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Facilities Management Practices and Their Relationship to Academic and Research Performance

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Abstract

This study examines the relationship between facilities management practices and academic and research performance in the Philippine Science High School System (PSHSS). Using a convergent mixed-methods design across sixteen campuses, the research assessed maintenance effectiveness, safety compliance, sustainability practices, space utilization, and equipment functionality. Quantitative data were gathered through surveys and institutional records, while qualitative insights came from interviews, focus group discussions, and document analyses.

Findings show that corrective maintenance systems are more established than preventive ones, with only **22% of campuses** implementing scheduled preventive maintenance. Compliance was stronger in administrative procedures such as report submission and inspections, while major constraints included budget limitations, procurement delays, inadequate technical manpower, and weak records management. Despite these challenges, user satisfaction remained high (90–100% utilization ratings). Statistical analyses confirmed that facilities management practices significantly influence academic achievement and research productivity.

The study highlights the need for institutionalizing preventive maintenance, strengthening technical staffing, adopting digital asset management, and standardizing compliance monitoring. These reforms will enhance resilience, operational efficiency, and educational quality in STEM secondary education.

Keywords: Facilities Management, preventive Maintenance, STEM Education, Academic Performance, Research Productivity

Introduction

Educational institutions are central to national development because they cultivate scientific, technological, and intellectual capacities that drive innovation, economic growth, and social progress. While curriculum, instruction, leadership, and governance are often emphasized in discussions of institutional effectiveness, the quality and functionality of physical learning and research environments are equally critical. Facilities management has therefore emerged as a strategic organizational function that supports instructional continuity, laboratory functionality, operational efficiency, environmental comfort, technological readiness, and institutional safety. In the context of science, technology,

engineering, and mathematics (STEM) education, facilities management is indispensable because experimentation, innovation, and research productivity depend on reliable and highly functional laboratories, calibrated instruments, and advanced information and communication technologies.

International studies consistently demonstrate that the physical condition of school facilities influences student outcomes and faculty effectiveness. Barrett et al. (2015) found that classroom design significantly affects learning progress, while Earthman (2004) emphasized that facility condition impacts both student performance and teacher productivity. More recent research highlights that sustainable and well-maintained environments enhance instructional delivery, student engagement, institutional competitiveness, and collaborative research (Byers et al., 2022; Noor & Pitt, 2022; OECD, 2023). Wong et al. (2023) further established that effective facilities management improves concentration, laboratory efficiency, and organizational productivity, whereas inadequate maintenance systems and poor environmental conditions hinder engagement and institutional effectiveness (Adeyemi & Martin, 2024). These findings underscore that facilities management is not merely a support service but a strategic determinant of academic and research excellence.

In the Philippines, public educational institutions face persistent challenges in facilities management, including deferred maintenance, aging infrastructure, inconsistent laboratory provisioning, limited financial resources, and varying levels of safety compliance (Commission on Audit, 2023; Department of Education, 2022). These issues are particularly critical in STEM institutions, where advanced laboratories and technologically equipped learning spaces are essential. The Philippine Science High School System (PSHSS), operating under the Department of Science and Technology, is the country's premier STEM secondary education network. Its mandate is to develop globally competitive scientists, innovators, and STEM professionals while promoting sustainability, resilience, and continuous improvement. The enactment of Republic Act No. 12310, or the Expanded PSHS System Act of 2025, further increased the demand for standardized, safe, and sustainable facilities by mandating the establishment of at least two campuses in every administrative region.

Despite the strategic importance of facilities management, limited empirical evidence exists on how facilities management practices influence academic and research performance in specialized STEM secondary schools. Most studies focus on higher education institutions or general K–12 environments, leaving a gap in understanding the unique requirements of STEM-focused secondary education. Moreover, few investigations have examined whether the relationship between facilities management and institutional performance varies according to campus size and geographic location. Addressing these gaps is crucial for evidence-based policy development, infrastructure planning, preventive maintenance systems, and sustainability initiatives that strengthen educational quality and research excellence.

This study responds to these gaps by examining the relationship between facilities management practices and academic and research performance across sixteen PSHS campuses. Guided by Facilities Management Systems Theory, Environmental Psychology Theory, and ISO 41001:2018, the study employs a convergent mixed-methods approach to assess maintenance effectiveness, safety compliance, sustainability practices, space utilization, and equipment functionality. By integrating quantitative data with qualitative insights, the research provides a comprehensive understanding of how facilities management influences institutional outcomes in STEM secondary education. The findings aim to inform administrators, policymakers, and facilities managers in strengthening governance, resource allocation, and strategic planning to support the PSHSS mandate of producing future scientists, innovators, and problem solvers.

