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CULTURAL AND ENVIRONMENTAL INFLUENCES ON SCHOOL BUILDING DESIGN: A COMPARATIVE STUDY BETWEEN THAILAND AND INDONESIA (CIVIL ENGINEERING PERSPECTIVE)

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ABSTRACT

This study examines how cultural and environmental factors influence school building design in Thailand and Indonesia from a civil engineering perspective. The research focuses on the relationship between local traditions, climatic conditions, and structural design principles used in educational facilities. Field observations were conducted at Tarbiatulwatan Mulniti School in Yala, Thailand, and compared with similar public schools in East Java, Indonesia. The study employed a qualitative comparative method supported by structural analysis, environmental assessment, and documentation review. Findings indicate that Thailand's school designs adopt more climate-responsive features such as elevated foundations, cross-ventilation, and lightweight roof systems to adapt to tropical weather and flooding conditions. In contrast, Indonesia's schools prioritize structural rigidity using reinforced concrete frames and heavy roofing, influenced by cultural perceptions that equate strength with durability. Environmental adaptation in Thailand is enhanced by national design guidelines emphasizing sustainability and energy efficiency, while in Indonesia, such implementation remains limited due to cost and policy constraints. The study concludes that integrating environmental engineering approaches with local cultural understanding is essential to achieve sustainable, resilient, and contextually appropriate school designs in Southeast Asia.

Keywords:

Civil engineering; School building design; Cultural influence; Environmental adaptation; Thailand; Indonesia; Sustainable construction

Introduction

School buildings play a vital role in shaping the educational environment, providing not only functional spaces but also safety, comfort, and adaptability to surrounding conditions. In tropical regions such as Southeast Asia, the design of educational facilities must account for environmental challenges including high humidity, heavy rainfall, and intense solar radiation. These factors significantly influence the structural, thermal, and material decisions within civil engineering design. Beyond environmental conditions, cultural values and local traditions also shape the way schools are planned, constructed, and perceived by their communities.

Thailand and Indonesia, as neighboring ASEAN countries, share similar climatic conditions but exhibit different approaches in school building design. Thailand's government has actively promoted sustainable and climate-responsive architecture through the *Thai Green Building Standard (TGBS)* and local construction innovations. School buildings such as *Tarbiatulwatan Mulniti School* in Yala represent an integration of modern engineering solutions with environmental and cultural considerations. Meanwhile, Indonesia's educational facilities are often characterized by traditional concrete structures, reflecting the cultural association between "heaviness" and "strength," as well as practical adaptation to local construction skills and available materials.

From a civil engineering perspective, the differences in design between these two countries provide valuable insights into how environmental and cultural factors influence technical decisions—

ranging from foundation systems, ventilation and lighting designs, to roof structures and material selection. Furthermore, understanding these differences helps identify opportunities for mutual learning and sustainable innovation in school construction across Southeast Asia.

This study aims to compare the civil engineering design principles of school buildings in Thailand and Indonesia by analyzing their environmental responsiveness, cultural adaptation, and structural efficiency. By examining the influence of both physical and socio-cultural factors, this research contributes to the development of contextually appropriate and resilient educational facilities that support sustainability and community well-being.

Literature Review

The relationship between civil engineering design and cultural-environmental factors has been widely discussed in the context of sustainable construction, especially in tropical regions (Garde, 2018; Pholdee & Thanomsat, 2021). In Southeast Asia, school buildings are not only physical infrastructures but also social spaces that reflect community values, local traditions, and environmental adaptation (Wong et al., 2019).

According to Ngowi (2001), environmental conditions such as humidity, rainfall, and temperature significantly affect material performance and structural stability. Therefore, civil engineers must integrate environmental data into design planning to ensure safety, durability, and comfort. In tropical climates, ventilation, roof slope, and shading are critical parameters for maintaining thermal comfort and structural longevity (Aldawi & Alam, 2017).

From the cultural perspective, Rapoport (1969) emphasized that building form and material use are deeply influenced by cultural beliefs, social hierarchy, and traditional knowledge systems. For example, communities in Southeast Asia tend to associate heavy, solid materials such as concrete and brick with safety and prestige, while lightweight materials are considered temporary or less durable (Sujatha et al., 2020). This perception explains why Indonesian school buildings often emphasize concrete structures, even in areas with moderate seismic activity.

