



Diagnostic Mapping and Solutions of Technology and Vocational Education for Educational Infrastructure Problems in Vocational High School

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ABSTRACT

Educational infrastructure is one of the essential factors supporting effective learning processes, particularly in Vocational High Schools (SMK), where competency-based learning emphasizes both theoretical and practical activities. However, SMK still faces various infrastructure limitations that affect learning effectiveness and students' competency achievement. This study aims to develop a diagnostic map and solutions based on Technological and Vocational Education (TVE) perspectives to address educational infrastructure problems at SMK. The study employed a qualitative descriptive method using observation, interviews, and documentation techniques for data collection. The findings reveal that infrastructure limitations are influenced by budget constraints, technological limitations, suboptimal facilities management, and insufficient collaboration with industry partners. Recommended solutions include optimizing existing facilities, gradually procuring educational infrastructure, strengthening partnerships with industries, improving digital infrastructure, and implementing sustainable maintenance programs. The resulting diagnostic map can serve as a basis for decision-making processes aimed at improving educational quality and supporting the effective implementation of Technological and Vocational Education at SMK.

Keywords:

Diagnostic Map,
Educational Infrastructure,
Technological and
Vocational Education,
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INTRODUCTION

Education is one of the primary instruments for developing high-quality and competitive human resources. Through education, individuals acquire the knowledge, skills, values, and attitudes necessary to participate actively in both social life and the workforce. The success of educational implementation is influenced by various factors, including the quality of educators, curriculum design, school management, the learning environment, and the availability of educational facilities and infrastructure. Educational infrastructure constitutes a crucial component in supporting the effectiveness of the learning process and improving educational quality. The availability of adequate facilities and infrastructure can create a conducive learning

environment and support the achievement of students' competencies (Barnawi & Arifin, 2021; Yahya et al., 2023).

Educational infrastructure is an integral component of educational provision, encompassing all physical and non-physical facilities utilized to support teaching and learning activities. Such infrastructure includes classrooms, laboratories, libraries, workshops, information and communication technology (ICT) equipment, internet networks, electricity supply systems, and various other supporting facilities. The availability and quality of educational infrastructure have a significant influence on learning effectiveness and the quality of graduates produced. Effective management of educational facilities and infrastructure not only serves as a support mechanism for instructional activities but also plays a crucial role in creating a safe, comfortable, and productive learning environment. Therefore, educational infrastructure management must be conducted in a planned, systematic, and sustainable manner to optimally support the achievement of educational objectives (Barnawi & Arifin, 2021; Suandi et al., 2024).

The rapid advancement of science and technology has brought significant changes to the field of education. The integration of digital technology into the learning process has become an unavoidable necessity, particularly in vocational education institutions that require mastery of technology-based competencies. Digital-based learning requires the support of hardware, software, internet access, and other supporting systems to function effectively. This condition necessitates that schools provide adequate facilities to enable students to develop skills that are aligned with technological advancements and the demands of the labor market. Adequate infrastructure serves not only as a support system for the learning process but also as a strategic means of enhancing the quality of graduates, enabling them to remain competitive in the era of digital transformation and the industrial revolution.

Technological and Vocational Education (TVE) is an educational field oriented toward the development of students' competencies, skills, and work readiness in accordance with the needs of the business and industrial sectors (Kamaruzzaman et al., 2025; Mazlan et al 2026). Technological and Vocational Education emphasizes a balance between theoretical mastery and practical application; therefore, it requires adequate learning facilities that are aligned with technological advancements and workforce demands (UNESCO, 2023; Directorate General of Vocational Education, 2023). The success of vocational education is largely determined by the availability of a learning environment that reflects actual workplace conditions, including laboratories, practical workshops, technological equipment, and other supporting facilities (Dybowsky, 1998; Anselmann et al., 2024). Therefore, strengthening educational infrastructure is a crucial factor in enhancing the quality of vocational education and producing graduates who are competent, adaptive, and well-prepared to meet the challenges of the workforce.

Vocational High Schools (SMK), as one form of implementation of Technological and Vocational Education, have the responsibility to produce graduates who are competent, professional, and prepared to enter the workforce or pursue higher levels of education. To achieve this objective, SMKs require adequate educational facilities and infrastructure to ensure that practical learning activities can be conducted optimally. Laboratories, practice workshops, computer equipment, internet networks, and other learning resources constitute essential components that must be available in accordance with the requirements of the vocational programs offered. Effective management of educational facilities and infrastructure can enhance the quality of educational services and assist schools in achieving learning objectives optimally (Mulyasa, 2022; Suandi et al., 2024).

