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# The Implementation of Teaching Factory in Vocational Education: A Systematic Review

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**ABSTRACT**

This study aims to comprehensively review the literature on Teaching Factory (TeFa) within vocational education, focusing on its role in narrowing the gap between classroom learning and industry demands. Through a Systematic Literature Review (SLR), the research synthesizes theoretical perspectives and empirical findings from peer-reviewed journals, conference papers, and other indexed publications published between 2020 and 2025. A structured screening and thematic coding process guided the selection of relevant works, enabling the identification of core variables, implementation strategies, and contextual factors shaping TeFa across countries. The review highlights that infrastructure readiness, teacher expertise, industry partnerships, and financial support influence successful TeFa practices. TeFa offers students authentic, industry-oriented experiences that strengthen technical and soft skills, thereby enhancing overall work-readiness. However, several challenges remain, such as resource limitations, uneven teaching practices, and the integration of digital manufacturing technologies. Moreover, gaps are evident in research concerning long-term digital factory planning, effective knowledge management, and data-based decision-making in vocational contexts. By systematically mapping these findings, this study advances the discourse on vocational education, offering evidence-based insights into the strengths, limitations, and future directions of TeFa. The results provide valuable input for educators, policymakers, and researchers to improve vocational education models, reinforce collaboration between schools and industry, and design sustainable frameworks for Teaching Factory implementation.

**Keywords:** Teaching Factory, Bibliometric Analysis, Systematic Literature Review, Vocational Learning.

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## INTRODUCTION

Conducting a systematic literature review (SLR) on Teaching Factory (TeFa) variables is of paramount importance because it provides a comprehensive synthesis of existing knowledge and offers a holistic examination of the complex interactions between schools, students, teachers, and industry. The TeFa model has been recognized as a significant innovation in vocational education, integrating authentic industrial systems and procedures into real learning environments. By bridging the gap between classrooms and workplaces, TeFa enables students to gain hands-on experiences, develop

employability skills, and enhance their adaptability to the demands of modern industry. (Mavrikios et al., 2017; Rentzos et al., 2014, 2015). However, its implementation is not without challenges, as institutions often face limited facilities, insufficient instructor competence, inadequate financial resources, and weak collaboration networks (Pratama et al., 2025; Wahjusaputri et al., 2021).

SLRs play a vital role in synthesizing fragmented findings into structured insights, enabling researchers to identify critical success factors such as institutional support, industry partnerships, and student engagement, while also highlighting recurring obstacles that hinder optimal implementation. The methodological rigor of SLRs, particularly when guided by frameworks such as PRISMA, ensures transparency, reliability, and reduced bias in study selection, appraisal, and synthesis (Chakraborty & Kar, 2024; Ghamrawi et al., 2025; Shrivastava & Mishra, 2025). This rigor is essential for evidence-based decision-making, allowing policymakers and educators to design vocational curricula that align more closely with industrial requirements and technological advancements (del Pilar García Rodríguez et al., 2023; Revuelta-Domínguez et al., 2022).

Beyond its educational role, TeFa serves as a dynamic platform for two-way knowledge transfer, where schools benefit from industrial expertise while industries gain from student innovation and collaborative research. Prior studies have shown that TeFa implementation contributes to improving production efficiency, reducing defects, and lowering operational expenses when advanced manufacturing and ICT-based practices are applied (Elizondo-Noriega et al., 2018; Mavrikios et al., 2019). Moreover, innovative approaches such as strengthening work culture, embedding creative economy perspectives, and expanding collaborative networks demonstrate how TeFa can evolve into a sustainable and scalable paradigm for vocational education in the digital era (Boejang et al., 2024; Nurmalasari & Swaramarinda, 2018; Suhartini et al., 2024). Despite these promising outcomes, significant research gaps remain. Among them are the transition from static factory planning to continuous digital factory models, the need for improved knowledge management systems, and the challenge of ensuring adequate data availability to support evidence-based improvements (Bermpohl et al., 2025; David & Gelbard, 2025). Addressing these gaps is crucial for advancing TeFa research and practice.

Conducting a systematic literature review (SLR) on Teaching Factory (TeFa) variables is of paramount importance because it provides a comprehensive synthesis of existing knowledge and offers a holistic examination of the complex interactions between schools, students, teachers, and industry. The TeFa model has been acknowledged as a notable advancement in vocational education, incorporating genuine industrial systems and methodologies into practical learning contexts. By bridging the gap between classrooms and workplaces, TeFa enables students to gain hands-on experiences, develop

employability skills, and enhance their adaptability to the demands of modern industry (Mavrikios et al., 2017; Rentzos et al., 2014, 2015).

