The Impact of School Infrastructure on Student Academic Performance in Sarawak, Malaysia: A Review

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ABSTRACT

This review synthesizes findings on key indicators which lead to positive educational outcomes in upgraded school facilities in Sarawak, Malaysia. It aspires to develop a feasible evaluative framework trying to fill the gap in the literature concerning the impact of physical school environments on educational attainment, as well as how we currently measure that impact. In this respect, the review aims to systemize the information on the nexus between educational infrastructure and achievement, establishing evaluative framework parameters, key performance indicators, contrasting assessment techniques, and addressing the particularities of Sarawak, Malaysia. This review incorporated various quantitative, qualitative, and mixed approaches and designed studies in Malaysia and other comparable developing contexts, particularly focusing on the impact of school facilities on educational outcomes, the role of the socioeconomic environment, and different administrative school management theories. There is a significant positive relationship between the upgraded physical facilities in school and the educational outcomes, with the mediating factors including student motivation and student satisfaction. This review also illustrates the comprehensive approaches which integrate the physical, environmental, and pedagogical elements with managerial frameworks. Most importantly, this study underscores the importance of customizing such frameworks in tune with the socioeconomic and cultural realities of the locality. Cross-sectional study designs, variable validation of frameworks, and the underrepresentation of psychosocial elements are some limitations to consider. By integrating the findings, the review illustrates the multifaceted nature of the relationship between infrastructure and educational outcomes and the importance of strategic planning and involvement of stakeholders. The review thus contributes to developing a practically applicable, context-sensitive framework for evaluating educational outcomes post-infrastructure changes. For Sarawak and comparable settings, this has considerable implications for policy, school administration, and focused actions.

Keywords: academic, infrastructure, indicator, performance, Sarawak

INTRODUCTION

Equitable access to quality education in Sarawak, Malaysia, needs to contend with one fundamental problem, the extensive problem of dilapidated infrastructure in schools. Sarawak is a large state and it has a high number of poorly-maintained schools. The condition of the educational and physical learning environments has transitioned from one of logistical concern to a foundational consideration in the attainment of a state's developmental goals with respect to educational outcomes and human capital (Barrett, Ambasz, Shmis, & Ustinova, 2019). This paper illustrates the impact of poorly maintained school infrastructure on student performance, educational inequity, and teacher productivity in Sarawak, to underline the demonstrated need and the impact of state intervention.

Academic research shows that a learner's surroundings and learning outcomes are linked and that poor learning environments make educational attainment more difficult (Barrett, Ambasz, Shmis, & Ustinova,

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2019) (Cumbicus, Suquilanda, & Maza, 2025) (Ha, Busari, & Nordin, 2022) The quality of school infrastructure is a determinant of the quality of education offered. Poor school infrastructure negatively impacts students' health, attendance, motivation, and learning. In Sarawak, the spatial and structural school infrastructure inequities are glaring, as a significant number of schools have been classified as broken, and needing major repairs. The impact of the physical school infrastructure on learning and educational outcomes is tangible. Research from settings like Sarawak, Malaysia have shown that better classroom conditions, including improved sanitation, electricity, and teaching materials, are linked to better educational outcomes, including higher test scores, reduced student absenteeism, and decreased school dropout rates (Yangambi, 2023) (Yue & Selvaratnam, 2025).

The scale of the infrastructure challenges is evident from local data, 1505 schools in dilapidated condition (News, 2023). In 2024 and 2025, government statements and media reports estimated that hundreds of schools in Sarawak, Malaysia were in a state of disrepair and required repairs or rebuilding, intervention supported by new federal and state funding. For instance, media reports in Mid-2024 mentioned over 555 schools in the state were in a state of disrepair, which motivated the Government of Malaysia to allocate and pledge to refurbish or rebuild many of the schools (Reporters, 2024) (Lorenzo Isaac, 2025). The pledged funding came from federal funding and state redevelopment projects. These pledged funding and school refurbishing projects were designed to make the school safer, in addition to creating a better learning environment (Reporters, 2024). Why does school infrastructure directly impact school performance? Simple utilities like water and electricity, infrastructure health and safety, and the state of school facilities, have an impact on student attendance, as poor classroom conditions like leaky roofs or dim lighting directly impact classroom interruptions (Abdullah, 2025).

For the following reasons, the value of improved infrastructure cannot be overemphasized. Improved infrastructure increases teacher satisfaction, improving retention rates, and service effectiveness. The availability of staff resources, space, and adequately equipped learning materials are powerful motivators. The availability of enriched science laboratories, adaptable libraries, and other resources such as dependable electricity and information and communication technology facilitates the implementation of more effective novel instructional strategies that promote critical thinking and superior examination results. Improved infrastructure positively influences learning outcomes and is more pronounced in value in developing regions, as research demonstrates the value of improved infrastructure while controlling for socioeconomic conditions (Kasdiah, Amdan, & Naldo, 2024).

Upgrading infrastructure in and of itself is usually ineffective. Teacher training, relevant curriculum, community participation, and scheduled routine maintenance are necessary supportive activities. Addressing infrastructure inadequately, especially in rebuilding situations, losing alignment with educational and pedagogical needs, and redesigning without structured long-term maintenance can easily lead to resource wastage (Barrett, Ambasz, Shmis, & Ustinova, 2019). Local media has featured the Sarawak state government focus on development initiatives for school infrastructure in Sarawak, Malaysia. Combined with management support for the schools, the anticipated development is promising. Scalable efforts of this magnitude will be necessary in capital development to improve educational value and student achievement advocacy (Meraw & Tuah, 2025) (Louis, 2025).

Research on key indicators of successful student academic performance in schools with infrastructure improvements has emerged as a critical area of inquiry due to its direct impact on educational quality and equity. The evolution of this field reflects growing recognition of the role that physical learning environments play in shaping student outcomes, with early studies emphasizing strategic planning and facility management (Ha, Busari, & Nordin, 2022) (Purba, 2024), followed by more recent investigations into classroom conditions and ergonomic factors (Norazman N. , Che-Ani, Hussain, J., & Ismail, 2021) (Latip, et al., 2024). The practical significance is underscored by data linking infrastructure quality to academic achievement, motivation, and well-being, highlighting the need for targeted investments to foster conducive learning environments (Jamshaid, Zaheer, Mukhtar, Baber, & Roohi, 2024) (Magwaga & Kikechi, 2024). Globally, disparities in infrastructure contribute to unequal educational opportunities,

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making this research vital for policy and practice, especially in regions like Sarawak, Malaysia, where educational development is ongoing (Obioma, 2023) 2023) (Mahajan & Rajagopal, 2024).

Despite extensive research on the influence of school facilities and socioeconomic factors on academic performance, significant knowledge gaps remain. Prior studies have often examined parental socioeconomic status and physical facilities separately or partially, with limited focus on their combined effects within specific local contexts (Werang, et al., 2024) (Magwaga & Kikechi, 2024) (Yangambi, 2023). Moreover, while infrastructure quality is acknowledged as important, there is a lack of comprehensive frameworks that integrate strategic planning, facility management, and classroom environment assessments to evaluate educational outcomes holistically (Mardiyah, Herawati, & Ali, 2025) (Nurafni, Sriwardona, & Rianawati, 2025) (Lahagu, Waruwu, Laia, & Harefa, 2024). Controversies persist regarding the relative weight of infrastructure versus pedagogical factors in driving student success, with some findings emphasizing teacher competence and leadership as mediators (Mukaromah, Werdiningsih, & Daryono, 2024) (Surianshah, 2022). The absence of localized, practical assessment models impedes effective resource allocation and policy formulation, potentially perpetuating educational inequities (Hasyim, 2025) (Fanani, 2023).

This review constructs a conceptual framework linking strategic educational planning, physical infrastructure quality, and student academic performance, grounded in theories of educational management and environmental ergonomics (Ha, Busari, & Nordin, 2022) (Norazman N. , Che-Ani, Mat Jusoh Hussain, & Wan Ismail, 2021) (Latip, et al., 2024). It defines key constructs such as classroom condition indices, strategic facility management, and academic achievement metrics, elucidating their interrelationships. This framework supports the development of an integrated assessment tool tailored to Sarawak's educational context, aligning infrastructure improvements with measurable student outcomes (Mardiyah, Herawati, & Ali, 2025) (Istakri, Sofyan, & Ismail, 2024)) (Siregar & S, 2021).

