INNOVATION IN INDUSTRY-BASED LEARNING IN VOCATIONAL EDUCATION: A SYSTEMATIC REVIEW OF BEST PRACTICES IN VARIOUS COUNTRIES AND THEIR RELEVANCE TO INDONESIA

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ABSTRACT
Vocational education plays a crucial role in preparing a skilled workforce for Industry 4.0, which demands technical expertise, critical thinking, and adaptability. Industry-Based Learning (IBL) models, successfully implemented in countries like Germany and Australia, integrate real-world industrial experiences into curricula. However, developing nations, including Indonesia, face challenges such as curriculum-industry misalignment, limited infrastructure, and insufficient industry engagement. This study employs a Systematic Literature Review (SLR) following the PRISMA framework to analyze 26 high-quality articles (2020–2024) on IBL innovations globally. Findings reveal effective models such as non-placement Work-Integrated Learning (WIL), digital competency frameworks, and challenge-based learning, which emphasize industry collaboration and practical skill development. For Indonesia, adapting these approaches—through virtual teaching factories, VR/AR-enhanced training, and dual VET systems—can address geographical and resource constraints. Key recommendations include flexible WIL implementation, digital upskilling for teachers, industry incentives, and policy reforms to align vocational education with labor market needs. The study highlights the need for contextual adaptation of global best practices to enhance Indonesia's vocational system.

Keywords: industry-based learning; vocational education; work-integrated learning; industry 4.0; indonesia

INTRODUCTION

Vocational education plays a crucial role in preparing a skilled workforce capable of meeting industrial demands, particularly in the era of Industry 4.0. Technological advancements such as digitization, automation, and artificial intelligence require workers to possess not only technical skills but also critical thinking, creativity, and adaptability (Schwab, 2016). To address these needs, many countries have implemented industry-based learning (IBL) models, which integrate real-world work experience into educational curricula through partnerships between schools and industries (Billett, 2011; Pilz, 2018). Countries like Germany, Switzerland, and Australia have demonstrated the success of IBL in bridging the gap between education and employment, producing graduates who meet industry standards (Cedefop, 2022; Harris et al., 2006). However, the implementation of IBL in developing countries, including Indonesia, still faces significant challenges. Key issues include curriculum misalignment with labor market needs, limited infrastructure, and insufficient industry involvement in the educational process (Ditjen Vokasi Kemdikbud, 2020). Although various innovations such as STEM-based learning, project-based learning (PBL), and problem-based learning have been studied (Ginaya et al., 2020; Suwardi, 2021), there remains a gap in understanding how these approaches can be adapted to the socio-economic and cultural contexts of developing nations. Furthermore, while Luhmann's social systems theory and Kelly's curriculum theory have been used to analyze vocational education in developed countries, their application in Indonesia

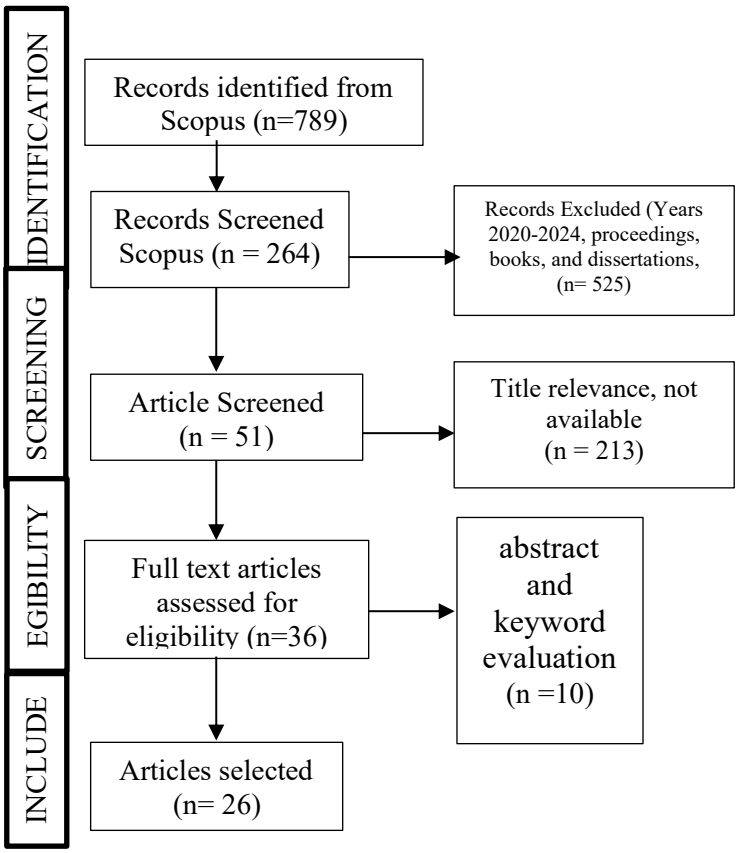
remains under-researched. This highlights the need for a systematic review of IBL innovations in developing countries and their potential implementation in Indonesia.