However, its implementation is not without challenges, as institutions often face limited facilities, insufficient instructor competence, inadequate financial resources, and weak collaboration networks (Pratama et al., 2025; Wahjusaputri et al., 2021). Therefore, to better comprehend the complicated issues surrounding TeFa and its role in vocational education, this study will examine three key research questions (RQ) that guide this review:

1. RQ1: Does the exploration of Teaching Factory remain a significant subject for future scholarly inquiry in vocational education and industry collaboration?
2. RQ2: What is the allocation of research investigations related to the Teaching Factory?
3. RQ3: What are the theoretical and practical implications from the perspective of future research?

These questions are designed to explore the current state of research, identify trends and gaps, and offer suggestions about how TeFa can evolve better to meet the needs of both educational institutions and industries. By systematically mapping these findings, this study aims to contribute to the growing discourse on vocational education and offer evidence-based insights into the strengths, limitations, and future directions of TeFa.

## METHOD

To ensure a rigorous and transparent synthesis of the literature on Teaching Factory (TeFa) variables, this study adopts a Systematic Literature Review (SLR) approach. The SLR method is chosen because it allows researchers to systematically collect, evaluate, and synthesize existing studies, thereby reducing bias and increasing the reliability of findings. Following established guidelines such as the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework, this review employs a structured process that includes defining research questions, determining inclusion and exclusion criteria, identifying relevant databases, and conducting a stepwise screening and quality appraisal of the literature. This methodological rigor ensures that the review not only maps existing knowledge but also identifies research gaps, trends, and opportunities for the future development of the TeFa model in vocational education.

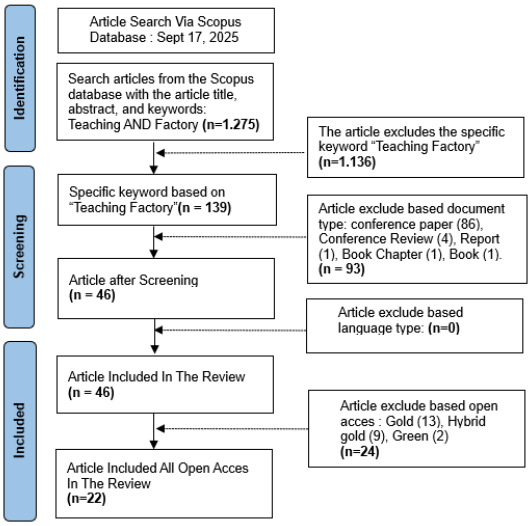


**Figure 1.** Systematic Literature Review information flow using PRISMA

To ensure a rigorous and transparent synthesis of the literature on Teaching Factory (TeFa) variables, this study adopts a Systematic Literature Review (SLR) approach. The SLR method is chosen because it allows researchers to systematically collect, evaluate, and synthesize existing studies, thereby reducing bias and increasing the reliability of findings. The initial phase of the systematic literature review (SLR) involved identifying relevant documents using the Scopus database from 2020 to 2025. Scopus was chosen because it is a globally recognized platform that provides a broad range of scientific publications. The search was conducted using the keyword "teaching factory".

After identifying the initial set of documents, the next step is to screen them. This is where you decide which papers to keep and which to discard. To make this process manageable, you first set up inclusion and exclusion criteria, which are the rules that determine if a document is a good fit for your research. Then you track all document information and your decisions in an Excel table. This makes it easy to filter and organize everything, as outlined in Table 1.

**Table 1.** Criteria Inclusion and Exclusion

| Criteria | Inclusion | Exclusion |
|---|---|---|
| Type of Document | Journal | Conference Paper, Conference Review, Report, Book Chapter, Book. |
| Language | English | Non English |
| Accessibility | Open Access | Not Open Access |
| Identifier Availability | Have DOI or ISSN | Does not have a DOI or an ISSN |

At this screening stage, the selection process becomes crucial. We carefully reviewed each journal and ultimately identified 24 papers that needed to be removed. These journals were eliminated because they did not meet the criteria we had initially established. We could not include articles without access

to the full text or the ability to open the files. After the initial screening, we moved on to the third stage: a detailed feasibility study. We took the remaining 46 documents and started a deep dive into each one. This involved a thorough review of the title, abstract, methods, results, and discussion sections of every single paper. Our main goal was to confirm that these documents were truly relevant to our research about Teaching Factories (TeFa) in vocational high schools (SMK).

We carefully reviewed each document to determine whether its content could contribute to our research. After this rigorous process, we narrowed it down to 22 papers that explicitly discuss the effectiveness of TeFa and present relevant data. This final, high-quality selection ensures that our subsequent analysis will be focused and meaningful, ultimately helping us build a strong understanding of how TeFa works in vocational schools.

## RESULTS & DISCUSSION

This study focuses on findings from 22 articles in the Scopus database on the Teaching Factory in vocational education. The data are drawn from an analysis of publication trends, including the number of articles published, their distribution over the years, and the journals in which they appear. This study also highlights the most influential aspects of Teaching Factory research, including the contributing authors, institutional affiliations, and the countries actively advancing this field.

