

turnitin unesa1

328 Production

 Project 10

Document Details

Submission ID**trn:oid::3618:142100657****Submission Date****Jun 8, 2026, 12:09 PM GMT+7****Download Date****Jun 8, 2026, 12:18 PM GMT+7****File Name****similarity erta_10+Layout+Article+176.pdf****File Size****1.8 MB****20 Pages****9,984 Words****59,034 Characters**

*% detected as AI

AI detection includes the possibility of false positives. Although some text in this submission is likely AI generated, scores below the 20% threshold are not surfaced because they have a higher likelihood of false positives.

Caution: Review required.

It is essential to understand the limitations of AI detection before making decisions about a student's work. We encourage you to learn more about Turnitin's AI detection capabilities before using the tool.

Disclaimer

Our AI writing assessment is designed to help educators identify text that might be prepared by a generative AI tool. Our AI writing assessment may not always be accurate (i.e., our AI models may produce either false positive results or false negative results), so it should not be used as the sole basis for adverse actions against a student. It takes further scrutiny and human judgment in conjunction with an organization's application of its specific academic policies to determine whether any academic misconduct has occurred.

Strengthening TVET through Entrepreneurship-Based Teaching Factory for SDG 4 and SDG 8: A Systematic Review and Field Needs Analysis

Indra Wahyu Suliswanto*, Ekohariadi, Ratna Suhartini

State University of Surabaya, Surabaya, Indonesia



DOI : <https://doi.org/10.63230/jocsis.3.4.328>

Sections Info

Article history:

Submitted: March 5, 2026
Final Revised: August 17, 2026
Accepted: August 30, 2026
First Available Online: September 27, 2026
Publication Date: December 27, 2027

Keywords:

Development Entrepreneurial Learning;
Industry-School Alignment;
Instructional Model Innovation;
Vocational Competency;
Workforce Preparation.

ABSTRACT

Objective: TVET systems face persistent challenges in producing graduates with both technical and entrepreneurial competencies demanded by contemporary labor markets. This study examined the integration of entrepreneurship education within Teaching Factory learning as a strategy for strengthening vocational competency development and workforce readiness, aligned with SDG 4 (Quality Education) and SDG 8 (Decent Work and Economic Growth). **Method:** A mixed exploratory design was employed, combining a Systematic Literature Review conducted in accordance with PRISMA 2020 guidelines and a field-based needs analysis. The SLR retrieved 1,247 records from Scopus, Web of Science, ScienceDirect, ERIC, with 75 articles meeting the inclusion criteria for thematic synthesis. The field needs analysis engaged 48 participants across three vocational high schools in East Java, Indonesia, including teachers, industry practitioners, students, curriculum coordinators, and school administrators, using semi-structured interviews, structured observation, and a validated needs analysis questionnaire. **Results:** SLR findings revealed that TeFa implementation and entrepreneurship education have been examined predominantly as separate research domains, with no integrated instructional framework validated through convergent evidence. Field data identified the largest competency gaps in entrepreneurial mindset (gap = 2.32), self-employment orientation (gap = 2.24), adaptability (gap = 2.19), and innovation capability (gap = 2.19) relative to industry expectations. Curriculum structural constraints and insufficient entrepreneurship integration were consistently identified as primary barriers. **Novelty:** A five-dimensional entrepreneurship-based TeFa framework organized around a four-phase iterative instructional cycle is proposed, contributing an empirically grounded foundation for curriculum innovation, vocational policy reform, and the realization of SDG 4 Target 4.4 and SDG 8 through TVET transformation.

INTRODUCTION

The global transformation of labor markets driven by technological advancement, automation, and the imperatives of Industry 4.0 has placed Technical and Vocational Education and Training (TVET) systems under considerable pressure to produce graduates who are not merely technically proficient but demonstrably workforce-ready. Across developing and developed economies alike, youth unemployment remains a structural challenge that persists despite rising enrollment rates in vocational programs (International Labour Organization, 2023). The World Economic Forum (2023) has identified critical mismatches between the competencies produced by formal vocational education and those demanded by contemporary industries, attributing this gap partly to instructional approaches that have not kept pace with the rapid evolution of occupational profiles. Disruptive technologies, including artificial intelligence, the Internet of Things, and advanced manufacturing systems, have redefined the nature of technical work, rendering traditional skill-transmission models increasingly inadequate for preparing vocational learners for dynamic employment contexts (Marope et al., 2020; UNESCO-UNEVOC, 2022). In this context, TVET institutions are called upon to reconceptualize their pedagogical frameworks not merely updating curriculum content,

but fundamentally restructuring how learning experiences are designed, delivered, and evaluated in relation to real-world labor market demands.

Alongside technical reconfiguration, the integration of entrepreneurship education into TVET has emerged as a strategic response to the dual challenges of graduate employability and the growing informalization of labor markets. Entrepreneurial competencies encompassing opportunity recognition, risk assessment, innovative thinking, resource mobilization, and self-employment orientation are no longer peripheral concerns in vocational education but have been identified as core dimensions of workforce readiness in the 21st century (European Commission, 2021; Lackéus, 2020). An entrepreneurial mindset, characterized by adaptability, problem-solving orientation, and proactive engagement with uncertainty, is increasingly recognized as a transferable competency applicable across diverse employment settings, not limited to business creation alone (Bacigalupo et al., 2016; Htay & Lim, 2021). Empirical evidence from Southeast Asian TVET contexts indicates that students who receive structured entrepreneurship education demonstrate higher self-efficacy for employment and greater readiness to engage in independent economic activities compared to those in conventional vocational programs (Sung et al., 2021; Wibowo et al., 2022). The incorporation of entrepreneurship as an embedded dimension of vocational learning rather than as a standalone elective module has therefore been proposed as a structural enhancement capable of increasing the long-term economic participation of TVET graduates.

Teaching Factory (TeFa) has gained international recognition as an industry-oriented instructional model that positions the vocational school as a quasi-production environment in which students engage with real or simulated work orders under conditions approximating actual workplace operations. Originating in German dual-system traditions and subsequently adapted across European, Asian, and African TVET contexts, TeFa aims to dissolve the conventional boundary between classroom-based instruction and industrial practice by embedding authentic production tasks within the formal learning environment (Abele et al., 2015; Putri et al., 2022). The model has demonstrated measurable benefits in improving students' practical competencies, workplace attitudes, and technical problem-solving capacities, particularly in manufacturing, hospitality, and engineering fields (Chryssolouris et al., 2016; Nurhadi et al., 2023). By exposing learners to the operational realities of production processes including quality control, time management, and client-oriented output standards TeFa creates conditions for competency development that conventional didactic approaches cannot readily replicate. Its capacity to foster industry collaboration while maintaining the pedagogical structures of formal schooling makes it a distinctive and theoretically significant model within the broader landscape of work-based learning.

Despite these acknowledged strengths, critical examination of TeFa implementation reveals a persistent imbalance in how the model has been operationalized across institutional contexts. Empirical studies consistently indicate that most TeFa programs prioritize the replication of technical production processes while devoting limited systematic attention to entrepreneurship integration, business-oriented learning experiences, and the development of higher-order employability skills (Köhler et al., 2021; Raharjo & Yudha, 2023). Students engaged in TeFa activities frequently develop technical fluency within narrowly defined production tasks but do not acquire the innovation capacity, market orientation, or entrepreneurial agency required to navigate complex and unpredictable labor market conditions (Rennung et al., 2016; Yahya et al., 2021). This conceptual narrowing wherein TeFa functions primarily as a production

simulation rather than an integrated entrepreneurship and employability development environment limits the model's potential contribution to long-term graduate outcomes. Furthermore, institutional constraints including limited educator entrepreneurial competency, insufficient industry engagement for business mentoring, and the absence of structured frameworks for assessing entrepreneurial learning outcomes have compounded the difficulty of broadening TeFa's instructional scope (Eichhorst et al., 2020; Subandi et al., 2022).

Previous international scholarship on the intersection of TeFa, entrepreneurship education, and TVET transformation has generated valuable insights while simultaneously exposing substantive methodological and conceptual gaps. Studies by Rennung et al. (2016) and Chryssolouris et al. (2016) established the theoretical architecture of TeFa as a competency development environment but were primarily focused on technical learning outcomes in European manufacturing contexts, with limited generalizability to developing-country TVET systems. Research by Htay and Lim (2021) and Sung et al. (2021) demonstrated positive relationships between entrepreneurship education and vocational graduates' self-employment intentions, yet these studies did not examine TeFa as the instructional vehicle for such education. Systematic reviews in adjacent fields such as Nguyen et al. (2021) on work-based learning and Shahroom and Hussin (2018) on Industry 4.0 in education have identified the need for integrated learning models but have not specifically addressed the convergence of entrepreneurship and TeFa within TVET. Methodologically, many existing studies rely on cross-sectional quantitative designs or single-institution case studies, which constrain the transferability of findings and do not capture the contextual variability of TeFa implementation across different national TVET systems (Köhler et al., 2021; Wibowo et al., 2022). The absence of studies that combine systematic analysis of the global literature with direct field-based evidence of institutional needs represents a notable gap in the evidence base.

More specifically, the literature has not yet produced a study that systematically integrates the dual perspectives of global research synthesis and practitioner-level needs analysis to examine how entrepreneurship-based TeFa can be strengthened as a TVET learning model. Existing reviews tend to address either the pedagogical dimensions of TeFa or the outcomes of entrepreneurship education in isolation, without examining how these two domains can be operationally integrated within vocational learning systems. Field-based evidence of what TVET educators, students, and industry stakeholders perceive as critical needs for entrepreneurship integration within TeFa programs remains sparse, particularly in the Indonesian context, where TVET enrollment is substantial but graduate employability indicators remain inconsistent (Badan Pusat Statistik, 2023; Direktorat Jenderal Pendidikan Vokasi, 2022). This absence of convergent evidence spanning both the international literature and ground-level institutional realities limits the foundation upon which evidence-based policy and curriculum reform can be constructed.