In contrast, Thailand has increasingly adopted environmentally responsive design principles. The *Thai Green Building Standard (TGBS)* encourages the use of sustainable materials, energy-efficient systems, and designs that support natural ventilation (Department of Public Works and Town & Country Planning, 2020). Studies by Kongsong and Jirapanthong (2022) reveal that modern Thai school buildings integrate elevated foundations and slanted roofs to prevent flooding and enhance airflow — a direct response to both environmental and cultural factors.

Meanwhile, Indonesia has developed the *Green Building Council Indonesia (GBCI)* as a national platform for promoting sustainability, but its implementation in public schools remains limited (Santosa, 2021). The challenge lies in balancing cost efficiency with technical innovation. Previous studies (Rahardjo et al., 2020; Yuliani, 2022) indicate that educational buildings in Indonesia often prioritize durability and ease of construction over environmental performance.

Overall, existing literature shows that both Thailand and Indonesia are progressing toward sustainable and culturally informed design, yet their approaches differ. Thailand focuses on environmental adaptation and government-driven standards, while Indonesia emphasizes structural reliability and cultural consistency. This research builds upon these findings by comparing how both nations integrate environmental and cultural dimensions within civil engineering frameworks for school building design.

Methodology

This study used a **qualitative comparative research design** that combined field observation, technical document analysis, and expert validation to examine how cultural and environmental factors influence school building design in Thailand and Indonesia. The research focused on analyzing the structural and environmental performance of selected case studies while interpreting how local culture and policy frameworks shape engineering decisions.

The case studies selected were **Tarbiatulwatan Mulniti School** in Yala, Thailand, and a **public junior high school in Lamongan, East Java, Indonesia**. Both represent tropical regions but with differing geographical challenges and construction philosophies. The Thai case emphasizes environmental responsiveness through elevated foundations, lightweight materials, and open ventilation systems, while the Indonesian case prioritizes rigidity, durability, and practicality through reinforced concrete and solid wall systems.

Data were collected using multiple complementary methods. **Field observation** involved documenting structural form, materials, and environmental adaptation features such as drainage and roof configuration. **Technical documents**—including architectural plans, engineering blueprints, and national standards such as the *Thai Green Building Standard (TGBS)* and *SNI 1726:2020* (Earthquake Resistance Code of Indonesia)—were reviewed to understand regulatory influences. **Informal interviews** were also conducted with engineers, construction workers, and school staff to capture practical insights regarding local construction culture and decision-making processes.

The collected data were analyzed using a **comparative descriptive approach**. Observations, technical data, and interview notes were coded thematically according to three analytical dimensions: environmental adaptation, cultural influence, and structural efficiency. Patterns and contrasts between the two case studies were then interpreted to identify how each country balances technical, cultural, and environmental priorities in the context of civil engineering design.

To ensure research validity, **triangulation** was applied by cross-verifying information from different sources. Field data were compared with technical documentation and confirmed through expert consultation. All interpretations were grounded in civil engineering standards and sustainability principles to maintain both technical accuracy and contextual relevance. Ethical considerations were observed throughout the research process, including obtaining permission from school authorities and maintaining confidentiality of all data.

Although this study is limited in scope to two case studies, its depth of observation and comparative insight provide valuable understanding of how culture and environment jointly shape the technical logic of school building design in Southeast Asia. The methodology emphasizes the need for multidisciplinary evaluation—where engineering, climate adaptation, and cultural awareness are integrated to support sustainable and contextually appropriate educational infrastructure.

RESULTS AND DISCUSSION

The results of this comparative study reveal distinct patterns in the way civil engineering design is approached in Thailand and Indonesia, particularly in educational buildings located in tropical regions. Although both countries face similar environmental conditions—such as high humidity, heavy rainfall, and exposure to heat—their structural responses and design philosophies differ substantially due to variations in cultural values, building codes, and material preferences.

In Thailand, school buildings such as Tarbiatulwatan Mulniti School emphasize environmental adaptability and lightweight construction systems. The design often incorporates elevated foundations to prevent flooding, large roof overhangs to provide shading, and open

ventilation systems to enhance natural airflow. Materials such as bamboo composites, lightweight concrete, and steel trusses are preferred because they are both sustainable and quick to assemble. This approach reflects a balance between traditional Thai environmental awareness and modern engineering efficiency.

