Journal of Information Systems Engineering and Management
2025, 10(49s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

Sustainable Development Goals (SDGS) of School Facilities and Infrastructure Management Model Based on Kaizen 5s Industrial Work Culture at State Vocational Schools in Bireuen Regency

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ARTICLE INFO

Received: 30 Dec 2024

Revised: 19 Feb 2025

Accepted: 27 Feb 2025

ABSTRACT

Introduction: Educational facilities and infrastructure are crucial components of the National Education Standards in Indonesia. The National Education System Law No. 20 of 2003, Article 45, mandates that all formal and non-formal educational institutions must provide facilities that support students' physical, intellectual, social, emotional, and psychological development.

Objective: This study aims to develop a Sustainable Development Goals (SDGs)-oriented school facilities and infrastructure management model by integrating the 5S Kaizen industrial work culture in vocational schools (SMK Negeri) in Bireuen Regency. Additionally, it evaluates the model's practicality and effectiveness in optimizing school facility management.

Method: Adopting a Research & Development (R&D) methodology using Plomp's model, the study followed five phases: analysis, design, development, implementation, and evaluation. Participants included school principals, vice principals, heads of expertise programs, workshop heads, administrative heads, and productive teachers. Research instruments comprised a model book, an implementation guidebook, and a module guide, validated through expert assessments, implementation observations, response questionnaires, and competency tests.

Results: The developed model demonstrated strong validity, with average validation scores of 4.57 (model), 4.62 (implementation guidebook), and 4.63 (module guide). Classical completeness was achieved, with positive participant response rates of 85.91% in trial I and 86.31% in trial II. N-Gain analysis indicated competency improvements of 61.75% and 62.21%, categorizing its effectiveness as moderate.

Conclusion: The model fosters a structured, industry-based approach to SDGs-aligned school facility management, promoting continuous improvement in vocational education. This study presents an innovative framework for integrating industrial methodologies, particularly 5S Kaizen, into educational infrastructure management, providing valuable insights for policymakers and school administrators in vocational education settings.

Keywords: Sustainable Development Goals (SDGs), School Facilities and Infrastructure Management, School Stakeholders, Industrial Work Culture, Kaizen 5S.

INTRODUCTION

The transition to Society 5.0 is marked by intense competition across all aspects of life, significantly influencing the demand for high-quality human resources. This era emphasizes human-centered integration with technology, thereby accelerating social and economic transformation [1]. Unlike Industry 4.0, which focused on machine-to-machine automation, Society 5.0 prioritizes human-machine collaboration to achieve resilience, economic efficiency, and sustainable development in various sectors, including education. In Indonesia, this global shift demands an open system, particularly in education, which is the core foundation for human resource development.

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One of the essential components in achieving high-quality education is the provision and management of adequate educational facilities and infrastructure. Educational institutions play a strategic role in ensuring that students receive not only knowledge but also character-building education that shapes responsible and competent citizens [2], [3]. However, despite regulatory frameworks emphasizing the importance of facilities and infrastructure in schools, there remains a significant gap between policy and implementation.

Educational facilities and infrastructure are crucial components of the National Education Standards in Indonesia. The National Education System Law No. 20 of 2003, Article 45, mandates that all formal and non-formal educational institutions must provide facilities that support students' physical, intellectual, social, emotional, and psychological development [4]. Furthermore, the Regulation of the Minister of Education and Culture No. 22 of 2023 stipulates the minimum standards for educational facilities, including furniture, educational media, books, learning resources, information and communication technology, and infrastructure such as laboratories, canteens, and places of worship.

Despite these legal provisions, many schools in Indonesia, especially in remote and underprivileged areas, struggle with inadequate infrastructure. Reports indicate that numerous schools lack proper classrooms, laboratory facilities, furniture, and access to digital learning tools [5]. Natural disasters, such as earthquakes and floods, further exacerbate the issue, damaging school buildings and making learning environments unsafe [6]. The disparity between urban and rural schools highlights a phenomenon gap where national education policies fail to ensure equitable access to quality educational infrastructure across different regions.

School infrastructure management is a critical component in ensuring a conducive learning environment. The management of educational facilities and infrastructure involves planning, procurement, inventory, supervision, maintenance, and elimination processes. Well-managed facilities directly impact student motivation, learning outcomes, and teacher productivity [7], [8]. However, several studies have pointed out deficiencies in the implementation of these management principles.