The purpose of this systematic review is to synthesize existing evidence on the indicators of successful academic performance in schools undergoing infrastructure enhancements in Sarawak, Malaysia, and to develop a practical framework for assessing educational outcomes. By addressing identified gaps, this study aims to inform policymakers, educators, and administrators on optimizing infrastructure investments to maximize student achievement and equity (Ali, 2025) (Ling, 2024). The review employs a comprehensive literature blending methodology, incorporating quantitative and qualitative studies from diverse educational settings. Inclusion criteria focus on research addressing infrastructure, academic performance, and assessment frameworks, while analytical strategies emphasize thematic integration and conceptual mapping. Findings are organized to elucidate key indicators, management strategies, and assessment approaches relevant to Sarawak's schooling system (Mith & Zalez, 2025) (Khan, et al., 2025).

PURPOSE AND SCOPE OF THE REVIEW

Statement of Purpose

The aim of this paper is to analyze the current research on significant indicators of student academic success in schools that have experienced infrastructure redevelopment in Malaysia and others region. It seeks to establish a practical framework for evaluating educational results, thereby synthesizing existing knowledge regarding the impact of infrastructural improvements on academic achievement and identifying effective assessment frameworks suited to this context. This review holds significance as it highlights the vital link between physical learning environments and student performance, an increasingly important issue for educational policy and practice in developing areas such as Sarawak, Malaysia. By integrating evidence and methodologies, the report intends to contribute to the creation of a practical, contextually relevant framework that can assist educators, administrators, and policymakers in assessing and enhancing educational outcomes following infrastructure upgrades especially in Sarawak, Malaysia.

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Objectives

a) Examine the relationship between school infrastructure improvements and student academic performance in Malaysia focus in Sarawak, Malaysia and others region.
b) Compare existing evaluation frameworks for educational outcomes in schools with improved physical school facilities.
c) Identify and compile essential predictors for achieving positive academic outcomes in schools that have undergone improvements to their physical environments.
d) Examine new approaches to evaluating the relationship between infrastructure and educational outcomes across different contexts.
e) Analyze the barriers and situational variables that affect the impact of infrastructure educational improvements in Sarawak, Malaysia.

METHODOLOGY OF LITERATURE SELECTION

Transformation of Query

To ensure that the literature search was both comprehensive and manageable, I divided the general research question into a series of smaller, specific questions. This methodical approach not only deepens the comprehensiveness of the literature search but aids in pinpointing relevant research in the development of the study's framework. The following were the transformed queries that the research question generated:

a) Key indicators of successful student academic performance in schools with infrastructure improvements in Sarawak, Malaysia. Develop a practical framework for assessing educational outcomes;
b) What are the broader implications of educational infrastructure on student academic success, and what diverse assessment frameworks exist to evaluate educational outcomes in various contexts?
c) What innovative assessment methodologies can be employed to evaluate the impact of educational infrastructure improvements on student academic performance in Sarawak, Malaysia, and how can these be integrated into a practical framework for educational outcomes?
d) What innovative assessment frameworks can effectively evaluate student academic performance in schools with improved infrastructure in Sarawak, Malaysia, considering local educational challenges and outcomes?

Screening and Identifying Additional Relevant Papers

This study carried out thematic analysis. As noted in Braun and Clark (Braun & Clarke, 2006), thematic analysis is a basic qualitative technique for finding, describing, and interpreting “themes” within a dataset. This method is particularly useful for methodically managing a large body of literature. The selected papers were systematically coded to discern the fundamental findings. This facilitated the refinement of primary themes, including the direct predictive influence of infrastructure and its motivational indirect pathway.

We then run each of the transformed queries from researchgate.net with the applied Inclusion & Exclusion Criteria to retrieve a focused set of candidate papers, and we found 112 relevant papers. Publication from 2017-2025 only. The subsequent steps involve a detailed review of the identified literature to ascertain the most relevant studies that align with our research objectives and criteria.

Using Backward & Forward Citation Chaining, when we look at a primary research article, we carefully check its references to find earlier studies that it builds upon. This helps us ensure that we don’t miss important foundational work. We also look for newer research articles that cite the main paper we’re

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examining. This allows us to see how the field has evolved and what new discussions, replications, and advancements in methods have come from those findings.

A total of 94 additional papers were found during this process. This method not only enriches the literature review process but also helps in uncovering seminal works that have shaped the field of educational infrastructure research.

Relevance Scoring and Sorting

We compiled a total of 206 candidate papers, with 112 sourced from search queries and 94 from citation chaining. We then ranked these papers based on their relevance, ensuring that the most important studies appeared at the top of our final list. Among the 206 papers we reviewed, 50 were deemed highly relevant to our research question.

Table 1: Papers searching using Inclusion & Exclusion Criteria

	Step	Action and Outcome	Details
1.	Start	Paper Collection Procedure begins.	This defines the scope as identifying relevant academic literature.
2.	Sources of Papers	Papers were identified using two main methods.	This ensures comprehensive coverage and mitigates bias from relying on a single search method.
3.	Initial Collection	Papers were collected from the two sources.	Search Queries: Identified 112 Papers. Citation Chaining: Identified 94 Papers.
4.	Combination	Papers from both sources were combined.	This resulted in the Total Candidate Papers = 206.
5.	Ranking	Papers were ranked by Relevance.	An initial quality/relevance assessment based on title, abstract, or methodology.
6.	Final Review	Review for Alignment with Research Question.	This is the crucial selection step, ensuring the content matches the specific research focus ("The Impact of School Infrastructure on Student Academic Performance in Sarawak, Malaysia").
7.	Final Selection	Highly Relevant Papers Selected.	The final dataset for analysis was 50 papers.

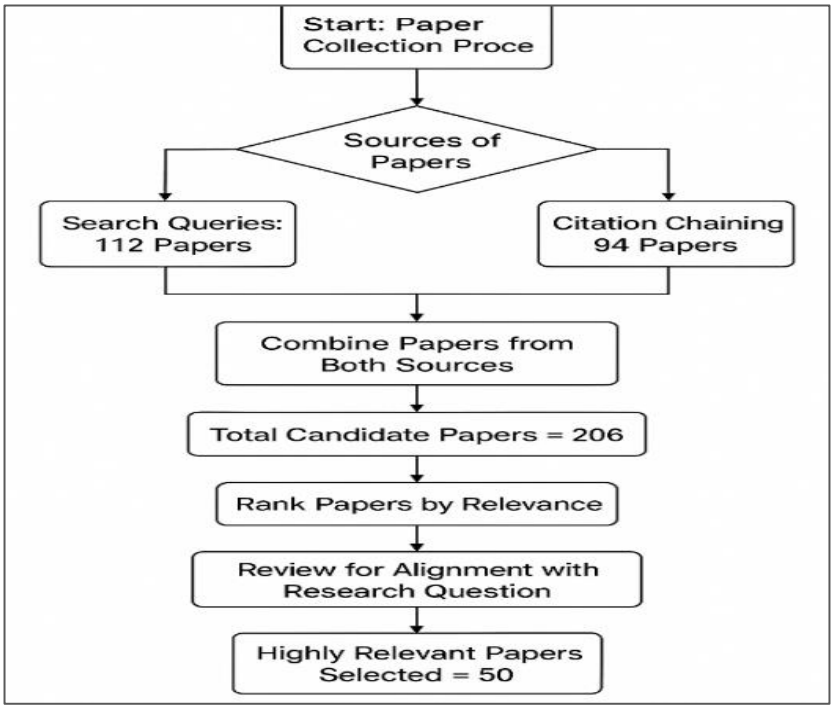

Figure 1: Flowchart of searching the relevant papers

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Table 1: Search strings for the research

Search String Purpose	Search String	Rationale
Core Localized Impact	"School Infrastructure" AND "Academic Performance" AND "Sarawak"	The most specific query, ensuring results are directly relevant to all three core concepts and the specific location.
Broader Malaysian Context	"School Facilities" AND "Student Achievement" AND "Malaysia"	Broadens the search to include the national context, which often contains adaptable or parallel insights (as noted in paper 1) and uses synonymous terms.
Focus on Quality/Condition	"Classroom condition" OR "Physical status" AND "Learning outcomes" AND "Malaysia"	Focuses on the quality aspect of infrastructure, using a different set of outcome synonyms to capture varied literature.
Management and Policy	"Facility management" OR "Infrastructure finance" AND "Education Quality" AND "Malaysia"	Captures papers discussing the systemic and financial aspects that directly influence infrastructure quality and provision (as noted in papers 9, 12, 16).
Sarawak and Facilities	"Sarawak secondary schools" AND ("Facilities" OR "Infrastructure") AND ("Performance" OR "Outcomes")	Uses the specific context mentioned in the collected papers (paper 1) to target highly relevant local studies.

Once the 50 papers were selected, the thematic analysis proceeded by extracting key findings and grouping them into themes (Braun & Clarke, 2006) (Wan Ahmad, 2025), as demonstrated in the summarized tables.