SMK Negeri 8 Manado is one of the vocational high schools that plays a strategic role in preparing competent human resources in accordance with labor market demands. In the implementation of learning activities, the school has made efforts to provide various facilities to support the teaching and learning process. However, based on the results of preliminary observations and field studies, several challenges related to educational infrastructure were still identified. These issues include a limited number of computer devices, unstable internet access, insufficient practical equipment in several vocational programs, inadequate laboratory capacity, and limited electrical power capacity to support the optimal use of technological devices. These conditions have the potential to hinder the implementation of practical learning, which is the primary characteristic of vocational education, and consequently affect students' competency attainment. The limitations of educational infrastructure can have various impacts on the learning process. Teachers face difficulties in implementing technology-based learning to its fullest extent, while students have fewer opportunities to engage in direct practical activities. Consequently, students' competency attainment becomes less optimal, and learning objectives cannot be achieved to their maximum potential. The findings of Yahya et al. (2023) indicate that the quality of educational facilities and infrastructure is closely associated with learning effectiveness and educational quality. Furthermore, suboptimal management of educational facilities may hinder the implementation of competency-based learning programs, which constitute a defining characteristic of vocational education.

To address these challenges, an approach is required that can identify the actual conditions occurring in the field, determine the root causes of the problems, analyze their impacts, and formulate appropriate and sustainable solutions. According to Bafadal (2020), the systematic identification of problems constitutes an essential initial step in developing strategies for improving educational quality. One approach that can be employed is a diagnostic map. A diagnostic map is an analytical tool used to illustrate the relationships among problems, their causes, impacts, and potential solutions, thereby facilitating decision-making processes and the formulation of more targeted improvement programs. Through the development of a diagnostic map, schools can obtain a more comprehensive understanding of the condition of their existing infrastructure as well as the factors influencing the effectiveness of its utilization.

Based on the foregoing discussion, this study aims to develop a diagnostic and solution mapping of Technical and Vocational Education and Training (TVET) in addressing educational infrastructure challenges at SMK Negeri 8 Manado. The study is expected to provide comprehensive information regarding the condition of educational infrastructure, the factors contributing to existing problems, the impacts of these challenges on the learning process, and alternative solutions that can serve as a basis for policy formulation and the development of educational facilities and infrastructure. Ultimately, these efforts are intended to enhance the quality of vocational education services at SMK Negeri 8 Manado.

METHODS

This study employed a qualitative descriptive method aimed at obtaining an in-depth understanding of the condition of educational infrastructure in vocational high schools (SMKs) and identifying various issues affecting the implementation of Technological and Vocational Education (TVE). A qualitative approach was selected because it enables a comprehensive understanding of phenomena occurring in the field through direct observation and interaction with informants involved in the educational process. The study focused on analyzing the

condition of school facilities and infrastructure, the factors contributing to infrastructure limitations, the impacts of these limitations on the learning process, and alternative solutions that can be implemented to improve the quality of educational services. The research was conducted at SMK Negeri 8 Manado, one of the vocational secondary schools that provides competency-based and work skills-oriented education. The research participants consisted of the principal, the vice principal for facilities and infrastructure, vocational subject teachers, educational support staff, and students directly involved in the utilization of educational facilities. Informants were selected purposively based on their knowledge of and involvement in the management and use of school facilities and infrastructure.

Data were collected through observation, interviews, and documentation. Observation was conducted to directly examine the physical condition of the school's educational facilities and infrastructure, including classrooms, laboratories, information and communication technology equipment, internet networks, practical training equipment, libraries, and other supporting facilities. In-depth interviews were conducted with informants to obtain information regarding the condition of the available infrastructure, challenges encountered, learning facility requirements, and the efforts undertaken by the school to address various existing issues. Documentation was used to complement the research data through the review of facility and infrastructure inventory records, reports on school facility conditions, photographs from observation activities, and other supporting documents relevant to the research focus.

The collected data were analyzed using descriptive qualitative analysis techniques through the processes of data reduction, data presentation, and conclusion drawing. During the data reduction stage, all information obtained from observations, interviews, and documentation was selected, categorized, and simplified according to the research focus. Subsequently, the data were presented in the form of descriptive narratives and tables to facilitate interpretation. The final stage involved drawing conclusions based on the analysis of the relationships among the condition of educational infrastructure, the factors causing existing problems, the resulting impacts, and alternative solutions that could be implemented to improve school facilities and infrastructure.

In this study, the analysis was conducted using a diagnostic mapping approach. This approach was employed to identify the main issues affecting educational infrastructure, analyze the root causes underlying these issues, examine their impacts on the learning process, and formulate solutions aligned with the needs of Technical and Vocational Education and Training (TVET). The results of the analysis were subsequently organized into a diagnostic map illustrating the systematic relationships among problems, causes, impacts, and solutions. This diagnostic map serves as a foundation for developing recommendations for educational infrastructure improvement at SMK Negeri 8 Manado.