Existing school infrastructure management models do not always align with the dynamic needs of educational institutions. For example, while the ISO 9001:2008 framework has been applied in some schools [9], it primarily focuses on procedural compliance rather than fostering an adaptive and participatory management approach. Similarly, research has shown that involving all school stakeholders—teachers, students, parents, and local communities—can enhance infrastructure management effectiveness, yet many schools lack such participatory mechanisms [10].

A key theoretical gap lies in the lack of integration between school infrastructure management and industry-based quality management frameworks. Kaizen 5S (Seiri, Seiton, Seiso, Seiketsu, and Shitsuke) is widely used in industrial settings to improve efficiency and sustainability, yet its application in educational facility management remains underexplored [11]. Studies have shown that vocational high schools (SMK) in Indonesia, which are expected to simulate industrial work environments, have not fully adopted 5S-based infrastructure management despite its potential benefits [12], [13]. This theoretical deficiency underscores the need for a new model that integrates industrial work culture into educational infrastructure management.

Several research studies have investigated the impact of school facilities on student learning outcomes. Jannah & Sontani (2018) found that well-managed facilities enhance student motivation, while [14]highlighted the role of infrastructure in improving learning effectiveness. Additionally, [15]emphasized that proper infrastructure management can mitigate disaster risks in schools. However, there is limited research on the implementation of structured facility management models tailored to the needs of vocational schools.

A preliminary study conducted in March 2023 at a vocational school in Bireuen Regency, Indonesia, revealed issues related to infrastructure management. Although the school had received socialization on the 5S management model in 2021, the COVID-19 pandemic hindered its proper implementation. Interviews with five vocational program heads and several teachers indicated that only one educational unit had received 5S training, while others were unaware of its principles. Furthermore, school leadership and administrative staff lacked a structured approach to infrastructure management, resulting in unorganized and deteriorating facilities.

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Comparative studies in other vocational schools, such as SMK Nusantara Weru in Cirebon Regency, have demonstrated that 5S-based management can significantly improve school infrastructure organization [15]. Similarly, vocational schools in Medan have applied 5S principles in their technical workshops, achieving an efficiency rate of 82.4% [14]. These findings suggest that integrating industrial work culture into school infrastructure management has the potential to enhance efficiency, sustainability, and accountability.

However, there remains a research gap regarding the adaptation of the Kaizen 5S model to the specific needs of vocational schools. While some schools have partially implemented these principles, there is no standardized framework that aligns 5S with Indonesia's educational infrastructure management policies. Additionally, there is insufficient research on how to scale this model to diverse school environments, considering factors such as budget limitations, stakeholder involvement, and regulatory compliance.

OBJECTIVES

Given the identified gaps, this study aims to develop and implement a Kaizen 5S-based school facilities and infrastructure management model for vocational high schools. The research objectives are: (1) to analyze the current state of infrastructure management in vocational schools and identify key challenges; (2) to evaluate the effectiveness of the Kaizen 5S model in improving school facilities and infrastructure management; (3) to propose a structured and adaptable framework for integrating 5S principles into vocational school infrastructure management; and (4) to assess stakeholder perceptions of the implementation of the proposed model.

The significance of this research lies in its potential to bridge the gap between industrial management best practices and educational infrastructure management. By adopting a systematic and participatory approach, this study seeks to enhance the efficiency and sustainability of school facilities, ultimately improving the quality of vocational education in Indonesia.

LITERATURE REVIEW

Management of Infrastructure Facilities in Schools

Effective management of educational infrastructure is crucial in ensuring the achievement of institutional goals. Facilities and infrastructure encompass all tangible assets that directly or indirectly support the teaching and learning process. Educational infrastructure refers to facilities that indirectly support education, such as school buildings, while educational facilities include resources directly utilized in instruction, such as teaching aids and laboratory equipment. The management of these components involves a comprehensive cycle comprising planning, procurement, utilization, maintenance, and disposal [16].

The key categories of educational facilities include (1) school buildings and furniture, (2) instructional tools such as textbooks, teaching aids, and laboratory equipment, and (3) educational media, including audio-visual materials. The management of these resources follows a structured approach to ensure their optimal utilization and sustainability. Schools are responsible for developing and implementing policies related to infrastructure management, including systematic planning based on standardized requirements and the formulation of a master plan encompassing buildings and laboratories. Additionally, schools must ensure effective dissemination of infrastructure policies to educators, staff, and students.

Library and laboratory management play a vital role in enhancing the learning experience. Library operations require well-defined guidelines for book borrowing and resource utilization, while laboratory facilities must be continuously upgraded to align with scientific and technological advancements. Furthermore, infrastructure supporting extracurricular activities should be developed in accordance with national facility standards. A well-managed infrastructure system contributes significantly to an efficient and conducive learning environment [17].