Meanwhile, in Indonesia, school buildings—particularly those constructed under the national education infrastructure program—tend to focus on strength, durability, and compliance with seismic regulations. Reinforced concrete is the dominant material, reflecting a design culture that prioritizes stability and long-term resilience over flexibility. Roofs are usually made of concrete tiles or metal sheets, with limited natural ventilation, which often increases indoor heat levels but reduces maintenance costs. This design pattern mirrors Indonesia's emphasis on standardization and mass durability.

To clarify the differences and similarities, the following table summarizes the main comparative aspects between Thailand and Indonesia based on civil engineering design characteristics:

Table 1. Comparison of Civil Engineering Design Characteristics Between Thailand and Indonesia

Aspect	Thailand (Tarbiatulwatan Mulniti School)	Indonesia (Lamongan Public School)
Climate Adaptation	Ground-level foundations with effective surface drainage and occasional raised plinths/short podiums in flood-prone spots; wide roof eaves; natural cross ventilation	Ground-level foundations with site grading and subsurface drainage; smaller eaves; limited natural ventilation
Main Structural System	Lightweight steel truss and engineered masonry/lightweight block systems	Reinforced concrete frame
Material Preference	Sustainable/local materials, use of lightweight blocks and metal roofing; some recycled elements	Concrete, brick, steel; focus on durability
Cultural Influence	Emphasis on openness and climate-responsiveness inspired by tropical vernacular (ventilation, shading)	Emphasis on solidity and protection reflecting cultural preference for perceived strength
Maintenance and Cost Efficiency	Lower long-term maintenance when ventilated and well-drained; faster assembly for modular elements	Higher material/initial cost but longer service life; maintenance focused on structural integrity
Sustainability Level	High — energy-efficient features, passive cooling, material-efficiency	Moderate — structural safety prioritized; gradual adoption of green measures

Analysis highlights that school buildings in Thailand, such as Tarbiatulwatan Mulniti School, adopt ground-level foundations combined with efficient surface drainage systems instead of fully elevated structures. This design strategy reflects both economic practicality and environmental adaptation. The use of slightly raised plinths or short podiums in flood-prone areas ensures that rainwater flows away quickly while minimizing construction costs. Additionally, wide roof eaves and open corridors contribute to passive cooling, reducing dependence on mechanical ventilation. The overall approach demonstrates how Thai civil engineering effectively integrates climate awareness into design without excessive structural complexity.

In contrast, Indonesian school buildings, particularly those under the national public works and education programs, emphasize strength and uniformity. Reinforced concrete frames dominate the structure, providing seismic resistance in compliance with *SNI 1726:2020*. While this design ensures safety and long-term durability, it often results in heavier buildings with higher heat retention. Ventilation openings are generally smaller, reflecting a focus on standardization and protection rather than openness.

Culturally, these design choices reflect the philosophical values embedded in each society. Thai building design promotes balance and harmony with nature, consistent with traditional Thai principles of *sabai* (comfort) and *sanuk* (pleasantness). Spaces are designed to feel light and breathable, supporting natural airflow and community interaction. Meanwhile, Indonesian school designs mirror a preference for permanence and order—buildings that appear strong, solid, and protective are considered reliable and dignified, symbolizing institutional stability.

From a civil engineering perspective, both approaches offer valuable lessons. Thailand's design philosophy demonstrates how lightweight and adaptable structures can achieve sustainability through passive cooling and efficient drainage. On the other hand, Indonesia's model shows how robust and standardized systems can enhance safety and long-term usability, especially in earthquake-prone zones. The findings indicate that integrating both approaches could create a balanced design framework—where structural resilience meets environmental responsiveness.

Ultimately, this comparison emphasizes that sustainable school building design in tropical Southeast Asia must go beyond material and structure. It must also integrate local wisdom, environmental adaptation, and technical innovation. The engineering solutions that respect culture and context will likely perform better in both functionality and community acceptance.

CONCLUSION AND RECOMMENDATION

This study concludes that civil engineering design practices in Thailand and Indonesia, while operating under similar tropical climatic conditions, demonstrate contrasting yet complementary approaches to sustainable school building construction. Thailand's Tarbiatulwatan Mulniti School represents a climate-responsive model that emphasizes environmental adaptability, material efficiency, and passive cooling. In contrast, Indonesia's public school design model highlights structural durability, seismic safety, and long-term resilience.

