A Systematic Literature Review on Implementation of Teaching Factory Model in Vocational Education

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Abstract: - The Teaching Factory (TeFa) model is a practical vocational learning innovation that brings industrial systems and procedures into schools. Vocational students can get real learning experiences according to the working environment through this model. However, implementing the teaching factory model faces various challenges, such as the availability of facilities, lack of instructor competence, lack of budget, and school management. Therefore, it is necessary to carry out various innovations in the TeFa model to get the most effective model. This study reviews and finds various innovations in TeFa implementation models from several countries using the Systematic Literature Review (SLR) method with the Scopus database. The results of the study show that various innovations in the TeFa learning model have a positive impact not only on students but also on schools and industry. The core competencies and challenges faced were also reviewed from the education and business sides. The results of this study can be a best practice and profoundly contribute to researchers and developers of teaching factory models, hoping to find a more innovative and applicable teaching factory model framework in the future.

Key-Words: - systematic literature review, teaching factory, vocational education, engineering, business, teaching model.

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1 Introduction

Vocational education plays a significant role in Indonesia's economic and social development. The need for manpower in various increasingly complex jobs makes vocational education a relevant institution that can provide skills and competencies in accordance with the industry. Vocational education institutions are responsible for producing a skilled workforce and equipping students with the ability to adapt to massive technological developments. Vocational education also contributes to reducing the unemployment rate in Indonesia. Implementing the Teaching Factory (TeFa) program in vocational high schools allows students to learn directly through real projects, collaborating with industry to get practical experience close to the actual situation.

The project learning method applied in TeFa also fosters the leadership spirit of students, [1]. Specifically, the key factor in developing student leadership skills in implementing the project is the structure of social interaction. This can be done by including group projects so that students can practice discussing the results they want to achieve

and the steps they need to take when conflicts arise in their group.

The TeFa program emerged from the brainchild of educators at the University of Puerto Rico-Mayagüez and the University of Washington, [2]. Tefa refers to a vocational school learning model that operates as closely as possible to the industry's actual climate, standards, and procedures. The TeFa program allows students to learn directly through real-world projects collaborating with industry. The principles in TeFa learning are based on the design of learning tools tailored to the general public's needs. TeFa involves various parties such as industry, local governments (local governments/city governments/provinces), parents, and the community in its planning, regulation, and implementation, [3].

The Teaching Factory (TeFa) model has several advantages, namely (1) going beyond ordinary lecture-based learning, (2) applying hands-on practical experience, and (3) providing students with real experience in learning by solving actual cases and problems, [4]. TeFa aims to help students become workers and entrepreneurs by helping them choose a field of work that suits their competencies, fostering their creativity through practice-based learning, providing the skills needed in the world of work, and expanding recruitment opportunities for vocational school graduates.

The main factor determining TeFa's success is the existence of an ecosystem that involves the business and industrial worlds, schools, teachers, and students, [5]. The application of TeFa in vocational education can be seen in several examples, such as the application of the environmentally friendly TeFa model in manufacturing eco-friendly concrete, fashion, and automotive. In addition, the TeFa model has also been adopted in information technology, hospitality, and agriculture, all of which have significantly contributed to improving the quality of education and student job readiness.

Malaysia has an AiF (Academy in Factory) model, a concept that combines academic learning with industrial training to overcome the gap between theory and practice in education, [6]. The program provides students with a more practical and relevant learning experience by allowing them to work directly in a factory environment. This can help students develop the skills needed in the world of work and prepare them to become skilled workers and entrepreneurs.

The factors supporting the success of the AiF program are a strong ecosystem between the business and industrial worlds and support from schools and teachers. The program has received a positive response from students and employers, who see it as an effective way to prepare a more prepared and competent future workforce.

The combination of traditional and technology-based learning theory approaches applied in TeFa provides advantages in the learning process, which is in line with the statement [7], which found that no single theory can stand alone as a complete theory of learning. [8] stated that the combination of theory and practice for vocational students is an important process for obtaining professional hard skills. In these conditions, laboratories are essential to recreate conditions found in industry. Combining all learning theories provides an adequate framework for studying and understanding the increasingly complex learning process in the digital age.