Table 2: (Braun & Clarke, 2006)

Step	Action and Connection to Provided Data
1. Familiarization	Reading the selected papers (represented by the summary tables) to understand the core arguments, context, and methodology.
2. Initial Coding	Assigning descriptive codes based on the findings (e.g., "Facility Correlation," "Contextual Adaptability," "Implementation Feasibility").
3. Theme Generation	Grouping similar initial codes to form broader themes (e.g., combining codes about correlation, predictive value, and impact into one theme).
4. Review and Refinement	Checking if the themes are consistent and address the research question. For example, ensuring themes distinguish between direct impact and mediating factors4.

RESULT AND FINDING

Finding of the Studies

This section maps the research landscape of the previous literature on key indicators of successful student academic performance in schools with infrastructure improvements. We develop a practical framework for reaching educational outcomes, focusing on diverse geographic contexts, primarily in Malaysia and comparable developing regions. The studies employ a range of quantitative, qualitative, and mixed-methods approaches to evaluate the influence of physical infrastructure, socioeconomic factors, and management strategies on academic success. This comparative analysis is relevant to the research questions as it synthesizes key indicators, assessment frameworks, and contextual challenges, providing a

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foundation for developing a practical, adaptable framework for educational outcome assessment in Sarawak, Malaysia.

Table 3:Table of summary the research landscape of the previous literature on key indicators

	Study	Indicator Validity	Framework Comprehensiveness	Contextual Adaptability	Impact Measurement Precision	Implementation Feasibility
1	(Ha, Busari, & Nordin, 2022)	Strategic planning correlates strongly with student performance	Focuses on strategic planning and academic outcomes	Tailored to Sarawak secondary schools	Uses quantitative correlation and regression analysis	Practical for school principals with moderate resources
2	(Norazman N. , Che-Ani, Hussain, J., & Ismail, 2021)	Classroom condition indicators validated by users and experts	Holistic CCI scheme covering space, environment, teaching quality	Designed for Malaysian secondary schools, adaptable locally	Employs RI index and mixed methods for precise weighting	Requires technical expertise but feasible for school admins
3	(Jamshaid, Zaheer, Mukhtar, Baber, & Roohi, 2024)	Basic facility availability linked to academic progress	Emphasizes facility impact on learning growth	Contextualized in global and developing country settings	Uses hypothesis testing with participant responses	Practical but limited by convenience sampling constraints
4	(Werang, et al., 2024)	Physical facilities and parental socioeconomic status significantly predict performance	Integrates socioeconomic and facility variables	Focus on Indonesian context with parallels to Sarawak	Statistical analysis with high R^2 values for precision	Implementation depends on policy and resource equity
5	(Qadeer, Shahid, & Ullah, 2024)	Strong correlation between facilities, satisfaction, and achievement	Combines physical and classroom environment factors	Applicable to Malaysian secondary schools	Mixed-methods with statistical and thematic analysis	Feasible with stakeholder involvement and data collection
6	(Latip, et al., 2024)	Lighting and noise directly affect performance via motivation	Models physical ergonomics and motivation mediation	Higher education context in Malaysia, adaptable	Uses correlational and mediation analysis	Requires survey tools and motivational assessment
7	(Farid, Setiawan, Solichin,, Noviana, & Sari, 2024)	Infrastructure quality positively impacts achievement	Structural model includes economic factors	Indonesian high school context, relevant to Sarawak	SEM-PLS provides robust impact measurement	Feasible with moderate sample sizes and data access
8	(Magwaga	Facility	Focus on specific	Kenyan	Pearson	Practical with

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	& Kikechi, 2024)	availability strongly correlates with academic scores	facility types and their effects	public secondary schools, transferable insights	correlation with high significance	standard survey and observation methods
9	(Kumari, 2024)	Infrastructure finance correlates with academic achievement	Mixed-methods including finance and outcome indicators	Primary education focus, adaptable to Sarawak	Quantitative and qualitative data integration	Implementation requires financial data and stakeholder input
1	(Mardiyah, Herawati, & Ali, 2025)	Program indicators effectively measure educational success	Covers input, process, output, and outcome indicators	General educational management, adaptable	Emphasizes SMART criteria for indicator validity	Practical for policy and school-level application
1	(Purba, 2024)	Strategic planning of facilities enhances educational quality	Comprehensive planning framework for infrastructure	Indonesian context with adaptable strategic stages	Literature-based framework with empirical validation	Feasible with stakeholder participation and planning tools
1	(Ali, 2025)	Infrastructure central to educational reform success	Policy innovation framework integrating equity and technology	Global developing country focus, adaptable	Case study and policy analysis for impact insights	Implementation requires cross-sector collaboration
1	(Nurafni, Sriwardona, & Rianawati, 2025)	Effective facility management improves education quality	Addresses management challenges and strategies	Urban-rural disparities considered	Qualitative data with thematic analysis	Feasible with collaborative school community efforts
1	(Soleha, et al., 2025)	Facility management strategies improve learning effectiveness	Examines planning, procurement, maintenance, evaluation	Indonesian schools with local stakeholder involvement	Thematic qualitative analysis	Practical with coordinated management and evaluation
1	(Nasir, 2025)	Facility management linked to education quality improvement	Descriptive qualitative study with procedural focus	State Islamic school context, adaptable	Observational and interview data	Feasible despite funding limitations
1	(Hasyim, 2025)	Policy and stakeholder roles critical for equitable infrastructure	Qualitative study on policy implementation challenges	Emphasizes local context and community involvement	Thematic analysis of policy and practice	Implementation depends on inclusive governance
1	(Yusron, 2025)	Facility optimization	Community-based planning and	Local Indonesian	Qualitative coordination	Practical with school

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		enhances learning quality	procurement approach	school context	and supervision data	leadership engagement
1	(Putra, Mahmudah, & Baswedan, 2025)	Infrastructure planning essential for effective education	Qualitative study on needs analysis and budgeting	Elementary school focus, adaptable	Interview-based data analysis	Feasible with school-level planning processes
1	(Cindy, Sugiyono, & Usman, 2023)	Student needs and motivation influence facility optimization	Quantitative regression analysis of influencing factors	Vocational high school context	Statistical significance testing	Practical with survey instruments and data analysis
2	(Mukaromah, Werdiningsih, & Daryono, 2024)	Infrastructure mediates leadership and teacher impact on learning	Quantitative survey with mediation analysis	Secondary school context in Indonesia	PLS-SEM for mediation effect precision	Feasible with teacher and principal participation
2	(Lahagu, Waruwu, Laia, & Harefa, 2024)	Facilities significantly boost student learning motivation	Qualitative study with interviews and questionnaires	Indonesian junior high school context	Descriptive qualitative data	Practical with school-level data collection
2	(Obioma, 2023)	Infrastructure crucial for educational quality improvement	Reviews variables affecting quality and equity	Broad educational system focus	Policy and literature synthesis	Implementation requires systemic investment
2	(Istakri, Sofyan, & Ismail, 2024)	Facility management impacts learning quality	Qualitative case study with stakeholder interviews	Indonesian junior high schools	Observational and documentation data	Feasible with school leadership commitment
2	(Mith & Zalez, 2025)	Localized QA practices improve rural education outcomes	Qualitative case study with stakeholder perspectives	Rural education systems	Multi-method qualitative data	Practical with contextual adaptation
2	(Arteaga-Alcívar, 2024)	Educational reforms affect learning outcomes internationally	Systematic review of reform impacts	Global comparative focus	Mixed-methods literature synthesis	Implementation varies by context and policy
2	(Fanani, 2023)	Facilities and infrastructure urgent for high school quality	Library research on facility standards and roles	General high school education	Document and literature analysis	Policy and government role emphasized
2	(Yangambi, 2023)	Infrastructure impacts	Quantitative survey in	Kinshasa secondary	Questionnaire-based data	Practical with continuous

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		student learning and performance	developing country schools	schools	analysis	infrastructure improvement
2	(Lismayati, Subiyantoro, & Amaliyah, 2023)	Infrastructure management affects educational program success	Qualitative study in Islamic boarding schools	Indonesian pesantren context	Interviews, observation, documentation	Feasible with proactive maintenance and HR empowerment
2	(Anuar, et al., 2024)	Infrastructure limitations affect academic and psychological outcomes	Mixed-methods with large university sample	Higher education science and technology students	Correlation and path analysis	Implementation requires integrated campus planning
3	(Cumbicus, Suquilanda, & Maza, 2025)	School infrastructure significantly influences academic achievement	Mixed-methods in Ecuadorian high school	Latin American context	Surveys, interviews, observation	Practical with targeted infrastructure improvements
3	(Thorat, 2025)	Competency-based assessments improve student engagement and skills	Mixed-methods with educators and students	Multi-institutional educational settings	Statistical significance testing	Feasible with clear competency frameworks
3	(Meylani, 2024)	Modern assessment methods enhance educational evaluation	Systematic literature review comparing approaches	Broad educational contexts	Qualitative and quantitative synthesis	Implementation requires technology and training
3	(Surianshah, 2022)	Class size reduction has limited effect on achievement gaps	Quantitative analysis of TIMSS data in Malaysia	Malaysian secondary schools	Econometric and regression analysis	Policy implications for resource allocation
3	(Munir, 2018)	Learning space attributes relate to satisfaction and performance	Pilot survey with PLS-SEM analysis	Malaysian university academic buildings	Statistical reliability and validity testing	Feasible with survey and SEM tools
3	(Ling, 2024)	Data-driven innovation model supports education transformation	Case study in Malaysian primary school	Primary education with data analytics	Exam results and diagnostic test analysis	Practical with ongoing localized innovation