The continuous improvement of school quality is an indispensable responsibility in education. This responsibility requires active participation from all components of the school environment, not solely the principal as the manager. Effective implementation of Total Quality Management (TQM) in schools necessitates collaboration across educators, administrators, and stakeholders to create a sustainable system of quality improvement. The role of leadership is

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pivotal in fostering an organizational culture that supports quality enhancement, emphasizing the principal's central position in guiding this initiative [18], [19].

Industrial Work Culture

Work culture is a fundamental aspect of industrial success, shaped by values derived from customs, religion, norms, and organizational regulations that evolve into habitual practices [20]. According to the Decree of the Minister of State Apparatus Empowerment and Bureaucratic Reform (2002), work culture represents a quality-driven daily approach that embodies meaningful values, fosters motivation, and inspires continuous improvement in service delivery.

Industrial work culture aims to reshape attitudes and behaviors to enhance productivity and address future challenges. Its implementation yields several benefits, including fostering cooperation, strengthening interpersonal relationships, promoting openness, enhancing family spirit, improving communication, boosting productivity, and increasing responsiveness to external developments. The core components of industrial work culture include:

1. Attitude: An evaluative stance towards objects, individuals, or events, reflecting mental positioning or emotions about ideas and behaviours.
2. Subjective Norms: Group-based norms that influence workers' behavior through external pressures to adhere to specific procedures.
3. Perception of Control: Workers' belief in their ability to execute or refrain from specific behaviors, shaped by control beliefs and influencing regulatory compliance.

Occupational Safety and Health (OSH) System: A formal framework for managing workplace hazards and ensuring effective safety measures.

1. Work Pressure: Psychological stress arising from workload, interpersonal relationships, or organizational roles, affecting both mental and physical well-being.
2. Intention: The intrinsic drive that influences an individual's decision to adopt or reject work culture principles, directly impacting work processes.
3. Core Task Behaviour: Compliance with technical operational procedures, such as adherence to safety protocols.
4. Control Behaviour: Workers' perception of their capability to uphold or deviate from workplace standards based on regulatory and environmental factors.
5. A well-established industrial work culture fosters efficiency, resilience, and sustained growth in an organization.

Industrial Work Culture Models

Effective industrial work culture models integrate methodologies such as Kaizen, Lean Management, Six Sigma, Total Quality Management (TQM), Just-In-Time (JIT), Theory of Constraints (TOC), Total Productive Maintenance (TPM), Value Stream Mapping (VSM), Kanban, and the SCRUM Framework to optimize resource and infrastructure management in the manufacturing sector. Kaizen, meaning "continuous improvement," emphasizes incremental progress and is often integrated with Lean, Six Sigma, and TQM for enhanced efficiency [21]. Lean Management focuses on waste reduction and resource optimization, while Six Sigma utilizes data-driven techniques to minimize defects and improve quality.

JIT methodology reduces inventory costs and enhances responsiveness to market demands. The Theory of Constraints (TOC) highlights the importance of identifying and managing key bottlenecks to enhance overall productivity [22]. TPM contributes to equipment effectiveness by emphasizing preventive maintenance (Shannon et al., 2023), whereas VSM visualizes material and information flow to improve efficiency and sustainability [23]. Additionally, Kanban and SCRUM enhance workflow flexibility and collaboration in project management.

Vocational schools can benefit from adopting the Kaizen 5S Industrial Culture Model, which integrates cleanliness and sustainability principles to enhance infrastructure management. Moreover, prioritizing facilities in school-based

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management can reduce teacher burnout and stress caused by excessive administrative demands. Implementing these industrial work culture models fosters sustainability and efficiency in educational settings.

Kaizen Culture

Kaizen, a Japanese term meaning "continuous improvement," is a fundamental philosophy in industrial management. It emphasizes making work easier by identifying optimal methods that enhance efficiency while maintaining high-quality outputs [24]. Kaizen culture is grounded in three core principles: (1) the belief that no process is perfect and always has room for improvement, (2) a commitment to continuous advancement, and (3) an improvement focus encompassing behavior, mindset, workflows, and quality outcomes.

Kaizen culture fosters ongoing enhancements in employee performance, production processes, product quality, operational cost reduction, and workplace safety. Originating in Japan, Kaizen extends beyond business environments, influencing personal, societal, and global advancements. The term combines "Kai" (change) and "Zen" (good), signifying progressive improvement. In organizational settings, it involves all employees in a systematic process aimed at optimizing operations and fostering a process-focused mindset.

