



Data-Based Participatory Facilities and Infrastructure Management Model for Improving the Quality of Basic Education in the Archipelago

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ABSTRACT

Objective: This study aims to develop a participatory and data-based model for managing basic education facilities and infrastructure to improve the quality of education services in the archipelago. The focus of the research is directed at the optimization strategy of BOS funds, the implementation of School-Based Management (SBM), and the use of data-based School Facilities Management System (SFMS). **Methods:** This research uses a descriptive qualitative approach with data collection techniques through in-depth interviews, participatory observations, and documentation studies. The research informants consisted of principals, teachers, and committees in two elementary schools in Simeulue Regency, who were purposively selected. Data analysis was carried out through reduction, thematic presentation, and conclusion drawing, with triangulation validation of sources and methods. **Results:** The results of the study show that the planning and implementation of infrastructure management have been carried out in a participatory, adaptive, and data-based manner, with school principals playing a central role in coordination. The main challenges include limited BOS funds, technical personnel and digital literacy. From the field findings, an Integrative Model for Participatory Facilities and Infrastructure Management (ISPBD Model) was formed, which emphasizes collaboration, budget efficiency, and public accountability. **Novelty:** This research offers a new conceptual model that integrates the principles of SBM, BOS fund optimization, and data-driven facility management, which has not previously been developed in an integrated manner in the context of elementary schools in the Indonesian archipelago.

INTRODUCTION

The problem of ineffective management of educational facilities and infrastructure remains a fundamental challenge in the implementation of basic education in Indonesia (Randan et al., 2025) This condition is a social fact that has direct implications for the quality of learning and achievement of student learning outcomes. Various studies have shown that some elementary schools, especially in the archipelago, still face limited facilities, such as damaged classrooms, dysfunctional laboratories, libraries with minimal collections, and inadequate sports and sanitation facilities (B. A. Fanani, 2,25); (Lubis and Sembiring, 2025); (Ogbuka, 2019). This situation not only reduces students' comfort and motivation to learn but also limits teachers' creativity in developing innovative and contextual learning strategies.

The results of the research (Achiri, 2024) and (Randan et al., 2025) confirm that the availability of decent, safe, and high-tech facilities and infrastructure contributes significantly to increasing student motivation, welfare, and learning achievement while increasing the effectiveness of teaching. However, the disparity in educational facilities between urban and archipelago areas remains significant, widening the gap in national education quality (Fadillah et al., 2025). If this condition is not immediately addressed, the young generation, who should have equal learning opportunities, will experience obstacles in developing their academic and social potential. Therefore, increasing the

effectiveness of the management of educational facilities and infrastructure is a strategic issue that needs serious attention in efforts to equalize the quality of education nationwide.

Previous research has shown that the management of facilities and infrastructure in elementary schools still faces various limitations, especially in terms of stakeholder participation and the use of data-based technology (Soleha et al., 2025). Bernisa et al. (2024) focused on the distribution and utilization of educational facilities without examining the integrated managerial dimension. Pasaribu et al., (2020) through a study of the School Facilities Management System revealed that the system is able to create harmony between management policies and practices, but still faces technical and administrative obstacles. Furthermore, Asyibli et al. (2025) stated that the implementation of School-Based Management (SBM) has the potential to increase the accountability and effectiveness of educational resource management, but its implementation has not been optimal due to the low managerial capacity of school principals, weak community participation, and limited understanding of the concept of quality management.

These findings reveal an important research gap, namely the lack of a model for the management of educational facilities and infrastructure that can integrate three main aspects: budget efficiency, participatory management, and the use of data-based technology. Most studies are still sectoral, highlighting one aspect separately in terms of budget policy, managerial approaches, and information systems. Thus, they have not produced a comprehensive and contextual conceptual framework for application in archipelagic areas with limited geographical characteristics and resources.

Based on these gaps, this study is directed to answer three main questions: (1) how the strategy of optimizing the use of School Operational Assistance (BOS) funds can be effectively applied for the maintenance and procurement of priority facilities in elementary schools in the archipelago region; (2) the extent to which the implementation of School-Based Management (SBM) can increase the participation of teachers, committees, and the community in the planning and supervision of facilities and infrastructure; and (3) how the implementation of a data-driven School Facilities Management System (SFMS) can improve the efficiency, transparency, and accountability of education asset management.

This study seeks to develop a participatory and data-based model for the management of educational facilities and infrastructure by combining the potential for BOS fund optimization, the application of SBM principles, and information technology support through SFMS. This approach is based on the views of I. H. Fanani and Anwar, (2023) who emphasize the importance of strategic management in improving the quality of education, and Uzorka and Kalabuki, (2024) who underline the role of technology-based collaborative leadership in creating an adaptive education system. In addition, Pant (2025) emphasized that modern educational governance must be built on the values of professionalism, integrity, and transparency to ensure public accountability.

Thus, this study assumes that improving the quality of basic education in the archipelago cannot be achieved without planned, transparent, and evidence-based management. Through an integrative approach that combines aspects of budget efficiency, stakeholder participation, and the use of digital data, this research is expected to make a conceptual contribution to strengthening education management models that are adaptive to geographical contexts, as well as offering practical solutions for local

governments and basic education units in realizing sustainable and quality-oriented governance of educational facilities.

