

Research Article

Impact of Physical Infrastructure and Technology on Student Learning Outcomes

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Abstract: The purpose of this study was to determine the effect of physical and technological infrastructure on student learning outcomes at SDN 48 Tana Bacue Kec. Segeri Pangkajene and Islands Regency. Data collection using questionnaires, documentation, observation and interviews. The purpose of this study was to determine partially and simultaneously the effect of physical infrastructure and technology on student learning outcomes at SDN 48 Tana Bacue Kec. Segeri Pangkajene and Islands Regency. The results of the research that have been conducted show that the results of this study concluded that there is an influence of physical infrastructure and technology on student learning outcomes at SDN 48 Tana Bacue Kec. Segeri Pangkajene and Islands Regency. Likewise, there is an influence of the Technology variable on Student Learning Outcomes at SDN 48 Tana Bacue Kec. Segeri Pangkajene and Islands Regency. The results of this study concluded that Physical Infrastructure and Technology have a significant influence on Student Learning Outcomes at SDN 48 Tana Bacue Kec. Segeri Pangkajene and Islands Regency. The results of this study concluded that Physical Infrastructure and Technology have a significant influence on Student Learning Outcomes at SDN 48 Tana Bacue Kec. Segeri Pangkajene and Islands Regency.

Keywords: Learning Outcomes, Physical Infrastructure, Technology.

1. Introduction

Quality education is the key to creating a generation that is intelligent, has strong character, and is ready to face future challenges. Education must provide equal opportunities for all citizens to develop their potential, gain relevant knowledge and skills, and contribute positively to national development (MY et al., 2023). One important factor in achieving quality education is adequate physical infrastructure. Physical infrastructure, often referred to as facilities and infrastructure, serves as the foundation that supports the learning process (Mustikayanti & Jariono, 2022; Suban & Ilham, 2023). Good facilities and infrastructure enable students to learn optimally by utilizing available resources to delve into various fields of knowledge. Therefore, it is crucial to understand how physical infrastructure and technology affect student learning outcomes, given the critical role they play in all aspects of educational life (Al-Ansi et al., 2019; Bafadal, 2003; Shenbagavalli, 2022).

Along with the rapid development of technology, the use of information and communication technology (ICT) in education has also become an equally important aspect. Technology has a significant impact on how students learn, how they interact with learning materials, and with the teaching provided by their instructors. In an increasingly connected and knowledge-based world, access to technology is a must. However, the disparity in infrastructure and technology access between urban and rural schools remains a significant problem. In many rural schools, such as SDN 48 Tana Bacue in Kecamatan Segeri, Kabupaten Pangkajene dan Kepulauan, limited infrastructure and technology serve as major obstacles that affect the quality of learning. Therefore, this issue requires serious attention from all parties involved in the educational sector (Undang-Undang No. 20 Tahun 2003).

In recent years, several studies have been conducted to analyze the impact of physical infrastructure and technology on student learning outcomes. For example, research by

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Copyright: © 2025 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (CC BY SA) license (https://creativecommons.org/li censes/by-sa/4.0/) Bafadal (2003) and Nurhadi (2014) shows that adequate educational facilities can improve learning effectiveness. Other studies also highlight the importance of technology in creating a more engaging and interactive learning environment, which can increase students' motivation and interest in participating in the learning process (Hasan, 2008). Additionally, several studies have identified a significant gap in education quality between urban and rural areas, especially concerning the availability of educational facilities and technology access (Bafadal, 2003).

However, despite numerous studies on this topic, there remains a gap in understanding the full extent of the impact of physical infrastructure and technology on learning outcomes, particularly in remote areas. Some studies focus on physical infrastructure in large cities but have not adequately addressed the state of education infrastructure in more rural and marginalized areas. Furthermore, while many studies have been conducted on the use of technology in education, the majority of these focus on schools that are already equipped with sufficient resources. In contrast, the condition of rural schools, with limited access to technology and educational tools, has not been thoroughly explored. Therefore, recent studies still show a gap in providing a comprehensive understanding of the direct relationship between infrastructure, technology, and student learning outcomes (Undang-Undang No. 20 Tahun 2003; Peraturan Menteri Pendidikan Nasional No. 24 Tahun 2007).