Addressing this gap requires a methodological approach that transcends single-method inquiry. The combination of a systematic literature review with a field-based needs analysis offers complementary epistemic functions: the former maps the trajectory, scope, and quality of existing knowledge on entrepreneurship-based TeFa in TVET, while the latter captures the specific contextual demands, resource constraints, and stakeholder expectations that must inform any practical learning model. Together, these methods yield a knowledge base that is simultaneously globally informed and locally grounded, enabling recommendations that are both theoretically defensible and

institutionally actionable. Such an integrative approach aligns with calls in the TVET research community for evidence syntheses that bridge the gap between international scholarship and the lived realities of vocational institutions in emerging economies (McGrath et al., 2020; Pavlova, 2021). The novelty of the present study lies precisely in this convergence bringing systematic evidence review into dialogue with field needs data to produce a substantive and context-sensitive understanding of how entrepreneurship-based TeFa can be developed as a strengthened instructional model within TVET.

The imperatives pursued in this study resonate directly with the United Nations 2030 Agenda for Sustainable Development, particularly SDG 4 (Quality Education) and SDG 8 (Decent Work and Economic Growth). SDG 4 Target 4.4 explicitly calls for substantially increasing the number of youth and adults who possess relevant technical and vocational skills for employment, decent jobs, and entrepreneurship by 2030 (United Nations, 2015). Concurrently, SDG 8 underscores the centrality of inclusive and sustainable economic growth, with entrepreneurship recognized as a principal mechanism for generating decent work opportunities in developing economies (International Labour Organization, 2023). The structural integration of entrepreneurship education within TVET therefore constitutes not merely a pedagogical innovation but a direct institutional contribution to global development targets. Teaching Factory, as an industry-embedded instructional model, holds particular strategic promise as the vehicle through which TVET systems can simultaneously fulfill their technical competency mandate and advance the entrepreneurial capabilities that SDG 4 and SDG 8 explicitly require. By positioning this study within the SDG framework, entrepreneurship-based TeFa is framed not as an isolated curriculum enhancement but as a systemic contribution to sustainable vocational transformation and the 2030 development agenda.

RESEARCH METHOD

Research design

This study employed a mixed exploratory design integrating two complementary methodological strands: a Systematic Literature Review (SLR) and a field-based needs analysis. The rationale for this integration rests on the epistemological principle that a robust understanding of entrepreneurship-based Teaching Factory (TeFa) learning in TVET requires both a synthesis of existing global scholarship and an empirically grounded assessment of contextual institutional needs. The SLR provided a structured examination of international research trends, conceptual frameworks, and identified gaps in the literature, while the field needs analysis generated primary data reflecting the practical demands, perceptions, and priorities of vocational education stakeholders. The combination of these approaches enables triangulation across documentary and field-based evidence sources, producing findings with both theoretical relevance and practical applicability (Creswell, 2018; Snyder, 2019).

Systematic literature review procedure

The SLR was conducted in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, which provide a transparent and replicable framework for identifying, screening, and selecting eligible studies (Page et al., 2021). Four electronic databases were searched: Scopus, Web of Science, ScienceDirect, and ERIC. These databases were selected based on their comprehensive coverage of peer-reviewed educational research and their indexing of vocational

education and training literature. The search was restricted to publications released between 2020 and 2026 to capture contemporary research developments aligned with post-pandemic TVET transformation and Industry 4.0 discourse.

The search strategy employed Boolean combinations of the following keywords: "Teaching Factory," "Entrepreneurship Education," "TVET," "Vocational Education," "Employability Skills," "Entrepreneurial Mindset," and "Industry-Based Learning." These terms were applied across title, abstract, and keyword fields using operators such as AND and OR to maximize retrieval sensitivity while maintaining conceptual relevance. The initial database search yielded a pool of records that were subsequently processed through a four-stage PRISMA screening sequence: identification, screening, eligibility assessment, and final inclusion.

During the identification stage, all retrieved records were compiled and duplicate entries removed using reference management software. In the screening stage, titles and abstracts were reviewed against predefined inclusion and exclusion criteria. Inclusion criteria required that articles: (a) were published in peer-reviewed journals indexed in Scopus, Web of Science, ScienceDirect, or ERIC; (b) addressed at least one of the following themes Teaching Factory implementation, entrepreneurship education in TVET, employability development, or vocational workforce readiness; (c) were written in English; and (d) fell within the 2020–2026 publication window. Articles were excluded if they: (a) were conference proceedings, book chapters, or grey literature; (b) focused exclusively on non-vocational educational contexts without transferable implications for TVET; or (c) lacked sufficient methodological transparency for analytical evaluation. Full-text eligibility assessment was applied to all records passing the screening stage, and final article selection was based on the degree to which each study contributed substantive evidence or conceptual insight relevant to the research objectives.

Data extraction and literature analysis

Each article that met the inclusion criteria was subjected to structured data extraction using a standardized matrix developed for this study. Extracted variables included: study context and country, research design, sample characteristics, theoretical framework, key variables examined, major findings, and identified limitations or gaps. This systematic extraction procedure enabled cross-study comparisons and facilitated the mapping of research trends across geographic regions, methodological orientations, and thematic emphases.

The analytical approach applied to the selected literature combined thematic synthesis, content analysis, and trend mapping (Thomas & Harden, 2008). Thematic synthesis involved the iterative identification of recurring conceptual categories across studies, particularly those related to entrepreneurship integration, TeFa implementation models, employability skill development, and workforce readiness frameworks. Content analysis was used to classify articles by methodological pattern quantitative, qualitative, mixed-methods, or conceptual and to assess the frequency and distribution of specific themes within the literature corpus. Trend mapping examined the temporal distribution of publications and the evolution of conceptual focus across the review period, enabling identification of emergent and underexplored areas. Conceptual relationships among key variables were mapped to identify coherence and inconsistency across findings, informing the articulation of research gaps that the present study addresses.

Field needs analysis

The field needs analysis was conducted in vocational high schools (Sekolah Menengah Kejuruan/SMK) in East Java, Indonesia, specifically within institutions implementing TeFa programs in automotive and engineering competency areas. This setting was selected on the basis that automotive vocational programs in Indonesia represent one of the most institutionally mature TeFa contexts, providing a relevant site for examining the current state and developmental needs of entrepreneurship integration within TeFa.

Participants were selected through purposive sampling, guided by criterion-based selection procedures that ensured informational relevance and stakeholder representativeness (Creswell & Poth, 2018). Participant categories included vocational teachers with direct TeFa instructional responsibilities, automotive industry practitioners engaged in school-industry collaboration, TVET students enrolled in TeFa-based programs, curriculum coordinators, and school administrators with institutional oversight of vocational learning programs. The total participant count was determined by theoretical saturation principles for qualitative components and by proportional representation criteria for questionnaire respondents.

Data collection techniques

Data were collected through three instruments: semi-structured interviews, structured observation, and a validated needs analysis questionnaire. Semi-structured interviews were conducted with teachers, industry practitioners, and school administrators, focusing on: current TeFa implementation practices, perceived gaps in entrepreneurship integration, barriers to employability-oriented instruction, and stakeholder expectations for learning model development. An interview protocol was developed and validated through expert review prior to data collection.

Structured observation was conducted in TeFa learning environments to examine instructional activities, student engagement patterns, production workflow alignment, and visible indicators of entrepreneurship-oriented practices. An observation checklist was developed based on TeFa implementation indicators derived from the SLR findings. The needs analysis questionnaire, administered to students and teachers, was structured using a five-point Likert scale to measure perceived importance and current implementation levels of entrepreneurship-related competencies within TeFa programs. The questionnaire underwent content validity assessment through expert panel review and reliability testing using Cronbach's alpha prior to administration. Informed consent was obtained from all participants, anonymity was maintained throughout data processing, and participation was voluntary with the right to withdraw at any stage.

Data analysis procedure

Qualitative data from interviews and observations were analyzed through thematic analysis following Braun and Clarke's (2006) six-phase framework: familiarization, initial code generation, theme construction, theme review, theme definition, and report production. Coding was conducted inductively from raw data and deductively in relation to the conceptual framework derived from the SLR. Categories were organized around the following analytical dimensions: current TeFa practice, entrepreneurship learning needs, employability skill priorities, and industry collaboration expectations. Triangulation was applied across interview, observation, and document sources to enhance the internal consistency of qualitative findings.

Quantitative data from the needs analysis questionnaire were analyzed using descriptive statistics, including frequency distribution, percentage analysis, and mean

score interpretation. Mean scores were interpreted against a predefined scale to categorize need levels as low, moderate, or high, providing a structured basis for prioritizing instructional recommendations.

Integration of the SLR and field needs analysis findings was conducted through comparative synthesis, wherein themes and gaps identified in the literature were mapped against empirical needs reported by field participants. This cross-source integration produced a consolidated understanding of the conceptual and practical directions required for developing entrepreneurship-based TeFa learning in TVET.

Trustworthiness and validity

Trustworthiness of the qualitative findings was established through Lincoln and Guba's (1985) four criteria. Credibility was addressed through source triangulation across interviews, observations, and documents, as well as member checking with selected participants who reviewed preliminary thematic summaries. Dependability was ensured through the maintenance of an audit trail documenting analytical decisions at each stage of data processing. Confirmability was supported by peer debriefing sessions with independent researchers familiar with TVET contexts and by expert validation of the coding framework. Transferability was addressed through detailed contextual description of the research setting and participant characteristics, enabling readers to assess applicability to comparable TVET environments.