The Teaching Factory (TeFa) model represents an innovative approach in vocational education that integrates academic instruction with industrial practices, providing students with opportunities to experience factory-like environments and industry-standard procedures (Edy & Dianawati, 2019; Pratama et al., 2025; Wahjusaputri et al., 2021). Its implementation requires close collaboration between schools and industry partners to design curricula aligned with actual industrial processes, standards, and technological developments (Edy & Dianawati, 2019; Tjiptady, 2019; Wahyudin et al., 2025). The implications of TeFa for vocational education are multifaceted. First, it enhances learning experiences by equipping students with both technical competencies and soft skills, such as teamwork, discipline, and problem-solving, thereby significantly improving employability and workplace readiness (Rosidah & Sutirman, 2023; Tanjung et al., 2025; Wahyudin et al., 2025).

Second, the model fosters robust industry collaboration, where partnerships ensure curriculum relevance while industries provide vital resources, including equipment, facilities, and expertise (Hiim, 2023; Triyanto et al., 2019). However, challenges remain, including limited infrastructure, inadequate budgets, and the shortage of qualified instructors capable of delivering industry-aligned teaching (Edy & Dianawati, 2019; Wahyudin et al., 2025; Wulansari et al., 2024). Different models of TeFa, such as mini-replicas of industries, integrated factories within schools, and special collaboration classes, further enhance its adaptability across various educational contexts (Tjiptady, 2019). Evidence indicates that TeFa contributes positively to skill enhancement, graduate employability, and alignment with labor-

market demands, making it a strategic approach for strengthening vocational education (Tanjung et al., 2025; Wahyudin et al., 2025).

To optimize outcomes, continuous collaboration with industry, adequate investment in infrastructure, and alignment of the curriculum with both educational and industrial standards are crucial (Hafid et al., 2019; Wahyudin et al., 2025). In conclusion, the Teaching Factory (TeFa) model continues to receive growing scholarly attention as an innovative bridge between academic learning and industrial practices. The reviewed studies demonstrate that TeFa enhances both technical competencies and soft skills such as teamwork, communication, and problem-solving, which are vital in modern industries (Rosidah & Sutirman, 2023; Tanjung et al., 2025). However, the effectiveness of TeFa is highly dependent on institutional readiness and teacher competence, where limitations in infrastructure and financial resources remain consistent obstacles across different contexts (Edy & Dianawati, 2019; Wahyudin et al., 2025). This duality highlights both the transformative potential and the structural weaknesses of TeFa implementation, suggesting that more systemic support is required to sustain long-term outcomes.

In my opinion, while the TeFa model offers a significant shift in vocational education by fostering both technical and soft skills, the challenges faced, particularly in infrastructure, budgets, and teacher qualifications, must be addressed to ensure its sustainability. Overcoming these structural limitations could restrict TeFa's transformative potential and prevent many educational settings from realizing its full benefits. Therefore, continuous support from both the government and industry partners is essential for maintaining the model's effectiveness.

***RQ1: Does the exploration of Teaching Factory remain a significant subject for future scholarly inquiry in vocational education and industry collaboration?***

According to data from the Scopus database, research on the Teaching Factory (TeFa) in vocational education has shown steady growth, particularly over the past decade. Compared to other domains of educational research, the number of TeFa-related studies remains relatively limited; however, its upward trajectory highlights its growing scholarly relevance in bridging vocational schools with industry practices.

In contrast to earlier works that emphasized production efficiency and reduced defect rates through ICT integration (Elizondo-Noriega et al., 2018; Mavrikios et al., 2019), Recent studies focus more on employability outcomes and entrepreneurial skills (Wahyudin et al., 2025; Yohana, 2020). This shift indicates a broader conceptualization of TeFa, moving from a narrow industrial-technical framework toward a holistic educational strategy. Such repositioning is consistent with global calls for vocational

education reform that prepare students not only for immediate employment but also for adaptability in uncertain labor markets (Hiim, 2023; Nurhayati et al., 2025).

The earliest works on TeFa emphasized aligning educational outcomes with industrial needs through production- and service-based learning models (Prianto et al., 2021; Sariwulan et al., 2020). In recent years, research has progressively expanded to examine diverse themes, including the role of 21st-century skills in supporting teachers' entrepreneurial competence (Wahyudin et al., 2025; Yohana, 2020), the integration of project-based learning for creativity and technical skills (Maksum et al., 2024), and the incorporation of digital technologies such as AI and Smart Factory frameworks to meet Industry 4.0 demands (Fajri et al., 2025; Wahjusaputri et al., 2024). Furthermore, studies highlight the contribution of TeFa in enhancing employability, entrepreneurial competencies, and school–industry collaboration (Wahyudin et al., 2025; Yohana, 2020). Collectively, these developments indicate that Teaching Factory remains a significant subject of scholarly inquiry, with continuing potential to inform sustainable vocational education models and strengthen industry–school partnerships