While previous studies have focused on physical infrastructure and technology in education, gaps still exist that need to be addressed. First, many studies focus on physical infrastructure in large cities, while fewer studies examine the conditions of education infrastructure in rural areas, which are more disadvantaged. In this context, research conducted at SDN 48 Tana Bacue provides valuable insights into how limited infrastructure and technology hinder the quality of education in rural schools. Additionally, although there has been considerable research on technology in education, most of this research focuses on the use of technology in well-resourced schools. In contrast, the conditions in rural areas, where access to technology and educational facilities is limited, require more attention to understand how these limitations affect student learning outcomes.

This research aims to address the existing gaps by analyzing the impact of physical infrastructure and technology on student learning outcomes at SDN 48 Tana Bacue, Kecamatan Segeri, Kabupaten Pangkajene dan Kepulauan. This study not only focuses on the impact of physical infrastructure and technology separately but also examines how both factors influence learning outcomes when considered together. The main goal of this study is to understand more deeply how limited physical infrastructure and technology hinder or support the learning process at schools in rural areas. This research is expected to provide a new contribution to the development of inclusive educational policies that are adaptive to the needs of schools in remote areas. The novelty of this research lies in its approach, which combines both factors, and its focus on rural schools with limited resources. The contribution of this research is expected to provide recommendations for government and stakeholders to improve educational facilities and increase technology access at underdeveloped schools (Bafadal, 2003; Hasan, 2008; Nurhadi, 2014).

By understanding the influence of physical infrastructure and technology on student learning outcomes, it is hoped that the quality of education in rural areas can be improved. This research aims to provide a clearer picture of the factors that need to be considered to improve educational quality and become the foundation for better policies in the development of education in Indonesia.

2. Literature Review

2.1. Infrastructure

Infrastructure, as defined, refers to the physical and organizational structures (such as buildings, roads, energy supply) necessary for the functioning of society and institutions (Sidarto & Budi, 2018). According to the Indonesian Dictionary (KBBI, 2024), infrastructure is interpreted as public facilities and infrastructure, which includes public services such as hospitals, roads, bridges, sanitation, and telecommunications. The Presidential Regulation of the Republic of Indonesia No. 38/2015 outlines the importance of infrastructure to support economic and social growth, emphasizing its role in enhancing the country's overall economic activities. The infrastructure system includes transportation, irrigation, drainage, public buildings, and other facilities required to meet the basic needs of humans within the social

and economic scope. It supports the essential functions of both social and economic systems in everyday life (Perpres, 2015).

According to Grigg (1998), infrastructure is a physical system that provides transportation, irrigation, drainage, building structures, and public facilities necessary to meet the basic needs of both social and economic needs. Infrastructure provides a connection between environmental systems by linking social and economic systems. As explained by Mankiw (2003), workers are more productive when they have the tools necessary to work, which is described as physical capital. In the same vein, Todaro (2006) asserts that the availability of infrastructure is a crucial factor in the speed and expansion of economic development. Thus, infrastructure plays a significant role in providing access to resources that increase efficiency and productivity in both social and economic activities, driving economic development in a region. Furthermore, it plays an essential role in improving the overall living standards of society, enhancing consumption values, workforce productivity, and prosperity (Tatom, 1993; Henner, 2000).