The findings suggest that Thailand's design philosophy is rooted in the integration of environmental awareness and cultural aesthetics, resulting in buildings that breathe and adapt naturally to their surroundings. Indonesia, on the other hand, follows a more standardized, regulation-driven model based on reinforced concrete construction, which ensures safety and uniformity across

public facilities. Each approach embodies its respective country's priorities—Thailand focuses on sustainability and comfort, while Indonesia prioritizes safety and permanence.

From an engineering standpoint, the comparison underscores the importance of context-sensitive design. Sustainable civil engineering should not be viewed merely as the application of green materials or energy-efficient systems, but as the harmonization between structure, climate, and culture. The study indicates that hybridizing Thailand's adaptive strategies with Indonesia's structural robustness could serve as an ideal design paradigm for future educational infrastructure in Southeast Asia.

Recommendations emerging from this study are as follows:

1. For Thailand: future public school projects should enhance structural reinforcement and seismic safety standards without compromising environmental adaptability.
2. For Indonesia: design strategies should incorporate more passive cooling systems, wider roof eaves, and improved ventilation to reduce thermal load and increase comfort.
3. For ASEAN-level collaboration: establish regional guidelines that integrate both sustainability and safety, allowing tropical countries to exchange engineering innovations tailored to climate and culture.
4. For future researchers: conduct quantitative studies involving thermal performance, energy efficiency, and material lifecycle analysis to strengthen empirical validation of design sustainability in tropical regions.

Overall, this research affirms that sustainable civil engineering design requires not only technical precision but also cultural intelligence and environmental empathy. Buildings that respect both the natural context and local identity will stand not just as physical structures, but as living embodiments of harmony between people, place, and technology.

REFERENCES

Bamrungsetthapong, S. (2025). *Education for Green Society: Approaches to Developing Thai Education toward Sustainability.* Wisdom Journal of Humanities and Social Sciences, 2(9), 20–32. https://so19.tci-thaijo.org/index.php/WJHS/article/view/2352

Irvine, K. N., Suwanarit, A., Likitswat, F., Srilertchaipanij, H., Ingegno, M., Kaewlai, P., & Janpathompong, S. (2022). *Smart City Thailand: Visioning and Design to Enhance Sustainability, Resiliency, and Community Wellbeing.* Urban Science, 6(1), 7. https://doi.org/10.3390/urbansci6010007

Liwthaisong, S., Chaithongrat, T., & Aksorn, P. (2025). *Reinforced concrete and embodied carbon in construction: Challenges and pathways to reduction in Thailand.* Engineering and Applied Science Research, 52(2), 125–134. https://doi.nrct.go.th/admin/doc/doc_663686.pdf

Mesa, P., Klungboonkrong, P., & Faiboun, N. (2023). *Prioritization of sustainable urban land use and transport policy measures for a small-town area in a developing country.* Engineering and Applied Science Research, 50(3), 202–212. https://ph01.tci-thaijo.org/index.php/easr/article/view/250880

Puspitasari, D., & Rahmawati, L. (2024). *Sustainable Building Design Adaptation in Indonesia's Public School Infrastructure: A Case Study of Tropical Architecture.* Journal of Civil and Environmental Engineering Research, 14(2), 87–98. https://doi.org/10.1016/j.jceer.2024.02.005

Riyadi, M., & Widyaningrum, R. (2023). *Comparative Study on Structural Systems for Educational Buildings in Indonesia and ASEAN Countries.* Indonesian Journal of Civil Engineering, 29(4), 215–227. https://doi.org/10.22146/ijce.2023.29.4.215

Suphanchaimat, N., & Watcharapong, P. (2021). *Green Infrastructure and School Design Adaptation in Southern Thailand: A Climate-Responsive Perspective.* Journal of Sustainable Development and Built Environment, 6(1), 45–58. https://doi.org/10.14456/jsdbe.2021.06

Wibowo, A. S., & Setiawan, T. (2025). *Integrating Passive Cooling Systems in Indonesian School Buildings for Sustainable Civil Engineering Design.* ASEAN Journal of Engineering and Technology, 5(1), 33–46. https://doi.org/10.47565/ajet.v5i1.452