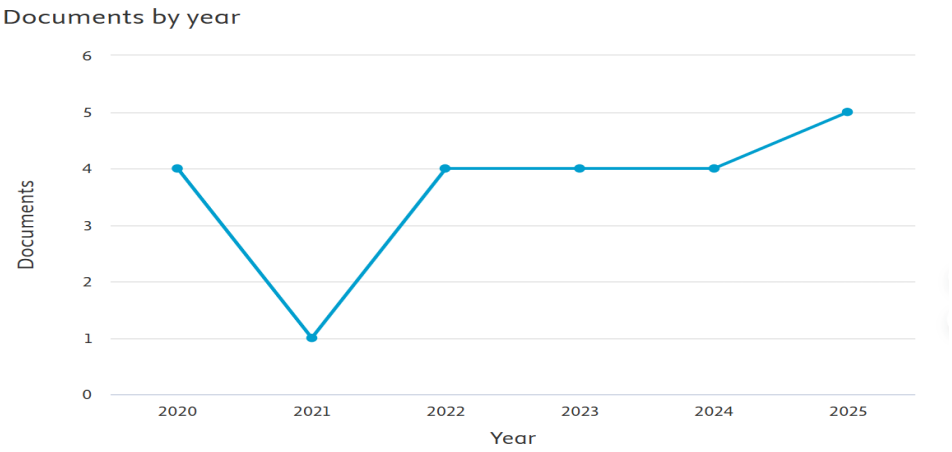


**Figure 1.** Number of Teaching Factory Publications (Analyze Result on Scopus)

Since 2020, the number of publications on Teaching Factory (TeFa) has remained relatively modest, indicating that this field is still emerging within vocational education research. As illustrated in Figure 1, the trend shows fluctuations, with only one article published in 2021, followed by four publications in 2022 and consistent publication through 2023–2024. The upward trend in 2025, with five publications, suggests growing academic interest in TeFa. This pattern highlights that while TeFa research is still limited compared to other educational domains, its trajectory demonstrates significant potential for future exploration. Such studies are critical for advancing knowledge on how TeFa contributes to vocational education, particularly in strengthening industry-school collaboration, enhancing students' employability, and integrating digital innovations for sustainable workforce development.

***RQ2: What is the allocation of research investigations related to the Teaching Factory?***

The analysis of the distribution of Teaching Factory (TeFa) research was conducted by categorizing articles by country or region, with a focus on the most active contributors. Understanding the allocation of TeFa scholarship is valuable for both academics and practitioners in shaping future research agendas, particularly in strengthening vocational education and enhancing school-industry collaboration. As illustrated in Figure 2, Indonesia leads the field with the most publications (20), followed by Malaysia (3). At the same time, Greece, Kazakhstan, and Ukraine each contributed a smaller share of publications. This distribution highlights that TeFa research is still concentrated mainly in Southeast Asia, with Indonesia playing a leading role in advancing the discourse on vocational education innovation (Hardiyanto et al., 2022; Nurhayati et al., 2025; Sariwulan et al., 2020; Wahyudin et al., 2025).

The strong presence of Indonesian scholarship suggests the strategic importance of TeFa for aligning national education policies with workforce development. At the same time, the limited international spread indicates the need for broader cross-country investigations to globalize and diversify the Teaching Factory framework.

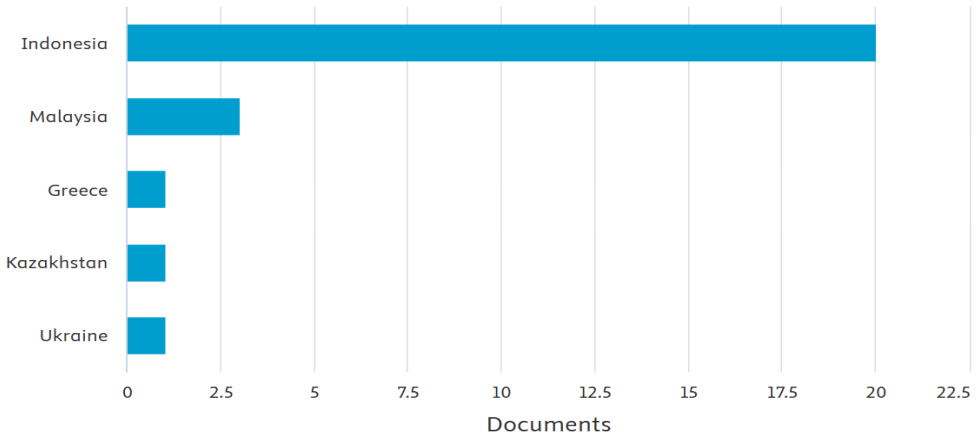


**Figure 2.** Top 5 Country Publications (Analyze Result on Scopus)

The allocation of scholarly inquiries on Teaching Factory (TeFa), categorized by country or territory, reveals Indonesia's dominance with the highest number of publications, followed by Malaysia. Other contributing countries include Kazakhstan, Ukraine, and Greece, albeit with a smaller share of articles. These findings indicate that research on TeFa is still primarily concentrated in Southeast Asia, particularly in Indonesia, reflecting the country's strong emphasis on vocational education reform and school–industry collaboration. Nevertheless, contributions from European and Central Asian countries demonstrate that the TeFa model is beginning to attract wider international attention. Furthermore, the VOSviewer mapping illustrates the interrelations among these countries, with Indonesia positioned as the central hub connected to Malaysia, Kazakhstan, Greece, and Ukraine, as shown in Figure 3.