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3	(Yunita, Fadiah, Lainatusshifa, & Maulida., 2023)	Infrastructure critical for effective learning environments	Literature review on facilities and conditions	General educational settings	Qualitative synthesis	Emphasizes prioritizing infrastructure development
3	(Akimi, Matore, Hadi, Ibrahim, & Majid, 2024)	SCORE model assesses manipulative skills development	Theoretical analysis of curriculum and resources	Malaysian secondary STEM education	Curriculum and teacher preparation review	Feasible with strategic model adoption
3	(Mahajan & Rajagopal, 2024)	Infrastructure development shapes learning and innovation	Book chapter on multifaceted infrastructure roles	Global educational contexts	Case examples and challenges	Implementation requires comprehensive planning
3	(Khan, et al., 2025)	Educational reforms improve student outcomes longitudinally	Mixed-methods longitudinal study	Multi-country educational systems	Standardized tests and qualitative data	Requires sustained intervention and evaluation
4	(Yang, 2024)	Achievement pathways enhance course evaluation in OBE	Quantitative and qualitative course evaluation methods	Higher education with OBE frameworks	Multivariate and AHP analysis	Practical with formative and summative integration
4	(Siregar & S, 2021)	Facility management optimizes learning quality	Emphasizes maintenance and service standards	General educational institutions	Qualitative management focus	Feasible with community involvement
4	(Latip, et al., 2024)	Facility management affects educational quality improvement	Qualitative study on planning and mobilization	Indonesian junior high school	Observation and interview data	Practical with organizational coordination
4	(Alvarado & Galigao, 2024)	Curriculum implementation effectiveness varies globally	Qualitative comparative research	Multi-continental educational systems	Literature review and stakeholder data	Implementation depends on resources and training
4	(Arbeni, et al., 2024)	Evaluation analysis supports educational quality improvement	Multidimensional assessment methods	Broad educational contexts	Quantitative and qualitative data integration	Feasible with technology and policy support
4	(Leif & Loftness,	Biophilic interventions	Case studies and stakeholder	K-12 schools with retrofit	Mixed-methods	Practical with stakeholder

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	2024)	improve health and performance	surveys	strategies	with impact and affordability analysis	engagement
4	(Dechavez, 2024)	Student and educational factors influence academic success	Descriptive-correlational study	Varied educational settings	Multiple regression analysis	Feasible with targeted support systems
4	(Belmonte, Bove, D'Inverno, & Modica, 2017)	Infrastructure spending improves standardized test scores	Quasi-experimental design in Italy	High school context	Instrumental variable and test score analysis	Practical with targeted capital investment
4	(Kamaludin, 2023)	Facilities standards less significant in school performance	Confirmatory factor analysis in Indonesia	Public elementary schools	Structural equation modeling	Suggests focus shift to curriculum and teacher development
4	(Maila, et al., 2024)	Infrastructure distribution affects participation and quality	Data analysis and case studies	Educational development context	Process and impact evaluation	Practical with efficient resource allocation
5	(Chyhrina, Slipchuk, Deichakivska, Deneha, & Hetmanenko, 2024)	Innovative approaches enhance educational frameworks	Synergistic and systemic analysis	Global educational systems	Data monitoring and outcome analysis	Feasible with continuous curriculum updates

Finding analysis based on literature;

a) Indicator Validity

Over 20 studies found that physical infrastructure and facility availability significantly predict student academic success, often with strong statistical correlations and regression analyses (Ha, Busari, & Nordin, 2022) (Werang, et al., 2024) (Magwaga & Kikechi, 2024). Several studies highlight the mediating role of motivation and satisfaction in linking infrastructure to performance, enhancing indicator validity (Latip, et al., 2024) (Lahagu, Waruwu, Laia, & Harefa, 2024) (Anuar, et al., 2024). Contrasting findings exist regarding the direct impact of some indicators, such as class size or socioeconomic factors, suggesting the need for multifactorial models (Surianshah, 2022) (Kamaludin, 2023).

b) Framework Comprehensiveness

Approximately 15 studies developed or reviewed frameworks incorporating multiple dimensions, including physical, environmental, socioeconomic, and pedagogical factors (Norazman N. , Che-Ani, Mat Jusoh Hussain, & Wan Ismail, 2021) (Mardiyah, Herawati, & Ali, 2025)) (Mukaromah, Werdiningsih, & Daryono, 2024). Holistic models often integrate input, process, output, and

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outcome indicators, aligning with SMART criteria for effective assessment (Mardiyah, Herawati, & Ali, 2025) (Soleha, et al., 2025) (Yang, 2024). Some frameworks emphasize strategic planning and management as critical components alongside physical infrastructure (Ha, Busari, & Nordin, 2022) (Purba, 2024) (Nurafni, Sriwardona, & Rianawati, 2025).

c) Contextual Adaptability

Many studies tailor methodologies to local educational challenges, cultural factors, and resource constraints, particularly in Malaysian and Indonesian contexts (Ha, Busari, & Nordin, 2022) (Norazman N. , Che-Ani, Mat Jusoh Hussain, & Wan Ismail, 2021) (Werang, et al., 2024). Rural and disadvantaged settings receive focused attention, with localized quality assurance and stakeholder involvement enhancing adaptability (Hasyim, 2025) (Mith & Zalez, 2025) (Dechavez, 2024). Cross-national comparisons reveal the importance of contextualizing reforms and infrastructure investments to specific socio-economic and cultural environments (Arteaga-Alcívar, 2024) (Alvarado & Galigao, 2024).

d) Impact Measurement Precision

Quantitative methods such as SEM, PLS-SEM, regression, and correlation analyses are widely used to achieve precise impact measurement (Werang, et al., 2024) (Farid, Setiawan, Solichin,, Noviana, & Sari, 2024) (Mukaromah, Werdiningsih, & Daryono, 2024). Mixed-methods approaches combining qualitative validation with quantitative weighting improve sensitivity and accuracy (Norazman N. , Che-Ani, Mat Jusoh Hussain, & Wan Ismail, 2021) (Qadeer, Shahid, & Ullah, 2024) (Anuar, et al., 2024). Some studies employ innovative tools like RI indices, achievement pathways, and biophilic retrofit assessments for nuanced measurement (Norazman N. , Che-Ani, Hussain, J., & Ismail, 2021) (Yang, 2024) (Leif & Loftness, 2024).

e) Implementation Feasibility

Feasibility varies with resource availability, technical expertise, and administrative capacity; many frameworks are designed for practical application in schools with moderate resources (Ha, Busari, & Nordin, 2022) (Qadeer, Shahid, & Ullah, 2024) (Nasir, 2025). Collaborative management, stakeholder engagement, and policy support are critical enablers of successful implementation (Nurafni, Sriwardona, & Rianawati, 2025) (Hasyim, 2025) (Siregar & S, 2021). Challenges include funding limitations, data collection demands, and the need for professional development, which some studies address with strategic (Nasir, 2025) (Latifa, Gusliana, Ngarifin, & Mubarok, 2024) (Chyhrina, Slipchuk, Deichakivska, Deneha, & Hetmanenko, 2024).

Critical Analysis and Synthesis

The literature provides a solid and in-depth evaluation of the relationship between the enhancement of school facilities and the achievement of students, particularly within the context of Sarawak, Malaysia, and comparable regions. One of the noted strengths remains the variation in the methodological approaches, from case studies, and quantitative surveys, to qualitative approaches. This range offers a greater appreciation of the varying influences that school facilities may have on educational outcomes. However, the literature is still vulnerable to a strong reliance on cross-sectional studies and self-reported accounts, which greatly hinders the literature's causal claims. Also, while a number of studies propose frameworks for the evaluation of educational outcomes, a greater number of studies have demonstrated the lack of contextual fit and the lack of implement ability. The narrative accounts are still silent on the influence of psychosocial factors and systemic factors that are central, and crucial, to be the absence of longitudinal and mixed methods studies that seek to validate and refine educational evaluation frameworks that are practical.