In Indonesia, the progress of IBL presents both advancements and challenges. The government has launched initiatives like the Link and Match Program to align vocational education with industry needs (Kemdikbud, 2020). However, implementation often lacks depth due to limited industry engagement, inadequate teacher training, and resource constraints (Wibowo et al., 2022). For example, Germany's dual system which combines classroom learning with company-based training, relies heavily on a strong apprenticeship culture and industry commitment, factors still developing in Indonesia (Pilz & Li, 2020). To address these challenges, Indonesia can learn from the experiences of other developing countries like India and South Africa, which emphasize community-based training and public-private partnerships in their IBL models (McGrath, 2012; Mehrotra, 2014). A locally tailored approach is considered more effective. Recent research also underscores the importance of active, creative, and practical learning strategies in the Industry 4.0 era (Irwanto, 2020). For instance, metacognitive approaches focusing on soft skills have proven effective in enhancing students' problem-solving abilities (Elmasari, 2022). Similarly, project-based learning (PBL) has been successful in developing practical skills and critical thinking (Fadillah et al., 2021). In specific sectors like automotive, work-based learning programs have shown positive results by combining contextual learning with industrial experience (Siswanto, 2013). Meanwhile, in tourism, problem-based learning (PBL) models have improved students' collaboration and soft skills (Ginaya et al., 2020). However, the success of these approaches heavily depends on the commitment of all stakeholders, including schools, governments, and industries (Hamdani & Suherman, 2021).

Luhmann's social systems theory and Kelly's curriculum theory provide a strong analytical foundation. Luhmann's theory emphasizes the interconnection between education and industrial systems, advocating for multi-stakeholder collaboration in IBL implementation (Luhmann, 1995). Meanwhile, Kelly's theory highlights the importance of aligning educational objectives with societal needs, including labor market demands (Kelly, 2009). By applying these theories, this study aims to provide an in-depth understanding of IBL adaptation in Indonesia. The role of applied guidance and counseling is also critical in supporting IBL, particularly in helping students transition from school to work (Gysbers & Henderson, 2014). However, the potential of these services remains underexplored, warranting further research. The novelty of this research lies in its focus on developing countries, which are often underrepresented in global discussions on vocational education innovation. By identifying best practices and evaluating their implications for Indonesia, this study is expected to provide policy recommendations for creating a more responsive and inclusive vocational education system that meets the demands of Industry 4.0 (Rauner & Maclean, 2009; Yoto et al., 2019).

METHOD

This study utilizes a Systematic Literature Review (SLR) methodology to investigate innovative approaches in industry-based learning within vocational education. The SLR approach was selected due to its rigorous framework that enables researchers to systematically identify, evaluate, and synthesize findings from existing studies while maintaining transparency (Kitchenham & Charters, 2007). This methodology also ensures research reproducibility and allows for verification by other scholars. To enhance methodological rigor, the research implements the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The PRISMA framework provides a structured approach for literature identification, screening, eligibility assessment, and inclusion (Moher et al., 2009). This protocol has been widely recognized for its effectiveness in maintaining transparency and accuracy in systematic reviews (Heydemans & Elmunsyah, 2024; Purnama et al., 2023; Syahrir et al., 2024).