2 Methodology

This study aims to find studies related to the implementation of Teaching Factory (TeFa) in Vocational High Schools (SMK), which were reviewed from various aspects using the Study Literature Review (SLR) method in all countries. The review was carried out by following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) procedure, which consists of four steps: identification, screening, eligibility, and inclusion, [9]. Figure 1 shows the process of implementing SLR in this study.

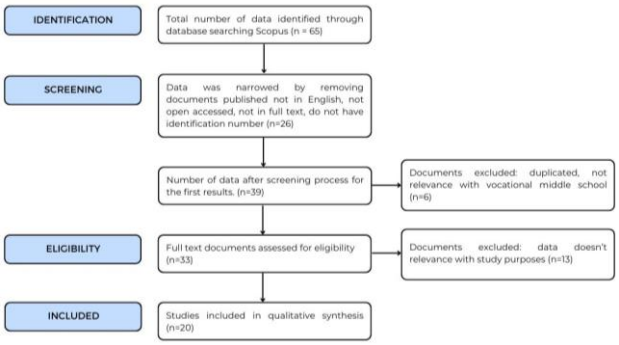

Fig. 1: SLR Process Flow

2.1 Identification

The first stage in SLR using PRISMA begins with the identification process. The researcher used the keyword formula "teaching factory" AND "vocational education" OR "industry" to find related documents. Documents are mined through the Scopus database because the global academic community has widely recognized this source and provides access to various scientific publications relevant to research.

2.2 Screening

The second stage is the screening process, where the obtained documents are selected or discarded based on the criteria determined by the researcher. Document data is entered in Excel tables to facilitate the filtering process. The inclusion and exclusion criteria are summarized in Table 1.

Table 1. Inclusion and exclusion criteria

Criteria	Inclusion	Exclusion
Types of documents	Articles, conference papers, book chapter	-
Accessibility	Open accessed	Not open accessed
Language	English	Non-English
Identifier availability	Have doi or ISSN	Doesn't have doi or ISSN

During this screening process, 32 documents were deleted for reasons such as the discussion referring to higher vocational education, duplicate documents, lack of access to full text, and articles that were not accessed.

2.3 Eligibility

The third stage of the Systematic Literature Review (SLR) process is to conduct a feasibility study by including 33 documents for further analysis. This process is carried out in detail, starting with reading and evaluating the title, abstract, methods, results, and discussions contained in each document. The main purpose of this process is to ensure that the documents are really relevant to the focus of the research being conducted, namely related to the effectiveness of the implementation of the Teaching Factory (TeFa) in vocational high schools (SMK). Each element in the document is carefully analyzed to assess whether the substance of the discussion can contribute to the research objectives. After going through a rigorous selection, only documents that explicitly discuss the effectiveness of TeFa and present relevant data are then considered for further analysis. The results of this stage screened 20 documents that met the criteria, considered relevant and significant to be analyzed in depth in order to enrich the understanding of the implementation and effectiveness of TeFa in vocational schools. This selection is important so that further analysis can focus on documents that have high quality and relevance, and are able to support the development of knowledge in this field.

3 Result and Discussion

This study has reviewed as many as 20 articles from the Scopus database. Most authors are researchers from Asian countries such as Indonesia, Malaysia, and Singapore, but there are also from Greece, Taiwan, and the USA. Table 2 (Appendix) shows the literature used in this review.

3.1 Teaching Factory Implementation in Term of Education

Rapid changes and technological improvements have also changed the paradigm of vocational education. The presence of the Industrial Revolution 4.0 has created a new vocational education environment known as Education 4.0. Education System 4.0 can influence vocational education, increase effectiveness, and how Industrial technologies can be applied to learning, [20]. Teaching Factory (TeFa) is a new learning model that emphasizes practical application, creating a good synergy between actual competency needs in the industry and learning in schools, [23]. TeFa utilizes real learning experiences gained from learning by doing in the hope of creating graduates ready to work to meet the needs of the industry.