Infrastructure is divided categories: into three economic, social, and administrative/institutional infrastructure. Economic infrastructure refers to actual resources that aid in production and consumption, such as public utilities (water supply, sanitation), public works (dams, canals, waste systems), and transportation (roads, railways, ports). Social infrastructure supports sectors such as health (hospitals, clinics), education (schools, libraries), and entertainment (parks, exhibition spaces). Administrative infrastructure includes institutions such as legal bodies, population administration, and cultural organizations. In terms of its physical form, infrastructure can be categorized into hard infrastructure (visible physical structures like roads, ports, airports) and soft infrastructure (systems, regulations, and norms that support economic and social activities) (Grigg, 1998). The essence of infrastructure lies in its ability to enhance connectivity, productivity, and efficiency while accelerating development and promoting new investments (Warsilah, 2015).

School infrastructure plays a critical role in supporting the teaching and learning process. It encompasses physical facilities such as school buildings, equipment, and essential utilities like electricity and water. Effective school infrastructure improves student focus, safety, and overall educational outcomes. As Meita (2017) notes, learning facilities directly impact student engagement, with well-equipped classrooms fostering a conducive learning environment. In terms of management and maintenance, regular upkeep is essential to prevent costly repairs, while strategic investments in infrastructure improve educational quality and student safety. Indicators of good school infrastructure include comfortable learning spaces, well-equipped classrooms, and appropriate facilities for extracurricular activities (Putri, 2017). The availability of learning facilities at home, such as study spaces, desks, books, and stationery, further supports the learning process, enhancing students' educational experiences and outcomes (Sanjaya, cited by Meita, 2017; Widiyaningsih, 2018).

2.2. Technology

Technology refers to the tools and systems humans develop to solve daily life problems. It encompasses the entire range of human-made resources that improve comfort and survival. From simple tools like fire and the wheel to modern inventions such as the printing press, telephones, and the internet, technology has significantly reduced physical barriers and enabled global communication. While technology has traditionally been associated with applied arts, over the last 200 years, its meaning has expanded to include the development and application of systems to address human challenges (Soleh, 2018). Information and communication technology (ICT), as part of technological advancements, plays a crucial role in transmitting messages and managing data effectively, reshaping how information is shared and processed globally.

The benefits of technology, particularly communication technology, have become indispensable in modern society. The need for social interaction and cross-cultural communication has been greatly facilitated by advancements in communication tools, which allow for the easy exchange of information across geographical and cultural boundaries (Tabrani, 2012). The rapid evolution of communication technologies has also impacted family dynamics, with varying effects on relationships. While some families see negative effects on their relationships, others find that technology helps maintain stronger connections. Additionally, in education, ICT has transformed learning, enabling more dynamic, creative, and interactive processes that align with the Indonesian government's educational goals (Soleh, 2018).

In the educational context, technology plays a vital role in enhancing the learning experience. By integrating technology, such as computers, the internet, and digital tools, into the classroom, teachers can create more engaging and effective lessons. The Indonesian government encourages the use of ICT in schools, as outlined in regulations like the Ministry of Education and Culture Regulation No. 78/2009. However, the full potential of ICT is often underutilized, primarily serving administrative functions or basic computer training. To optimize its use, proper system management is required, ensuring that technology is integrated into all aspects of educational administration and teaching (UNESCO, 2018). This integration not only improves educational efficiency but also prepares students for the challenges of a technology-driven world.

2.3. Learning Outcomes

Learning outcomes refer to the results achieved after engaging in educational activities aimed at reaching certain achievements. Bloom's taxonomy identifies learning outcomes across three domains: cognitive, affective, and psychomotor. The cognitive domain encompasses knowledge, comprehension, application, analysis, synthesis, and evaluation; the affective domain involves attitudes, receiving, responding, values, organization, and character; and the psychomotor domain focuses on skills, physical abilities, and intellectual capabilities (Suprijono, 2010). These outcomes are the indicators of a student's ability to demonstrate what they have learned, reflecting their development in various aspects of their behavior and skills (Hamalik, 1995).