Theoretical Framework

The theoretical foundation of this study integrates **Facilities Management Systems Theory**, **Environmental Psychology Theory**, and the **ISO 41001:2018 Facilities Management Standard**. Together, these frameworks provide a multidimensional lens for understanding how facilities management practices influence academic and research performance in specialized STEM secondary education institutions such as the Philippine Science High School System (PSHSS).

Facilities Management Systems Theory

Facilities Management Systems Theory posits that institutional performance depends on the effective integration of infrastructure, operational processes, human resources, and organizational objectives. It views facilities management as a **strategic organizational function** rather than a purely technical or administrative activity. According to Alexander (2013) and Then (2020), facilities management systems operate through the coordination of maintenance operations, infrastructure planning, environmental sustainability, safety compliance, and space optimization—all of which contribute to institutional productivity and service quality.

In the context of educational institutions, this theory emphasizes that well-managed facilities support instructional continuity, laboratory functionality, and operational efficiency. For STEM schools, where experimentation and innovation are central to learning, facilities management ensures that laboratories, makerspaces, and scientific equipment remain functional, safe, and conducive to inquiry. The theory therefore provides the structural foundation for examining how maintenance effectiveness, safety compliance, sustainability practices, space utilization, and equipment functionality collectively influence institutional outcomes.

Environmental Psychology Theory

Environmental Psychology Theory explains how physical environments affect human behavior, motivation, cognitive functioning, and overall well-being. In educational settings, the theory suggests that environmental factors such as lighting, ventilation, spatial layout, and ergonomic design influence student engagement, concentration, and academic achievement (Barrett et al., 2015; Cheryan et al., 2023). Similarly, faculty productivity and research creativity are shaped by the comfort, safety, and functionality of their workspaces.

Applying this theory to facilities management, the study assumes that **the quality of physical learning and research environments directly affects academic and research performance**. Safe, sustainable, and well-maintained facilities foster positive psychological responses—such as motivation, satisfaction, and engagement—that translate into improved institutional outcomes. Conversely, poor maintenance, inadequate safety compliance, and dysfunctional equipment can lead to stress, reduced productivity, and lower performance levels. Environmental Psychology Theory thus provides the behavioral and cognitive dimension of the study, linking physical conditions to human performance.

ISO 41001:2018 Facilities Management Standard

The ISO 41001:2018 standard defines facilities management as the **integration of people, place, process, and technology** to enhance organizational productivity and service quality. It establishes a globally recognized framework for managing facilities systematically and strategically. The standard emphasizes continuous improvement, sustainability, and alignment between facilities management objectives and organizational goals.

Within the PSHSS context, ISO 41001 serves as the operational backbone of the study. It provides measurable criteria for assessing maintenance effectiveness, safety compliance, and sustainability practices. The standard's emphasis on process integration and performance measurement aligns with the study's mixed-methods approach, which combines quantitative indicators with qualitative insights to evaluate institutional effectiveness. ISO 41001 also supports the development of evidence-based recommendations for preventive maintenance, compliance monitoring, and facilities governance across campuses.

Integrative Perspective

The integration of these three theoretical foundations creates a **systems-oriented and human-centered framework**. Facilities Management Systems Theory provides the structural and organizational lens; Environmental Psychology Theory offers the behavioral and experiential dimension; and ISO 41001:2018 establishes the operational and performance standards. Together, they explain how facilities management practices—when effectively implemented—can transform institutional environments into catalysts for academic excellence and research innovation.

Figure 1. Theoretical Integration for Facilities Management Study

Figure 1 presents the integration of three theoretical foundations: Facilities Management Systems Theory, Environmental Psychology Theory, and ISO 41001:2018 Facilities Management Standard. Each theory contributes a distinct lens—organizational and strategic, behavioral and cognitive, and operational and performance-based. Their intersection represents enhanced institutional performance characterized by safe and functional environments, sustainability and compliance, and improved academic and research outcomes.

- **Facilities Management Systems Theory** provides the *organizational and strategic perspective*, emphasizing the integration of infrastructure, processes, and human resources to achieve institutional efficiency and sustainability.

- **Environmental Psychology Theory** offers the *behavioral and cognitive perspective*, explaining how physical environments influence motivation, engagement, and performance among students, faculty, and staff.
- **ISO 41001:2018 Standard** introduces the *operational and performance framework*, defining measurable criteria for maintenance effectiveness, safety compliance, and continuous improvement.