Literature Review and Conceptual Framework

A. Optimizing School Operational Assistance Funds (BOS)

The School Operational Assistance Fund (BOS) is one of the Indonesian government's strategic policy instruments for supporting the implementation of equitable, effective, and equitable basic education. Through this policy, the government seeks to ensure that each school has sufficient financial resources to support the teaching and learning process and manage educational facilities. *Permendikbudristek Number 63 of 2022* emphasizes that the use of BOS funds is directed to finance routine school operational activities, including the maintenance and improvement of infrastructure facilities that directly impact the quality of learning.

In the context of education management, the optimization of BOS funds is not only related to the effectiveness of budget use but also includes aspects of efficiency, transparency, and public accountability. Julia and Ahmad (2025) explained that BOS is the main instrument in realizing the efficiency of educational resource allocation, especially in the post-pandemic period, which requires adjustments to needs-based funding mechanisms. Meanwhile, Theoline et al. (2025) emphasize that the use of targeted BOS can improve student learning comfort and teacher performance effectiveness, as long as the planning and reporting process is carried out transparently and data-based.

However, several studies have shown that the effectiveness of BOS in improving the condition of educational facilities still faces challenges. Safitri et al. (2025) stated that the low capacity of school financial management and weak internal supervision system caused some BOS funds to have an optimal impact on improving the quality of facilities and infrastructure. For this reason, Hasanah (2025) emphasizes the need for an accountability mechanism and a digital monitoring system so that the management of education funds can be publicly accounted for. In the context of elementary schools in the archipelago, optimizing BOS funds has become more complex due to limited infrastructure, high transportation costs, and a lack of technical personnel in the field. Therefore, a budget management model that is not only efficient but also adaptive to the geographical characteristics of the archipelago is needed.

B. School-Based Management (MBS)

School-Based Management (SBM) is a paradigm of education decentralization that gives schools greater autonomy in managing resources and making strategic decisions according to local needs. This model is based on the principles of participation, transparency, accountability, and collaboration between principals, teachers, school committees, and the community (Ramadhan et al., 2025). In the context of facilities and infrastructure management, MBS acts as an internal quality control system that encourages schools to independently and accountably plan, implement, and evaluate the development of educational facilities.

Asyibli et al. (2025) explained that MBS can improve the effectiveness and efficiency of resource management because decision-making is based on contextual information at the school level. This approach also strengthens the sense of ownership of the facilities used, thus having an impact on improving the maintenance and utilization of educational assets. In line with that, Wardhani et al. (2025) emphasized that participatory planning

through deliberations with committees and parents is an important element in building a collaborative culture in schools.

However, several studies have found that the implementation of MBS is often not optimal. Kusuma et al. (2020) stated that the limitations of the managerial competence of school principals and weak public support caused the implementation of MBS to be limited to administrative formalities. Tirtawati et al. (2025) added that low understanding of quality management principles and limited supporting facilities are the main obstacles in the effective implementation of MBS. Therefore, MBS must be combined with data-based management mechanisms so that decisions taken are more measurable and can be evaluated objectively.

C. Data-Driven Facility Management System (SFMS)

The School Facilities Management System (SFMS) is a contemporary approach to educational asset management that emphasizes the use of information technology and empirical data as the basis for decision making. Santos et al. (2025) explained that SFMS allows schools to conduct periodic facility audits, monitor the physical condition of buildings, and plan evidence-based preventive maintenance. By utilizing digital data such as DAPODIK, Education Report Cards, and asset inventory applications, schools can determine the priority scale of improvement and budget allocation that is more targeted.

Heinrich (2007) emphasized that an evidence-based decision-making approach to facility management can increase efficiency, reduce policy errors, and strengthen public accountability. Meanwhile, Lavy and Bilbo (2009) found that the use of accurate data in the maintenance of educational facilities can extend the life of assets and reduce long-term operational costs. Mulyati and Suryaman (2025) also confirmed that schools that have implemented a data-based facility management system show a significant increase in the transparency and performance of infrastructure management.

However, the implementation of SFMS in Indonesian elementary schools, especially in archipelagos, faces various obstacles. Mulyanti (2025) noted that the limitations of technological infrastructure, human resource competence, and lack of regional policy support are the main inhibiting factors in the implementation of the facility management digitalization system. Therefore, synergy is needed between increasing the digital capacity of education personnel, developing integrated information systems, and supporting regional regulations so that the implementation of SFMS can be sustainable and improve the quality of education.

D. Synthesis of Research Theory and Conceptual Framework

Based on the above literature review, it can be concluded that improving the quality of basic education cannot be separated from the effectiveness of managing facilities and infrastructure in schools. The three main approaches are BOS Fund Optimization, School-Based Management (SBM), and Data-Based Facility Management System (SFMS), which have complementary contributions. BOS acts as a financial instrument to support the maintenance and construction of priority facilities, SBM serves as a participatory mechanism that strengthens collaboration and accountability of school citizens, and SFMS acts as a technology-based system to improve efficiency, transparency, and evidence-based decision-making.

The integration of these three approaches forms a conceptual model called the "Data-Based Participatory Facilities and Infrastructure Management Model." This model

combines the principles of budget efficiency, stakeholder participation, and evidence-based management as a strategic foundation for creating a quality, adaptive, and sustainable learning environment. In the context of elementary schools in the archipelago, this model is expected to address geographical challenges, limited resources, and the need for more transparent and collaborative educational governance.