RESULTS AND DISCUSSION

Results

Systematic literature review findings - article selection process

The article selection process followed the PRISMA 2020 guidelines (Page et al., 2021), ensuring systematic transparency across all stages of identification, screening, eligibility assessment, and final inclusion. The initial database search across Scopus, Web of Science, ScienceDirect, and ERIC retrieved 1,247 records using the defined keyword combinations. Following automated and manual duplicate removal, 894 unique records remained for title and abstract screening. Of these, 621 records were excluded at the screening stage due to irrelevance to the study's thematic scope primarily studies addressing general higher education pedagogy without vocational specificity, or entrepreneurship education outside TVET contexts. Full-text eligibility assessment was applied to 273 articles, of which 198 were subsequently excluded for the following reasons: insufficient methodological transparency ($n = 54$), publication format ineligibility including conference proceedings and book chapters ($n = 71$), absence of empirical or conceptual contribution to TeFa or entrepreneurship-TVET integration ($n = 47$), and publication outside the 2020–2026 window ($n = 26$). A total of 75 articles met all inclusion criteria and formed the corpus for thematic synthesis and analytical review.

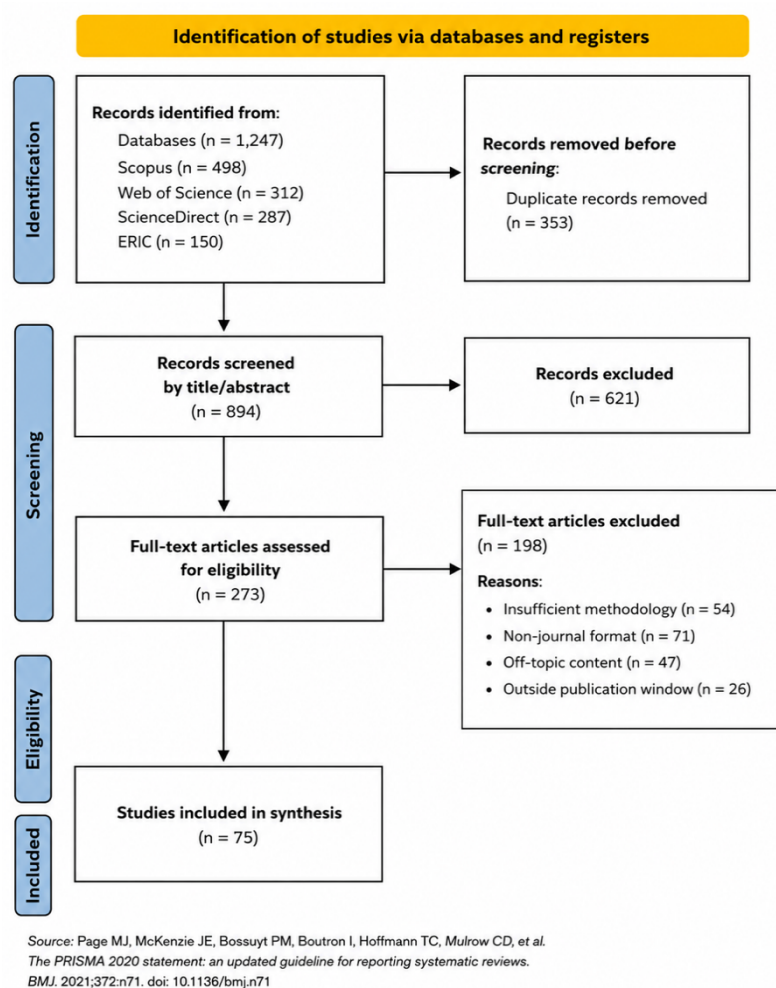


Figure 1. PRISMA flow diagram of article selection

As illustrated in Figure 1, the PRISMA flow diagram documents a proportional exclusion rate of approximately 94% from the initial retrieved records to the final included corpus. This high exclusion rate reflects the specificity of the inclusion criteria and the relatively narrow intersection of TeFa pedagogy, entrepreneurship education, and TVET within indexed literature. The final corpus of 75 articles provided a substantive and analytically tractable evidence base for the objectives of this review.

Bibliometric and publication trends

Table 1 presents the distribution of 75 included articles across the publication period of 2020–2025, revealing a discernible increase in scholarly output from 7 articles in 2020 to a peak of 18 articles in 2023, followed by a moderate stabilization in 2024 (n = 16) and 2025 (n = 10). The 2022–2024 interval concentrated the highest density of empirical studies (n = 48; 64%), indicating that field-based research on TeFa and entrepreneurship integration entered a productive phase concurrent with post-pandemic vocational reform initiatives across multiple national contexts. The thematic shift observable across the publication timeline from COVID-19 TVET adaptation in 2020 toward competency-based curriculum innovation and integrated entrepreneurship-based learning models in 2024–2025 suggests an evolving scholarly orientation from crisis-response documentation toward proactive instructional design research.

Table 1. Distribution of articles by publication year

Year	Number of Articles	Percentage (%)	Dominant Theme
2020	7	9.3	TeFa implementation; COVID-19 TVET adaptation
2021	10	13.3	Employability skills; digital vocational learning
2022	14	18.7	Entrepreneurship integration; workforce readiness
2023	18	24.0	TeFa-industry collaboration; entrepreneurial mindset
2024	16	21.3	Competency-based TVET; curriculum innovation
2025	10	13.3	Entrepreneurship-based learning models; SLR studies
Total	75	100	

Source: Authors' own analysis of included literature (2020–2025)

As presented in Table 2, Indonesia represented the single largest national contributor to the corpus, accounting for 29.3% of included articles ($n = 22$), consistent with the Indonesian government's large-scale TeFa expansion policy under the vocational revitalization program (Revitalisasi SMK). Germany contributed 14.7% of articles ($n = 11$), primarily comprising conceptual and design-based studies reflecting its established dual-system infrastructure, while Malaysian and Chinese studies concentrated on quantitative assessment of entrepreneurship education outcomes. Table 2 further shows that quantitative and mixed-methods approaches collectively dominated the corpus, appearing in approximately 61% of articles, indicating a prevailing orientation toward measurable outcomes. This methodological pattern simultaneously reveals a relative underrepresentation of qualitative and participatory approaches capable of capturing stakeholder experience and institutional complexity with greater contextual depth.

Table 2. Country and research method distribution

Country/Region	n	(%)	Dominant Method
Indonesia	22	29.3	Mixed-methods; quasi-experimental
Germany	11	14.7	Conceptual; design-based research
Malaysia	9	12.0	Quantitative; survey-based
China	7	9.3	Quantitative; longitudinal
Nigeria/Sub-Saharan Africa	6	8.0	Qualitative; case study
United Kingdom	5	6.7	Systematic review; mixed-methods
Other (multiple)	15	20.0	Varied
Total	75	100	

Source: Authors' own analysis of included literature (2020–2025)

Figure 2 illustrates the annual publication trend across the review period, depicting a progressive increase from 7 articles in 2020 to a peak of 18 in 2023, followed by a moderate decline to 16 in 2024 and 10 in 2025. The upward trajectory observed between 2020 and 2023 suggests that scholarly interest in entrepreneurship-oriented vocational learning intensified in the period following COVID-19-related TVET disruptions and

accelerated Industry 4.0 adoption. The post-2023 stabilization visible in Figure 2 may reflect a transition from emergent to consolidating scholarship, wherein earlier exploratory and descriptive studies are giving way to more integrative and evaluative research designs.

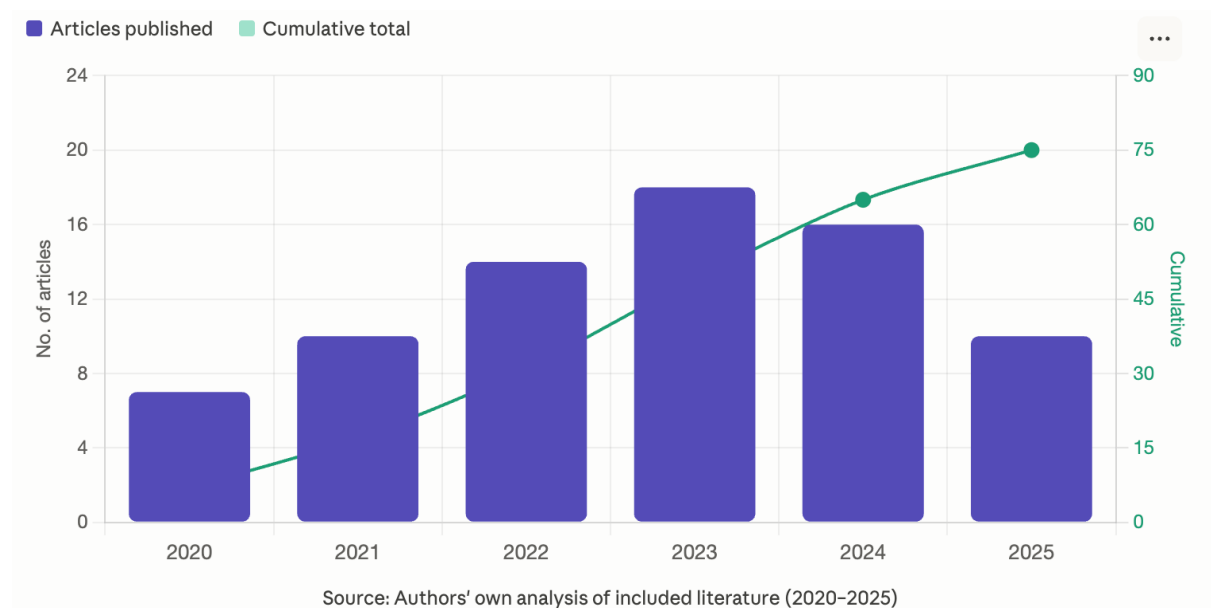
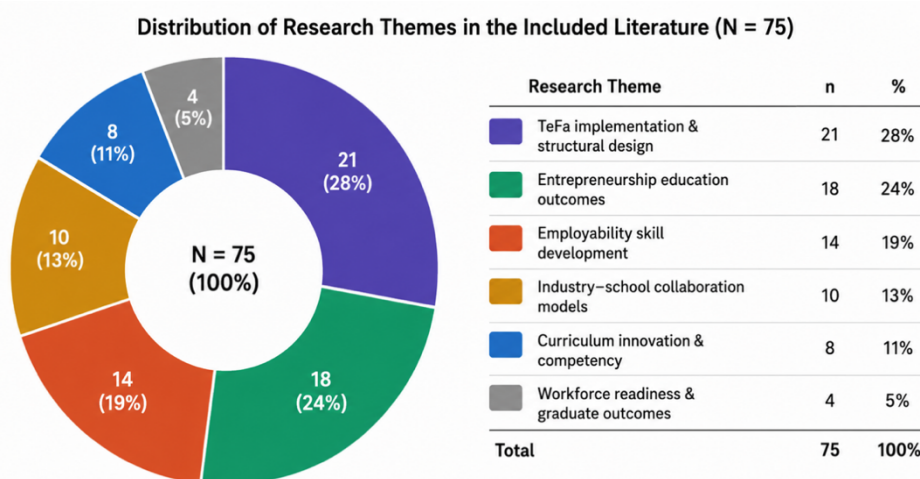