Learning outcomes are influenced by both internal and external factors. Internal factors include physiological and psychological aspects. Physiological factors such as a student's physical health can significantly impact their ability to focus and perform in learning activities. Psychological factors, particularly motivation, are crucial as they drive students to engage in learning activities and achieve their goals. Motivation can stem from both intrinsic and extrinsic sources, and fostering a positive learning environment can help enhance students' drive and interest in their studies (Suprijono, 2010). These internal factors play a vital role in determining how effectively students learn and achieve their outcomes.

External factors also influence learning outcomes, including influences from the school, community, and family. School-related factors such as teacher-student interaction, curriculum, and available learning resources directly affect students' learning experiences. Furthermore, the social environment, such as peer relationships, media, and community activities, can shape a student's engagement and motivation to learn. Family dynamics, including parenting styles and the overall family environment, can either support or hinder a student's academic progress, emphasizing the importance of a balanced and conducive external environment for optimal learning outcomes (Mappa, 1977; Suprijono, 2010).

3. Methods

The research was conducted at SDN 48 Tana Bacue, Segeri District, Pangkep Regency, South Sulawesi Province, from December 2024 to February 2025. The research employs a quantitative descriptive approach, utilizing descriptive analysis and multiple linear regression to assess the influence of physical infrastructure (X1) and technology (X2) on student learning outcomes (Y). Data will be collected through observation, documentation, and questionnaires. The population comprises 22 students from class VI, and the entire class will serve as the sample. Data analysis will include validity and reliability tests using correlation and Cronbach's Alpha methods, followed by descriptive statistics (mean and standard deviation) and classical assumption tests, such as normality, multicollinearity, and heteroscedasticity. Hypothesis testing will involve F-tests and t-tests to assess the overall and partial impacts of infrastructure and technology on learning outcomes. A multiple linear regression model will be used for further analysis, with the equation $y = \beta 0 + \beta 1X1 + \beta 2X2$ $+ \varepsilon$, where y represents learning outcomes, and X1 and X2 represent infrastructure and technology, respectively. The coefficient of determination (R²) will measure the explanatory power of the independent variables on the dependent variable (Putro & Kamal, 2013).

4. Results

4.1. Normality Test

The normality test aims to determine whether the residuals of the regression model are normally distributed or not. The normality test uses the Normal P-P Plot graph which is displayed in Figure 1.



Figure 1. Normal P-P Plot.

From Figure 1, it can be seen that the data distribution is close to the normal line, which can be said that the residuals of the regression model are normally distributed.

4.2. Multicollinearity Test

The multicollinearity test aims to determine whether there is an intercorrelation in the regression model by looking at the tolerance and VIF values, where the test results are shown in Table 4.9.

Madal		Colienearity Statistic	
	Model	Tolerance	VIF
1	Physical Infrastructure	0,766	1,305
	Technology	0,501	1,996

Table 1. Mulitcollineari

From Table 1 it is known that the Infrastructure variable has a Tolerance value of 0.766 with 0.766 > 0.01 and a VIF value of 1.305 with 1 < 10, Technology has a Tolerance value of 0.501 with 0.501 > 0.01 and a VIF value of 1.996 with 1.996 < 10 which can be said that the regression model does not occur intercorrelation.

4.3. Heteroscedasticity Test



Figure 2. Scatterplot.

The heteroscedasticity test is used to determine whether there is an inequality of variance or residuals from a model using a scatterplot. Figure 4.3 shows that the data distribution does not form a certain pattern, which can be said that there is no heteroscedasticity in the regression model.

4.4. Hypothesis Test

Hypothesis testing aims to determine whether there is an influence between physical infrastructure and technology on student learning outcomes using the simultaneous test (F test) and partial test (t test), where the simultaneous test is shown in Table 2.