Conceptually, this framework can be described as follows.

1. Inputs: BOS funds, human resource capacity, and school infrastructure.
2. The process includes participatory planning (MBS), data-driven decision-making (SFMS), and transparent oversight.
3. Outputs: Efficiency in fund use, improvement of the quality of facilities, and public accountability.
4. Outcome: Improving the quality of basic education services and the sustainability of school asset management.

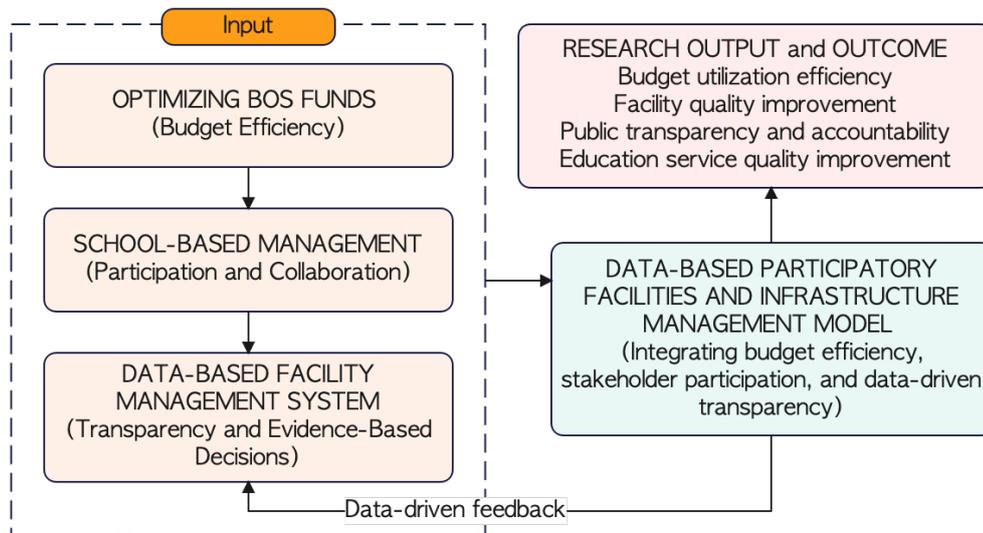


Figure 1. Conceptual Framework

This conceptual framework emphasizes that the governance of educational facilities and infrastructure oriented towards collaboration and data-driven decision-making is the main foundation for creating a basic education system that is effective, transparent, and responsive to the needs of the people in the archipelago.

RESEARCH METHOD

This study uses a descriptive qualitative approach because it aims to describe in depth and contextualize the process of managing facilities and infrastructure in elementary schools in the archipelago. This approach was chosen so that researchers could understand the phenomenon of education management from the perspective of actors in the field, namely, school principals, teachers, and committees, not only through numbers or statistical data. The main focus of this research is directed at efforts to build a participatory data-based model of facilities and infrastructure management that emphasizes budget-use efficiency, school citizen engagement, and transparency in decision-making.

The research was conducted in Simeulue Regency, Aceh Province, which is geographically an archipelago with unique challenges in the equitable distribution of the quality of education. These geographical conditions limit transportation, logistical access,

and educational infrastructure. Therefore, this area is considered relevant for use as a research location because it can provide an authentic picture of the school's strategy in dealing with limited resources. Two elementary schools were used as research locations: SD Negeri 1 Simeulue Tengah and SD Negeri 7 Simeulue Timur. These two schools were chosen purposively because they represent two different conditions: one school is located in the center of the sub-district with relatively easy access, while the other is located in a coastal area with limited facilities and human resources.

The informants in this study consisted of school principals, teachers, and school committees who were directly involved in the process of planning, managing, and evaluating educational facilities and infrastructure. The selection of informants was carried out using purposive sampling techniques, considering their experience, involvement, and strategic role in school management. To maintain the systematics of data presentation and the confidentiality of informant identities, each respondent is assigned a certain code, as shown in Table 1.

Table 1. Research Informant Coding

| No | Jabatan/Peran | Kode |
|----|--|------|
| 1 | Principal of State Elementary School 1 Simeulue Tengah | Ka 1 |
| 2 | Principal of State Elementary School 7 Simeulue Timur | Ka 2 |
| 3 | Committee of State Elementary School 1, Central Simeulue | Km 1 |
| 4 | East Simeulue State Elementary School Committee 7 | Km 2 |
| 5 | Teacher of State Elementary School 1 Simeulue Tengah | Gr 1 |
| 6 | Teacher of State Elementary School 1 Simeulue Tengah | Gr 2 |
| 7 | Teacher of State Elementary School 1 Simeulue Tengah | Gr 3 |
| 8 | Teacher of State Elementary School 7 Simeulue Timur | Gr 4 |

Table 1 is a reference for processing and analyzing the data. Each direct quote from the interview will use the informant's code (for example, Ka 1, Gr 2, or Km 1) to maintain the confidentiality of the interviewees while ensuring consistency of the analysis between respondents.