This collaboration pattern highlights the potential for expanding cross-national research networks, which will be essential for formulating a systematic and globally relevant research agenda on the Teaching Factory in the future (Sariwulan et al., 2020; Wahjusaputri et al., 2021; Wahyudin et al., 2025).

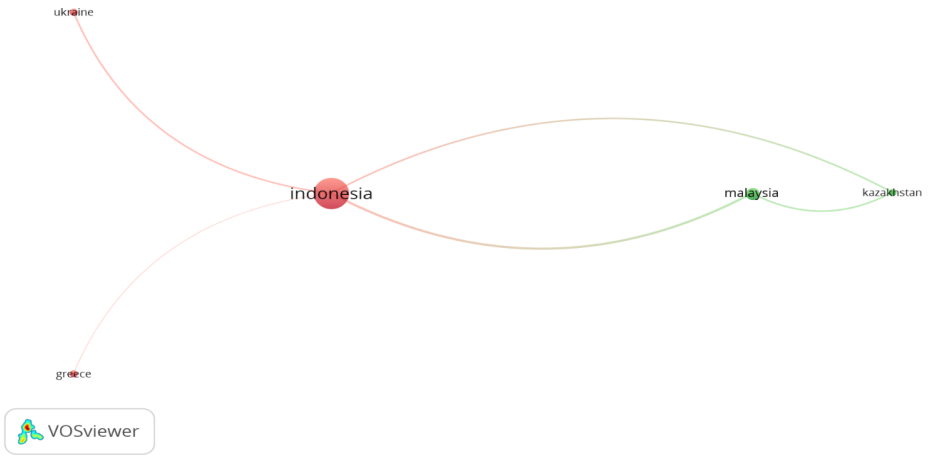


**Figure 3.** Network country visualization (Result VOS Viewer)

These findings further reinforce the idea that the development of Teaching Factory (TeFa) is not solely a matter of concern in countries with strong vocational education systems such as Indonesia and Malaysia but is also gaining attention in several non–Southeast Asian contexts, including Greece, Ukraine, and Kazakhstan. The Teaching Factory model demonstrates broad applicability across diverse educational settings, as it offers a framework for integrating industry practices into formal education and developing more inclusive and globally relevant vocational learning models (Prianto et al., 2021; Wahyudin et al., 2025).

Comparative evidence from Southeast Asia and European contexts illustrates that while Indonesia dominates the volume of TeFa research (Hardiyanto et al., 2022; Sariwulan et al., 2020), Studies from Greece and Kazakhstan highlight the model's flexibility across different industrial landscapes (Prianto et al., 2021; Wahyudin et al., 2025). This contrast positions Indonesia as a knowledge hub but also reveals the importance of extending research beyond regional boundaries to achieve global applicability. The findings suggest that international collaboration is crucial to enrich theoretical perspectives and to validate TeFa across diverse socioeconomic settings (Nurhayati et al., 2025; Wahjusaputri et al., 2021).

Second, the allocation of Teaching Factory (TeFa) scholarship based on institutional affiliations is predominantly characterized by contributions from Universitas Negeri Padang (Indonesia) with six articles, followed by Universitas Negeri Jakarta (Indonesia) with three articles. Several other institutions have also played a significant role, including Universiti Kebangsaan Malaysia, Universitas Negeri Yogyakarta, and Universitas Negeri Medan, each contributing two publications. Additionally,

institutions such as Indraprasta PGRI University, University of Muhammadiyah Prof. Dr. Hamka, University of Muhammadiyah Prof. Dr. Hazairin, the Ministry of Education and Culture (MOEC), and the Economic Education Department of Universitas Negeri Padang have each produced a single article (see Figure 4). These findings indicate that Indonesian universities dominate research output on TeFa, reinforcing Indonesia's role as a central hub for advancing vocational education innovation, while Malaysian institutions provide important complementary contributions. The distribution across multiple universities also reflects growing institutional interest in integrating industry-based practices within academic environments (Maksum et al., 2025; Nurhayati et al., 2025; Wahjusaputri et al., 2021).