To ensure data trustworthiness, this study employed both source triangulation and method triangulation techniques. Source triangulation was conducted by comparing information obtained from the principal, teachers, educational staff, and students, while method triangulation was carried out by comparing the results of observations, interviews, and documentation. Through this process, the data collected were expected to demonstrate a high level of validity and credibility, thereby providing an accurate representation of the educational infrastructure conditions and the proposed development solutions at SMK Negeri 8 Manado.

RESULTS AND DISCUSSION

This study aims to identify educational infrastructure challenges at SMK Negeri 8 Manado and to develop a diagnostic map and corresponding solutions based on the perspective of Technological and Vocational Education (TVE). Data were collected through observations, interviews, and documentation of the school's facilities and infrastructure conditions. The findings indicate that the educational infrastructure continues to face several constraints that affect the effectiveness of the learning process. These constraints include limited information technology equipment, unstable internet access, inadequate practical training equipment, insufficient laboratory facilities, and electrical power capacity that has not yet been optimized to support technology-based learning.

This condition has a direct impact on the implementation of practical learning, which constitutes a primary characteristic of Technical and Vocational Education and Training (TVET). According to Pavlova (2009), vocational education requires a learning environment that reflects real workplace conditions, enabling learners to develop their competencies optimally. Therefore, the availability of adequate infrastructure is a crucial factor in improving the quality of vocational high school (SMK) graduates.

Identification of Educational Infrastructure Problems

Table 1. Identification of Educational Infrastructure Problems at SMK Negeri 8 Manado

No	Infrastructure Aspect	Observed Condition	Level of Influence
1	Computer Equipment	The number of computer units has not yet met the needs of students.	High
2	Internet Network	Internet connectivity is insufficiently stable at certain times.	High
3	Practical Training Equipment	Some practical training equipment is not yet available in a complete set.	High
4	Laboratory	The capacity of the laboratory space remains limited.	Moderate
5	Electrical Power Supply	The electrical power supply does not yet fully support all technological devices.	Moderate

Source: Observation and Interview Results (2026)

The most dominant challenges were identified in the areas of computer equipment, internet connectivity, and practical training tools. These three aspects exert a substantial influence on the implementation of learning activities, as they are directly associated with students' practical learning experiences. This finding is consistent with Barnawi and Arifin (2021), who asserted that educational facilities and infrastructure are essential components in supporting the effectiveness of the learning process and the achievement of educational objectives. Limitations in facilities and infrastructure can impede the learning process and reduce the quality of educational services provided to students.

Diagnostic Map of Educational Infrastructure Problems

Based on the results of the data analysis, several key factors were identified as influencing the condition of educational infrastructure at SMK Negeri 8 Manado. These factors were subsequently analyzed using a diagnostic mapping approach to identify the relationships among problems, causes, impacts, and potential solutions. The findings indicate that limitations in computer equipment, internet connectivity, and practical training tools have affected the

implementation of competency-based learning. These results are consistent with the findings of Chasovy et al. (2023), who reported that the availability of facilities and infrastructure significantly influences the quality of learning in vocational high schools.

Table 2. Diagnosis Map and Solutions for Technology and Vocational Education (TVE)

Problem	Cause	Impact	Solution
Limited computer equipment	Limited procurement budget	Computer-based practical activities are not conducted optimally	Gradual procurement of equipment
Unstable internet connection	Limited network capacity and bandwidth	Digital learning activities are disrupted	Enhancement of internet network capacity
Incomplete practical equipment	Limited funding and lack of external support	Students' competencies are not developed to their full potential	Collaboration with industry partners (DUDI) for the procurement of practical equipment
Limited laboratory space	Limited physical space and facilities	Practical activities become less effective	Expansion and development of laboratory facilities
Inadequate electrical power supply	Limited electrical installation capacity	The use of electronic devices is disrupted	Increasing electrical power capacity

Source: Researcher's Analysis Results (2026)

The budget factor is the primary cause of most educational infrastructure problems. In addition, the rapid advancement of technology continuously increases the demand for educational facilities and infrastructure, requiring schools to make ongoing adjustments. According to UNESCO (2016), the success of vocational education is strongly influenced by the ability of educational institutions to provide a learning environment that supports the development of students' skills and competencies. Therefore, strengthening educational infrastructure should become a priority in the development of vocational schools.