Research data were collected through three main techniques: in-depth interviews, participatory observations, and documentation studies. Interviews were conducted directly with principals, teachers, and school committees using semi-structured guidelines to allow researchers to delve deeper into information related to educational facility management strategies. Questions were directed toward the planning process, use of BOS funds, forms of collaboration between school parties, and application of data-based systems in decision-making. Participatory observation is carried out to see firsthand the activities of schools in maintaining, improving, and developing educational facilities and infrastructure. Researchers participate in school activities such as *RKAS planning meetings*, mutual cooperation, and committee meetings to understand the social dynamics between school principals, teachers, and the community.

In addition, a documentation study was conducted on a number of official documents, such as the School Work Plan and Budget, reports on the use of *BOS funds*, inventory lists of facilities and infrastructure, *DAPODIK data*, and Education Report Cards. The analysis of this document aimed to verify the information obtained from the interviews and observations, as well as to ensure the validity of the data collected. All data were then reduced, categorized, and systematically compiled based on the main themes of the study: budget efficiency, school citizen participation, and data-driven transparency.

Data analysis was carried out following the steps (Huberman, 2019) which include three stages: data reduction, data presentation, and conclusion drawing. The reduction stage was carried out by sorting out data relevant to the research focus and arranging them into thematic categories. The data presentation stage was carried out in the form of descriptive narratives, tables, and direct quotes from the informants that have been coded so that the patterns and relationships between the findings can be clearly seen. Meanwhile, the conclusion-drawing stage is carried out iteratively, where the researcher interprets the meanings that emerge from the results of the reduction and observation to build a conceptual model of participatory-data-based management of facilities and infrastructure.

To maintain data validity, this study used source and method triangulation techniques. Source triangulation was carried out by comparing data from principals, teachers, and school committees to ensure the consistency of the information obtained. Meanwhile, the triangulation method is carried out by combining the results of interviews, observations, and documentation so that the data obtained are complementary to each other. In addition, the researcher also conducts a member check, which confirms the results of the interview and the initial interpretation to the informant to ensure that the research findings are in accordance with their context and experience.

The entire research process was conducted in compliance with the ethical principles of social and educational research. Each informant was given an explanation of the purpose of the research and guaranteed confidentiality through a coding system. The data obtained will be used for academic purposes only and will not be disseminated without permission. With this approach, the research is expected to produce a complete, factual, and reflective picture of how elementary schools in the archipelago manage educational facilities and infrastructure efficiently, participatorily, and data-driven.

RESULTS AND DISCUSSION

Result

A. Planning of Facilities and Infrastructure Optimization Strategy

Planning is the initial stage that determines the direction and success of the strategy for optimizing school facilities and infrastructure. Based on interviews with school principals, teachers, and school committees, it was found that the planning process was carried out systematically, directed, and participatorily. The activity began with a joint deliberation at the beginning of each school year, involving the principal, treasurer, operator, teacher council, and school committee, to analyze the needs and determine the priority use of the School Operational Assistance Fund. This approach confirms that the school has implemented School-Based Management principles that emphasize transparency, participation, and accountability at every planning stage.

From the interview results, several important aspects were identified. First, limited BOS funds are the main challenge in meeting all priority needs, so schools must scale priorities based on urgency. Second, there are still technical obstacles, such as a lack of maintenance personnel and the unavailability of a structured routine maintenance schedule. Third, the deliberation process has become an effective medium for collaboration across school elements to establish policies relevant to the factual conditions in the field. Data from the Education Report Card and DAPODIK are used as a basis for determining resource allocation, especially for the maintenance of important

facilities such as repairing leaky roofs, replacing mobiles, and procuring information technology-based learning media.

In addition, the principal plays an active role in building collaboration between teachers, staff, committees, the community, and external stakeholders. This form of cooperation strengthens transparency while increasing the sense of shared responsibility for the management of educational infrastructure. Activities such as mutual cooperation, parent meetings, and community participation in school activities are effective means of fostering a sense of belonging to educational facilities. Although the implementation of the School Facilities Management System has not been fully optimal, schools have shown progress by utilizing internal data as the basis for decision-making, reflecting the growing awareness of the importance of data-driven management.

Table 2. Planning of Facilities and Infrastructure Optimization Strategy

| Informan | Pernyataan |
|-----------------|---|
| Ka1 | The main challenge is the limited allocation of BOS funds that must be allocated for multiple needs, making it difficult to meet all the priorities for repairs and procurement of facilities at the same time. |
| Gr1 | Obstacles that often arise are the lack of technical personnel for minor repairs and the absence of a systematic routine maintenance schedule. As a result, some damaged facilities were only repaired after conditions were severe enough. |
| Gr2 | The strategy carried out by schools in maximizing the use of BOS Funds begins with deliberations attended by the Principal, Treasurer, Operator, Teacher Council, and School Committee to analyze the allocation of BOS funds that will be used for the management of facilities and infrastructure that are urgently needed and support learning activities. |
| Ka2 | The school's strategy in implementing School-Based Management is to involve the entire board of teachers and staff in designing programs, as well as building collaborative relationships with committees, communities, and stakeholders. |
| Gr3 | Community collaboration and participation are carried out through deliberations with committees and guardians, mutual cooperation activities to improve facilities, and school events such as religious holidays. |
| Gr4 | The planning for the implementation of SFMS has not been fully structured, but the school has used DAPODIK data and the results of the evaluation of the condition of infrastructure facilities in management planning. |
| Km1 | School planning is done through early year meetings involving teachers, staff, and committees to develop an annual work plan. |
| Km2 | Collaboration with the community can be seen from the activities of delivering school programs and visions and missions during the meeting of students' guardians, as well as requests for input from the community regarding school programs. |