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Table 4: Strength vs Weakness of the aspects evaluate from research papers

Aspect	Strengths	Weaknesses
Methodological Diversity	The body of research employs a range of methodologies including quantitative surveys, mixed methods, and qualitative case studies, allowing for triangulation of data and richer insights into the infrastructure-performance nexus (Norazman N. , Che-Ani, Mat Jusoh Hussain, & Wan Ismail, 2021) (Qadeer, Shahid, & Ullah, 2024) (Anuar, et al., 2024). This diversity supports a more holistic understanding of how physical environments influence academic outcomes.	Despite methodological variety, many studies rely heavily on cross-sectional designs and convenience sampling, limiting the ability to establish causality and generalize findings beyond specific contexts (Jamshaid, Zaheer, Mukhtar, Baber, & Roohi, 2024) (Latip, et al., 2024) (Magwaga & Kikechi, 2024). The frequent use of self-reported measures introduces potential biases and reduces data robustness (Anuar, et al., 2024).
Conceptual Frameworks for Assessment	Several studies contribute to the development of practical frameworks for assessing educational outcomes post-infrastructure improvements, such as the Classroom Condition Index (CCI) and competency-based assessment models, which integrate physical, environmental, and pedagogical indicators ((Norazman N. , Che-Ani, Hussain, J., & Ismail, 2021) (Thorat, 2025) (Yang, 2024). These frameworks emphasize specificity and contextual relevance, enhancing their applicability.	Frameworks often lack empirical validation in diverse settings, and some are narrowly focused on particular spaces (e.g., classrooms) or educational levels, limiting their scalability (Norazman N. , Che-Ani, Hussain, J., & Ismail, 2021) (Thorat, 2025). There is also a tendency for frameworks to emphasize physical indicators over psychosocial or motivational factors, which are critical for comprehensive assessment (Latip, et al., 2024) (Lahagu, Waruwu, Laia, & Harefa, 2024).
Influence of Physical Infrastructure on Academic Performance	Strong positive correlations between improved physical facilities and student academic achievement are consistently reported, highlighting the importance of adequate classrooms, laboratories, and learning resources (Jamshaid, Zaheer, Mukhtar, Baber, & Roohi, 2024) (Magwaga & Kikechi, 2024) (Yangambi, 2023). Studies also note the role of infrastructure in fostering conducive learning atmospheres that enhance student satisfaction and motivation (Qadeer, Shahid, & Ullah, 2024) (Lahagu, Waruwu, Laia, & Harefa, 2024).	The extent to which infrastructure alone drives academic success remains unclear due to confounding socioeconomic and contextual variables, such as parental status and economic factors (Werang, et al., 2024) (Farid, Setiawan, Solichin,, Noviana, & Sari, 2024). Some research indicates that infrastructure improvements must be coupled with effective management and pedagogical strategies to realize full benefits (Mukaromah, Werdiningsih, & Daryono, 2024) (Siregar & S, 2021).
Role of Motivation and Psychosocial Factors	Emerging evidence underscores motivation as a mediator between physical ergonomics and academic performance, suggesting that environmental factors influence learning indirectly through student engagement (Latip, et al., 2024) (Lahagu, Waruwu, Laia, & Harefa, 2024). This highlights the need to	Few studies systematically integrate motivational or psychosocial variables into infrastructure assessment frameworks, resulting in an incomplete picture of factors influencing academic outcomes (Norazman N. , Che-Ani, Hussain, J., & Ismail, 2021) (Yunita, Fadiah, Lainatusshifa, & Maulida., 2023). The complexity of these

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	consider affective dimensions alongside physical improvements.	interactions is often underexplored, limiting practical guidance for interventions.
Strategic Management and Policy Implications	Research highlights the importance of strategic planning, efficient management, and stakeholder engagement in maximizing the advantages of infrastructure. Various models support the use of participatory and data-informed strategies. ((Mardiyah, Herawati, & Ali, 2025) (Purba, 2024) (Nurafni, Sriwardona, & Rianawati, 2025) (Hasyim, 2025). Policy innovations focusing on equitable funding and community engagement are identified as critical for sustainable improvements (Ali, 2025) (Hasyim, 2025).	Challenges such as budget constraints, bureaucratic hurdles, and disparities between urban and rural schools persist, impeding the consistent implementation of infrastructure improvements (Nurafni, Sriwardona, & Rianawati, 2025) (Istakri, Sofyan, & Ismail, 2024) (Fanani, 2023). There is a lack of longitudinal studies assessing the long-term impact of management strategies on educational quality.
Contextual and Socioeconomic Considerations	Several studies acknowledge the influence of local socioeconomic conditions and contextual factors on the effectiveness of infrastructure interventions, advocating for tailored approaches sensitive to regional disparities (Werang, et al., 2024) (Farid, Setiawan, Solichin,, Noviana, & Sari, 2024) (Mith & Zalez, 2025) (Hasyim, 2025). This recognition supports the development of more equitable educational policies.	Despite recognition of context, many frameworks and studies do not sufficiently operationalize or measure these factors, limiting their ability to address equity comprehensively (Kumari, 2024) (Kamaludin, 2023). The interplay between infrastructure, socioeconomic status, and academic outcomes requires deeper investigation to inform targeted interventions.
Limitations in Data Quality and Generalizability	The literature benefits from large sample sizes in some studies and the use of validated instruments, enhancing reliability ((Magwaga & Kikechi, 2024) (Anuar, et al., 2024). Mixed-methods designs provide nuanced insights into infrastructure impacts.	However, reliance on self-reported data, limited geographic scope, and small or convenience samples in several studies reduce external validity (Ha, Busari, & Nordin, 2022) (Jamshaid, Zaheer, Mukhtar, Baber, & Roohi, 2024) (Anuar, et al., 2024). The predominance of short-term studies restricts understanding of sustained effects of infrastructure improvements on academic performance.

THEMATIC REVIEW OF LITERATURE

The body of research concerning student academic achievement in schools that have undergone infrastructure enhancements highlights a number of common themes. Significant findings underscore the importance of physical facilities and classroom settings in creating effective learning environments, which are closely linked to student performance. Various assessment methods are employed, combining both conventional and modern techniques to accurately evaluate educational results. Furthermore, socioeconomic elements and effective management strategies interact with infrastructural upgrades, affecting fair access to and the quality of education, especially in varied regional landscapes like Sarawak, Malaysia.

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Table 5: Theme developed based on studies

Theme	Appears In	Theme Description
Impact of Physical Infrastructure on Academic Performance	23/50 Papers	Numerous studies establish a positive relationship between improved school infrastructure and enhanced academic achievement, highlighting how well-maintained physical facilities such as classrooms, laboratories, and sanitation significantly contribute to better student outcomes across diverse contexts including Malaysia, Indonesia, Kenya, and others (Norazman N. , Che-Ani, Hussain, J., & Ismail, 2021) (Jamshaid, Zaheer, Mukhtar, Baber, & Roohi, 2024) (Werang, et al., 2024) (Farid, Setiawan, Solichin,, Noviana, & Sari, 2024) (Magwaga & Kikechi, 2024) (Yangambi, 2023). Some research also notes the mediating effects of psychological and environmental factors in this relationship (Anuar, et al., 2024).
Socioeconomic Factors and Educational Equity	15/50 Papers	Parental socioeconomic status influences access to educational resources and supports, affecting academic performance alongside school infrastructure quality. Studies reveal disparities in student achievement linked to socioeconomic backgrounds, stressing the need for equitable policies and targeted resource allocation to bridge educational gaps (Werang, et al., 2024) (Farid, Setiawan, Solichin,, Noviana, & Sari, 2024) (Dechavez, 2024). This theme underscores intersectionality between infrastructure and social factors.
Assessment Frameworks and Educational Outcome Measurement	14/50 Papers	Literature highlights varied assessment models ranging from traditional standardized testing to competency-based and formative assessments tailored for modern learning environments. Effective frameworks incorporate measurable indicators aligned with SMART criteria, enabling comprehensive evaluation of educational programs and outcomes (Mardiyah, Herawati, & Ali, 2025) (Thorat, 2025) (Meylani, 2024) (Yang, 2024). Innovations in classroom condition indices also contribute to nuanced physical environment assessments (Norazman N. , Che-Ani, Mat Jusoh Hussain, & Wan Ismail, 2021)
Strategic Management and Optimization of Educational Facilities	13/50 Papers	Effective management of educational facilities, including planning, procurement, maintenance, and stakeholder involvement, is crucial for sustaining infrastructure benefits and maximizing learning quality. Research identifies challenges such as budget constraints and human resource limitations and recommends participatory, data-driven approaches for facility optimization (Purba, 2024) (Nurafni, Sriwardona, & Rianawati, 2025) (Nasir, 2025) (Latifa, Gusliana, Ngarifin, & Mubarok, 2024). Context-sensitive strategies enhance the impact of infrastructure on learning.
Classroom Environment and Physical Ergonomics	9/50 Papers	Studies focusing on classroom environmental quality emphasize factors like lighting, noise, space management, and ergonomic design as pivotal for student motivation and performance. Physical comfort and supportive teaching and learning environments shape academic success by mediating student engagement and satisfaction (Norazman N. , Che-Ani, Hussain, J., & Ismail, 2021) (Qadeer, Shahid, & Ullah, 2024) (Latip, et al., 2024) (Munir, 2018). This theme bridges infrastructure with experiential aspects