The intersection of these three theories represents **enhanced institutional performance**, characterized by safe and functional environments, sustainability and compliance, and improved academic and research outcomes. This integrative model underscores that facilities management is both a technical and human-centered discipline—linking organizational systems, environmental conditions, and operational standards to educational excellence.

Methodology

The methodological choices in this study were guided by the complexity of the research problem. Facilities management in STEM secondary education is not a purely technical issue; it involves measurable operational indicators as well as contextual realities shaped by human experiences, institutional governance, and environmental conditions. A single methodological approach would not adequately capture these multidimensional aspects.

Quantitative methods are essential for establishing statistical relationships between facilities management practices and institutional outcomes such as academic performance and research productivity. However, numbers alone cannot explain the lived experiences of students, faculty, and administrators who interact daily with laboratories, classrooms, and support systems. Qualitative inquiry provides the necessary depth to understand how maintenance systems, safety compliance, and sustainability practices are perceived and implemented across diverse campuses.

By integrating both approaches, the study ensures that findings are not only empirically valid but also contextually meaningful. This methodological integration strengthens the credibility of the results and supports evidence-based recommendations for facilities governance in the Philippine Science High School System.

Research Design

This study employed a **convergent parallel mixed-methods design** to examine the relationship between facilities management practices and academic and research performance across the sixteen campuses of the Philippine Science High School System (PSHSS). The mixed-methods approach was selected because facilities management encompasses both measurable operational indicators and contextual institutional experiences that cannot be fully captured through a single method.

Quantitative and qualitative data were collected simultaneously, analyzed independently, and integrated during interpretation to develop a comprehensive understanding of the research problem (Creswell & Plano Clark, 2018). The quantitative component focused on identifying statistical relationships among variables, while the qualitative component explored lived experiences, operational realities, and institutional practices. This design allowed triangulation of findings, enhancing validity and depth of interpretation.

Research Locale

The study was conducted across **sixteen PSHS campuses** distributed throughout Luzon (8), Visayas (3),

and Mindanao (5). These campuses vary in size, infrastructure age, laboratory complexity, and resource availability, providing a diverse representation of institutional conditions. The PSHSS was chosen as the research locale because it is the country's premier STEM secondary education system under the Department of Science and Technology (DOST), operating specialized laboratories, makerspaces, and ICT facilities essential for science and research instruction.

Population and Sampling Procedure

The study population consisted of **students, faculty members, administrators, and facilities management personnel**.

- **Students:** Grades 9–12 were prioritized because they engage more intensively in laboratory and research activities.
- **Faculty:** Teachers and researchers from science, mathematics, engineering, computer science, and AdTech disciplines.
- **Administrators and Technical Staff:** Campus directors, engineers, science research specialists, maintenance personnel, and property custodians.

For the **quantitative component**, proportionate stratified sampling was used to ensure representation across campuses and respondent groups. The sample size was computed using **Cochran's formula** at a 95% confidence level and 5% margin of error.

For the **qualitative component**, purposive sampling identified information-rich participants with direct experience in facilities management operations. This approach allowed the inclusion of respondents who could provide detailed insights into maintenance systems, safety compliance, laboratory functionality, and sustainability practices.

Research Instruments

The study utilized both quantitative and qualitative instruments aligned with the conceptual framework.

1. **Facilities Management Assessment Questionnaire**
   - Developed based on ISO 41001:2018, Facilities Management Systems Theory, and related literature.
   - Measured five dimensions: maintenance effectiveness, safety compliance, sustainability practices, space utilization, and equipment functionality.
   - Used a **five-point Likert scale** ranging from 1 (Very Poor) to 5 (Very Excellent).
   - Underwent expert validation by specialists in facilities management, educational management, and research methodology.
   - Achieved a **Content Validity Index (CVI) of 0.9074** and **Cronbach's alpha ≥ 0.70**, indicating strong validity and reliability.
2. **Institutional Records and Documents**
   - Included academic performance reports, General Weighted Average (GWA) summaries, research productivity logs, laboratory utilization records, maintenance schedules, calibration certificates, and safety audit reports.
   - Served as secondary data sources for triangulation and validation.
3. **Qualitative Instruments**
   - Semi-structured interview guides and focus group discussion protocols were used to gather contextual data on facilities management implementation, operational challenges, and institutional experiences.

- Document review checklists were employed to analyze preventive maintenance plans, safety protocols, and sustainability initiatives.

Figure 2. Conceptual Framework

The conceptual framework illustrates how **facilities management practices** influence institutional performance outcomes within the Philippine Science High School System (PSHSS). Grounded in the **Input–Process–Output–Outcome (IPOO)** model and aligned with **ISO 41001:2018**, the framework integrates organizational, environmental, and operational dimensions.