The learning concept in TeFa combines the achievement of school curriculum competencies with the production process and world of work standards. This is done to produce graduates who are competent and have character through the completion of goods and/or services products as learning media, [27]. The principles applied in TeFa learning include: 1) the design of learning tools, facilities, technology transfer, and learning methods that are tailored to needs; 2) the implementation of TeFa is not intended to exploit students so that the orientation is not to seek profit; 3) TeFa is a means of the process of building professional competence so that its implementation and management can be accounted for; 4) TeFa produces products and/or services that are appropriate and appropriate to needs; 5) TeFa develops competencies and internalizes the character of the world of work.

The implementation of TeFa in vocational schools is divided into 3 categories, [27]. First, TeFa is based on fulfilling student competencies. This model produces the output of students' competencies and characters as well as products with industry-standard quality, but the products produced have not been utilized by the community or the world of work. Second, TeFa is based on the needs of the community; this model produces competency and character outputs as well as products that are in great demand and ordered by the community. The

quality and quantity of TeFa products have been able to meet the needs of the community. Third, TeFa is based on partnerships with the world of work. This model has student competency outputs and quality products that meet the standards of the world of work and can meet the needs of the world of work stably and sustainably. Recruiting experienced workers from outside, preparing production sites, developing product utilization management patterns, and increasing operational hours are carried out to meet the needs of the world of work.

3.1.1 Output TeFa

The TeFa produces significant benefits targeting three components: students, schools, and industry, [26]. Students can practice using industry workflows and tools, developing work skills in a contextual environment that mimics actual industry conditions. This allows them to gain invaluable practical experience and prepares them more effectively for the challenges of the workforce. This kind of contextual learning strengthens theoretical understanding and improves students' technical abilities and practical skills. On the other hand, schools get opportunities to develop and improve the quality of learning through collaboration with industry. This collaboration not only improves the quality of teaching but also allows the development of a curriculum that is more relevant and up-to-date with the needs of the industry. From an industry perspective, they will get graduates who are superior and ready to work, which will provide convenience for the recruitment process and the fulfillment of the workforce in their industry. Overall, the Teaching factory plays a crucial role in shaping the next generation of skilled professionals in the manufacturing industry by offering a dynamic learning environment that combines theory with practical applications, preparing students for workforce challenges, [22].

Several studies explain that the Teaching Factory (TeFa) model can effectively be applied to vocational education because the programs offered by TeFa are attractive, strong industry partnerships, and skilled teachers, [14]. The TeFa model of vocational education in Pringgabaya has also succeeded in creating collaboration between educational institutions and industry, supporting the practical learning process and encouraging innovation and competitiveness. Additionally, research shows that the TeFa model produces positive attitudes such as responsibility, discipline, honesty, cooperation, and leadership spirit, [28]. One of the creative and interesting applications of the TeFa model is the mobile workshop implemented by SMK 1 Pringgabaya. This model combines a mobile workshop equipped with a solar-powered electric cart. This cart not only serves as a source of electricity for mechanics but also as an additional service for customers. These services include smartphone charging and hot drink sales for customers who are waiting for their motorcycles to be repaired. The existence of solar energy carts not only provides additional income for mobile workshops but also fosters the entrepreneurial spirit of students. The TeFa model applied at SMK 1 Pringgabaya provides more value to the sustainable implementation of TeFa.

However, the TeFa program also has some drawbacks. For example, there is a lack of facilities that support student practices and school locations that are outside the reach of the industry, [14]. In addition, the TeFa learning process has not entirely had a significant impact on student's learning outcomes and job readiness, [15]. Therefore, efforts are needed to improve infrastructure and optimize the relationship between schools and industry so that the TeFa model can benefit students and the surrounding environment more effectively.

After reviewing the studies that have been carried out, Table 3 presents findings in the form of the main points which are the outputs of the TeFa learning model at the dimensions of teachers, students, schools, and industries.

Table 3. Output TeFa

Dimensions	Output
Teacher	Competency development
	Increased cooperation
Student	Upskilling
	Soft skills development
	Contextual understanding
School	Improving the quality of learning
	Classroom infrastructure development
	School Reputation
Industry	Fulfillment of skilled labor
	Increasing industry innovation

Table 3 indicates that TeFa not only improves students' skills and employability but also strengthens the relationship between education and industry, making it an effective model for supporting professional development and improving vocational education outcomes.