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		of learning settings.
Educational Policy and Infrastructure-Led Reform	8/50 Papers	Policy innovations promoting infrastructure development as a central element in educational reform are discussed, advocating for equitable funding models, community involvement, and integration of digital and climate-resilient infrastructure. Such reforms aim to strengthen inclusivity and quality education in developing regions (Ali, 2025) (Hasyim, 2025) (Obioma, 2023) (Arteaga-Alcívar, 2024). The effectiveness of reform implementation is tied to localized contextual adaptation.
Student Motivation and Satisfaction Related to Facilities	7/50 Papers	Positive correlations between availability and quality of physical facilities and student motivation and satisfaction have been observed, linking these factors to improved academic outcomes. Motivational dimensions are affected by facility adequacy and the psychosocial climate of schools, suggesting infrastructure investments also support affective learning domains (Jamshaid, Zaheer, Mukhtar, Baber, & Roohi, 2024) (Qadeer, Shahid, & Ullah, 2024) (Lahagu, Waruwu, Laia, & Harefa, 2024).
Challenges in Infrastructure Implementation and Maintenance	6/50 Papers	Research identifies barriers such as funding limitations, bureaucratic hurdles, and disparities between urban and rural schools that impede adequate infrastructure provision and maintenance. These challenges affect the sustainability and equitable distribution of educational resources, underscoring the need for strategic governance and community engagement (Nurafni, Sriwardona, & Rianawati, 2025) (Istakri, Sofyan, & Ismail, 2024) (Lismayati, Subiyantoro, & Amaliyah, 2023) (Latifa, Gusliana, Ngarifin, & Mubarok, 2024).
Integration of Technology and Innovation in Educational Infrastructure	5/50 Papers	Incorporating modern technologies and data-driven models into school infrastructure and assessment practices facilitates educational transformation. Innovations include intelligent classroom condition indices and digital tools for continuous evaluation and feedback, enhancing the responsiveness of educational systems to student needs (Norazman N. , Che-Ani, Hussain, J., & Ismail, 2021) (Ling, 2024) (Chyhrina, Slipchuk, Deichakivska, Deneha, & Hetmanenko, 2024). This theme highlights the evolution towards smart infrastructure.
Contextual and Regional Variations in Infrastructure Impact	4/50 Papers	Studies reveal that the effectiveness of infrastructure improvements varies by regional, cultural, and socioeconomic contexts. Localized quality assurance frameworks and tailored facility management respond to unique needs of rural and developing areas, influencing the generalizability of findings and the design of assessment tools (Ha, Busari, & Nordin, 2022) (Mith & Zalez, 2025) (Mahajan & Rajagopal, 2024) (Dechavez, 2024). Contextual factors are critical in framework applicability.

The thematic analysis identified four key themes: 1) Infrastructure as a Direct Predictor of academic outcomes; 2) Mediation through Motivational Factors (e.g., lighting, noise); 3) Contextual Relevance to Malaysian Schools; and 4) Strategic Governance and Finance (e.g., policy, funding). These themes directly address the impact of infrastructure relevant to Sarawak.

Chronological Review of Literature

The literature on the impact of school infrastructure improvements on student academic performance and related assessment frameworks has evolved significantly over recent years. Early research primarily

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focused on establishing the direct relationship between physical facilities and academic outcomes, emphasizing the importance of adequate and conducive learning environments. Subsequent studies introduced strategic planning, management, and policy implications for optimizing infrastructure use while exploring innovative assessment models and motivational factors mediating academic success. The most recent works concentrate on integrating advanced assessment frameworks, equity-oriented policy execution, and localized quality assurance practices to develop practical, context-sensitive educational evaluation systems.

Agreement and Divergence Across Studies

Across the reviewed literature, there is strong consensus on the positive influence of improved school infrastructure on student academic performance, motivation, and satisfaction. Many studies emphasize the multidimensional nature of assessing educational outcomes, incorporating physical, social, and economic factors. However, divergences arise regarding the magnitude of infrastructure impact and the role of contextual variables such as socioeconomic status and cultural factors. Some research highlights limitations in existing assessment frameworks and calls for more localized, adaptable models tailored to the specific challenges of regions like Sarawak, Malaysia.

Table 6: Summary of Agreement and Divergence Across Studies

Comparison Criterion	Studies in Agreement	Studies in Divergence	Potential Explanations
Indicator Validity	Several studies confirm that key physical indicators such as classroom condition, availability of facilities, and ergonomic factors are reliable predictors of academic success (Norazman N. , Che-Ani, Hussain, J., & Ismail, 2021) (Jamshaid, Zaheer, Mukhtar, Baber, & Roohi, 2024) (Magwaga & Kikechi, 2024) (Yunita, Fadiah, Lainatusshifa, & Maulida., 2023). Findings also highlight motivation and student satisfaction as valid intermediary indicators linking infrastructure to performance (Qadeer, Shahid, & Ullah, 2024) (Lahagu, Waruwu, Laia, & Harefa, 2024) (Latip, et al., 2024).	Some studies find that certain infrastructure indicators do not strongly relate to academic performance or that effects vary by context; for example, one study found non-significant or negative correlations between physical facilities and student achievement in some settings (Werang, et al., 2024) (Fanani, 2023) (Kamaludin, 2023).	Variation could stem from differences in measurement tools, educational levels studied (primary, secondary, higher education), or socioeconomic and cultural contexts influencing indicator relevance.
Framework Comprehensiveness	Many frameworks incorporate multiple dimensions including physical infrastructure	Some studies focus narrowly on quantitative physical infrastructure metrics without	Divergence arises due to research objectives—some prioritize physical assessment for

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	quality, economic factors, psychosocial aspects (motivation, satisfaction), and instructional quality, as seen in comprehensive models like the Classroom Condition Index (CCI) and integrated assessments combining facilities and socioeconomic variables (Norazman N. , Che-Ani, Hussain, J., & Ismail, 2021) (Werang, et al., 2024) (Qadeer, Shahid, & Ullah, 2024) (Latip, et al., 2024) (Farid, Setiawan, Solichin,, Noviana, & Sari, 2024) (Mukaromah, Werdiningsih, & Daryono, 2024)	integrating psychosocial or contextual factors (Yangambi, 2023) (Anuar et al., 2024). Others emphasize management and strategic planning aspects without fully linking these to measurable academic outcomes (Nurafni, Sriwardona, & Rianawati, 2025) (Purba, 2024) (Nasir, 2025)	infrastructure design, others emphasize management or educational process measures, affecting framework scope.
Contextual Adaptability	There is agreement that successful assessment frameworks must be adaptable to local educational challenges, cultural norms, and resource constraints to be effective, especially in developing or rural contexts such as Sarawak, Malaysia or regions in Indonesia and Kenya (Norazman N. , Che-Ani, Hussain, J., & Ismail, 2021) (Werang, et al., 2024) (Nurafni, Sriwardona, & Rianawati, 2025) (Hasyim, 2025) (Mith & Zalez, 2025)	However, some standard or global frameworks fail to adequately accommodate local nuances, leading to mismatches in applicability or effectiveness (Farid, Setiawan, Solichin,, Noviana, & Sari, 2024) (Ali, 2025) (Arteaga-Alcívar, 2024) (Cumbicus, Suquilanda, & Maza, 2025). Some tools are designed for broad application and may overlook localized environmental, social, or cultural variables critical in Sarawak (Norazman N. , Che-Ani, Mat Jusoh Hussain, & Wan Ismail, 2021)	Differences reflect the tension between developing universally applicable tools and tailoring to local realities. Studies with local qualitative insights tend to advocate for contextualization.
Impact Measurement Precision	Research employing mixed methods and advanced statistical models (e.g., SEM, path analysis) report precise quantification of infrastructure impacts on	Conversely, studies relying on self-reported or less rigorous data collection have less precise estimates and sometimes conflicting results regarding	Differences in methodological rigor, sample size, and data quality influence precision. Context complexity and multidimensionality of