Table 2. Simultaneous Test			
Model		F	Sig
1	Regression	3,622	0,036

From Table 2, it is known that the sig value is 0.036, which means that there is a simultaneous influence between physical infrastructure and technology on student learning outcomes. Furthermore, to find out the partial test can be presented in Table 3

Table 3. Simultaneous Test

Mode		Т	Sig
1	(Constant)	1,834	0,085
	Physical	2,172	0,045
	Infrastructure		
	Technology	-2,747	0,014

Table 3 shows that the Physical Infrastructure variable, has a sig value of 0.045 < 0.05, so it is said that there is an influence between physical infrastructure on improving student learning outcomes, the Technology variable has a sig value of 0.014 < 0.05 which can be said that there is an influence between technology and student learning outcomes.

able 4. Simple Entear Regression Coefficient				
		Unstandardized Coefficients		Standardized Coefficients
Model		В	Std. Error	Beta
1	(Constant)	46,697	25,466	
	Physical Infrastructure	0,665	0,306	0,479
	Technology	1,923	0,700	0,749

Table 4. Simple Linear Regression Coefficient

From Table 4, a linear regression model can be formed as follows:

y=46,697+0,665x_1+1,923x_2

From the linear regression model above, it can be said that the constant is 46.697, meaning that if the physical infrastructure and technology are 0, then the student learning outcomes remain at 46.697. If the Physical Infrastructure increases by 1 unit, it will increase the learning outcomes variable by 0.665, as well as the Technology, if it increases by 1 unit it will increase the Student Learning Outcomes variable by 1.923. The positive sign states that if the physical infrastructure and technology are good then the increase in student learning outcomes is also getting better.

4.5. Coefficient of Determination

The coefficient of determination explains that how capable the regression model is of explaining variations in the dependent variable by looking at the Adjusted R-Square value displayed in Table 5.

Table 5. Test Results of the Coefficient of Determination (R2)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0,636	0,404	0,293	6,913

Table 5. shows that the Adjusted R Square value is 0.293 which states that the effect of physical infrastructure and technology can improve student learning outcomes at a moderate level because only 29.3%, while 70.7% is influenced by other variables not explained in this study.

5. Discussion

This study aims to determine the description of physical and technological infrastructure variables on student learning outcomes at 48 Tana Bacue State Elementary School, Pangkep Regency, each research variable and the results of hypothesis testing have been stated in the previous description. The discussion of the research results here is based on these two elements.

The influence of physical infrastructure on the learning outcomes of students at SD Negeri 48 Tana Bacue, Pangkep Regency

One of the objectives of this study is to determine the effect of physical infrastructure on the learning outcomes of students of SD Negeri 48 Tana Bacue, Pangkep Regency, so that data collection is carried out for the purposes of this study. Physical infrastructure in this study is placed as an independent variable (x1). Measurement for physical infrastructure variables is based on indicators of school facilities. Data on Physical Infrastructure is obtained through data collection using an instrument in the form of a questionnaire. The data collection instrument in the form of a questionnaire contains statements which are then given to respondents and then responded to or filled in according to the instructions for filling out the questionnaire.

Data processing in this study was carried out using the SPSS 16.0 for windows program. Data processing aims to test the hypothesis. Data processing in this study includes descriptive analysis and regression analysis. Descriptive analysis is done to describe the physical infrastructure based on the data that has been obtained. Regression analysis is used to determine the presence and absence of the influence of physical infrastructure on student learning outcomes, in this case using multiple regression analysis because this study consists of two independent variables and one dependent variable.

Based on data analysis on data obtained from distributing questionnaires to a sample of 22 students, it is known that physical infrastructure affects student learning achievement. This is known from the results of multiple regression tests obtained regression equationy=46,697+0,665x_1+1,923x_2 , with provisions of the Constant value (β_0) of 46.697, R2 value of 0, and Fcount value of 0.665. The equation shows that the regression coefficient of the Physical infrastructure variable (x_1) is 0.665; meaning that if the other independent variables remain and physical infrastructure (x_1) has an increase of one point, then the Learning outcomes (y). increased by 0.665%. the coefficient is positive, meaning that there is a positive influence between physical infrastructure (x_1) and Learning outcomes (y). Based on the exposure of the results of the data analysis above, it shows that there is a significant influence between character education on the learning achievement of students at 48 Tana Bacue State Elementary School, Pangkep Regency.