Taichi Ohno, former President of Toyota Motors Corporation, introduced Kaizen as a managerial strategy that integrates all employees in the pursuit of gradual yet continuous enhancement. Though rooted in Japanese industry, Kaizen is universally applicable, as organizations worldwide seek sustainable improvements. It aligns with methodologies such as Total Quality Management (TQM), Zero Defects (ZD), and Just-In-Time (JIT), all of which prioritize quality control and system refinement.

Kaizen culture represents a structured and disciplined approach to continuous improvement, engaging all organizational levels in enhancing work systems, quality, and productivity to create a conducive and efficient work environment.

Characteristics and Dimensions of Kaizen Culture

Kaizen culture embodies continuous improvement, natural progression, and active participation within an organization. The three primary characteristics define Kaizen culture:

1. Continuity: Kaizen is an ongoing journey toward quality enhancement and efficiency. Rooted in Japan's long-term cultural orientation, it fosters an ever-evolving process where improvements are always possible.
2. Natural Progression: Unlike technological innovations or structural changes, Kaizen follows an organic and incremental path without definitive time constraints.
3. Participation: Effective Kaizen requires active engagement at all organizational levels, from top management to employees, ensuring collective intelligence and problem-solving.

Kaizen culture is structured around five key dimensions that define its effectiveness in organizational development:

1. Work Discipline: Organizations must instill self-discipline among employees to adhere to established standards and maintain consistency in performance.
2. Work Environment: A conducive and supportive workplace fosters productivity, creativity, and a commitment to organizational goals.
3. Employment Relations: Harmonious relationships between superiors and subordinates, as well as among employees, cultivate trust, teamwork, and mutual respect.
4. Leadership: Strong leadership is essential to inspire, motivate, and direct employees toward shared objectives, reinforcing the principles of Kaizen.
5. Employee Training: Continuous learning and professional development enhance employee skills, ensuring a culture of sustained improvement and quality enhancement.

Kaizen Culture Indicators

Kaizen cultural indicators are better known as the term 5S culture, which consists of five main principles that need to be applied in effective and efficient management [25], namely:

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1. Seiri (Brief): Concise is concerned with the activity of classifying necessary and unnecessary items, as well as removing unnecessary items from the workplace. This activity aims to free up workspace and increase flexibility in space utilization.
2. Seiton (Neatness): Neat means grouping items by use and arranging them in an adequate way so that the time it takes to search and find items is shorter. In this application, each item usually has a specific label according to its volume and function.
3. Seiso (Clean): Clean means maintaining the condition of goods or machines so that they are ready to be used in a proper and clean state. This includes cleaning the work environment, such as machinery, work tools, floors, and other areas of the workplace to create a clean and safe work environment.
4. Seiketsu (Care): Treat means expanding the concept of cleanliness in the employee's personal self and constantly maintaining a concise, neat, and clean condition. The application of this principle requires standards and must be made part of the company's annual plan schedule.
5. Shitsuke (Diligence): Diligence means building a self-discipline attitude and making 5S activities a daily habit. This includes adherence to the rules that exist in every job, as well as consistency in maintaining cleanliness, neatness, and order.

METHODS

Research Design

This research is a research and development (R&D) using a model approach developed by Plomp (1997). The Plomp model includes five stages of development, namely: (1) preliminary investigation stage, (2) design stage, (3) realization/construction stage, (4) test, evaluation, and revision stage, and (5) implementation stage (Rohmat, 2012).

Data Collection Techniques

To measure the validity, practicality, and effectiveness of the Kaizen 5S industrial work culture-based school facilities and infrastructure management model, a research instrument was compiled and developed. The instruments used in this study are: 1) data collection technical sheet, 2) model validation sheet, 3) model observation sheet, and 4) learning outcome test.

Validation Sheet

All validation sheets in this study were used to measure the validity of the model, the validity of the management device, and the validity of the instruments required in this study. The validation sheets used in this study are: a) model book validation sheets, b) model implementation guidebook validation sheets, and c) module book validation sheets for the implementation of school facilities and infrastructure management models based on the Kaizen 5S industrial work culture.

Observation Sheet

1. Observation Sheet on the Implementation of the School Facilities and Infrastructure Management Model Based on the Kaizen 5S Industrial Work Culture
2. Observation Sheet on the Implementation of the School Facilities and Infrastructure Management Model Based on the Kaizen 5S Industrial Work Culture
3. The observation sheet on the implementation of the school facilities and infrastructure management model based on the kaizen 5S industrial work culture was used by observers in observing the implementation of the school facilities and infrastructure management model based on the kaizen 5S industrial work culture using the management tools developed.