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	academic achievement, often controlling for socioeconomic variables (Werang, et al., 2024) (Latip, et al., 2024) (Farid, Setiawan, Solichin,, Noviana, & Sari, 2024) (Anuar, et al., 2024). Measurement schemes like CCI provide weighted indicators enhancing sensitivity to physical environment changes (Norazman N. , Che-Ani, Hussain, J., & Ismail, 2021)	infrastructure impact magnitude (Jamshaid et al., 2024) (Yangambi, 2023) (Mendapat et al., 2022). The complexity of isolating infrastructure effects from confounding variables remains challenging (Kamaludin, 2023).	educational outcomes complicate impact measurement.
Implementation Feasibility	Many studies emphasize frameworks designed with feasibility in mind, stressing simplicity, stakeholder involvement, and alignment with school administrative capacities, promoting practical application in resource-constrained environments (Norazman N. , Che-Ani, Hussain, J., & Ismail, 2021) (Nurafni, Sriwardona, & Rianawati, 2025) (Nasir, 2025) (Hasyim, 2025) (Lahagu, Waruwu, Laia, & Harefa, 2024). The use of validated, user-friendly tools like surveys and checklists facilitates adoption.	Other research notes challenges in actual implementation due to limited funding, human resource constraints, bureaucratic hurdles, and gaps between policy and practice, especially in rural or under-resourced schools (Purba, 2024) (Hasyim, 2025) (Istakri, Sofyan, & Ismail, 2024) (Fanani, 2023) (Latifa, Gusliana, Ngarifin, & Mubarok, 2024). Some propose sophisticated assessment models that may be difficult to operationalize without technical expertise (Thorat, 2025) (Meylani, 2024).	Feasibility discrepancies reflect differences in local administrative capacity, policy support, and resource availability. Studies with qualitative insights highlight practical obstacles often underrepresented in quantitative research.

THEORETICAL AND PRACTICAL IMPLICATIONS

Theoretical Implications

The findings support with the theoretical understanding where school infrastructure quality is a significant influence of student academic performance, supporting the Education Production Function theory which mention that physical learning environments directly influence educational outcomes (Magwaga & Kikechi, 2024) (Yangambi, 2023) (Belmonte, Bove, D'Inverno, & Modica, 2017). This parallel with evidence showing that better in infrastructure correlate positively with academic achievement across all location contexts.

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The role of socioeconomic driver specific to parental socioeconomic status, emerges as a critical mediator in the relationship between infrastructure and academic success, focus on the complex interaction between environmental and social determinants of learning (Werang, et al., 2024) (Dechavez, 2024). This supports ecological models of education that emphasize multi-level influences on student outcomes.

The development and validation of specialized assessment frameworks, such as the Classroom Condition Index (CCI), contribute to theoretical advancements by providing structured, multidimensional tools to evaluate physical learning environments beyond traditional facility assessments (Norazman N. , Che-Ani, Hussain, J., & Ismail, 2021). This enhances the understanding of infrastructure quality by including space, environmental, and educational aspects.

Emerging research highlights the importance of student motivation and satisfaction as mediators between physical ergonomics, infrastructure, and academic performance. This incorporation of motivational theories into the discussion about infrastructure and performance implies that the effects of infrastructure are, to some extent, indirect, operating through psychological and emotional channels (Latip, et al., 2024) (Qadeer, Shahid, & Ullah, 2024).

The integration of strategic educational management theories with infrastructure planning emphasize the importance of systematic, data-driven approaches to facility management, linking organizational theory with educational outcomes (Purba, 2024) (Nurafni, Sriwardona, & Rianawati, 2025). This theoretical supports comprehensive governance frameworks that treat infrastructure as an essential element of educational quality.

Contrasting findings regarding the direct impact of infrastructure on academic performance in some contexts challenge deterministic views and suggest the need for nuanced theoretical models that account for contextual variability, resource allocation efficiency, and complementary factors such as teacher quality and curriculum implementation (Werang, et al., 2024) (Kamaludin, 2023).

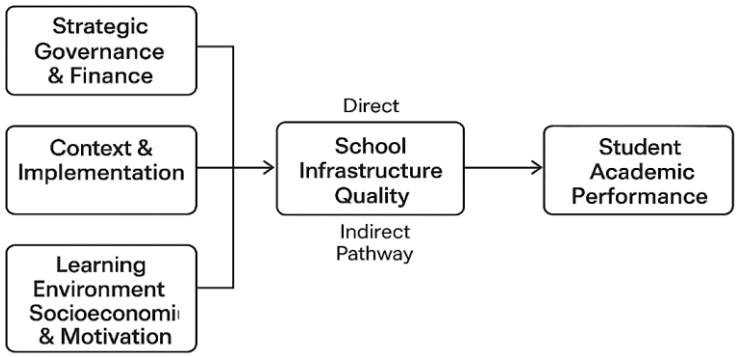

Figure 2: Sarawak Schools Infrastructure-Academic Performance Framework (The Author)

Practical Implications

Policymakers and educational administrators must focus on strategically improving school infrastructure, specifically classrooms, laboratories, and other necessary facilities, as this yields considerable positive impact on student academic achievements (Farid, Setiawan, Solichin,, Noviana, & Sari, 2024) (Magwaga & Kikechi, 2024) (Yangambi, 2023). These developments are central to addressing equity in enhanced and supportive learning environments.

The adoption of extensive, context-driven assessment frameworks, like the CCI, affords school administrators the ability to monitor and improve classroom conditions systematically. As a result, this supports the continuous improvement of physical-learning environments (Norazman N. , Che-Ani, Mat

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Jusoh Hussain, & Wan Ismail, 2021). This straightforward device supports evidence-based facility management.

Integrated policies on addressing socioeconomic disparities with infrastructure and supplementary support for poor families yield educational inequity dividends reinforced border-crossing collaborations between educational social welfare sectors (Werang, et al., 2024) (Dechavez, 2024).

To improve the infrastructure on learning quality in resource-poor environments, school leadership and facility management must involve strategic, participatory, and efficient resource management (Purba, 2024) (Nurafni, Sriwardona, & Rianawati, 2025) (Nasir, 2025). School managers being trained and built in capacity to pursue these initiatives is another need.

Improvements in physical infrastructure and classroom environments can lead to increased student satisfaction and motivation and can indirectly enhance academic performance. This suggests that investments in learning environments should also pay attention to ergonomic and psychosocial dimensions (Qadeer, Shahid, & Ullah, 2024) (Latip, et al., 2024) (Lahagu, Waruwu, Laia, & Harefa, 2024).

Reforms in education and quality assurance frameworks should include infrastructure as a key component so that physical improvements are made in tandem with innovations in curriculum and teaching methods. This will help in maximizing learning outcomes (Mith & Zalez, 2025) (Arteaga-Alcívar, 2024). Such a comprehensive approach will facilitate the sustainable development of education.

LIMITATIONS OF THE LITERATURE

Table 7: Table of limitations of the Literature across studies

Area of Limitation	Description of Limitation	Papers which have limitation
Geographic Bias	Many of the research on a particular area or a specific country tends to create generalizability issues. This concentration on certain boundary regions invariably lowers the external validity of the findings and may fail to capture the local particularities that may determine the primary research question of academic performance and the impacts of infrastructure.	(Ha, Busari, & Nordin, 2022) (Werang, et al., 2024) (Farid, Setiawan, Solichin,, Noviana, & Sari, 2024) (Magwaga & Kikechi, 2024) (Yangambi, 2023)
Small Sample Sizes	The use of small and convenience samples still remains a frequent methodological flaw that may lead to loss of statistical power and weaker conclusions. This, in turn, contributes to loss of reliability and generalizability in drawing conclusions to the wider population.	(Jamshaid, Zaheer, Mukhtar, Baber, & Roohi, 2024) (Mukaromah, Werdiningsih, & Daryono, 2024) (Munir, 2018) (Latip, et al., 2024)
Cross-Sectional Design	The use of cross-sectional research design limits the ability to draw any causal effects of the research question on infrastructure and resultant academic outcomes. Inability to address the time dimension may also hinder assessing the impacts which may play a defining role in education	(Kumari, 2024) (Khan, et al., 2025) (Anuar, et al., 2024))
Limited Contextual Factors	The focus of research only on the physical aspects of educational infrastructure, without considering the distribution of relevant social, cultural, and policy resources, will restrict the research in its potential scope and skew the understanding of the real impact	(Werang, et al., 2024) (Hasyim, 2025) (Farid, Setiawan, Solichin,, Noviana, & Sari, 2024) (Obioma, 2023)