TeFa's role in education is exceptionally influential on several things, such as improving soft skills, Mental, and student work ethic, providing the latest industrial knowledge and production methods,

developing a curriculum that is adapted to industrial developments, and being able to facilitate the knowledge transfer process for teachers and students, [11]. The support provided by the industry to the TeFa program, either in the form of cost sharing, machine or software grants, teaching materials, technology, and work knowledge, can add to the success of implementing the TeFa program in vocational schools.

Overall, TeFa plays a crucial role in creating a dynamic learning environment, combining theory with practical applications. This approach prepares students for the challenges in the world of work and contributes to the formation of a generation of skilled professionals. Providing intensive practical experience ensures students' readiness to enter and contribute to a competitive labor market.

3.1.2 Flexibility of TeFa Learning Model Development

TeFa offers good learning flexibility. Allows easy adjustment to various needs and conditions of the school, including the industries involved in it. Teaching Factory can integrate multiple advanced technologies such as augmented reality (AR), virtual reality (VR), and the Internet of Things (IoT) so that they can be adapted according to the latest technological developments and industry needs. TeFa learning model can be combined with AR technology, [24]. The development of this model reduces production failure by 12% and increases student productivity by up to 10%. The flexibility of the TeFa model also allows the application of learning approaches through innovative hybrid methods, [24]. This implementation yielded successful results, evidenced by the completion of four hybrid case studies in which Engineering students remotely guided laboratory personnel to produce and assemble customized project tasks in Computer-Aided Maintenance and Manufacturing (CAM), [19].

3.2 Teaching Factory Implementation in Terms of Business

Previous research has shown that the Teaching Factory (TeFa) model can be a best practice for creating a sustainable knowledge community and economy, [29]. The learning model can improve community services and welfare by providing flexibility in financial management based on economic and productivity principles, as well as the application of healthy and independent business practices, [30]. The application of the TeFa model in the Solar Panel Car Workshop can be considered a success, [4]. The success of the implementation of TeFa is seen from several indicators, including the income earned and the improvement of students' skills. The positive impact is the creation of new jobs and the empowerment of the local economy, [4]. Other research also states that the implementation of TeFa can foster an entrepreneurial spirit, create independence, and train students to work professionally, [29].

Another example of the success of the TeFa model is the implementation of Edotel activities. Edotel is the name of a hotel whose management is under the auspices of the school and is managed by both teachers and students. The factors that determine the success of TeFa in Edotel are professional teachers, adequate facilities and infrastructure as a place to learn, and good support from the school, [17].

Results [12] show that Prakerin and TeFa learning have a positive and significant effect on improving students' entrepreneurial skills. This is certainly a positive opportunity for the future of young vocational school graduates. This success certainly requires a good plan from educational institutions, which must prepare teachers with competence, manage time properly, and motivate students.

However, other studies show that although the implementation of TeFa has been successful in terms of income, this program has not been successful in encouraging graduates to become job creators, [16]. This shows that not all TeFa can be said to be successful in implementing the program perfectly. Several factors, such as the lack of supporting facilities, the location of the school is not strategic, the obstacles to cooperation between vocational education and industry are still weak, and the learning method is not optimal, [17]. Therefore, continuous evaluation and improvement are needed in the implementation of TeFa so that the main goal, which is to create graduates who are ready to work and able to create jobs, can be better achieved.

Growing students' interest in entrepreneurship is a challenge for vocational schools. Entrepreneurship education in vocational high schools through Tefa system learning can have a positive effect on arousing students' interest in making entrepreneurship a cornerstone of life after they complete their education. [13] stated that entrepreneurship education in vocational high schools positively affects collaborative learning and the development of students' entrepreneurial competencies. This is influenced by factors such as the competence of school principals, entrepreneurship training, and the participation of business actors in the industrial world.

3.3 Challenges of Teaching Factory Implementation

Currently, vocational education that implements the Teaching Factory program faces various challenges that must be overcome to succeed. One of the main challenges is the limited resources, both in terms of physical facilities and funding, [18]. Many vocational schools do not have the necessary equipment or technology to support industry-based learning. This results in a gap between the curriculum taught and the real needs in the industrial world. The solution to this challenge is to collaborate with industry to get standard facility support with industry or apply for grants to the government/industry.