The implementation of the school facilities and infrastructure management model based on the kaizen 5S industrial work culture is measured from four aspects, namely: 1) preliminary description, 2) representation and solution of the proposed problem, 3) management scope and functional management methods, 4) closing activities. Aspects provided (Internet ↔ Perceived).

The primary data collection method employed in this study is unstructured interviews. This technique allows for an in-depth exploration of participants' insights, experiences, and perceptions. To ensure robustness and triangulation,

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observation and document analysis are also utilized as supplementary techniques. These additional methods confirm and enrich the data obtained through interviews, enhancing the validity of the findings.

Participant Selection and Model Testing

Research on the development of a school facilities and infrastructure management model based on industrial work culture has been carried out in several State Vocational High Schools (SMK) in Bireuen Regency, Aceh Province. This research was carried out in the period January 2024 to October 2024. The dimensions of the activities covered in this study include the management of school resources and the development of the culture of school residents.

The subjects in the research on the development of a school facilities and infrastructure management model based on the Kaizen 5S industrial work culture are the Principal, Vice Principal, Head of Department, Head of Workshop, as well as Productive Teachers, Normative Teachers, and Adaptive Teachers at State Vocational High Schools (SMK) in Bireuen Regency.

Table 1. Number of Sample Respondents

No.	Location	Number of Samples
1	SMK Negeri 1 Simpang Mamplam	10
2	SMK Negeri 1 Jeunieb	10
3	SMK Negeri I Jeumpa	8
4	SMK Negeri 1 Bireuen	12
5	SMK Negeri 1 Peusangan	13
6	SMK Negeri 2 Peusangan	13
7	SMK PP Negeri Bireuen	13
8	SMK Negeri 1 Gandapura	13

The data listed in the table above is the number of samples in this study. The sampling technique used is the purposive sampling technique, which is a sampling technique for data sources with certain considerations. According to Sugiyono (2016), purposive sampling is a sampling technique by selecting people or elements who are considered to know the most about what the researcher expects, so that it can provide convenience in exploring the object being researched and developed.

Data Analysis

The data obtained from the research activities were analyzed to answer questions related to whether the school facilities and infrastructure management model based on the Kaizen 5S industrial work culture, including the tools and instruments developed, has met the criteria of validity, practicality, and effectiveness. Data obtained from experts and practitioners were analyzed to determine whether the school facilities and infrastructure management model based on the Kaizen 5S industrial work culture, along with the developed tools and instruments, met the validity criteria based on the strength of the theoretical foundation as well as internal consistency among the components of the model. The data from the field trial was used to evaluate whether the school facilities and infrastructure management model based on the Kaizen 5S industrial work culture, the developed research devices, and instruments met the criteria of practicality and effectiveness.

RESULTS

Research Findings

This study aims to develop and test a school facilities and infrastructure management model based on the Kaizen 5S industrial work culture in vocational schools, focusing on the model development process, as well as testing its

Journal of Information Systems Engineering and Management
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e-ISSN: 2468-4376
https://www.jisem-journal.com/

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practicality and effectiveness. Based on the results of the field trial, some important findings can be conveyed as follows:

The Development Process of the Kaizen 5S Industrial Work Culture-Based Facilities and Infrastructure Management Model

The model development process in this study follows the Plomp research phase, which includes the initial investigation, design, and implementation phases. In the initial investigation phase, an analysis of the needs and problems in the field is carried out, as well as a literature review to explore relevant theories. In the design phase, the Kaizen 5S industrial work culture-based school facilities and infrastructure management model was designed and validated by experts and practitioners. In the implementation phase, the model was tested in the context of vocational schools (SMK), both through limited trials and extensive field trials. The Plomp approach provides a clear and directed structure in model development, so that the results achieved are more measurable and relevant to the needs in the field.