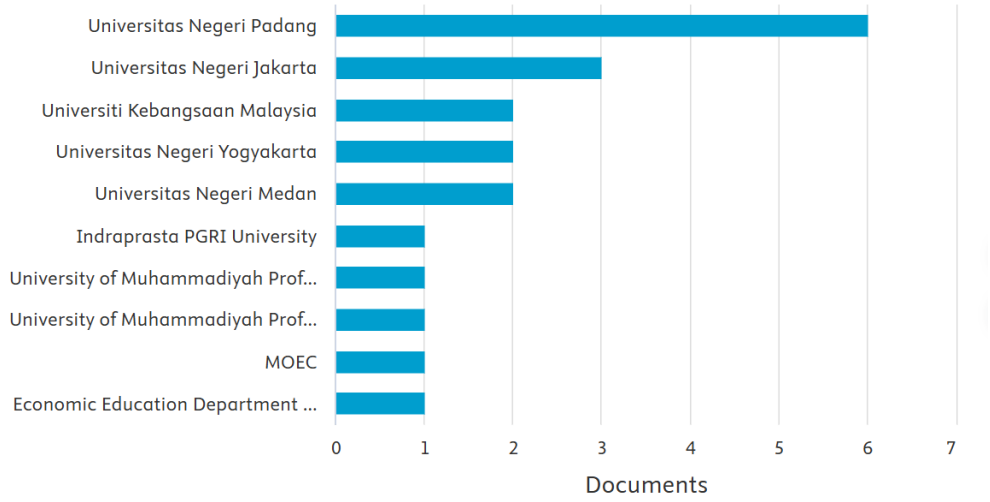


**Figure 4.** Network country visualization (Analyze Result on Scopus)

The dissemination of the Teaching Factory (TeFa) scholarship across the top 10 institutional affiliations demonstrates that research interest is not confined to Indonesian universities—such as Universitas Negeri Padang, Universitas Negeri Jakarta, Universitas Negeri Yogyakarta, and Universitas Negeri Medan—but also extends to international institutions such as Universiti Kebangsaan Malaysia. This indicates that while Indonesia remains the central hub of TeFa-related studies, academic engagement is gradually expanding across borders, reflecting the broader relevance of the Teaching Factory in diverse educational contexts and its potential to become a globally recognized vocational education model (Fajri et al., 2025; Maksum & Purwanto, 2022; Nurhayati et al., 2025).

Third, the allocation of Teaching Factory (TeFa) research based on journal sources is relatively dispersed, with publications appearing across various international and national outlets. As illustrated in Figure 5, these include the *Academic Journal of Interdisciplinary Studies*, *Economic Annals XXI*, *Cakrawala Pendidikan*, *International Journal of Evaluation and Research in Education*, and the *International Journal on Advanced Science, Engineering and Information Technology*. Each of these

journals has published a single article on TeFa within the 2020–2024 period. This distribution pattern indicates that, while research on TeFa has begun to attract scholarly attention, it has not yet been concentrated within a single core journal. Instead, studies are disseminated across interdisciplinary and education-related platforms, suggesting that TeFa remains an evolving field with opportunities for establishing stronger publication niches and specialized outlets in the future (Fajri et al., 2025; Maksum & Purwanto, 2022; Wahyudin et al., 2025).

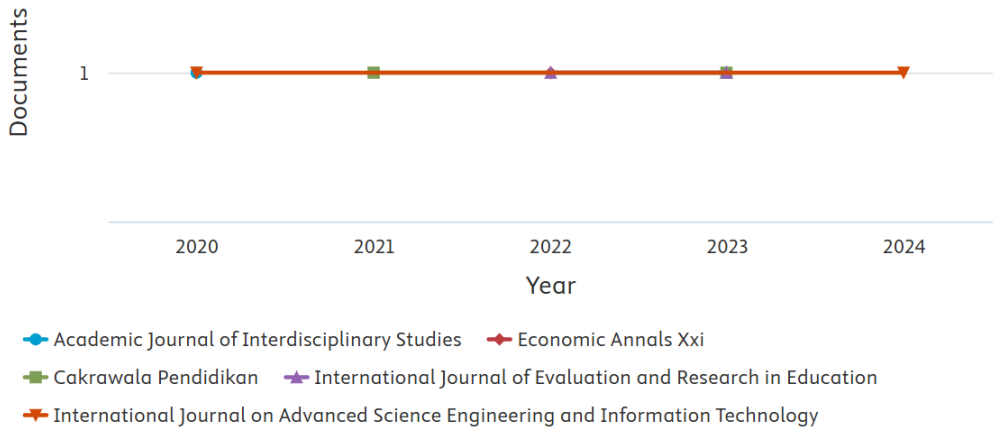


**Figure 5.** Number Of Articles by Sources (Top 5 Sources on Scopus)

Fourth, the author's distribution of Teaching Factory (TeFa) research indicates that scholarly contributions are relatively balanced, with no single researcher showing clear dominance. Among the top contributors, Maksum, H.; Purwanto, W.; and Wahjusaputri, S. each produced three articles, while Bunyamin, B.; Hasan, H.; Nastiti, T.I.; Siman; and Triono, S. authored two publications each. In addition, Abishev, A.R., and Agung, I. contributed 1 article each (see Figure 6). This distribution suggests that TeFa research is advancing through a collaborative, diverse authorship base rather than being concentrated in a few dominant scholars. Such a pattern reflects the emerging, interdisciplinary nature of TeFa studies, in which multiple researchers from diverse backgrounds are contributing to the growing body of literature on vocational education and industry–school collaboration (Maksum & Purwanto, 2022; Wahjusaputri et al., 2021; Wahyudin et al., 2025).