Figure 2. Annual publication trend of included articles (2020–2025)

Figure 3 presents the thematic mapping of the 75 articles across six identified research clusters. As shown in Figure 3, TeFa implementation and structural design constituted the largest cluster ($n = 21$; 28%), followed by entrepreneurship education outcomes in TVET ($n = 18$; 24%), employability skill development ($n = 14$; 18.7%), industry-school collaboration models ($n = 10$; 13.3%), curriculum innovation and competency frameworks ($n = 8$; 10.7%), and workforce readiness and graduate outcomes ($n = 4$; 5.3%). The preponderance of studies in the first two clusters together accounting for 52% of the corpus as visible in Figure 3 confirms that TeFa implementation and entrepreneurship education have been examined predominantly as distinct rather than integrated research domains, with the remaining clusters receiving comparatively limited scholarly attention despite their relevance to graduate employment outcomes.



Source: Authors' own analysis of included literature (2020–2025)

Figure 3. Research theme mapping

Thematic synthesis of previous studies

Table 3 presents the thematic classification of 12 representative studies selected from the final corpus, organized by research focus, methodology, key findings, and identified research gap. As shown in Table 3, studies examining TeFa implementation including Nurhadi et al. (2023), Köhler et al. (2021), Yahya et al. (2021), Subandi et al. (2022), and Putri et al. (2022) consistently reported that TeFa functions effectively as a technical competency development environment while entrepreneurship integration remains structurally absent or peripheral. Concurrently, studies addressing entrepreneurship education outcomes in TVET including Wibowo et al. (2022), Htay and Lim (2021), and Sung et al. (2021) demonstrated measurable positive effects on entrepreneurial intention and vocational self-efficacy but did not examine TeFa as the instructional vehicle through which these outcomes were achieved. Table 3 further reveals that conceptual and policy-oriented studies including Raharjo and Yudha (2023), Lackéus (2020), Eichhorst et al. (2020), and McGrath et al. (2020) explicitly identified the need for integrated entrepreneurship–TeFa frameworks yet did not provide empirical validation of such frameworks. This pattern of recognition without operationalization constitutes the most consistent research gap evident across Table 3 and indicates a substantive deficit in the evidence base that the present study directly addresses.

Table 3. Thematic classification of selected studies

Author(s)	Year	Research Focus	Methodology	Key Findings	Research Gap
Nurhadi et al.	2023	TeFa implementation in Indonesian SMK	Mixed-methods	TeFa improved practical competencies; entrepreneurship integration was minimal	No entrepreneurial outcome indicators measured
Köhler et al.	2021	TeFa challenges in Industry 4.0	Conceptual/review	Institutional barriers limit TeFa scalability	Lack of field-based validation
Yahya et al.	2021	TeFa in Malaysian vocational colleges	Qualitative case study	TeFa strengthens technical readiness; entrepreneurship poorly embedded	Absence of entrepreneurial competency framework
Wibowo et al.	2022	Entrepreneurship education in Indonesian SMK	Quantitative survey	Structured entrepreneurship education raised graduate self-efficacy	TeFa not examined as instructional vehicle
Htay & Lim	2021	Entrepreneurship education and self-employment intention	Survey/SEM	Positive effect on TVET graduates' entrepreneurial intention	Contextual factors of TeFa not considered
Subandi et al.	2022	TeFa implementation constraints	Qualitative	Educator competency and infrastructure gaps impede entrepreneurial learning	No employability assessment conducted
Putri et al.	2022	TeFa in Indonesia:	Mixed-methods	Policy support	Industry

Author(s)	Year	Research Focus	Methodology	Key Findings	Research Gap
al.		challenges and opportunities		exists but implementation unevenness persists	collaboration inadequately analyzed
Sung et al.	2021	Entrepreneurship education and student outcomes	Meta-analysis	Entrepreneurship education positively influences vocational students' performance	TeFa not included as independent variable
Raharjo & Yudha	2023	Industry-based learning models in SMK	Conceptual	Need for integrated entrepreneurship–TeFa model identified	Empirical validation absent
Lackéus	2020	Experiential entrepreneurship in education	Comparative study	Experiential approaches outperform traditional instruction in entrepreneurial competency	TVET-specific contexts underrepresented
Eichhorst et al.	2020	Vocational education in the digital age	Policy analysis	Digital transformation requires entrepreneurial skill reorientation	No TeFa-specific analysis conducted
McGrath et al.	2020	TVET for African development	Literature review	TVET reform requires contextualized, industry-integrated approaches	Entrepreneurship integration undertheorized

Source: Authors' own synthesis of included literature (2020–2025)

Research gap identification

Figure 4 presents the conceptual research gap framework derived from systematic analysis of the 75 included articles, positioning four interrelated domains Teaching Factory, Entrepreneurship Education, Employability Skills, and TVET Transformation as overlapping constructs without a unifying instructional architecture in the existing literature. As illustrated in Figure 4, bilateral relationships between domain pairs have been addressed in the literature: TeFa and technical skill development, entrepreneurship education and self-employment intention, and employability skills and graduate outcomes each represent documented research trajectories. However, Figure 4 identifies the central intersection of all four domains the site where entrepreneurship-based TeFa would function as an integrated instructional model supporting TVET transformation as an empirically unoccupied space in the current literature. Four intersecting limitations derived from the corpus substantiate the gap depicted in Figure 4. First, entrepreneurship integration within TeFa has been treated as additive rather than structural (Köhler et al., 2021; Subandi et al., 2022). Second, employability-oriented TeFa instructional models specifying competency indicators and assessment criteria are absent from the literature (Nurhadi et al., 2023; Yahya et al., 2021). Third, the dominance of single-institution and European-context studies limits applicability to Southeast Asian and Sub-Saharan African TVET systems (McGrath et

al., 2020; Putri et al., 2022). Fourth, industry practitioner perspectives on entrepreneurial and employability needs remain systematically underrepresented across the corpus, with most studies drawing exclusively on educator or student samples.

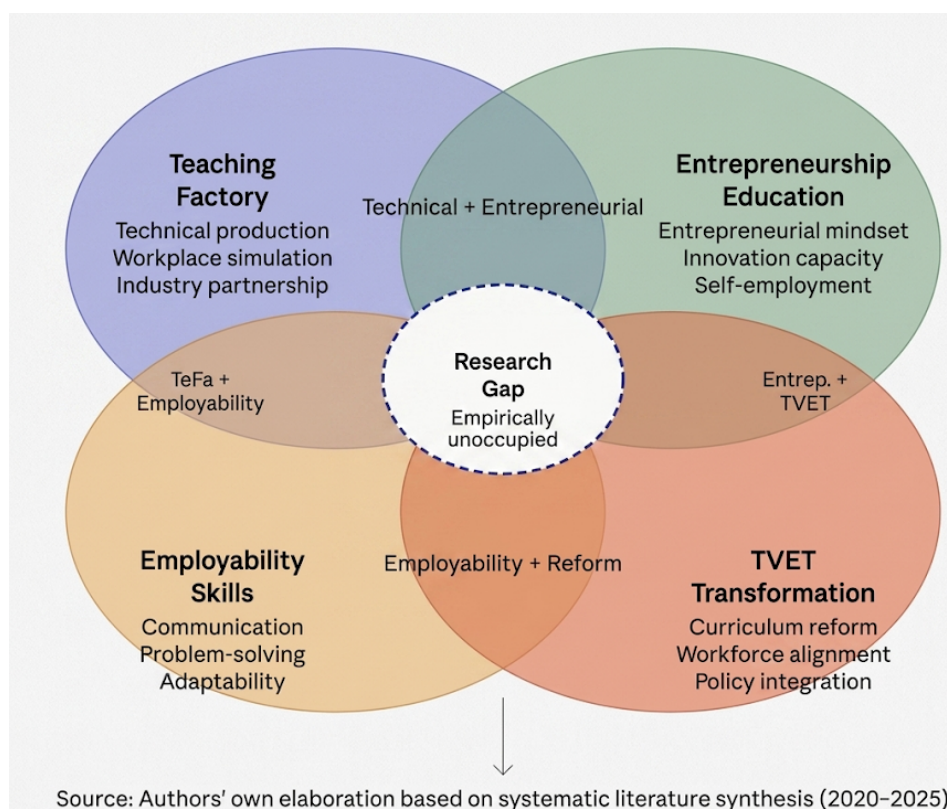


Figure 4. Conceptual research gap framework

Field needs analysis findings

Participant demographic profiles

Table 4 presents the demographic characteristics of the 48 participants engaged across the field needs analysis. As shown in Table 4, students constituted the largest single participant category ($n = 16$; 33.3%), followed by vocational teachers ($n = 14$; 29.2%) and automotive industry practitioners ($n = 10$; 20.8%). Table 4 further indicates that industry practitioners registered the highest mean years of professional experience (13.7 years), followed by school administrators (15.2 years) and vocational teachers (11.4 years), suggesting that participant knowledge bases across categories were substantive and contextually relevant. The inclusion of industry practitioners alongside school-based participants addresses the systematic underrepresentation of industry voices in prior TeFa research identified in the SLR findings reported in Table 3, and provides a comparative basis for analyzing the alignment between institutional practices and labor market expectations.