Table 3. Thematic Analysis of Strategy Planning

| Tema Utama | Subtema | Temuan Utama | Interpretasi |
|--|--|--|---|
| Resource Limitations | Limited BOS funds and technical personnel | BOS funds are not yet sufficient for all priorities; technical personnel are minimal and there is no routine maintenance schedule. | Schools need to implement a system of preventive maintenance and medium-term planning for efficiency. |
| Collaboration and Participation | Cross-party deliberation and mutual cooperation | Routine deliberations involve all parties; Mutual cooperation is carried out in the improvement of school facilities and activities. | A participatory culture has been established, reinforcing SBM principles and a sense of belonging. |
| Data-Driven Management | Utilization of DAPODIK and Education Report Card | Data is used for needs analysis and priority planning. | Schools are starting to implement evidence-based decision-making practices |



| Tema Utama | Subtema | Temuan Utama | Interpretasi |
|-------------------------------|--|--|--|
| School-Based Management (MBS) | Transparency and collective responsibility | Involvement of teachers and committees in school program planning. | even though they are not optimal. MBS Be the basis for participatory management and public transparency in schools. |

Based on the analysis in Table 3, it was found that the strategic planning of optimizing educational facilities and infrastructure in elementary schools in the archipelago region shows that the process has led to a participatory and data-based management system. Planning is carried out through a routine deliberation mechanism at the beginning of each school year, involving various elements, such as school principals, teachers, treasurers, operators, committees, and the community. This cross-element engagement reflects the application of School-Based Management (SBM) principles that emphasize transparency and accountability in decision-making. The deliberation process is not only a forum for administrative coordination but also serves as a means of collective reflection in determining the priority needs of schools. The results of the analysis show that planning is directed at the maintenance of main facilities, such as repairing leaky roofs, replacing mobiles, and providing information technology-based learning media that supports teaching and learning activities.

On the other hand, although the limited funding of BOS and technical personnel is still the main obstacle, schools can adapt through three strategic patterns that are consistently found in the field. First, the pattern of participatory collaboration is realized through cooperation between schools and the community in mutual cooperation activities and deliberation with students' guardians to create a sense of belonging to the educational environment. Second, a data-based management pattern that can be seen through the use of Education Report Cards and DAPODIK as the basis for budgeting and prioritizing facility needs is observed. Third, the pattern of strengthening SBM is reflected in the involvement of all school components in program planning and the open and responsible implementation of school activities. Although the implementation of the School Facilities Management System (SFMS) has not been fully formalized, the use of internal school data has become the first step towards evidence-based management practices. Overall, the results of this study show that schools in the archipelago have moved towards a more efficient, transparent, and sustainable system of planning facilities and infrastructure by fostering a reflective and collaborative culture to improve the quality of educational services.

B. Implementation of Facilities and Infrastructure Optimization Strategy

The implementation stage is a concrete manifestation of the results of strategic planning for managing educational facilities and infrastructure. Based on in-depth interviews with principals, teachers, and committees at two public elementary schools in Simeulue Regency, the implementation of the strategy shows a systematic, participatory, and data-based work pattern. The school has carried out a program of procurement, repair, and maintenance of facilities according to the work plan prepared through joint deliberation and by referring to the Education Report Card and DAPODIK.

The principal acts as the main coordinator, ensuring that each activity runs according to the plan and the results of the annual evaluation. Teachers actively participate in the implementation of activities, both in terms of supervision, mutual cooperation, and the

use of learning facilities. The committee and community also support collaboration and personnel contributions to the school's physical activities.

Table 4. Research Interview on the Implementation of Facility Optimization Strategy and Infrastructure

| Report | Statement |
|-------------|---|
| Ka 1 | The school has implemented the results of planning deliberations by referring to the data of the Education Report Card and DAPODIK in the implementation of real activities. The use of BOS funds is focused on priority needs such as roof repairs, mobile replacements, and the procurement of IT-based learning media that supports the effectiveness of the teaching and learning process. The principal ensures that every procurement and maintenance of facilities is carried out according to the work plan and the results of the annual evaluation. |
| Gr 1 | In the implementation of the activities that have been planned, it is not only carried out by the principal, but involves all parties in the school. |
| Gr 2 | What has been designed at the beginning of the year and has been outlined in the RKAS will be implemented as a school program both regarding facilities, infrastructure, and other activities that have been prepared in the planning. |
| Ka 2 | The implementation of the school planning strategy has been implemented through several real activities involving all elements of the school and the community. At the beginning of each year, the school holds a working meeting with teachers, staff, and committees to determine priority programs based on the results of the evaluation of the Education Report and DAPODIK data. The results of the meeting were then followed up with the implementation of maintenance programs and the procurement of infrastructure facilities, such as classroom repairs and the procurement of learning technology devices. |
| Gr 3 | The school involves the community and parents in mutual cooperation activities and deliberations with the committee to support school programs and activities. |
| Gr 4 | The management of facilities and infrastructure is carried out by utilizing DAPODIK data and the results of evaluation of facility conditions as a basis for decision-making. |
| Km 1 | At the beginning of each year, the school holds meetings with teachers, staff, and committees to establish priority work plans and programs. |
| Km 2 | The school builds collaboration with the community through the delivery of the school's vision, mission, and programs and receives input as a form of joint participation. |