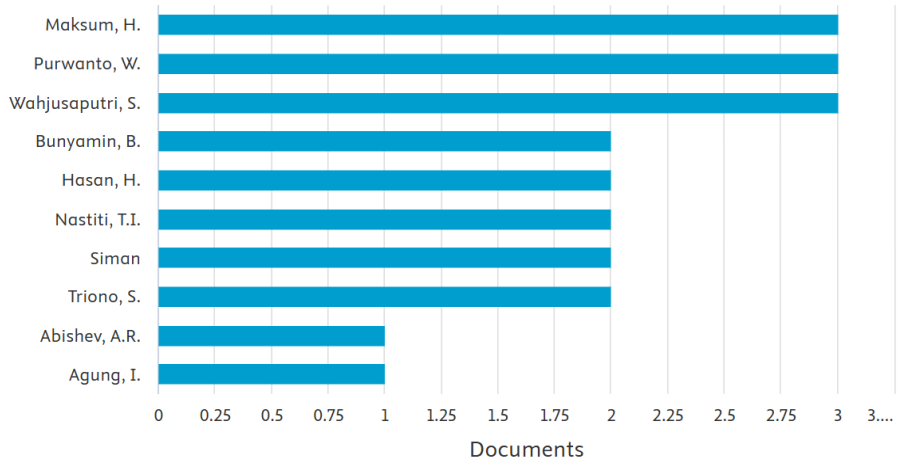


**Figure 6.** Count Of Publications by Author (Top 10 Authors on Scopus)

***RQ3: What are the theoretical and practical implications from the perspective of future research?***

The examination was conducted on 22 manuscripts collected from the Scopus database, and VOS viewer was employed to visualize keyword co-occurrences in Teaching Factory (TeFa) research. The results carry both theoretical and practical implications for future inquiries in vocational education and industry collaboration. The metadata analysis identifies which variables and themes have been extensively explored and which remain under-researched, thereby providing a foundation for advancing the TeFa research agenda.

The evolution of TeFa research also demonstrates a strong integration of digital innovations such as artificial intelligence, extended reality, and innovative factory systems (Fajri et al., 2025; Wahjusaputri et al., 2024). Compared to conventional models of work-based learning (Hafid et al., 2019; Tjiptady, 2019). These digitalized approaches expand the scope of TeFa beyond hands-on replication toward immersive simulations of industrial environments. While promising, this advancement raises challenges concerning equitable access to technology and the preparedness of teachers to facilitate such innovations (Bermpohl et al., 2025; Maksum et al., 2025).

As illustrated in Figure 7, the strongest associations emerge around clusters such as *vocational education, vocational schools, competence, entrepreneurship, learning, and Industry 4.0*, alongside technological integrations like *artificial intelligence* and *animated simulation*. Other clusters highlight themes related to *attitudes, involvement, and collaboration* between the education and business sectors. From a theoretical perspective, these results map out the evolution of TeFa as a concept that bridges industry and education. In contrast, from a practitioner's perspective, they provide insights for implementing sustainable TeFa models that prepare students for real-world challenges. Overall, this

bibliometric mapping reinforces the centrality of TeFa in aligning vocational education with 21st-century workforce demands (Fajri et al., 2025; Maksum et al., 2024; Wahyudin et al., 2025).

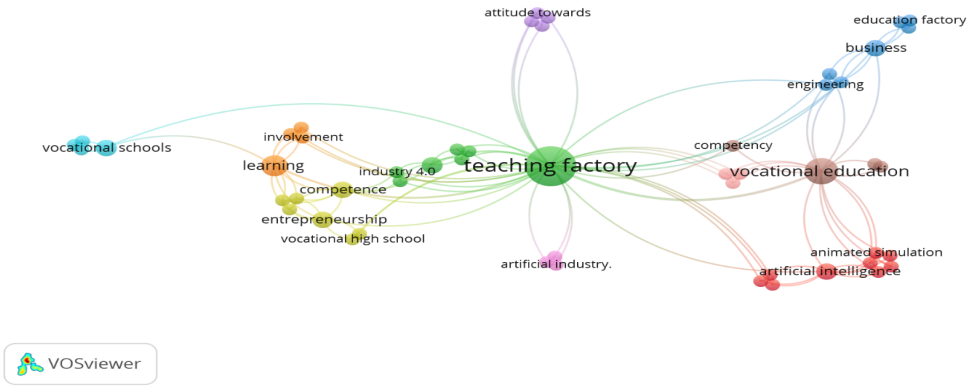


**Figure 7.** Co-Occurrence Framework and Representation of Key Terms (Result VOS Viewer)

Despite the positive impacts on skill development and employability, several unresolved issues persist. Limited budget allocations and uneven teaching practices often undermine the scalability of TeFa (Edy & Dianawati, 2019; Wulansari et al., 2024). Moreover, research in Indonesia highlights substantial gains in aligning school curricula with industry needs (Triyanto et al., 2019; Wahyudin et al., 2025). Comparative studies suggest that these improvements are context-dependent and not easily transferable to regions with weaker industrial infrastructures (Hiim, 2023; Wulansari et al., 2024). This underscores the necessity for adaptive models that respond to local socio-economic realities.