Table 4. Demographic characteristics of participants

Participant Category	n	(%)	Mean Years of Experience	Educational Background
Vocational teachers (TeFa instructors)	14	29.2	11.4 years	S1/S2 in Vocational/Technical Education
Automotive industry practitioners	10	20.8	13.7 years	D3/S1 in Engineering/Business

Participant Category	n	(%)	Mean Years of Experience	Educational Background
TVET students (Grade XI–XII)	16	33.3	N/A	Currently enrolled in TeFa program
Curriculum coordinators	5	10.4	9.8 years	S1/S2 in Education Management
School administrators	3	6.3	15.2 years	S2 in Educational Administration
Total	48	100		

Source: Authors' own field data (2026)

Current conditions of teaching factory implementation

Table 5 presents a cross-institutional comparison of existing TeFa practices across the three participating schools. As shown in Table 5, TeFa implementation remained predominantly production-centered and technical in orientation across all three sites, with no institution demonstrating a fully structured entrepreneurship integration framework. School B exhibited the most advanced developmental profile in Table 5, incorporating a basic business simulation unit and partial communication skill instruction, though these elements constituted isolated additions rather than systematically embedded dimensions of the TeFa instructional cycle. Table 5 further reveals that industry partnership status varied substantially across institutions: School A maintained an active MoU with two companies, while Schools B and C reported inactive or informal industry relationships respectively, constraining the authenticity of workplace simulation and the alignment of production experiences with current industry standards. The competency orientation column in Table 5 indicates that all three schools conceptualized TeFa primarily as a technical proficiency environment, with student roles consistently framed as task executors rather than as entrepreneurially oriented agents exercising independent judgment, client responsiveness, or innovative problem-solving.

Table 5. Existing teaching factory practices in TVET institutions

Implementation Dimension	School A	School B	School C
Production unit type	Automotive repair workshop	Automotive service center	Fabrication and maintenance unit
Industry partnership status	Active MoU with 2 companies	MoU inactive (not renewed)	No formal MoU; informal relationships
Entrepreneurship activities	None structured	Basic business simulation (1 unit)	Occasional market day activity
Competency orientation	Primarily technical	Technical with limited business orientation	Technical only
Student role in production	Executor (task-following)	Executor with limited client interaction	Executor only
Employability skills explicitly taught	No	Partially (communication only)	No
Assessment type	Product quality and speed	Product quality; limited soft skills	Product quality only

Source: Authors' own field observation and document analysis

Figure 5 illustrates the observed TeFa learning structure across the three participating institutions, depicting a linear instructional sequence: teacher demonstration → student skill practice → production task execution → product quality assessment. As shown in Figure 5, this four-phase structure produces a closed instructional cycle oriented exclusively toward technical output quality. Notably absent from the structure depicted in Figure 5 are phases corresponding to market orientation, entrepreneurial problem-solving, client negotiation, business planning, innovation reflection, or self-directed production ideation dimensions that the SLR findings identified as constitutive of entrepreneurship-based TeFa models. The gap between the current structure represented in Figure 5 and the requirements of an entrepreneurship-integrated TeFa model provides empirical grounding for the instructional framework proposed in Section 9.

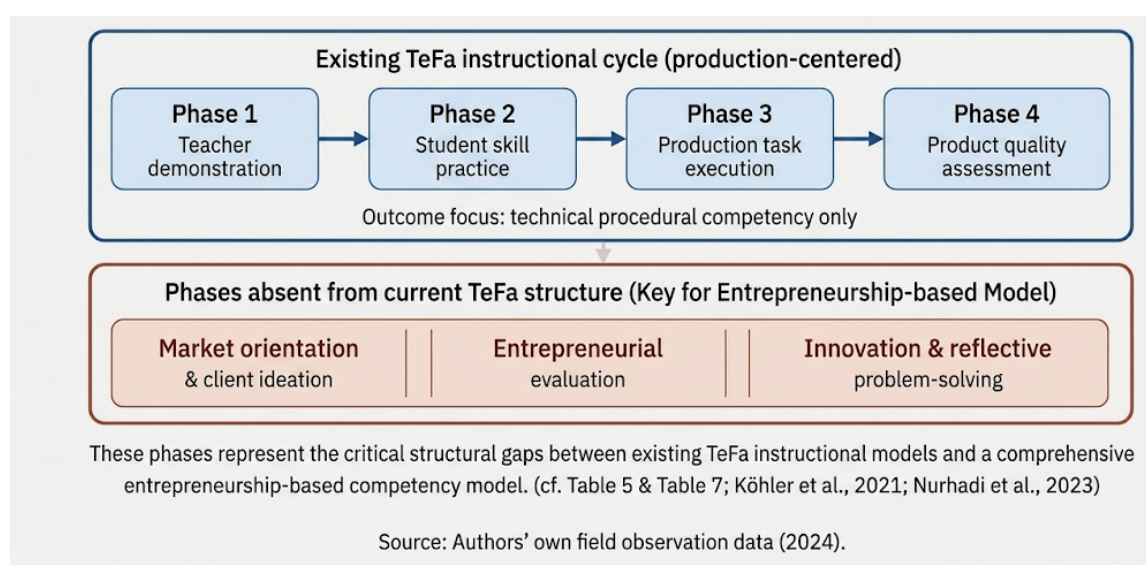


Figure 5. Conceptual research gap framework

Employability and entrepreneurship skill needs

Table 6 presents the competency gap analysis derived from needs analysis questionnaire responses, comparing current TeFa implementation mean scores against industry expectation mean scores across nine competency dimensions. As shown in Table 6, technical and procedural competency exhibited the smallest gap between current practice and industry expectation (gap score = 0.18; priority: Low), confirming that existing TeFa structures are functionally effective at producing technical skill. In contrast, Table 6 identifies entrepreneurial mindset (gap = 2.32), self-employment orientation (gap = 2.24), adaptability (gap = 2.19), and innovation capability (gap = 2.19) as the dimensions with the largest discrepancies, each classified at the Very High priority level. The data presented in Table 6 indicate that these four competencies currently receive the lowest mean implementation scores (ranging from 1.74 to 1.92 out of 5.00), despite registering among the highest industry expectation scores, suggesting a systematic inversion of instructional emphasis relative to labor market demand. Communication skills (gap = 1.74) and problem-solving orientation (gap = 1.88) also registered gaps classified as High priority in Table 6, reflecting limited integration of interpersonal and higher-order cognitive competencies within the production-centered TeFa structure.

Table 6. Identified employability and entrepreneurship competency needs

Competency Dimension	Current TeFa Mean (1-5)	Industry Expectation Mean (1-5)	Gap Score	Priority Level
Technical/procedural skill	4.12	4.30	0.18	Low
Communication skills	2.41	4.15	1.74	High
Teamwork and collaboration	2.87	4.22	1.35	High
Problem-solving orientation	2.53	4.41	1.88	High
Adaptability to change	2.18	4.37	2.19	Very High
Digital readiness	2.34	4.28	1.94	High
Entrepreneurial mindset	1.87	4.19	2.32	Very High
Innovation capability	1.92	4.11	2.19	Very High
Self-employment orientation	1.74	3.98	2.24	Very High

Source: Authors' own field questionnaire data (2026)

Figure 6 displays the divergence in competency prioritization between school-based and industry-based stakeholders, as derived from interview data and cross-referenced with the gap scores reported in Table 6. As illustrated in Figure 6, industry practitioners ranked adaptability, entrepreneurial mindset, and problem-solving as the three most critical competencies for graduate employability, while teachers ranked technical skill, communication, and teamwork as their primary instructional priorities. The divergence visible in Figure 6 indicates a misalignment in the educational goals guiding TeFa design and the workforce demands shaping graduate recruitment criteria a pattern that corroborates the industry alignment issues identified thematically in Table 7 and the competency gap data presented in Table 6.