- **Independent Variables (Inputs):** Facilities management practices encompass five dimensions—maintenance effectiveness, safety compliance, sustainability practices, space utilization, and equipment functionality. These represent the institutional inputs that shape the quality of learning and research environments.
- **Dependent Variables (Outcomes):** Institutional performance is measured through two key outcomes:
  - **Academic Performance:** General Weighted Average (GWA) and student achievement indicators.
  - **Research Productivity:** Innovation outputs and collaborative projects reflecting scientific engagement and institutional research capacity.
- **Moderating Variables:** Campus size and geographic location may influence the strength and direction of these relationships, as resource availability, infrastructure age, and environmental conditions vary across campuses.

This framework assumes that effective facilities management transforms organizational resources into safe, functional, and sustainable learning environments, thereby enhancing academic achievement and research productivity. It provides a systems-oriented lens for evaluating how operational processes and governance mechanisms contribute to institutional excellence in STEM secondary education.

Data Gathering Procedure

Prior to data collection, formal approval was secured from the **Office of the Executive Director of PSHSS** and participating campus directors.

1. **Quantitative Data Collection:**
   - Surveys were distributed both online and in printed form.
   - Respondents were briefed on the study's objectives, confidentiality measures, and voluntary participation.
   - Institutional records were requested from authorized offices to supplement survey data.
2. **Qualitative Data Collection:**
   - Interviews and focus group discussions were conducted with administrators, faculty, and facilities personnel.
   - Sessions were audio-recorded (with consent) and transcribed verbatim.
   - Document analysis was performed on maintenance plans, safety audits, and sustainability reports.
3. **Data Triangulation:**
   - Combined survey results, institutional records, and qualitative insights to ensure credibility and minimize bias.
   - Employed **member checking**, **peer debriefing**, and **audit trails** to enhance trustworthiness.

Data Analysis

Quantitative Analysis:

- Descriptive statistics (frequency, percentage, mean, standard deviation) were used to determine levels of facilities management practices and institutional performance.
- **Pearson correlation** tested relationships between facilities management dimensions and academic/research performance.
- **Multiple regression analysis** identified predictive influences of maintenance effectiveness, safety compliance, and sustainability practices on institutional outcomes.
- **ANOVA** examined differences in facilities management and performance across campus size and location.
- Effect sizes were computed using **Eta Squared (η^2)**, interpreted as small (0.01), moderate (0.06), or large (0.14).

Qualitative Analysis:

- Data were analyzed using **Braun and Clarke's (2022) thematic analysis framework**, involving coding, theme generation, and interpretation.
- Emerging themes were categorized under maintenance practices, compliance implementation, operational challenges, and improvement opportunities.
- Integration of qualitative and quantitative findings produced **meta-inferences** that explained statistical relationships through contextual realities.

This methodological framework ensured that both measurable relationships and contextual realities were captured. The integration of quantitative rigor and qualitative depth provided a holistic understanding of how facilities management practices influence academic and research performance across PSHS campuses.

Results

The findings of this study provide important insights into how facilities management practices influence academic and research performance across Philippine Science High School System (PSHSS) campuses. Several key themes emerged from the quantitative analyses and qualitative narratives.

Preventive vs. Corrective Maintenance

The results revealed that **corrective maintenance systems were more established than preventive ones**, with only 22% of campuses implementing preventive maintenance according to schedule. This imbalance suggests that campuses are more reactive than proactive in addressing facility issues. While corrective maintenance ensures immediate functionality, the lack of preventive systems increases long-term risks of equipment failure, higher costs, and operational disruptions. Qualitative interviews reinforced this finding, with administrators citing budget constraints and procurement delays as barriers to preventive maintenance implementation. This aligns with ISO 41001:2018, which emphasizes continuous improvement and lifecycle-based asset management.

This suggests that campuses are more consistent in documentation and reactive repairs than in proactive maintenance planning. Qualitative interviews confirmed that preventive maintenance was often deprioritized due to budget limitations and procurement delays.

Compliance and Administrative Practices

Compliance was stronger in administrative procedures such as report submission (56%) and pre-repair inspections (54%) compared to structured preventive maintenance. This indicates that campuses prioritize documentation and procedural compliance but struggle with consistent execution of maintenance schedules. The reliance on administrative compliance without robust preventive systems may create a false sense of operational readiness. Faculty respondents noted that while reports were filed, actual laboratory maintenance was often delayed, affecting research continuity.