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	of infrastructure on educational outcomes.	
Reliance on Self-Reported Data	Reliance on subjective self-reports regarding academic achievement and satisfaction poses threats to validity and objectivity of findings due to biases such as social desirability and recall bias, thereby affecting the accuracy of outcome evaluations.	(Qadeer, Shahid, & Ullah, 2024) (Farid, Setiawan, Solichin,, Noviana, & Sari, 2024) (Anuar, et al., 2024)
Lack of Longitudinal Studies	Few longitudinal studies limit our understanding of the prolonged impacts of positive changes to infrastructure over time. Without longitudinal studies tracking such changes, understanding the sustainability and educational outcome evolution on the backside of such interventions becomes difficult.	(Kumari, 2024) (Khan, et al., 2025)
Narrow Focus on Physical Facilities	Many studies concentrating on educational infrastructure fail to take into consideration equally important educational inputs such as the quality of teaching and other determinants of learning. This limited focus on only physical infrastructure constrains the comprehensive understanding of drivers of educational achievement.	(Ha, Busari, & Nordin, 2022) (Yunita, Fadiah, Lainatusshifa, & Maulida., 2023) (Kamaludin, 2023)
Inconsistent Assessment Frameworks	The absence of comparable assessment tools and congruent study frameworks limits the understanding and integration of findings across studies. This lack of standardized variables and indicators limits effective benchmarking and extensiveness of generalizations across educational areas and contexts.	(Norazman N. , Che-Ani, Mat Jusoh Hussain, & Wan Ismail, 2021) (Thorat, 2025) (Meylani, 2024)

Gaps and Future Research Directions

Table 6: Gap for future researcher to consider

	Gap Area	Description	Future Research Directions	Justification	Research Priority
1	Longitudinal validation of infrastructure impact	Most studies use cross-sectional designs limiting causal inference on infrastructure's effect on academic performance.	Conduct longitudinal and experimental studies in Sarawak schools to track academic outcomes pre- and post-infrastructure improvements.	Longitudinal data are essential to establish causality and understand sustained impacts of infrastructure on student success (Ha, Busari, & Nordin, 2022) (Werang, et al., 2024) (Khan, et al., 2025).	High
2	Integration of psychosocial factors in assessment frameworks	Existing frameworks focus predominantly on physical and environmental indicators, neglecting motivation and psychosocial mediators.	Develop and empirically test comprehensive frameworks incorporating motivation, satisfaction, and psychosocial variables alongside physical infrastructure	Motivation mediates the relationship between physical ergonomics and performance, indicating the need for holistic assessment models (Latip, et al., 2024) (Lahagu, Waruwu, Laia, & Harefa, 2024) (Anuar, et al., 2024)	High

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			metrics.		
3	Contextual adaptation of assessment tools	Many frameworks lack validation in diverse local contexts, especially rural and resource-limited Sarawak schools.	Adapt and validate existing assessment schemes like CCI for Sarawak's unique cultural, socioeconomic, and geographic conditions.	Contextual factors critically influence framework applicability and effectiveness, requiring tailored tools for local relevance (Norazman N. , Che-Ani, Hussain, J., & Ismail, 2021) (Hasyim, 2025) (Mith & Zalez, 2025)	High
4	Multifactorial models including socioeconomic variables	Limited integration of socioeconomic status and infrastructure variables in predicting academic outcomes.	Design multifactorial models that simultaneously analyze infrastructure quality, parental socioeconomic status, and school management factors in Sarawak.	Socioeconomic disparities modulate infrastructure impact on achievement, necessitating integrated analytical approaches (Werang, et al., 2024) (Farid, Setiawan, Solichin,, Noviana, & Sari, 2024) (Dechavez, 2024)	High
5	Precision in impact measurement methodologies	Variability in measurement precision due to reliance on self-reports and limited use of advanced statistical models.	Employ mixed-methods with robust quantitative techniques (e.g., SEM, PLS-SEM) combined with qualitative validation to enhance measurement accuracy.	Advanced modeling improves sensitivity and validity of impact assessments, reducing bias from self-reported data (Norazman N. , Che-Ani, Mat Jusoh Hussain, & Wan Ismail, 2021) (Farid, Setiawan, Solichin,, Noviana, & Sari, 2024) (Mukaromah, Werdiningsih, & Daryono, 2024)	Medium
6	Feasibility and scalability of assessment frameworks	Some frameworks require technical expertise or resources beyond typical school capacities in Sarawak.	Develop user-friendly, resource-appropriate assessment tools with training modules for school administrators and teachers in Sarawak.	Practical implementation depends on resource availability and administrative capacity; scalable tools increase adoption (Ha, Busari, & Nordin, 2022) (Qadeer, Shahid, & Ullah, 2024) (Nasir, 2025).	Medium
7	Long-term effects of strategic management on infrastructure outcomes	Lack of longitudinal studies assessing how strategic planning and facility management influence educational quality	Conduct longitudinal evaluations of strategic facility management interventions and their sustained effects on academic performance.	Strategic management is critical but underexplored longitudinally; understanding long-term effects can guide policy (Purba, 2024) (Nurafni, Sriwardona, & Rianawati, 2025) (Nasir, 2025)	Medium

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		over time.			
8	Equity-focused infrastructure policy implementation	Insufficient research on how policy and stakeholder engagement affect equitable infrastructure distribution in Sarawak.	Investigate policy implementation processes and stakeholder roles in promoting equitable infrastructure access, focusing on marginalized communities.	Equity in infrastructure access is vital for reducing educational disparities; policy effectiveness depends on inclusive governance (Hasyim, 2025) (Obioma, 2023) (Maila, et al., 2024)	High
9	Integration of innovative assessment methodologies	Limited application of competency-based and data-driven assessment models in infrastructure impact studies.	Explore the incorporation of competency-based assessments and data-driven innovation models to evaluate educational outcomes post-infrastructure upgrades.	Modern assessment methods enhance evaluation relevance and support continuous improvement aligned with 21st-century skills (Thorat, 2025) (Ling, 2024) (Yang, 2024)	Medium
1	Addressing funding and resource constraints in infrastructure improvements	Funding limitations and resource disparities hinder consistent infrastructure upgrades and maintenance.	Research cost-effective infrastructure improvement strategies and sustainable funding models tailored to Sarawak's economic context.	Financial constraints are a major barrier; identifying sustainable solutions is crucial for long-term infrastructure quality (Fanani, 2023) (Nasir, 2025) (Chyhrina, Slipchuk, Deichakivska, Deneha, & Hetmanenko, 2024)	High

CONCLUSION

Research demonstrates that improvements to school facilities are likely to positively influence student achievement, particularly in regions like Sarawak, Malaysia. This influence may stem from the school's infrastructure, including classrooms, laboratories, libraries, and the general learning environment, which are particularly important in the construction of places that foster student participation, satisfaction, and motivation, which promote learning. Nevertheless, one must remember that many factors contribute to the achievement of the desired academic goals. Such factors include the socioeconomic environment, managerial efficacy, and the teaching quality, which are perhaps more instrumental than the improvements in the facilities in realizing the desired academic goals. The literature suggests that improvements to facilities must take other factors into account to achieve improvements in learning outcomes and that tailored managerial initiatives to improve educational quality and equity facilitate that integration and strategy.

Educational outcome assessment frameworks that have been developed for schools with enhanced infrastructure focus on multidimensional and integrated approaches that include physical, spatial, social, and instructional parameters. Such frameworks focus on the integration of input, process, output, and outcome dimensions to reflect the complexity of educational outcomes.

The application of practical assessment tools like classroom condition indices and competency-based evaluations can be possible in resource-constrained settings as long as there is the right technical skill and community involvement. However, there is still insufficient empirical validation and limited scalability of

these frameworks, particularly in terms of the motivational and psychosocial components, which are crucial in the performance-infrastructure relationship.

The design and success of infrastructure-related interventions as well as the evaluation frameworks are strongly influenced by the socio-cultural context, including socioeconomic disparity, cultural practices, and rural vs. urban settings. Localized quality assurance practices and inclusive policy frameworks designed to address inequitable systemic configurations problem to offer the needed adjustments are critical to ensuring that infrastructure investments conversion of educational resource are improves the educational value. Higher precision in impact measurement can be achieved through more sophisticated quantitative approaches like structural equation modeling and mixed methods that richly elaborate the causal pathways and mediation relationships. However, constraints such as limited funding, expectation of data collection, and the need for professional skill development continue as challenges that impede widespread implementation.

The research, therefore, calls for more flexible and comprehensive strategies in the assessment of educational outcomes. It is important to consider not only the quality of the infrastructure, but also the management, the motivation of the students and teachers, and the socioeconomic factors that may exist. The aim is to develop a contextually appropriate framework grounded in robust empirical research, particularly in regions such as Sarawak. This can assist educators and policymakers in determining the extent of the improvements to build infrastructure and the subsequent impact on students' academic outcomes. This suggests that future research ought to be directed toward the integration of a cross-sectional and longitudinal mixed-method approach in order to improve educational outcomes, thereby advocating the provision of quality infrastructure in Sarawak, Malaysia.

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