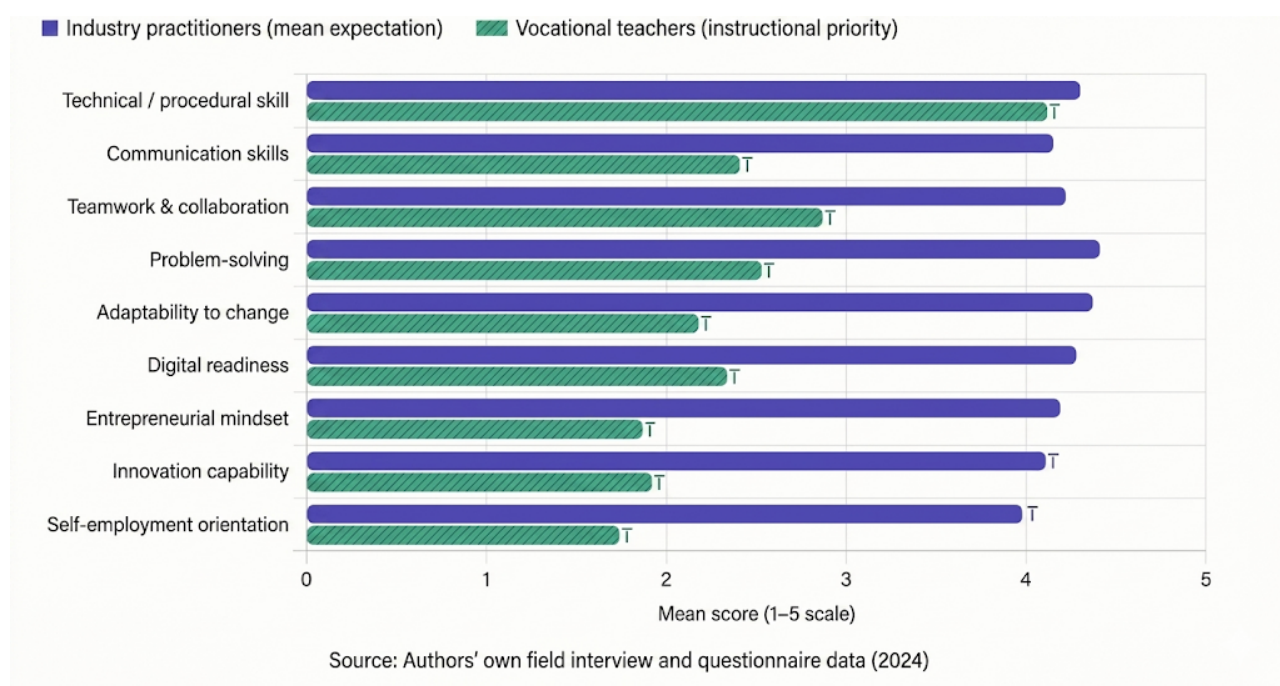


Figure 6. Stakeholder priority competencies

Stakeholder perspectives

Table 7 presents the thematic coding outcomes from semi-structured interview data, organized by stakeholder category, primary theme, analytical summary, and frequency of mention. As shown in Table 7, curriculum limitation was the most broadly shared thematic concern across stakeholder groups, identified by 13 of 14 teachers and all 5 curriculum coordinators as a primary constraint on entrepreneurship integration within TeFa. Table 7 further reveals that industry practitioners (9/10) identified entrepreneurial initiative, client orientation, and problem-solving under uncertainty as the most consistently insufficient competencies among TeFa graduates a finding that directly parallels the Very High priority gap scores for entrepreneurial mindset, adaptability, and problem-solving reported in Table 6. The student perspectives presented in Table 7 indicate that 14 of 16 student participants experienced entrepreneurship content as abstract and structurally disconnected from TeFa production activities, reflecting the instructional gap between the existing TeFa learning structure illustrated in Figure 5 and the competency dimensions prioritized by industry stakeholders in Figure 6. The convergence of responses across four stakeholder categories on two core issues entrepreneurship insufficiency in instructional design and curriculum structural constraint suggests that strengthening entrepreneurship-based TeFa requires coordinated intervention at both the instructional design and curriculum policy levels.

Table 7. Stakeholder perspectives on entrepreneurship-based teaching factory learning

Stakeholder Category	Primary Theme	Representative Analytical Summary	Frequency
Vocational teachers	Instructional challenge	Absence of entrepreneurship-oriented lesson plans; limited educator training in entrepreneurial pedagogy	11/14
Vocational teachers	Curriculum limitation	TeFa curriculum documents do not specify entrepreneurship competency indicators or assessment rubrics	13/14
Industry practitioners	Industry alignment	Graduate technical skills adequate; entrepreneurial initiative, client orientation, and problem-solving under uncertainty consistently insufficient	9/10
Industry practitioners	Industry collaboration	Irregular school-industry communication limits relevance of TeFa production activities to current industry standards	8/10
Students	Entrepreneurial learning barrier	Entrepreneurship content perceived as abstract and disconnected from TeFa production activities; no practical business experience within TeFa	14/16
Students	Instructional challenge	Production tasks are repetitive; no opportunities for creative problem-solving or independent decision-making	12/16
Curriculum coordinators	Curriculum limitation	National vocational curriculum provides insufficient flexibility for entrepreneurship integration within TeFa structures	5/5
School administrators	Institutional challenge	Industry partnership agreements require renewal and resource investment not consistently supported at institutional level	3/3

Source: Authors' own thematic analysis of interview data (2026)

Proposed conceptual direction

Figure 7 presents the proposed entrepreneurship-based TeFa learning framework for TVET, developed through the convergent integration of SLR findings and field needs analysis data reported across Tables 1–7 and Figures 1–6. As illustrated in Figure 7, the framework organizes TeFa learning around five interconnected dimensions: Technical Production Competency, Entrepreneurship Integration, Employability Skill Development, Industry Collaboration, and Workforce Readiness Alignment. The positioning of these five dimensions in Figure 7 reflects the analytical synthesis presented throughout the Results section: Technical Production Competency represents the established strength of TeFa confirmed across Tables 5 and 6, while Entrepreneurship Integration, Employability Skill Development, and Industry Collaboration represent the three structural dimensions identified as most critically underdeveloped in both the literature (Table 3; Figure 4) and field data (Tables 6 and 7; Figures 5 and 6).

Figure 7 further depicts a cyclical instructional sequence of four phases Market Orientation and Ideation, Collaborative Production, Entrepreneurial Evaluation, and Reflective Innovation designed as an iterative cycle rather than a terminal sequence. This cyclical structure, absent from the current linear TeFa model shown in Figure 5, positions entrepreneurship as the organizing logic of TeFa's instructional architecture rather than as supplementary content. As shown in Figure 7, industry partner input is integrated at the Market Orientation and Entrepreneurial Evaluation phases, directly addressing the industry collaboration gaps identified in Table 5 and Table 7. Employability skill development is represented in Figure 7 as a cross-cutting objective embedded within each instructional phase, consistent with the field finding that employability competencies documented across the gap scores in Table 6 are most effectively developed through authentic, goal-directed production activities rather than through isolated instructional modules.

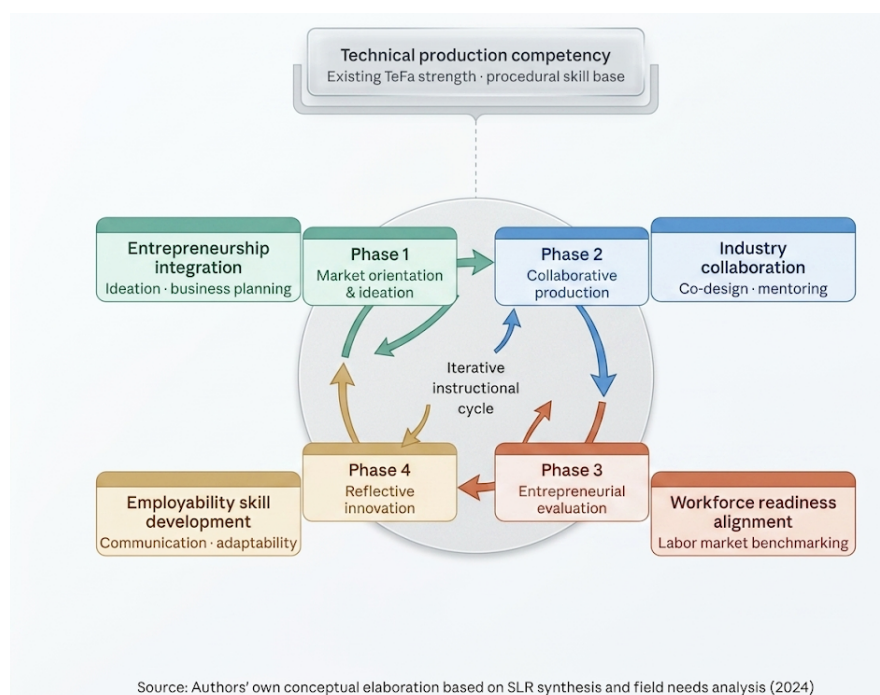


Figure 7. Proposed entrepreneurship-based teaching factory learning framework for TVET

Discussion

The systematic literature review findings reveal a discernible trajectory in global TVET scholarship: research attention has progressively shifted from narrow technical skill transmission toward broader competency-oriented and industry-aligned learning models, with Teaching Factory emerging as a structurally distinctive approach within this transition. The bibliometric analysis identified a concentration of empirical output between 2022 and 2024, a pattern consistent with the accelerated vocational reform discourse generated by post-pandemic labor market restructuring and Industry 4.0 adoption across multiple national contexts (UNESCO-UNEVOC, 2022; World Economic Forum, 2023). The thematic distribution of the corpus where TeFa implementation and entrepreneurship education together accounted for 52% of included articles yet were examined predominantly as separate research domains reflects a conceptual bifurcation that constrains the theoretical development of integrated vocational learning models. This bifurcation parallels findings by McGrath et al. (2020) and Pavlova (2021), who identified the persistent separation between technical competency development and broader employability or entrepreneurial frameworks as a structural limitation in TVET research and policy. The literature's treatment of TeFa primarily as a production simulation environment, rather than as a potential vehicle for entrepreneurial and employability competency development, suggests that the model's theoretical scope has been underutilized relative to its instructional architecture a gap that the present study's convergent design was constructed to address.