Academic Performance

Quantitative analysis showed that campuses with higher ratings in maintenance effectiveness and equipment functionality had better **General Weighted Averages (GWA)** among students. Regression analysis confirmed that facilities management practices significantly predicted academic performance, with preventive maintenance and safety compliance emerging as strong predictors.

Qualitative data revealed that students perceived well-maintained laboratories and classrooms as motivating and conducive to learning. Faculty emphasized that reliable equipment reduced instructional disruptions and improved teaching effectiveness.

Research Productivity

Research outputs were positively associated with facilities management quality. Campuses with functional laboratories and calibrated equipment reported higher levels of innovation projects, collaborative research, and participation in science fairs. Regression models indicated that **equipment functionality and sustainability practices** were significant predictors of research productivity.

Interviews with faculty and research specialists highlighted that inadequate facilities often limited experimentation and discouraged collaborative projects. Conversely, campuses with strong facilities support fostered innovation and student-led research initiatives.

Operational Constraints

Budget limitations, procurement inefficiencies, inadequate technical manpower, and weak records management systems emerged as major constraints. These challenges were consistently reported across campuses, regardless of size or location. Larger campuses often had more resources but faced complexity in managing diverse facilities, while smaller campuses struggled with limited staffing and outdated infrastructure. These findings highlight the moderating role of campus size and geographic location, as institutional capacity directly affects facilities management effectiveness.

User Satisfaction

Despite operational challenges, **user satisfaction remained high**, with utilization ratings ranging from 90% to 100%. This paradox suggests that stakeholders value the availability of facilities even when maintenance systems are imperfect. Qualitative data revealed that students and faculty often adapted to constraints by improvising laboratory setups or sharing equipment. While satisfaction levels are encouraging, they may mask underlying inefficiencies that could hinder long-term institutional performance.

Integration with Theoretical Frameworks

The results validate the study's theoretical foundations. Facilities Management Systems Theory is reflected in the need for integrated processes and governance mechanisms. Environmental Psychology Theory is evident in the link between facility conditions and human performance outcomes. ISO 41001:2018 provides the operational lens, highlighting the importance of preventive maintenance and compliance monitoring. Together, these frameworks explain why facilities management is both a technical and strategic determinant of institutional success.

Implications for Policy and Practice

The findings of this study underscore the central role of facilities management in sustaining academic excellence and research productivity across PSHSS campuses. Several actionable implications emerge:

1. **Institutionalize Preventive Maintenance Programs** Preventive maintenance compliance was the weakest dimension. PSHSS governance should adopt system-wide preventive maintenance protocols, supported by lifecycle-based asset management and dedicated budget allocations. This will reduce reliance on corrective systems and ensure long-term operational efficiency.
2. **Strengthen Procurement and Resource Allocation** Procurement delays and budget limitations were consistently identified as barriers. Streamlining procurement processes, decentralizing certain approvals, and allocating funds specifically for laboratory upkeep and equipment calibration will enhance responsiveness and reduce downtime.
3. **Standardize Compliance Monitoring** Variations in compliance across campuses highlight the need for standardized monitoring tools. A centralized compliance dashboard, aligned with ISO 41001:2018, can track maintenance schedules, safety audits, and sustainability initiatives, ensuring consistency and accountability.
4. **Expand Technical Manpower and Training** Limited technical staff hindered preventive and specialized maintenance. PSHSS should invest in capacity-building programs, hiring additional engineers and technicians, and providing continuous training in facilities management standards.

5. **Integrate Sustainability into Facilities Governance** Sustainability practices were strongly linked to research productivity. Embedding environmental management policies—such as waste reduction, energy efficiency, and green laboratory practices—into facilities governance will not only improve research outcomes but also align PSHSS with national and global sustainability goals.
6. **Enhance Records and Information Systems** Weak records management reduced efficiency in tracking maintenance and compliance. Implementing digital facilities management systems will improve transparency, facilitate audits, and support evidence-based decision-making.

Dimension / Indicator	Compliance / Performance Level (%)	Notes / Observations
Preventive Maintenance	22% compliant	Weakest dimension; most campuses reactive rather than proactive
Maintenance Reports Submitted	56% compliant	Administrative compliance stronger than operational execution
Pre-repair Inspections	54% compliant	Moderate compliance; often delayed due to procurement issues
Completion of Unscheduled Repairs	59% compliant	Corrective systems more established than preventive
Safety Compliance	70–80% compliant (varies)	Regular inspections conducted; hazard controls in place
Documentation Compliance	~60% compliant	Gaps in inventory and records management noted
Environmental Compliance	40–50% compliant	Inconsistent sustainability practices across campuses
Institutional Compliance	~75% compliant	Policies generally followed, but uneven implementation
Academic Performance (GWA)	85–90% satisfactory to excellent	Higher in campuses with strong maintenance and equipment functionality
Research Productivity	70–80% satisfactory to excellent	Stronger outputs in campuses with functional labs and calibrated equipment
User Satisfaction (Facility Use)	90–100% utilization ratings	High satisfaction despite operational constraints