(Ambon et al., 2024; Purnama et al., 2023)

Figure 1. PRISMA Diagram

The literature search was conducted using Publish or Perish 8 software to query the Scopus database, employing key search terms including: learning innovation, industry-based learning, vocational education, developing countries, and Indonesia. The initial search yielded 789 articles. Subsequent filtering applied the following criteria: 1) Publication date restriction (2020-2024), reducing results to 264 articles; 2) Document type limitation to research articles only (excluding proceedings, books, and dissertations), resulting in 256 articles; 3) Title relevance screening, narrowing the selection to 54 articles, and 51 available in full-text. The review process continued with abstract and keyword evaluation (eligibility phase), followed by comprehensive full-text assessment, ultimately identifying 26 high-quality articles for in-depth analysis. This multi-stage screening process guarantees the inclusion of only the most pertinent and methodologically sound studies. For a detailed visualization of the selection process, please refer to the accompanying PRISMA flow diagram.

RESULTS AND DISCUSSION

Exploration of Industry-Based Learning Innovations in Various Countries

The global landscape of vocational education has witnessed significant innovations in industry-based learning, with various countries adopting unique models to bridge the gap between education and industry needs. Yong et al., (2024) explored the non-placement Work-Integrated Learning (WIL) model at the University of Nottingham Malaysia (UNM), where students engage in industrial projects without physical placement. This approach, tested in chemical engineering, offers a viable alternative for vocational fields in Indonesia, particularly where geographical constraints or limited industry partnerships hinder traditional internships. Similarly, Inderanata & Sukardi, (2023) demonstrated the superiority of hands-on

demonstration methods over traditional lectures in Indonesian vocational education, emphasizing the importance of practical skills such as machinery operation and safety procedures to enhance student readiness for the workforce.

The alignment of skills development with industry requirements has become a paramount concern in vocational education systems worldwide. Kiong et al., (2022) established the efficacy of specialized communication modules in Malaysian cosmetology education, revealing dual benefits in enhancing both professional preparedness and customer relationship management. This focus on practical skill integration finds parallel in Véchot et al., (2022) Process Safety Competency Development Program (PSCDP), an innovative transnational collaboration between SABIC and Texas A&M University that established a benchmark for chemical sector education. The principle of experiential learning is further exemplified by Yang (2021) open-source integrated circuit design initiative, which significantly elevated student competencies through authentic industry-academic partnerships. Complementing these models, Prieto et al., (2020) demonstrated the effectiveness of Spain's dual VET system through its alternating training structure, simultaneously strengthening industry ties and corporate citizenship. These diverse approaches collectively inform Billett et al., (2024) conceptual framework analyzing Singapore's workplace learning ecosystem, particularly the symbiotic relationship between worker initiative and organizational learning environments in advanced vocational systems.

Digital transformation has revolutionized vocational education delivery globally. Hassan et al., (2023) employed deep learning algorithms in Norway to bridge skill gaps between graduates and industry needs, creating an innovative data-driven framework for curriculum alignment. In India, Chatterjee et al., (2021) applied the TAM 3 model to digital VET initiatives, identifying key factors driving technology adoption, including perceived usefulness and peer support. These technological approaches resonate with Akimov et al., (2023) exploration of Open Innovation in Education 4.0, which emphasized the necessity of multilevel collaboration among educational institutions, governments, and corporations to develop digital-era competencies. Project-based and challenge-based learning methodologies have demonstrated remarkable effectiveness across diverse contexts. Rampersad, (2020) longitudinal study in Australia established the efficacy of project-based WIL in developing Industry 4.0 skills, while Vilalta-Perdomo et al., (2022) in the UK validated Challenge-Based Learning as a powerful tool for cultivating collaborative competencies in modern industries. Dieck-Assad et al., (2021) advanced this paradigm through Mexico's innovative "i-Semester with industrial partner" model, which integrated challenge-based learning with automotive and electronics industry projects while contributing to Sustainable Development Goals through triple helix collaboration.

Structural innovations in vocational education have yielded significant results worldwide. Hayes & Cejnar, (2020) developed Industry and Community Project Units in Australia, effectively merging real-world industry projects with academic learning. Nigeria's TVET system benefited from Okolie et al., (2021) PBL-Teaching Factory hybrid model, while Salvador et al., (2023) created a groundbreaking cross-program PBL approach in Brazil that connected undergraduate and graduate studies with Industry 4.0 partners. These structural innovations complement Sutiman et al., (2022) findings in Indonesia, where active industry involvement in internship programs significantly enhanced curriculum relevance and graduate competitiveness. At the policy level, comprehensive national strategies have demonstrated substantial impact on vocational education systems. Clarke et al., (2020) comparative study of four EU nations revealed the superior effectiveness of standards-based approaches for sustainable construction competencies. Piatkowski, (2020) EU-wide analysis of Continuing Vocational Training highlighted Western Europe's advantage in technological adaptation, offering valuable lessons for developing nations. Attard et al., (2021) further demonstrated the potential of industry-school-university partnerships through Australia's local infrastructure projects that enhanced STEM engagement via Inquiry-Based Learning.