The influence of technology on the learning outcomes of students at SD Negeri 48 Tana Bacue, Pangkep Regency

The regression coefficient of the Technology variable (x_2) is 1.923, which means that if the other independent variables are constant and technology (x_2) increases by one point, then the learning outcomes (y) will increase by 1.923. the coefficient is positive, meaning that there is a positive influence between technology (x_2) on Learning Outcomes (y). Based on the exposure to the results of the data analysis above, it shows that there is a significant influence between physical infrastructure on the learning outcomes of students at 48 Tana Bacue State Elementary School, Pangkep Regency.

The influence of physical infrastructure and technology on learning achievement at SD Negeri 48 Tana Bacue, Pangkep Regency

The coefficient of determination can be measured by the R Square or Adjusted R-Square value. R-Square is used when the independent variable is only 1 (commonly called Simple Linear Regression), while Adjusted R-Square is used when the independent variable is more than one. Based on the results of regression analysis, it can be seen that the Adjusted R-Square value is 0.293, indicating that the proportion of the influence of physical infrastructure variables (x_1) and technology (x_2) on learning outcomes (y) is 29.3%. While 71.7% is influenced by other variables which in this study are not included in the research variables.

Based on the regression results, it can be concluded that Physical Infrastructure (x1) and Technology (x2) together or simultaneously have an influence on improving student learning achievement but with a percentage of 29.3%.

6. Conclusion

This study aimed to investigate the influence of physical infrastructure and technology on student learning outcomes at SD Negeri 48 Tana Bacue, Pangkep Regency. The findings reveal that both physical infrastructure and technology have a significant impact on students' academic achievement. The analysis showed that improvements in physical infrastructure, measured through the availability of school facilities, result in a positive increase in learning outcomes. Specifically, an increase in physical infrastructure by one unit corresponds to a 0.665% increase in learning outcomes. Similarly, technology also plays a pivotal role, with a 1-point increase in technology usage contributing to a 1.923% improvement in learning outcomes. Moreover, when both physical infrastructure and technology are considered together, they account for 29.3% of the variance in student performance, suggesting that while they do contribute significantly, other factors beyond infrastructure and technology play a larger role in determining learning outcomes.

The value of this research lies in its contribution to understanding how physical infrastructure and technology influence educational outcomes, particularly in rural areas. The study provides crucial insights into how even in under-resourced schools, improving physical infrastructure and integrating technology can positively affect student learning. This research emphasizes the importance of creating conducive learning environments that support both academic and social growth. It also highlights the necessity for policymakers to prioritize educational infrastructure improvements and technological integration as part of efforts to enhance educational quality, particularly in remote or underdeveloped areas. The originality of this study is reflected in its specific focus on a rural school in Pangkep Regency, an area that has been underexplored in the broader discourse on educational infrastructure and technology. This research could serve as a model for future studies seeking to explore the intersection of infrastructure, technology, and educational outcomes in similar contexts.

7. Limitation

The study's scope was limited to a single school, which may not fully represent the broader population of schools in rural areas. Additionally, the study focused solely on physical infrastructure and technology as the independent variables, excluding other potential factors that could influence learning outcomes, such as teacher quality, socioeconomic status, and parental involvement. Future research could expand the scope by examining multiple schools in different regions to provide a more comprehensive understanding of the relationship between infrastructure, technology, and student achievement. Furthermore, exploring other variables that may contribute to academic success would enrich the findings and offer a more holistic view of the educational landscape. This study lays the groundwork for further research into how infrastructure and technology can be leveraged to improve learning environments, particularly in underserved regions. As such, future scholars are encouraged to explore the interaction of these factors with other educational interventions to create sustainable and inclusive educational systems.

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