Table 1: Summary of Facilities Management Compliance, Academic Performance, and Research Outputs Across PSHS Campuses

Table 1 highlights that **preventive maintenance is the weakest area**, with only 22% compliance, while corrective maintenance and administrative compliance are relatively stronger. Safety and institutional compliance are satisfactory, but environmental compliance remains inconsistent. Academic performance (measured by GWA) and research productivity are positively associated with effective facilities

management, particularly equipment functionality and sustainability practices. Despite systemic challenges, user satisfaction remains high, reflecting stakeholder adaptability and resilience.

Predictor Variable	Academic Performance (GWA)	Research Productivity (Innovation Outputs, Projects)	Notes / Interpretation
Preventive Maintenance	r = .42*, *β = .31*	r = .38*, *β = .27*	Significant positive predictor; proactive systems enhance outcomes
Corrective Maintenance	r = .36*, *β = .24*	r = .33*, *β = .22*	Effective but reactive; supports continuity but less predictive
Safety Compliance	r = .40*, *β = .29*	r = .35*, *β = .25*	Strong predictor; safe environments improve engagement
Sustainability Practices	r = .28*, β = .19	r = .41*, *β = .32*	More influential on research productivity than academic performance
Space Utilization	r = .22, β = .15	r = .26*, β = .18	Moderate influence; efficient use of space supports collaboration
Equipment Functionality	r = .44, **β = .34**	r = .47, **β = .36**	Strongest predictor; functional labs and calibrated equipment drive outcomes

Note. *p < .05; *p < .01. Correlation coefficients (r) indicate strength of relationships; standardized regression coefficients (β) indicate predictive power in multiple regression models.

Table 2: Regression and Correlation Results: Predictors of Academic Performance and Research Productivity

Table 2 shows that **equipment functionality** was the strongest predictor of both academic performance and research productivity, confirming the critical role of reliable laboratories and calibrated instruments. Preventive maintenance and safety compliance also emerged as significant predictors, highlighting the importance of proactive systems and safe environments. Sustainability practices were more strongly associated with research productivity, reflecting the role of environmentally conscious operations in fostering innovation. Space utilization had moderate but meaningful effects, particularly in collaborative research contexts.

The study demonstrates that while corrective maintenance and administrative compliance are relatively strong, preventive maintenance remains weak. Facilities management practices significantly influence both academic achievement and research productivity, with campus size and location moderating these relationships. High user satisfaction, despite operational constraints, reflects stakeholder resilience but may mask systemic inefficiencies.

Discussion

The findings of this study highlight the critical role of facilities management in shaping both academic

performance and research productivity across the Philippine Science High School System (PSHSS). By integrating quantitative results with qualitative insights, several nuanced themes emerge that explain how facilities management practices influence institutional outcomes.

Preventive vs. Corrective Maintenance

The study revealed a significant imbalance between preventive and corrective maintenance systems. Only 22% of campuses complied with preventive maintenance schedules, while corrective maintenance was more consistently implemented. This suggests that campuses are operating in a **reactive mode**, addressing problems only after they occur rather than preventing them. While corrective maintenance ensures immediate functionality, its dominance reflects short-term problem-solving rather than long-term sustainability.

Qualitative narratives reinforced this finding, with administrators citing **budget constraints, procurement delays, and limited technical manpower** as barriers to preventive maintenance. This aligns with ISO 41001:2018, which emphasizes lifecycle asset management and continuous improvement. The lack of preventive systems not only increases costs but also disrupts instructional continuity, particularly in laboratory-based STEM education where equipment reliability is essential.

Compliance and Administrative Practices

Compliance performance was stronger in administrative procedures such as report submission (56%) and pre-repair inspections (54%) compared to preventive maintenance. This indicates that campuses prioritize documentation and procedural compliance, possibly to meet institutional audit requirements, but struggle with consistent execution of maintenance schedules.

Faculty interviews revealed a disconnect between **paper compliance and operational reality**. While reports were filed, actual laboratory maintenance was often delayed, leading to interruptions in research and experimentation. This finding suggests that compliance is being treated as a bureaucratic requirement rather than a functional tool for ensuring safety and efficiency.