Table 5. Thematic Analysis of Strategy Implementation

| Main Theme | Subtopic | Key Findings | Interpretation |
|---|---|---|--|
| Data-Driven Management | The Use of Education Report Cards and DAPODIK as the basis for activities | Schools refer to actual data in determining the priorities of improvement programs and the procurement of facilities. | The use of data improves decision accuracy and efficiency in BOS fund allocation. |
| Collective Participation and Gotong Royong | Involvement of teachers, committees, and the community | The implementation of the strategy is carried out through cooperation across school and community elements. | The active involvement of all parties strengthens a sense of belonging and shared responsibility for the progress of the school. |
| Principal Coordination and Leadership | Koordinasi kegiatan, pengawasan, dan evaluasi tahunan | The principal leads the work meeting, directs the use of the BOS, and ensures that the activities are in accordance with the annual evaluation. | Participatory leadership builds a culture of transparency and accountability in schools. |
| Transformative Collaboration | Synergistic school-community relations | The school collaborates with the committee and the community on the facility maintenance program. | Cross-actor collaboration strengthens the sustainability of the program and public support for the school. |

The results of the study show that the implementation of the strategy for optimizing facilities and infrastructure in elementary schools in the Simeulue Island region has been carried out with a collaborative, adaptive, and data-based approach. The school followed up on the results of the planning deliberations by implementing a program for the procurement and maintenance of facilities, referring to the data of the Education Report Card and DAPODIK. The use of BOS funds focuses on priority needs, such as roof repairs, mobile replacements, and the provision of IT-based learning media.

The principal proactively performs managerial functions by leading annual coordination, supervision and evaluation. Teachers contribute to operational activities and ensure the sustainability of facility use. The committee and community showed real support through mutual cooperation activities and the submission of input to school programs.

Overall, the implementation results describe a planned, transparent, and participatory facility management system in which every decision is based on objective data and collective aspirations. A culture of cooperation and community involvement are key factors for the success of the strategy, which not only improves the physical condition of schools but also fosters social responsibility in maintaining the sustainability of the quality of education in the archipelago.

C. Challenges of Optimizing Facilities and Infrastructure

To identify the various obstacles that arise in efforts to optimize educational facilities and infrastructure in elementary schools, the researcher conducted in-depth interviews with principals, teachers, and committees from two schools, namely, SDN 1 Simeulue Tengah and SDN 7 Simeulue Timur. This interview focused on the aspects of challenges faced in three main strategies, namely, the optimization of BOS funds for priority facilities, the implementation of School-Based Management (MBS), and the implementation of the School Facilities Management System (SFMS).

Table 6. Research Interview on the Challenges of Optimizing Facilities and Infrastructure

| Report | Statement |
|-------------|--|
| Ka 1 | The main challenge is the limited allocation of BOS funds that must be allocated for multiple needs, making it difficult to meet all the priorities for repairs and procurement of facilities at the same time. |
| Gr 1 | Obstacles that often arise are the lack of technical personnel for minor repairs and the absence of a systematic routine maintenance schedule. As a result, some damaged facilities were only repaired after conditions were severe enough. |
| Gr 2 | Not completely. Data is indeed used, but the limitations of technical ability in reading and analyzing data make its utilization not optimal. We still need training in educational data analysis. |
| Ka 2 | The challenge we face is that not all teachers and committees have a deep understanding of strategic planning and data-driven budgeting. As a result, coordination and division of roles are sometimes not optimal. Limited meeting time and documentation are also an obstacle. |
| Gr 3 | The biggest challenge is the limitation of adequate supporting devices such as computers. In addition, there has been no specific training on the use of data-based facility management systems for teachers or school staff for human resource improvement. |
| Gr 4 | The obstacle is the active participation of teachers and parents in planning meetings, mainly due to busyness and economic factors that are sometimes lacking in terms of financial support. |
| Km 1 | We want to contribute, but sometimes the economic limitations of the community make it difficult to provide financial support. In addition, communication between the school and the |

| Report | Statement |
|-------------|--|
| | committee still needs to be improved so that the aspirations of the community can be more accommodated. |
| Km 2 | The challenge lies in the sustainability of participation. When there is a gotong royong or development activity, the community is enthusiastic, but after that the involvement begins to decrease. We need a strategy so that community participation remains consistent and planned. |