The field needs analysis data substantiate and extend this conceptual limitation by providing ground-level empirical evidence of its institutional consequences. The competency gap scores reported across nine dimensions indicate that the largest discrepancies between current TeFa practice and industry expectation are concentrated precisely in the competencies that existing TeFa programs structurally neglect: entrepreneurial mindset (gap = 2.32), self-employment orientation (gap = 2.24), adaptability (gap = 2.19), and innovation capability (gap = 2.19). These findings align with Htay and Lim's (2021) observation that TVET graduates consistently demonstrate technical adequacy while exhibiting deficits in the entrepreneurial and adaptive competencies increasingly required by contemporary labor markets, and with Wibowo et al.'s (2022) identification of self-efficacy gaps among Indonesian SMK graduates in non-technical employment contexts. The stakeholder interview data reinforce this interpretation: 13 of 14 teachers identified curriculum structural constraint as a primary barrier to entrepreneurship integration, while 9 of 10 industry practitioners specified entrepreneurial initiative and problem-solving under uncertainty as the most consistently insufficient attributes among TeFa graduates. This convergence across methodologically distinct data sources questionnaire, interview, and observation indicates that the competency misalignment is not attributable to isolated institutional factors but reflects a systemic orientation in TeFa design that prioritizes output quality over entrepreneurial agency. Subandi et al. (2022) and Köhler et al. (2021) similarly identified educator competency limitations and institutional curriculum constraints as compounding factors in TeFa's restricted entrepreneurial scope, suggesting that the barriers observed in the present field data are not unique to the Indonesian context but reflect broader structural patterns in TeFa implementation internationally.

The conceptual integration of entrepreneurship education within TeFa learning, as proposed in the framework emerging from this study, is theoretically grounded in experiential learning theory (Kolb, 1984) and its contemporary applications to vocational education contexts. Lackéus (2020) demonstrated that experiential

entrepreneurship approaches those embedding entrepreneurial problem-solving within authentic production or service contexts rather than delivering entrepreneurship as declarative content produce measurably stronger effects on entrepreneurial competency development than conventional instructional approaches. TeFa's existing structural capacity for authentic industry simulation positions it as a natural environment for this form of experiential entrepreneurship, provided that its instructional cycle is redesigned to incorporate market orientation, client-responsive production planning, and entrepreneurial evaluation phases. This reconceptualization aligns with Bacigalupo et al.'s (2016) EntreComp framework, which defines entrepreneurial competency not as a set of isolated business skills but as an integrated capacity encompassing opportunity sensing, resource mobilization, and adaptive action under uncertainty all of which can be operationalized within a production-oriented TeFa environment when the instructional architecture explicitly foregrounds these dimensions. The industry collaboration dimension of the proposed framework further connects to Eichhorst et al.'s (2020) argument that meaningful vocational transformation requires industry partners to function as co-designers of learning experiences rather than merely as placement providers, a role that demands active renegotiation of school-industry partnership agreements and educator professional development programs oriented toward entrepreneurial pedagogy.

The theoretical and practical implications of this study extend across three interrelated levels of vocational education systems. At the instructional design level, the proposed framework suggests that TeFa's production cycle can serve as the organizing structure for entrepreneurship-based competency development without displacing its technical learning function an integration that addresses the additive treatment of entrepreneurship identified as a limitation in the literature (Köhler et al., 2021; Subandi et al., 2022) by reconceptualizing entrepreneurship as the instructional logic governing how production tasks are selected, executed, and evaluated. At the curriculum policy level, the finding that all five curriculum coordinators in the field data identified national curriculum flexibility as a structural constraint points toward the need for vocational education policy frameworks that accommodate competency-based TeFa designs incorporating entrepreneurial learning indicators and assessable entrepreneurial outcomes, consistent with the curriculum innovation directions identified by Nurhadi et al. (2023) and Putri et al. (2022) in Indonesian TVET contexts. At the systemic level, the alignment between global SLR-identified gaps and locally observed institutional needs suggests that the conceptual framework developed here carries relevance beyond the specific Indonesian context to TVET systems in other developing economies undergoing analogous tensions between technical skill production and graduate employability. The study's contribution is, however, bounded by the absence of experimental or longitudinal data validating the proposed framework's effects on measurable entrepreneurial and employability outcomes a limitation that delineates the primary agenda for subsequent research, including instrument development for entrepreneurial competency assessment within TeFa environments, quasi-experimental implementation studies, and multi-site comparative analyses across national TVET contexts.

CONCLUSION

Fundamental Findings: This study established that the structural integration of entrepreneurship education within Teaching Factory learning represents an empirically substantiated and theoretically coherent direction for strengthening TVET systems

confronting the dual challenge of technical competency production and graduate employability. The convergence of systematic literature review findings and field-based needs analysis data across two methodologically distinct evidence streams confirmed a consistent pattern: existing TeFa programs develop technical procedural competencies with measurable effectiveness, yet leave entrepreneurial mindset, adaptability, innovation capability, and self-employment orientation the competency dimensions most consistently prioritized by industry stakeholders without systematic instructional attention. The competency gap scores documented in this study, particularly the 2.32-point discrepancy in entrepreneurial mindset and the 2.24-point discrepancy in self-employment orientation between current TeFa practice and industry expectation, provide quantifiable evidence that the misalignment between vocational learning outcomes and labor market demands is not attributable to technical deficiency but to a structural narrowing of TeFa's instructional scope. The proposed five-dimensional entrepreneurship-based TeFa framework, organized around a four-phase iterative instructional cycle, addresses this narrowing by repositioning entrepreneurship as the organizing logic of TeFa's pedagogical architecture rather than as peripheral supplementary content. This repositioning constitutes the study's central theoretical contribution: that TeFa's existing structural capacity for authentic industry simulation can serve as the instructional vehicle for entrepreneurship education when its production cycle is deliberately redesigned to incorporate market orientation, entrepreneurial evaluation, and reflective innovation phases alongside collaborative technical production. **Implications:** The findings of this study carry structured implications across instructional, curricular, and systemic levels of TVET development. At the instructional level, the four-phase cyclical model proposed in this study offers vocational educators a replicable design architecture for integrating entrepreneurial learning objectives within production-based TeFa activities without dismantling the technical competency development function that TeFa currently performs. This design architecture directly addresses the finding that 13 of 14 participating teachers identified the absence of entrepreneurship-oriented lesson plans as a primary instructional constraint, pointing toward the need for targeted educator professional development programs oriented toward entrepreneurial pedagogy within vocational production environments. At the curriculum policy level, the identification of national curriculum structural inflexibility as a shared concern across all five participating curriculum coordinators indicates that policy-level intervention is a necessary complement to instructional redesign specifically, the development of national vocational curriculum frameworks that specify entrepreneurial competency indicators, incorporate assessable entrepreneurial learning outcomes, and provide the structural flexibility required for industry co-design of TeFa learning experiences. At the systemic level, the framework's emphasis on repositioning industry partners as co-designers of instructional content particularly at the market orientation and entrepreneurial evaluation phases carries direct operational implications for how school-industry memoranda of understanding are negotiated, renewed, and structurally embedded within institutional TeFa governance. For TVET policymakers in Indonesia and comparable developing-economy contexts, these findings collectively indicate that sustainable vocational transformation requires coordinated intervention across all three levels rather than isolated improvement at any single point in the educational system. **Limitations:** The interpretive scope of this study's findings is bounded by several methodological constraints that bear explicit acknowledgment. The field needs analysis was conducted exclusively within three vocational high schools in East Java, Indonesia, operating

within the automotive engineering competency area, which limits the direct institutional transferability of findings to vocational programs in other competency fields, regional settings within Indonesia, or TVET systems in other national contexts. The participant sample of 48 individuals, while purposively selected to ensure cross-stakeholder representativeness, does not constitute a sufficiently large or randomized sample to support statistical generalization of the competency gap scores or stakeholder perspective frequencies reported in the results. The cross-sectional design of the field data collection precludes longitudinal or causal inference regarding the relationship between entrepreneurship-integrated TeFa design and measurable changes in graduate entrepreneurial competency or employment outcomes over time. The proposed framework, while grounded in the convergent synthesis of international literature and institutional field evidence, remains at the conceptual stage and has not been subjected to experimental implementation or quasi-experimental outcome evaluation. These boundaries define the conditions under which the study's findings should be applied by practitioners and the thresholds beyond which its claims should not be extended without additional empirical corroboration. **Future Research:** The limitations and conceptual directions identified in this study delineate a substantive agenda for subsequent empirical and methodological inquiry. Quasi-experimental and design-based research studies are needed to implement the proposed entrepreneurship-based TeFa framework within actual vocational learning environments and assess its effects on entrepreneurial mindset development, employability competency acquisition, and industry alignment among students across diverse vocational fields and institutional contexts. Instrument development research represents a parallel and equally pressing priority: validated assessment tools capable of measuring entrepreneurial competency dimensions including innovation capacity, self-employment orientation, and adaptive problem-solving within production-based TeFa environments are currently absent from the TVET assessment literature, and their development would provide the measurement infrastructure necessary for rigorous outcome evaluation in subsequent implementation studies. Multi-site comparative research examining TeFa or dual-system equivalents across established national contexts including Germany, Malaysia, and selected Sub-Saharan African TVET systems would generate cross-contextual evidence capable of identifying which dimensions of the proposed framework are most sensitive to national institutional conditions and which demonstrate transferable applicability. Longitudinal cohort studies tracking the labor market trajectories of graduates from entrepreneurship-integrated TeFa programs over periods of three to five years post-graduation would produce the outcome evidence most directly relevant to policy investment decisions. Taken together, these research directions position the present study not as a terminal contribution but as a foundational reference point from which the empirical validation and iterative refinement of entrepreneurship-based TeFa as a transformative TVET learning model can proceed.

ACKNOWLEDGEMENTS

The authors express gratitude to the principals, vocational teachers, curriculum coordinators, and students of the participating vocational high schools (Sekolah Menengah Kejuruan) in East Java, Indonesia, for their willingness to contribute time and experiential knowledge to the field needs analysis component of this study. Appreciation is also extended to the automotive industry practitioners whose professional perspectives substantially informed the competency gap analysis and stakeholder priority findings reported in this work.