Academic Performance

Regression analyses confirmed that facilities management practices significantly predicted academic performance. Preventive maintenance, safety compliance, and equipment functionality emerged as the strongest predictors. This supports **Environmental Psychology Theory**, which posits that safe, functional, and well-maintained environments enhance motivation, concentration, and learning outcomes.

Students reported that well-lit, ventilated, and properly maintained laboratories increased their engagement and confidence in conducting experiments. Faculty emphasized that reliable equipment reduced instructional disruptions, allowing them to focus on pedagogy rather than troubleshooting technical issues. These findings demonstrate that facilities management is not peripheral but central to academic achievement.

Research Productivity

Research outputs were also strongly influenced by facilities management practices. Equipment functionality and sustainability practices were the most significant predictors of research productivity. This reflects the importance of **functional laboratories and environmentally conscious operations** in

fostering innovation.

Qualitative data revealed that campuses with calibrated equipment and sustainable practices (e.g., waste management, energy-efficient labs) reported higher levels of collaborative projects, innovation initiatives, and participation in science fairs. Conversely, campuses with outdated or poorly maintained facilities struggled to sustain research momentum. This finding underscores the role of sustainability not only in environmental stewardship but also in driving creativity and innovation.

Operational Constraints

Across campuses, respondents consistently identified **budget limitations, procurement inefficiencies, inadequate technical manpower, and weak records management systems** as major constraints. These challenges were more pronounced in smaller or geographically remote campuses, highlighting the moderating role of campus size and location. Larger campuses had more resources but faced complexity in managing diverse facilities, while smaller campuses struggled with limited staffing and outdated infrastructure.

This finding validates **Facilities Management Systems Theory**, which emphasizes the integration of infrastructure, processes, and human resources. Without adequate resources and governance mechanisms, facilities management systems cannot fully support institutional performance.

User Satisfaction

Despite operational challenges, user satisfaction remained high, with utilization ratings ranging from 90% to 100%. This paradox suggests that stakeholders value the availability of facilities even when maintenance systems are imperfect. Qualitative accounts revealed that satisfaction often reflected **adaptability and resilience** rather than optimal service quality. Students improvised laboratory setups, and faculty adjusted teaching strategies to cope with equipment limitations.

While high satisfaction is encouraging, it may mask systemic inefficiencies that could hinder long-term institutional performance. This finding highlights the importance of distinguishing between **perceived satisfaction and actual service quality** in evaluating facilities management effectiveness.

Integration with Theoretical Frameworks

The results validate the study's theoretical foundations:

- **Facilities Management Systems Theory** is reflected in the need for integrated processes, governance mechanisms, and resource allocation.
- **Environmental Psychology Theory** is evident in the link between facility conditions and human performance outcomes.
- **ISO 41001:2018** provides the operational lens, emphasizing preventive maintenance, compliance monitoring, and continuous improvement.

Together, these frameworks explain why facilities management is both a technical and human-centered determinant of institutional success. The study's meta-inferences demonstrate that facilities management practices enhance institutional performance by creating safe, sustainable, and functional environments that promote learning, innovation, and productivity.

The study demonstrates that while corrective maintenance and administrative compliance are relatively strong, preventive maintenance and sustainability practices remain weak. Facilities management practices significantly influence both academic achievement and research productivity, with campus size

and location moderating these relationships. High user satisfaction reflects resilience but may conceal systemic inefficiencies. Addressing these gaps through evidence-based governance, resource allocation, and standardized compliance monitoring will enhance institutional resilience, operational efficiency, and educational quality across the PSHSS.

Conclusion

The results of this study extend beyond institutional performance within the PSHSS and carry broader implications for national education policy and global sustainability agendas. By demonstrating that facilities management practices significantly influence both academic achievement and research productivity, the study underscores the need to treat facilities governance as a **strategic pillar of STEM education** rather than a peripheral support function.

Alignment with National Education Policy

The Philippine government has prioritized STEM education as a driver of innovation and competitiveness under the **K–12 curriculum reforms** and the **Philippine Development Plan**. The PSHSS, as the country's premier STEM secondary education system, plays a critical role in producing future scientists, engineers, and innovators. The findings suggest that **policy frameworks must integrate facilities management into educational planning**, ensuring that laboratories, classrooms, and research spaces are maintained to international standards.

Institutionalizing preventive maintenance, streamlining procurement, and expanding technical manpower are not merely operational improvements—they are **policy imperatives** that directly affect student learning outcomes and national research capacity. By embedding facilities management into education governance, the Department of Science and Technology (DOST) and the Department of Education (DepEd) can strengthen the resilience and competitiveness of STEM institutions nationwide.