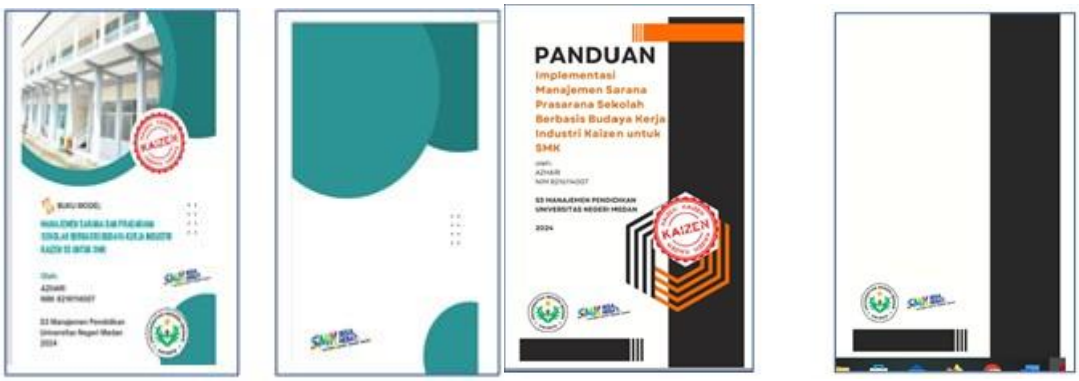

Figure 1. Model Book and Guidance Implementation Book

Figure 2. Module Implementation Book

Practicality of the Kaizen 5S Industrial Work Culture-Based Facilities and Infrastructure Management Model

The results of the field trial show that the school facilities and infrastructure management model based on the Kaizen 5S industrial work culture meets the criteria of practicality. Based on the assessment by experts (IP/IO) and observers (IO), this model obtained a high average score (4.60 for experts and 4.03 for observers at the limited trial stage; 4.60 for experts and 4.22 for observers at the broad-field trial stage), which shows that this model is practical and feasible to apply in vocational schools.

Journal of Information Systems Engineering and Management
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e-ISSN: 2468-4376
https://www.jisem-journal.com/

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Effectiveness of the Kaizen 5S Industrial Work Culture-Based Facilities and Infrastructure Management Model

The effectiveness of the Kaizen 5S industrial work culture-based school facilities and infrastructure management model is measured based on three main indicators, namely the management process, management ability, and stakeholder response. Based on the results of the limited field trial and the wide field trial, here are the findings related to the effectiveness of this model:

Management Process

In a limited and extensive field trial, the data showed that the application of the Kaizen 5S industrial work culture-based school facilities and infrastructure management model resulted in a significant N-Gain score. The average N-Gain in the limited field trial was 61.75%, while in the wide field trial it reached 62.21%. This shows a significant increase in the competence of the participants involved in the trial, which is included in the effective category.

To ensure the validity of the data, statistical tests were carried out which included normality tests and homogeneity tests. The results of the normality test using the Kolmogorov-Smirnov test showed a p-value of 0.200, which indicates that the data is normally distributed. This confirms that the measurements made on the field trials are reliable. In addition, the results of the homogeneity test showed a p-value of 0.413, which showed that the data group in the limited trial and the broad trial were homogeneous. Thus, the comparison between the two groups can be done validly without the influence of unwanted variables.

Manageability

The ability of participants to manage school facilities and infrastructure after using this model has also experienced a significant improvement. The average score of the manageability in the limited trial was 4.5, which indicates a high level of ability in implementing the model. In the wide field trial, the average score increased to 4.22, also showing excellent ability in managing facilities and infrastructure with this model.

Stakeholder Response

Stakeholder responses to this model show positive results. In the limited field trial, 85.91% of stakeholders gave a positive response to the benefits and usefulness of the school facilities and infrastructure management model based on the Kaizen 5S industrial work culture. On a wide field trial, the response rate increased to 86.31%, indicating that the model is well received and is expected to be used in the future

Thus, the comparison between the two groups can be done validly, without the influence of unwanted variables, which strengthens the validity of the results of this study. It also shows that the applied management model can be applied effectively in both trial groups without being affected by significant external factors.

Kaizen 5S Industrial Work Culture-Based Facilities and Infrastructure Management Research Products

The research on the development of a school facility and infrastructure management model based on the Kaizen 5S industrial work culture has resulted in three main products, namely:

School Facilities and Infrastructure Management Model Based on Kaizen 5S Industrial Work Culture. This model is a framework developed to help manage school facilities and infrastructure based on the principles of Kaizen 5S (Seiri, Seiton, Seiso, Seiketsu, and Shitsuke). This model is designed to be applied practically in vocational schools to improve the efficiency and effectiveness of facility and infrastructure management.

Model Implementation Guide. This guide is prepared to assist schools in implementing the Kaizen 5S-based facilities and infrastructure management model step by step. This guide includes an explanation of the theory, implementation procedures, and how to conduct continuous evaluation and improvement.

Training Modules. This module serves to train educators and infrastructure managers at vocational schools so that they can understand and apply the Kaizen 5S-based facilities and infrastructure management model. This module contains training materials, case studies, and evaluations of model implementation.

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e-ISSN: 2468-4376
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The products of this study, which include a Kaizen 5S-based facilities and infrastructure management model, implementation guides, and training modules, are designed to improve the management of facilities and infrastructure in vocational schools, especially with the aim of creating a more efficient, effective, and sustainable managerial process. These products make a significant contribution in supporting the achievement of educational goals and preparing vocational schools to face challenges in managing facilities and infrastructure in the future.