Table 7. Thematic Analysis of Strategy Implementation Challenges

| Main Theme | Subtopic | Key Findings | Interpretation |
|--|---|--|---|
| BOS Budget and Fund Limitations | Insufficient funds for repair and procurement needs | BOS funds are divided for many school operational needs so that not all priority programs can be realized. | Schools need to develop budget efficiency strategies and seek alternative funding sources through partnerships. |
| Lack of Technical Personnel and Competent Human Resources | There is no dedicated maintenance team yet | Maintenance of the facility is still carried out by teachers and staff without technical support. | Showing the need for technical training and increasing the capacity of school human resources. |
| Constraints on Data and Technology Utilization | Digital literacy and data analysis are still low | DAPODIK and evaluation data have not been fully used for strategic planning. | Digital literacy needs to be strengthened so that the SFMS system can be implemented optimally. |
| Coordination and Limited Meeting Time | Role distribution is not optimal | Principals, teachers, and committees are not yet fully synchronized in data-driven planning. | The effectiveness of SBM still needs to be improved through communication and regular meetings. |
| Limitations of IT Devices and Infrastructure | Limited computer facilities and networks | Some schools do not yet have adequate tools for data-driven systems. | Showing the inequality of technological resources between regions. |
| Community Engagement and Awareness | Participation decreases post-activity | The community was enthusiastic at the beginning, but was not consistent in maintaining the facilities. | A sustainable participation strategy based on socio-economic empowerment is needed. |

Based on the interview results, the challenge of optimizing educational facilities and infrastructure in elementary schools in the Simeulue Islands region is closely related to the limitations of financial, technical, and social resources. Limited BOS funds are the most dominant obstacle because they must be allocated to many needs simultaneously. As a result, schools need to set strict priorities, which often leads to some urgent needs being delayed.

In addition, the lack of technical personnel and the absence of a routine maintenance system often result in damage to the facility being left to become severe before repair. Another obstacle arises from uneven digital literacy and managerial competence, especially in reading and using educational data as a basis for strategic decision making. This challenge is exacerbated by the limitations of IT equipment and inadequate Internet networks in island schools.

On the social side, although community participation is quite high in the early stages of activities such as mutual cooperation or development, this involvement is not always sustainable. Economic factors and a lack of collective awareness of the need to maintain school facilities also reinforce these barriers.

Thus, it can be concluded that the optimization of facilities and infrastructure requires an integrated approach that strengthens human resource capacity, data-based planning, funding efficiency, and sustainable community participation. Local government support through increasing technology literacy, school-community collaboration incentives, and strengthening the SFMS will be the key to the sustainability of infrastructure management strategies in the archipelago.

D. Integrative Patterns of Research Results

The overall results of the interviews and thematic analysis were based on three main aspects: planning, implementation, and challenges. The integrative pattern describes the dynamics of managing educational facilities and infrastructure in elementary schools in the Simeulue Islands region. This pattern shows a functional link between participation-based planning processes, the implementation of adaptive and collaborative strategies, and challenges stemming from resource constraints.

The integrative pattern reflects how each school seeks to optimize existing resources through collaboration between stakeholders (stakeholders), the use of educational data (DAPODIK and Education Report Cards), and the application of the principles of transparency and public accountability in the management of infrastructure facilities.

These findings also confirm that the management of educational facilities in the archipelago requires not only technical skills but also collaborative leadership, social participation, and the use of data-based technology to realize an efficient and sustainable system.

Table 8. Integrative Patterns of Research Results of Optimization of Facilities and Infrastructure

| Research Aspects | Key Findings | Integrative Pattern | Academic Meaning |
|--------------------------------|--|--|---|
| Strategy Planning | The planning process is carried out in a participatory manner by involving the principal, teachers, committees, and the community. The use of DAPODIK data and Education Report cards is the basis for setting priorities. | Data-Driven Participatory Collaboration Planning of facilities and infrastructure is based on joint deliberation and empirical evidence from school data. | Realize participatory management and <i>evidence-based planning</i> that strengthens the accountability of school programs. |
| Strategy Implementation | The procurement and maintenance program is carried out in a mutual cooperation manner with the support of BOS and community funds. The principal coordinates activities according to the results of the annual evaluation. | Collaborative and Adaptive Leadership The principal plays the role of the main driver in translating the plan into real action through cross-actor coordination. | Realize participatory management and <i>evidence-based planning</i> that strengthens the accountability of school programs. |
| Management Challenges | Limited BOS funds, technical human resources, IT tools, and community participation are the main obstacles. | Interrelated Structural and Social Constraints Challenges arise from a combination of | Indicates the need for a systemic and adaptive approach in the management of educational facilities. |



| Research Aspects | Key Findings | Integrative Pattern | Academic Meaning |
|--------------------------------------|--|---|--|
| Three-Dimensional Integration | Planning, implementation, and evaluation are interconnected in one continuous cycle. | economic, geographical, and managerial factors. Integrative Model of Data-Based Participatory Infrastructure Management (ISPBD Model) | Describe a new framework for managing educational facilities that combines efficiency, collaboration, and evidence-based accountability. |

From the entire research process, three main integrative patterns were obtained that formed a conceptual model of the management of educational facilities and infrastructure in elementary schools in the archipelago.

1. Pattern of Strengthening Human Resources (HR) Capacity

Schools are beginning to realize the importance of improving the competence of principals, teachers, and committees in managing data-driven educational facilities. Capacity-building efforts are carried out through technical training, mentoring, and strengthening digital literacy in the use of DAPODIK and Education Report Cards.

2. Patterns of Collaboration and Community Participation

Community involvement is not only in the form of physical mutual cooperation but also in participation in decision-making, evaluation, and supervision of the use of BOS funds. This pattern reinforces a sense of belonging and social responsibility for the sustainability of school facilities.