Contribution to Global Sustainability Goals

The study also resonates with the **United Nations Sustainable Development Goals (SDGs)**, particularly:

- **SDG 4 (Quality Education):** Ensuring inclusive and equitable quality education requires safe, functional, and sustainable learning environments. Facilities management practices directly contribute to this goal by improving academic performance and research productivity.
- **SDG 9 (Industry, Innovation, and Infrastructure):** Functional laboratories and calibrated equipment foster innovation and research, aligning with the goal of building resilient infrastructure and promoting sustainable industrialization.
- **SDG 11 (Sustainable Cities and Communities):** Integrating sustainability practices into campus operations—such as waste management and energy efficiency—supports the creation of safe, resilient, and sustainable educational communities.

UNESCO STEM Education Frameworks

The findings also align with **UNESCO's STEM education frameworks**, which emphasize the importance of enabling environments for inquiry-based learning and innovation. UNESCO advocates for **holistic STEM ecosystems** where infrastructure, pedagogy, and policy converge to empower learners.

The study demonstrates that facilities management is a critical component of this ecosystem, providing the physical and operational foundation for inquiry, experimentation, and collaboration.

In conclusion, the study bridges institutional realities with national and global priorities. Facilities management practices are not only operational necessities but also **strategic levers for advancing STEM education, national innovation capacity, and global sustainability commitments**. By strengthening preventive maintenance, compliance monitoring, sustainability integration, and resource allocation, PSHSS governance can contribute to both the **Philippine education agenda** and the **global movement toward sustainable, high-quality STEM education**.

Recommendations

Based on the results and discussion, the following recommendations are proposed to strengthen facilities management practices and enhance academic and research performance across PSHSS campuses:

1. **Institutionalize Preventive Maintenance Programs**
- Develop a **system-wide preventive maintenance policy** aligned with ISO 41001:2018 standards.
- Allocate dedicated budgets for preventive activities to reduce reliance on corrective systems.
- Establish campus-level maintenance schedules with centralized monitoring to ensure compliance.
- Train custodians and technical staff in preventive maintenance planning and execution.

2. **Streamline Procurement and Resource Allocation**
- Simplify procurement processes by reducing bureaucratic bottlenecks and decentralizing approvals for urgent repairs.
- Create a **special facilities management fund** for laboratory upkeep, equipment calibration, and spare parts acquisition.
- Adopt lifecycle costing in budget planning to anticipate long-term maintenance needs.

3. **Standardize Compliance Monitoring**
- Implement a **digital compliance dashboard** across campuses to track preventive schedules, safety audits, and sustainability initiatives.
- Require quarterly compliance reports validated by independent auditors to ensure accountability.
- Integrate compliance indicators into institutional performance evaluations.

4. **Expand Technical Manpower and Capacity-Building**
- Recruit additional engineers, laboratory technicians, and facilities specialists to address manpower shortages.
- Provide continuous professional development programs on facilities management systems, safety protocols, and sustainability practices.
- Establish a **PSHSS Facilities Management Training Center** to build internal expertise and reduce reliance on external contractors.

5. **Integrate Sustainability into Facilities Governance**
- Embed sustainability practices into daily operations, including waste segregation, energy efficiency, and green laboratory initiatives.
- Align campus sustainability programs with **SDG 4 (Quality Education), SDG 9 (Innovation and Infrastructure), and SDG 11 (Sustainable Communities)**.
- Encourage student-led sustainability projects to foster innovation and environmental stewardship.

6. **Strengthen Records and Information Systems**
- Develop a **centralized digital records management system** to track maintenance schedules, compl-

iance reports, and equipment inventories.
- Ensure accessibility of records for administrators, auditors, and faculty to support transparency and evidence-based decision-making.
- Use data analytics to identify patterns in maintenance needs and optimize resource allocation.

7. Policy Integration and Advocacy

- Advocate for the inclusion of facilities management in **national education policy frameworks** under DOST and DepEd.
- Position facilities governance as a strategic priority in STEM education planning, linking infrastructure quality to student outcomes and research productivity.
- Collaborate with government agencies and international organizations (e.g., UNESCO) to align PSHSS facilities management practices with global STEM education standards.

These recommendations emphasize that facilities management is not merely an operational concern but a **strategic driver of institutional excellence**. By institutionalizing preventive maintenance, streamlining procurement, standardizing compliance, expanding manpower, integrating sustainability, and strengthening records systems, PSHSS can enhance resilience, efficiency, and educational quality. Aligning these initiatives with national policy and global sustainability goals ensures that PSHSS remains a leader in STEM education and innovation.

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