DISCUSSION

The process of developing this model has succeeded in finding a school facility and infrastructure management model based on the Kaizen 5S industrial work culture which is applied to State Vocational High Schools (SMK) in Bireuen Regency. The results of the study show that the application of Kaizen 5S in the management of school facilities and infrastructure at the State Vocational School of Bireuen Regency can be successful with a high level of effectiveness. These findings support the views which state that Kaizen can improve management efficiency and quality when adapted to local contexts [26], [27]. In this study, the success of the model is supported by adjustments to local needs and the active role of stakeholders in supporting the implementation of the model.

This research also offers a significant contribution to novelty, namely in the application of Kaizen 5S in the education sector, especially in the management of facilities and infrastructure in vocational schools. Although Kaizen 5S is usually applied in the industrial sector, this study proves that the principles can be adapted and applied in vocational education with positive results. This novelty shows that Kaizen 5S is not only relevant for improving efficiency in industry, but can also be an effective management model in the context of education, especially in vocational schools that require a sustainable and efficient managerial approach [28], [29].

However, this study also provides a new perspective on the view stateing that the application of Kaizen in the education sector may face challenges such as resistance of educators, bureaucracy, and limited resources [30]. While these challenges can occur, the results of this study show that these obstacles can be overcome through appropriate implementation strategies, such as the preparation of local needs-based models and increased teacher involvement through training. The adaptation of the model to local needs is a novelty that fills the gap in the existing literature, where there have not been many studies that emphasize the importance of local adaptation in the application of Kaizen-based managerial principles [31].

In addition, this study underlines the importance of adapting the education system to changes and environmental needs, as stated [32]. In this context, the Kaizen 5S approach provides flexible and sustainable management solutions, which are relevant to improve the efficiency of the management of vocational school facilities and infrastructure. Therefore, although the challenges of implementing Kaizen 5S in the education sector remain, the results of this study prove that with proper planning and adjustment, the approach can be an effective tool to improve the quality of facilities and infrastructure management [33], [34].

The practicality of the school facilities and infrastructure management model based on the Kaizen 5S industrial work culture is consistent with simple and easy-to-understand management principles, which are in accordance with the needs of the educational environment at vocational schools. In line with the educational management theory put forward by [35], which emphasizes the importance of simplicity and sustainability in managerial models, Kaizen 5S is designed to provide practical and systematic measures that can be easily implemented by various parties in vocational schools. This model prioritizes simple, continuous improvement steps, which can be applied immediately without requiring major changes in the school structure.

This study also shows alignment with the findings of [36], who emphasized that the practicality of a management model is highly dependent on the model's ability to adapt to real conditions in the field. This is evident in the IP/IO assessment from observers which shows that Kaizen 5S is able to adapt well to operational challenges in vocational schools, such as limited resources and the need for efficient management of facilities and infrastructure.

The effectiveness of the Kaizen 5S work culture-based school facilities and infrastructure management model at the Bireuen Regency State Vocational School was evaluated based on three main indicators, namely management results, management ability, and stakeholder response [37], [38]. Based on the test results, this model has proven to be

effective in improving the management of facilities and infrastructure in schools, which is reflected in the significant improvement in each of the indicators measured.

The results of this model management were measured through increasing the value of pretest and posttest results, N-gain test, and normality test. The n-gain test showed a score of 62.21%, which was included in the effective category. These findings show significant progress and support the findings of other studies, such as those revealed in the study Carnerud et al. (2018), which emphasized that the application of Kaizen can improve overall managerial performance. However, although the results of the n-gain test showed high effectiveness, these results contradict the more critical findings in the study conducted by [39], which found that the application of Kaizen in some cases took longer to show significant results in more complex organizations [40]. This difference may be related to the context of the application in the Bireuen Regency State Vocational School which has simpler characteristics compared to the large organizations studied by [41], [42].

Although there is a difference in the time it takes to achieve significant results, this difference is not an obstacle to this study. In fact, the results obtained in this study can be considered an encouraging achievement, given the complexity and smaller size of the school. The success of the faster implementation of this model in Bireuen Regency State Vocational Schools shows that Kaizen 5S can be applied with greater flexibility at a smaller, more focused institutional level. This actually indicates that Kaizen 5S can be an adaptive and effective model for various organizational scales, including smaller schools such as the State Vocational School of Bireuen Regency.