The effectiveness of the project program in the development of leadership skills is greatly influenced by the underlying structure of social interaction, [1]. This process should pay attention to conflict prevention, as tensions between participants can hinder skill growth. In addition, the complications of educational materials need to be overcome to ensure that the content delivered is not only relevant but also acceptable to all parties. Discussion of the final results is important to evaluate the project's achievements and strengthen the reflective abilities of participants. All this must be done taking into account the direct relationship between the project activities and the appropriate professional training specifications, as well as the effective management position of the teacher as the director of the learning and training process.

In addition, limitations in terms of competent teaching staff are also an obstacle. Many vocational teachers do not have direct experience in the industry or are poorly trained in using the latest technology. Therefore, teacher training and capacity-building efforts are essential to ensure that they can provide relevant teaching and fit the needs of the industry.

Cooperation with industry is also a challenge in itself. Often, a lack of communication and collaboration between schools and the business world can hinder efforts to provide students with the necessary practical experience. Not all industries can get involved in the Teaching Factory program due to concerns about costs or resources.

Another equally important challenge is curriculum adaptation. Integrating industry needs into school curricula requires flexibility and innovation, but bureaucratic education systems often find it difficult to adapt quickly. The licensing and ratification process of the new curriculum can take a long time, which can hinder the implementation of the Teaching Factory program.

In addition, resistance from students and parents to new approaches to learning is also a challenge. Students feel more comfortable with traditional learning methods and are sceptical of the changes introduced by the Teaching Factory program. Students are less motivated to create jobs [31], therefore, it is essential to conduct adequate socialization and involve all stakeholders in this change process.

Another factor that is no less important is the management of the school. The TeFa program can still support the absorption of vocational school graduates in the world of work, [10]. This is because the TeFa program organized by the school is still fixated on low skills, so DUDI's needs for middle and high skills have not been met. To overcome this, the government's authority is needed for schools to develop TeFa learning following the potential and environmental conditions, continue to develop curricula and practices of cooperation with industry, and increase collaboration from various parties, both cooperation between schools; government; and DUDI.

Overall, while the Teaching Factory program has great potential to improve the quality of vocational education and the relevance of graduates in the workforce, its success is highly dependent on the school's ability to address these challenges through solid collaboration, ongoing training, and effective curriculum adaptation.

4 Conclusion

The Teaching Factory (TeFa) model has proven effective in improving vocational students' skills and job readiness. Through the application of industrial practice-based learning methods, students gain not only theoretical knowledge but also practical experience that is relevant to the needs of the world of work. This improvement is seen in the students' more skilled technical abilities and their more mature mental readiness to face job challenges. TeFa also helps build soft skills such as teamwork, communication, and problem-solving, which are essential in a real-world work environment.

Implementing the TeFa model will be optimal if vocational education collaborates with industry to ensure the curriculum remains relevant and up-to-date. In addition, it is necessary to conduct periodic training for instructors to continue to improve their competence and keep up with the latest technological developments. Assessment and feedback from the industry are also critical to improving and adapting the TeFa program to the needs of the job market. Educational institutions

should also provide adequate facilities and equipment so that the learning process can run optimally and students get an experience close to the actual industry conditions. On the other hand, industry involvement does not only stop at curriculum preparation but also in providing direct assessment and feedback on student performance and the TeFa program itself. Continuous evaluation from industry will help schools adapt and improve their programs according to the needs of the ever-changing job market. It is also important for educational institutions to provide facilities and equipment that are close to industry standards so that students can have an authentic learning experience and can experience what working conditions are like in the real world. With strong synergies between schools, industry, and instructors, as well as adequate infrastructure support, TeFa can be a learning model that is not only effective but also sustainable in producing graduates who are ready to face the challenges of the modern world of work.

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The authors equally contributed in the present research, at all stages from the formulation of the problem to the final findings and solution.

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Conflict of Interest

The authors have no conflicts of interest to declare that are relevant to the content of this article.

