, innovation readiness, and change management. This central role is consistent with studies emphasizing that

educational transformation requires leaders who can communicate purpose, mobilize stakeholders, and connect innovation to institutional goals (Domingo et al., 2025; Nilo et al., 2025).

The operational core of the framework consists of smart infrastructure, human capability, classroom operations and technical support, and data privacy and ethics. These components respond directly to the barriers identified by the respondents. Infrastructure must be reliable and scalable; faculty and staff require continuing development; systems need maintenance and user support; and data collection must be governed by clear rules for protection, access, retention, and ethical use. The framework therefore avoids treating procurement as the endpoint of implementation.

AI and learning analytics serve as an evidence-generating mechanism that links classroom data to personalized support and institutional decision-making. However, analytics should be monitored for accuracy and bias and should be used to enhance learning rather than impose punitive surveillance. Sustainability, cost efficiency, student engagement, equity, and accessibility are positioned as continuing institutional outcomes. Feedback through monitoring, evaluation, and policy refinement completes the cycle, allowing the institution to adjust its technologies and practices as needs and conditions change.

CONCLUSION

The study established that stakeholders perceived significant challenges in implementing AI- and IoT-enabled smart classrooms. Inadequate teacher training was the most strongly identified barrier, followed by insufficient connectivity and technological infrastructure. Data privacy policy and institutional resistance were also recognized as meaningful concerns. The findings demonstrate that smart classroom adoption is not solely a technical matter; it is an organizational transformation involving people, policies, resources, leadership, and ethical responsibilities.

The proposed framework contributes a structured basis for institutional planning by integrating leadership and governance, infrastructure, human capability, technical operations, data privacy and ethics, learning analytics, sustainability, equity, accessibility, and continuous improvement. Successful implementation therefore requires a phased and coordinated approach in which technology investments are matched by faculty development, reliable support systems, responsible data governance, and sustained administrative commitment.

Recommendations

1. Educational institutions should conduct a comprehensive readiness assessment covering connectivity, equipment, technical support, faculty competence, data governance, accessibility, and long-term financial capacity before expanding smart classroom systems.
2. Faculty and staff development should be continuous and practice-based. Training should address not only the operation of AI and IoT tools but also digital pedagogy, learning analytics, cybersecurity awareness, ethical decision-making, and classroom management in connected environments.
3. Institutions should establish clear data governance policies that define authorized access, security controls, retention periods, acceptable educational uses, accountability mechanisms, and procedures for evaluating algorithmic bias or inaccurate automated outputs.
4. A phased implementation strategy should be adopted through pilot classrooms, regular technical evaluation, preventive maintenance, user feedback, and gradual scaling. Dedicated technical support and lifecycle budgeting should accompany each stage.
5. Future studies should involve larger and more diverse samples, compare multiple institutions, and examine actual learning, operational, equity, and sustainability outcomes after implementation. Longitudinal and mixed-method designs may provide stronger evidence regarding the effectiveness of the proposed framework.

References

Ali, Z. H., Ali, H. A., & Badawy, M. M. (2015). Internet of Things (IoT): Definitions, challenges and recent research directions. International Journal of Computer Applications, 128(1), 37–47.

Alshammari, M., & Korr, J. (2022). The effectiveness of smart classroom technologies in enhancing student engagement and interactivity. International Journal of Educational Technology in Higher Education, 15–30.

Chan, C. K. Y., & Lee, K. K. W. (2023). A comprehensive AI policy education framework for university teaching and learning. International Journal of Educational Technology in Higher Education.

Delgado, S. J., Panganiban, N. J., & Robles, K. A. (2023). The role of AI-powered analytics in building a human-centered smart campus. International Journal of Smart Systems, 135–143.

Domingo, E. K., Cruz, J. N., Mallari, M. O., & Florencondia, N. T. (2025). Assessing the influence of transformational and transactional leadership styles on the academic performance of engineering students. International Journal of Progressive Research in Science and Engineering, 189–192.

Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2010). Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. Journal of Research on Technology in Education, 42(3), 255–284.

Fernando, J. G., Endaya, M. J., Mallari, M. O., & Cuison, L. T. (2022). The efficacy of a third-party enterprise system in state universities and colleges (SUC) setting. Journal of Positive School Psychology, 7773–7780.

Gunasekaran, D. S., Gnanakumar, P., Jinda, T., Kadu, R. K., K., A. I., & Nayak, D. C. (2024). Digital transformation of classroom: Impact of AI and IoT in the educational sector. Educational Administration: Theory and Practice, 13461–13469.

Hossain, M. U., & Cummings, J. (2023). Challenges in implementing smart classroom technologies: A systematic review. Educational Technology Research and Development, 71(1), 35–57.

Huang, Y., & Lin, C. (2023). Personalized learning in smart classrooms: Opportunities and challenges. Journal of Computer Assisted Learning, 39(2), 271–283.

Kumar, P. D. S. K. V., Perera, L. W. R. S., & Jayasekara, K. A. D. A. K. B. (2020). Big data in education: Data-driven decision making. International Journal of Educational Management, 34(4), 735–746.

Nilo, M. J., Dungca, E. J., Mallari, M. O., & Florencondia, N. T. (2025). Leadership dynamics: A comparative study of public sector and academic settings. Iconic Research and Engineering Journals, 317–326.

Santos, J. V., Ramos, L., & Mallari, M. O. (2025). Assessment of facility management performance: A basis for digitalizing reporting systems in educational institutions. Journal of Interdisciplinary Perspectives, 14–21.

Ve, D., Soundarraj, D. P., Morwani, D. H., Jani, D. J., Pathak, D., & Pal, S. (2024). Digital transformation of classroom: Impact of AI and IoT in educational sector. Journal of Informatics Education and Research, 1114–1119.

Viennet, R., & Pont, B. (2017). Education policy implementation: A literature review and proposed framework (OECD Education Working Papers No. 162). OECD Publishing.