The ability to manage facilities and infrastructure at the field trial stage showed a significant improvement. The average score of management ability of 4.22, which is included in the high category, shows that management stakeholders, both teachers and administrative staff, are able to implement the Kaizen 5S principles well. These results are in line with the research of Jaca et al. (2018), which showed that Kaizen 5S can improve management skills in many sectors, including education. However, research by [43] notes that in some implementations, management skills only improve in a limited way in the short term, because changes in work culture require enough time to internalize. However, this study shows that at the Bireuen Regency State Vocational School, the Kaizen 5S application produces a faster positive impact, perhaps thanks to the commitment of the school management in supporting this change [44].

Positive responses from stakeholders, namely teachers and school management, are also important indicators of the success of this model. A survey of stakeholders showed that 86.31% of respondents gave a positive assessment of the implementation of the Kaizen 5S-based facilities and infrastructure management model. This figure shows strong acceptance from relevant parties, which supports the sustainability of the implementation of this model. This finding is in line with the results of research by [45] which emphasizes the importance of stakeholder support in the success of Kaizen-based managerial models. However, there is a different view which notes that while the level of acceptance from stakeholders is crucial, in some cases, a very positive response can potentially mask the remaining challenges, such as the mismatch between expectations and the reality of model implementation [46], [47]. Nevertheless, the results of this study show that the positive response of stakeholders at the Bireuen Regency State Vocational School is enough to reflect the success and acceptance of this model.

Based on these three indicators, it can be concluded that the Kaizen 5S work culture-based school facilities and infrastructure management model at the Bireuen Regency State Vocational School has proven to be effective in improving the management of facilities and infrastructure in schools. Significant improvements in management outcomes, management capabilities, and positive responses from stakeholders provide strong evidence that the application of this model can have a positive impact in creating a more efficient and productive school environment. Although there are some findings that suggest that the application of this model in different contexts can show slower results or certain challenges, overall, the results of this study provide solid evidence that Kaizen 5S can be effectively applied in Bireuen Regency State Vocational Schools, and these differences in results actually show the success of adapting this model at a more focused scale and context.

CONCLUSION

This study successfully developed a school facilities and infrastructure management model based on the Kaizen 5S industrial work culture at the State Vocational Schools in Bireuen Regency. The development process followed the

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Plomp approach and resulted in a model that integrates Seiri, Seiton, Seiso, Seiketsu, and Shitsuke principles to enhance efficiency and productivity in school environments. The model was adapted to the unique needs and characteristics of vocational schools, creating a more structured and organized management system. Practicality testing of the model demonstrated its high feasibility for implementation, as confirmed by evaluations from experts and practitioners. The Practicability Index (IP) averaged 4.60, while the Observation Index (IO) averaged 4.22, both classified as "high," indicating that the model is practical and applicable in vocational schools. Additionally, effectiveness testing revealed significant improvements in facilities and infrastructure management. The model enhanced efficiency, optimized resource utilization, and increased stakeholder participation. Analyzed through n-gain scores, management assessments, and stakeholder responses, the findings indicated that 62.21% of improvements were in the effective category, management competence scored 4.22 (high category), and stakeholder approval reached 86.31% (positive category).

The Kaizen 5S-based model provides strategic guidance for vocational schools in enhancing facilities and infrastructure management. This approach can be adopted by other vocational institutions facing similar challenges, promoting efficiency, resource optimization, and an improved learning environment. The model minimizes waste, maximizes resource utilization, and fosters higher productivity among students and staff. An implementation guide offers detailed steps for schools to systematically adopt this model, ensuring the integration of industrial work culture principles into school management. This guide not only presents theoretical concepts but also facilitates hands-on implementation, reducing the risk of misapplication and maximizing benefits across different school settings. The guide module serves as an educational tool for training educators, staff, and students on the significance of industrial work culture in facilities and infrastructure management. It enables internal training and simulation exercises before full implementation, preparing schools for a smoother transition. Additionally, the module promotes independent learning and encourages active participation in maintaining school infrastructure. By instilling Kaizen 5S values, the module contributes to developing a disciplined and efficient workforce ready for industrial careers.

Future research should test the model in diverse State Vocational Schools across Aceh, considering variations in location, student population, and available facilities. Evaluating its effectiveness in different contexts will provide a more comprehensive understanding of its success under varying conditions. Then, continuous support should be provided during the early stages of implementation to assist schools in overcoming potential obstacles and ensuring smooth adoption. The last, a more detailed and structured training module should be developed for teachers and students to facilitate easier comprehension and effective implementation of the Kaizen 5S-based management model. Improved instructional materials will enhance knowledge retention and practical application in vocational school settings.

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