Table 2 presents the distribution of keywords used by authors in the reviewed literature, reflecting the field's thematic orientation and research focus. The ranking is based on the *Total Link Strength*, which indicates the level of co-occurrence and interconnectedness among keywords across the analyzed studies. Notably, “Teaching Factory” emerges as the most dominant keyword with the highest link strength (39), underscoring its central role in vocational education research. Other frequently associated terms, such as “Vocational Education,” “Course Requirements,” “Education Computing,” and “Engineering Education,” highlight the diverse dimensions of inquiry, ranging from curriculum development to technological integration. Meanwhile, keywords such as “Hybrid Teaching,” “Personnel Training,” and “Quality Learning” illustrate the pedagogical and human resource aspects scholars address. The presence of “Simulation Model” and “Academic Performance” further indicates a growing interest in applied learning methods and measurable educational outcomes. Collectively, these findings illustrate the multifaceted landscape of research, where Teaching Factory serves as a pivotal construct interlinked with broader educational innovations and performance indicators.

**Table 2.** Keyword by author (Analyze Result on Scopus)

| Rank | Keyword | Total Link Strength |
|---|---|---|
| 1. | Teaching Factory | 39 |
| 2. | Vocational Education | 19 |
| 3. | Course Requirements | 15 |
| 4. | Education Computing | 15 |
| 5. | Engineering Education | 15 |
| 6. | Hybrid Teaching | 15 |
| 7. | Personnel Training | 15 |
| 8. | Quality Learning | 15 |
| 9. | Simulation Model | 14 |
| 10. | Academic Performance | 14 |

From a theoretical standpoint, TeFa advances the discourse on vocational education by introducing a collaborative paradigm where schools and industries function as co-producers of knowledge (Mavrikios et al., 2017; Rentzos et al., 2015). Practically, however, its success is contingent upon building sustainable institutional ecosystems that can withstand financial, technological, and human resource constraints (Pratama et al., 2025; Suhartini et al., 2024). The juxtaposition of these perspectives illustrates that while TeFa has demonstrated clear benefits, its long-term viability requires multidimensional strategies, including government policy support, industry incentives, and continuous professional development for educators.

Based on the mapping outcomes and an examination of antecedent investigations, several deficiencies have been identified in prior research on Teaching Factory (TeFa). Most existing studies are concentrated in Southeast Asian contexts, particularly Indonesia, leaving limited insights from other regions with different vocational education systems and industrial landscapes. Therefore, future research should be expanded to countries or regions beyond this geographical scope to capture broader perspectives and ensure the global relevance of TeFa practices. Such studies will not only address gaps in the existing literature but also provide a more comprehensive understanding of how Teaching Factory contributes to vocational education reform, enhances employability, and strengthens school–industry collaboration across diverse contexts. In doing so, the findings can enrich theoretical understanding and offer practical strategies for implementing sustainable Teaching Factory models aligned with the dynamics of digital transformation and Industry 4.0.

Taken together, the expanded findings of this review position Teaching Factory as both a pedagogical innovation and a systemic challenge in vocational education. Its contributions to employability, industry collaboration, and digital transformation are well-documented (Tanjung et al., 2025; Wahyudin et al., 2025). Nevertheless, gaps in research remain, particularly in knowledge

management, digital factory planning, and data-driven evaluation (Bermpohl et al., 2025; David & Gelbard, 2025). Future studies should therefore aim to globalize TeFa practices, strengthen cross-country collaboration, and explore emerging technologies that can enhance both efficiency and inclusivity in vocational education systems.

## CONCLUSION

The Teaching Factory (TeFa) model is a promising framework that enhances vocational education by bridging the gap between education and industry, preparing students for the challenges of Industry 4.0. Future research should focus on expanding TeFa globally, particularly beyond Southeast Asia, and on exploring its integration with emerging technologies such as AI and digital simulation. TeFa fosters collaboration between schools and industries, creating a co-creative knowledge environment that adapts to global economic demands. Its sustainability depends on policy alignment, infrastructure, digital integration, professional development for educators, and strong industry partnerships. Addressing gaps in digital transformation, knowledge management, and global scalability will strengthen TeFa's impact and ensure its relevance in vocational education reforms worldwide

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