3. Data-Driven Management Pattern

The systematic use of school data has begun to be applied to strategic decision-making. Although still limited, the use of DAPODIK data and the Education Report has improved the accuracy of facility procurement and maintenance programs. This pattern is the basis for the future implementation of the School Facilities Management System (SFMS).

The integrative pattern of research results shows that the optimization of educational facilities and infrastructure in elementary schools in the Simeulue Islands region is driven by the synergy between participation-based management, collaborative leadership, and the use of educational data as a basis for decision-making.

These three aspects reinforce each other: data-driven planning leads to realistic strategies, collaborative execution ensures effectiveness, and participatory evaluation drives public accountability. Challenges that arise in terms of funds, technical personnel, and limited equipment are drivers for schools to innovate and strengthen a more adaptive facility management system.

Conceptually, the results of this study form an Integrative Model of Participatory-Data-Based Facilities and Infrastructure Management (ISPBD Model), which can be used as a conceptual framework for the management of educational facilities in the archipelago. This model emphasizes that the success of infrastructure management is determined not only by financial factors but also by social participation, collaborative leadership, and information technology-based innovation.

Discussion

The results of this study show that the optimization of educational facilities and infrastructure in elementary schools in the Simeulue Island region is carried out through a participatory, adaptive, and data-based approach. These findings confirm the theory of School-Based Management (SBM), emphasizing autonomy, participation, and accountability as the main pillars of educational governance (Puspitasari et al., 2025). The involvement of school principals, teachers, committees, and the community in the process of planning and supervising infrastructure facilities proves that the participatory management model has been implemented at the elementary-school level. This condition is in line with Verayanti's (2025) opinion that school-community collaboration increases the effectiveness of educational resource management.

The implementation of facilities and infrastructure management strategies based on DAPODIK data and Education Reports shows progress towards evidence-based management. This supports the findings of Wachyudin et al. (2025) and Mou et al. (2019), who emphasized that the use of school information and data systems can improve planning accuracy, budgeting efficiency, and public accountability. Although the School Facilities Management System has not been formally implemented, the practice of utilizing school data marks the readiness of educational institutions for the digitalization of facility governance.

However, the results of this study also reveal a number of structural challenges that are typical of the archipelago context, such as limited BOS funds, a lack of maintenance technical personnel, and limited technological devices and network infrastructure. This finding clarifies the views of Ningsih et al. (2025) and Justman and Teubal (1995), who state that the success of infrastructure management is not only determined by policy but also by technical capacity, financial resources, and technological support. Barriers to data literacy and technical skills also strengthen the argument of Nirmayanthi et al. (2024) that human resource capacity development is an important component in the implementation of MBS and data-based management systems.

On the social side, the dynamics of community participation, which tend to be high at the beginning of activities but decrease at the maintenance stage, show the importance of a sustainability strategy for community participation. This supports Cintiara et al.'s (2025) theory on the need to strengthen collaborative leadership to maintain long-term stakeholder commitment. Therefore, participatory sustainability strategies based on local economic empowerment and periodic communication mechanisms are recommended for schools in remote areas.

Conceptually, this study expands on a previous study by introducing the Integrative Model of Participatory-Data-Based Facilities and Infrastructure Management (ISPBD Model), which combines budget efficiency, community collaboration, and school data utilization. This model offers a theoretical contribution to the field of educational management, especially in remote geographical contexts, where logistical constraints require adaptive and innovative management strategies. Practically, these findings indicate that the successful management of educational facilities in the archipelago requires multi-layered support, ranging from human resource training and the provision of technological tools to affirmative policies for 3T (frontier, outermost, disadvantaged) regions.

Thus, this study strengthens the understanding that the management of educational infrastructure is not just an administrative process but a dynamic system influenced by social, technical, financial, and digital factors. The integration of participatory and data-

driven approaches is an ideal strategy for realizing inclusive, effective, and sustainable educational services in the archipelago.

CONCLUSION

Fundamental Finding: This study shows that the management of facilities and infrastructure in elementary schools in the Simeulue Islands region has been carried out in a participatory and data-based manner. The planning and implementation of activities refer to the Education Report Card and DAPODIK, with the involvement of school principals, teachers, committees, and the community in decision-making and implementation of facility maintenance activities. The principal plays the role of the main coordinator in ensuring the efficient and targeted use of BOS funds, while mutual cooperation is a social force that supports facility sustainability. **Implications:** These findings imply that implementing evidence-based management and collective participation is key to realizing effective infrastructure management in the archipelago. The resulting Integrative Model of Participatory Facilities and Infrastructure Management (ISPBD Model) can be a strategic framework for schools and local governments to strengthen transparency, budget efficiency, and integration of the School Facilities Management System (SFMS) in the future. **Limitation:** This study was limited to two primary schools in Simeulue Regency; therefore, the results cannot be generalized to all contexts of the archipelago. The approach used was qualitative and descriptive, without a quantitative measurement of program effectiveness. In addition, the implementation of the SFMS is still in the conceptual stage, and the short research time does not allow for a long-term assessment of the sustainability of community participation. **Future Research:** Future research should expand the study location to more schools in the archipelago, combine quantitative and longitudinal methods, and conduct empirical tests on the effectiveness of the ISPBD Model and the application of data-based SFMS. Follow-up studies should also examine the 3T regional education policy in more depth to obtain an adaptive, inclusive, and sustainable management strategy for facilities and infrastructure.

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