AUTHOR CONTRIBUTIONS

Indra Wahyu Suliswanto contributed to conceptualization, research design, data collection coordination, thematic synthesis of SLR findings, and drafting of the manuscript. **Ekohariadi** was responsible for methodology development, field needs analysis supervision, quantitative data analysis, and critical review of the manuscript. **Ratna Suhartini** contributed to the theoretical framework, literature validation, data interpretation, and final revision of the manuscript. All listed authors have reviewed and approved the final version of this submission

CONFLICT OF INTEREST STATEMENT

The authors declare that no conflict of interest, either financial or personal in nature, exists that could have influenced the design, execution, interpretation, or reporting of this study. No funding was received from commercial entities with a direct stake in the findings, and no author holds institutional, professional, or personal relationships that could constitute a competing interest with respect to the content of this manuscript.

ETHICAL COMPLIANCE STATEMENT

This manuscript adheres fully to the principles of research and publication ethics. The study was conducted with academic integrity, and all data reported herein were collected, processed, and presented accurately and transparently. Informed consent was obtained from all research participants prior to data collection, and participant anonymity and confidentiality were maintained throughout the study. No data were fabricated, falsified, or selectively reported.

STATEMENT ON THE USE OF AI OR DIGITAL TOOLS IN WRITING

The authors acknowledge the use of digital and AI-based tools as supplementary support during the research and writing processes of this article. Specifically, Gemini Ai was employed to assist with manuscript drafting, structural refinement, and language editing at selected stages of writing.

REFERENCES

- Abele, E., Metternich, J., Tisch, M., Chryssolouris, G., ElMaraghy, W., ElMaraghy, H., Renn, O., Urgo, M., Valckenaers, P., & Sihn, W. (2015). Learning factories for research, education, and training. *Procedia CIRP*, 32, 1–6. <https://doi.org/10.1016/j.procir.2015.02.187>
- Bacigalupo, M., Kampylis, P., Punie, Y., & Van den Brande, G. (2016). *EntreComp: The entrepreneurship competence framework*. Publications Office of the European Union. <https://doi.org/10.2791/593884>
- Badan Pusat Statistik. (2023). *Keadaan ketenagakerjaan Indonesia Februari 2023*. Badan Pusat Statistik Republik Indonesia. <https://www.bps.go.id>
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101. <https://doi.org/10.1191/1478088706qp063oa>
- Chryssolouris, G., Mavrikios, D., & Rentzos, L. (2016). The teaching factory: A manufacturing education paradigm. *Procedia CIRP*, 57, 44–48. <https://doi.org/10.1016/j.procir.2016.11.009>
- Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). SAGE Publications.
- Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry and research design: Choosing among five approaches* (4th ed.). SAGE Publications.

- Direktorat Jenderal Pendidikan Vokasi. (2022). *Laporan kinerja Direktorat Jenderal Pendidikan Vokasi tahun 2022*. Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi Republik Indonesia. <https://www.vokasi.kemdikbud.go.id>
- Eichhorst, W., Rinne, U., & Wozny, F. (2020). *Vocational education and training in the digital age* (IZA Discussion Paper No. 13736). Institute of Labor Economics. <https://doi.org/10.2139/ssrn.3724438>
- European Commission. (2021). *Entrepreneurship education at school in Europe: Eurydice report*. Publications Office of the European Union. <https://doi.org/10.2797/706463>
- Htay, M., & Lim, S. (2021). Entrepreneurship education and its effects on students' entrepreneurial intentions in TVET institutions. *Journal of Technical Education and Training*, 13(2), 1–12. <https://doi.org/10.30880/jtet.2021.13.02.001>
- International Labour Organization. (2023). *World employment and social outlook: Trends 2023*. International Labour Office. https://www.ilo.org/global/research/global-reports/weso/WCMS_865332/lang-en/index.htm
- Köhler, C., Weißfloch, U., & Zenker-Hoffmann, A. (2021). Teaching factory implementation challenges in the context of Industry 4.0. *Procedia Manufacturing*, 55, 492–498. <https://doi.org/10.1016/j.promfg.2021.10.067>
- Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Prentice Hall.
- Lackéus, M. (2020). Comparing the impact of three different experiential approaches to entrepreneurship in education. *International Journal of Entrepreneurial Behavior & Research*, 26(5), 937–971. <https://doi.org/10.1108/IJEBr-04-2019-0254>
- Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. SAGE Publications.
- Marope, M., Chakroun, B., & Holmes, K. (2020). *Unleashing the potential: Transforming technical and vocational education and training*. United Nations Educational, Scientific and Cultural Organization. <https://unesdoc.unesco.org/ark:/48223/pf0000119320>
- McGrath, S., Ramsarup, P., Zeelen, J., Wedekind, V., Allais, S., Lotz-Sisitka, H., Monks, T., Openjuru, G., & Russon, J.-A. (2020). Vocational education and training for African development: A literature review. *Journal of Vocational Education & Training*, 72(4), 465–487. <https://doi.org/10.1080/13636820.2019.1679969>
- Nguyen, H. T., Pham, H. T., & Le, A. V. (2021). Work-based learning in TVET: A systematic review. *International Journal of Training Research*, 19(3), 241–258. <https://doi.org/10.1080/14480220.2021.1957595>
- Nurhadi, D., Pramono, S. E., & Hartanto, W. (2023). Teaching factory model implementation in vocational high schools. *Jurnal Pendidikan Vokasi*, 13(1), 45–58. <https://doi.org/10.21831/jpv.v13i1.52341>
- Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., ... Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, 372, n71. <https://doi.org/10.1136/bmj.n71>
- Pavlova, M. (2021). Technology and vocational education for sustainable development. In R. Maclean (Ed.), *Life in schools and classrooms: Past, present and future* (pp. 631–648). Springer. https://doi.org/10.1007/978-981-10-3654-5_38
- Putri, A. R., Sugiyono, & Haryanto. (2022). Teaching factory implementation in Indonesia: Challenges and opportunities. *Journal of Education and Learning*, 16(3), 388–396. <https://doi.org/10.11591/edulearn.v16i3.20341>

- Raharjo, E., & Yudha, R. P. (2023). *Pengembangan model pembelajaran berbasis industri pada SMK* [Manuscript in preparation]. Graduate School, Universitas Negeri Surabaya.
- Rennung, F., Luminosu, C. T., & Draghici, A. (2016). Service provision in the framework of Industry 4.0. *Procedia – Social and Behavioral Sciences*, 221, 372–377. <https://doi.org/10.1016/j.sbspro.2016.05.127>
- Shahroom, A. A., & Hussin, N. (2018). Industrial revolution 4.0 and education. *International Journal of Academic Research in Business and Social Sciences*, 8(9), 314–319. <https://doi.org/10.6007/IJARBS/v8-i9/4593>
- Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research*, 104, 333–339. <https://doi.org/10.1016/j.jbusres.2019.07.039>
- Subandi, S., Rahmawati, F., & Kurniawan, B. (2022). Constraints in teaching factory implementation at vocational schools. *Cakrawala Pendidikan*, 41(2), 312–323. <https://doi.org/10.21831/cp.v41i2.47821>
- Sung, Y. T., Chang, K. E., & Liu, T. C. (2021). The effects of integrating entrepreneurship education with experiential learning on vocational students' performance: A meta-analysis. *Computers & Education*, 94(2), 252–275. <https://doi.org/10.1016/j.compedu.2021.104128>
- Thomas, J., & Harden, A. (2008). Methods for the thematic synthesis of qualitative research in systematic reviews. *BMC Medical Research Methodology*, 8, Article 45. <https://doi.org/10.1186/1471-2288-8-45>
- UNESCO-UNEVOC. (2022). *TVET in a time of COVID-19 and beyond: A global review of challenges and responses*. UNESCO-UNEVOC International Centre for Technical and Vocational Education and Training. <https://unevoc.unesco.org/home/TVET+in+a+Time+of+COVID-19>
- Wibowo, A., Saptono, A., & Suparno, S. (2022). Entrepreneurship education in Indonesian vocational schools: Impact on graduate employability. *Jurnal Pendidikan dan Kebudayaan*, 7(1), 1–14. <https://doi.org/10.24832/jpnk.v7i1.2156>
- World Economic Forum. (2023). *Future of jobs report 2023*. World Economic Forum. <https://www.weforum.org/reports/the-future-of-jobs-report-2023>
- Yahya, M., Majid, L. A., & Atan, N. A. (2021). The implementation of teaching factory in Malaysian vocational colleges: Issues and prospects. *Asian Journal of Vocational Education and Humanities*, 2(1), 1–10. <https://doi.org/10.53797/ajveh.v2i1.1.2021>

***Indra Wahyu Suliswanto, M.Pd. (Corresponding Author)**

Doctoral Program in Vocational Education, Graduate School,

State University of Surabaya

UNESA Campus Main Road, Lidah Wetan, Lakarsantri District, Surabaya City,
East Java 60213

Email: indra.22005@mhs.unesa.ac.id

Prof. Dr. Ekohariadi, M.Pd.

Doctoral Program in Vocational Education, Graduate School, State University of
Surabaya, Indonesia

UNESA Campus Main Road, Lidah Wetan, Lakarsantri District, Surabaya City,
East Java 60213

Email: ekohariadi@unesa.ac.id

Prof. Dr. Ratna Suhartini, M.Si.

Doctoral Program in Vocational Education, Graduate School, State University of
Surabaya, Indonesia

UNESA Campus Main Road, Lidah Wetan, Lakarsantri District, Surabaya City,
East Java 60213

Email: ratnasuhartini@unesa.ac.id