Discussion of Educational Technology and Vocational Education Solutions

Based on the diagnostic mapping results, the solutions that can be implemented include the gradual provision of facilities and infrastructure according to priority needs, enhancement of internet network capacity, development of laboratory facilities, and improvement of electrical power capacity. In addition, schools need to strengthen collaboration with the Business and Industrial Sector (DUDI) to support the provision of practical training facilities that align with labor market requirements.

Collaboration with Industry and the Business Sector (DUDI) can be implemented through practical equipment assistance programs, the utilization of industrial facilities as training sites for students, and curriculum alignment with industry needs. The Directorate General of Vocational Education (2023) explains that partnerships between vocational high schools (SMKs) and industry constitute one of the primary strategies for improving the quality of vocational education.

In addition to providing new facilities, schools need to optimize the management of existing infrastructure and educational resources. The development of digital inventory systems and the implementation of regular maintenance programs can enhance the efficiency of facility utilization. Matin and Fuad (2018) state that effective facilities and infrastructure management can improve the efficiency of educational resource utilization and support the achievement of learning objectives.

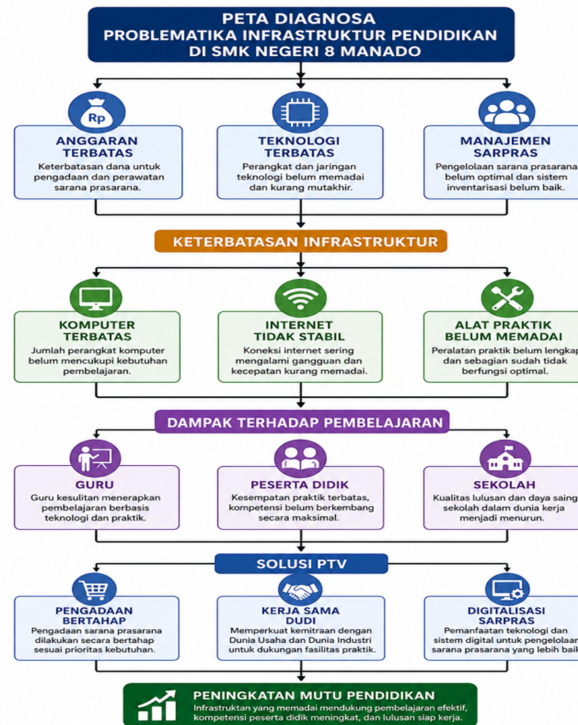


Figure 1. Diagnostic Map of Educational Infrastructure Challenges at SMK Negeri 8 Manado

The diagnostic map illustrates the relationships among causal factors, existing problems, impacts, and potential solutions that can be implemented to improve the quality of educational infrastructure at SMK Negeri 8 Manado. This diagnostic framework can serve as a foundation for planning more targeted and sustainable facilities and infrastructure development programs.

CONCLUSION

Based on the research findings, it can be concluded that the educational infrastructure at SMK Negeri 8 Manado continues to face various challenges that affect the effectiveness of the learning process and the achievement of students' competencies. The identified issues include limited information and communication technology (ICT) equipment, unstable internet connectivity, insufficient practical training equipment, inadequate laboratory capacity, and limited electrical power capacity to support technology-based learning. The situation has prevented practical learning activities from being implemented optimally, thereby potentially affecting the quality of learning outcomes and students' readiness to enter the workforce. The analysis revealed that the educational infrastructure challenges at SMK Negeri 8 Manado are influenced by several factors, including limited funding for the procurement and development of facilities, rapid technological advancement, suboptimal management of educational facilities and infrastructure, and partnerships with the Business and Industrial Sector (DUDI) that still require strengthening. These factors are interrelated and have implications for the utilization of learning facilities as well as the quality of educational services provided by the school.

The development of the diagnostic map in this study successfully illustrates, in a systematic manner, the relationships among existing problems, causal factors, resulting impacts, and alternative solutions that can be implemented. The diagnostic map can serve as a foundation for planning and decision-making related to the development of educational infrastructure,

particularly in supporting the implementation of Technological and Vocational Education (TVE) at SMK Negeri 8 Manado.

To continuously improve the quality of educational infrastructure, several strategic efforts are required, including optimizing the utilization of existing facilities, procuring educational facilities and infrastructure based on priority needs, enhancing internet network quality and information technology facilities, strengthening collaboration with industry and the world of work (DUDI) in the provision of practical training facilities, and implementing a systematic inventory and periodic maintenance system for educational resources and infrastructure. Through these efforts, it is expected that the quality of the learning process will improve, students' competencies will develop optimally, and the quality of graduates from SMK Negeri 8 Manado will become increasingly aligned with labor market demands and technological advancements.

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