APPENDIX

Table 2. Overview of Included Studies

Author & Year	Country	Title	Research Method	Theme Result
[10]	Indonesia	The Influence of Absorption Graduates Vocational Education: A Case Study	Case study	The effect of school management and the industrial environment on student absorption. The TeFa program is less effective in supporting the absorption of graduates into the world of work.
[11]	Indonesia	Sister-cousin TF model based on the influence of work preparedness and learning outcome	Mix method	Partnership system in TeFa. Benefits of industry support for TeFa implementation.
[12]	Indonesia	Strategies to improve entrepreneurship skills of youth considering the business and industry effects	Descriptive quantitative	The benefits of TeFa on students' entrepreneurial abilities. Challenges of TeFa entrepreneurship and learning internship program. Strategies for the success of the TeFa entrepreneurship and learning internship program.
[13]	Indonesia	Factors influencing the development of entrepreneurship competency in vocational high school students: A case study	Case study	The influence of entrepreneurship education on collaborative learning and entrepreneurial competency development. Increase students' interest in entrepreneurship. Factors that affect the success of entrepreneurship education.
[14]	Indonesia	Teaching Factory Implementation for Fashion Design and Production Program at Vocational High School 3 Cilegon, West Java, Indonesia	Qualitative	The effectiveness of the TeFa program at vocational schools majoring in Fashion Design.
[15]	Indonesia	Support in implementation of teaching factory and industry collaboration towards learning outcome and work preparedness of vocational high school student	Mix Method	Implementation of TeFa and industry collaboration to support the learning outcomes and job readiness of vocational school students in East Java.
[16]	Indonesia	The Effectiveness of Creative Products and Entrepreneurship Learning and Teaching Factory to Prepare for Job Creator in the Industrial Revolution Era 4.0	Case study	The effect of the TeFa application on students' capabilities to build a business.
[17]	Indonesia	Edupreneurship through teaching factory in the vocational school of hospitality expertise	Qualitative	The implementation of TeFa through the Edotel program. Factors influencing the success of the Edotel program.
[18]	Indonesia	The Teaching Factory-based Administration Model of Regional Public Service Agency for School's	Qualitative	Benefits of implementing the TeFa learning model.

Author & Year	Country	Title	Research Method	Theme Result
		Financial Independence		
[4]	Indonesia	Energy Efficiency through Solar Panelled Mobile Workshop for Vocational Education Teaching Factory	Undefined	The application of the TeFa model is based on a mobile workshop at SMK Negeri 1 Pringgabaya, Lombok. The impact of implementing the TeFa model of mobile workshops.
[6]	Malaysia	Reshaping the Curriculum for Academy in Factory in Malaysia	Undefined	Application of the AiF model in Malaysia. The effectiveness of the AiF program in skill development and.
[19]	Taiwan	Obstacles of Implementing a Teaching Factory: An Analysis in Vocational Secondary School	Quantitative	Obstacles for vocational schools that have and have not implemented TeFa.
[20]	Greece	A hybrid teaching factory model towards personalized education 4.0	Classroom action research	Implementation of the hybrid model on the TeFa working concept. The effectiveness of hybrid models on pedagogical abilities.
[21]	Greece	Cyber-Physical Systems and Education 4.0 –The Teaching Factory 4.0 Concept	Undefined	The implementation of the 4.0 education system through TeFa.
[22]	Greece	Integrating Manufacturing Education with Industrial Practice Using Teaching Factory Paradigm: A Construction Equipment Application	Undefined	A change in academic perspective for the better from implementing the TeFa program.
[23]	Greece	A Two-way Knowledge Interaction in Manufacturing Education: The Teaching Factory	Mix method	Benefits of the TeFa program for academics and industry. The role of TeFa in shaping the professional generation.
[24]	Greece	Collaborative Machine Tool design: the Teaching Factory paradigm	Undefined	Tefa Program and its implementation.
[25]	Greece	Augmented Reality supported Product Design towards Industry 4.0: a Teaching Factory paradigm.	RnD	Augmented reality (AR) is used to evaluate the effectiveness of product design on TeFa.
[26]	USA	Microelectronics Teaching Factory (MTF) di Arizona State University East.	Undefined	Model application Microelectronics Teaching Factory (MTF) di Arizona State University East.
[27]	USA	Microelectronics teaching factory, a venue for learning and building real-world products by engineering technology students.	Undefined	Benefit of TeFa program for students, institutions, and industry