The collective insights from these studies present a rich tapestry of industry-based learning innovations, ranging from Malaysia's non-placement WIL to Germany's standards-based approach and Mexico's challenge-based i-Semester model. These diverse approaches share common success factors including robust industry collaboration, practical skill development, and adaptive learning structures. For Indonesia, these global best practices offer particularly relevant solutions for addressing geographical constraints, enhancing technology integration, and strengthening industry partnerships in vocational education. The demonstrated effectiveness of these models across different cultural and economic contexts suggests strong potential for successful adaptation within Indonesia's evolving vocational education landscape.

Identification of Innovative Practices That Can Be Adapted

The transformation of Indonesia's vocational education system requires innovative approaches to industry-based learning that address local challenges while preparing students for Industry 4.0 demands. Yong et al., (2024) present non-placement Work-Integrated Learning (WIL) as a viable solution, developing critical competencies like virtual collaboration and creative problem-solving through virtual teaching factories-particularly valuable for Indonesian schools facing geographical constraints in organizing conventional internships. This approach aligns with the government's link-and-match policy while leveraging digital technologies to overcome infrastructure limitations.

Technological integration emerges as a crucial adaptation area for Indonesian vocational schools. Inderanata & Sukardi, (2023) demonstrate how VR/AR-enhanced demonstrations can elevate technical training beyond basic competencies, addressing the urgent need for Industry 4.0-ready graduates. The digital competency assessment framework developed by Mei et al., (2023) and Hassan et al., (2023) data-driven curriculum alignment model provide systematic approaches to modernizing Indonesia's vocational curriculum, particularly in technical fields where keeping pace with technological advancements remains challenging. These technological solutions complement Chatterjee et al., (2021) TAM3 model for digital technology adoption, offering a balanced strategy combining policy support with grassroots implementation.

The development of industry-relevant competencies demonstrates particular significance for Indonesia's varied vocational education sectors. Kiong et al., (2022) provide evidence for the efficacy of structured communication training programs in service-oriented fields, while Véchot et al., (2022) developed a Process Safety Competency Development Program that fulfills essential requirements in manufacturing sectors. These methodologies align with the conceptual framework proposed by Billett et al., (2024), which underscores the importance of authentic workplace learning environments that integrate both technical skill acquisition and innovation capability development - a combination particularly vital for Indonesia's growing industrial sectors. Complementing these findings, Beer & Mulder, (2020) established digital literacy and self-management skills as fundamental competencies that should be incorporated into Indonesia's Continuing Vocational Education and Training (CVET) framework. Further reinforcing this perspective, Zhou et al., (2022) demonstrated that vocational instructors' engagement in industrial learning experiences-whether through formal internships, informal collaborative arrangements, or structured training programs-leads to measurable improvements in both technical knowledge and pedagogical skills.

Collaborative education-industry models provide structural blueprints for Indonesian vocational reform. Rageth & Renold, (2020) analysis of successful dual systems offers insights for balanced stakeholder collaboration, while Akimov et al., (2023) Open Innovation framework emphasizes multi-sector partnerships through cloud technologies. Yang, (2021) open-source project approach presents a cost-effective solution for technical programs with equipment limitations, directly addressing resource constraints in Indonesian vocational schools. These models align with Piatkowski, (2020) findings on the correlation between vocational training investment and workforce competency in high-productivity economies.

Innovative pedagogical approaches demonstrate significant adaptation potential. Vilalta-Perdomo et al., (2022) Challenge-Based Learning model and Okolie et al.'s (2020) integration of Problem-Based Learning with teaching factories provide structured methods to contextualize learning within real industry challenges. Salvador et al., (2023) extend this through multi-stakeholder PBL projects in Industry 4.0 contexts, while Attard et al., (2021) inquiry-based local infrastructure projects show how Indonesia's development agenda could create authentic learning experiences. These approaches are complemented by Sutiman et al., (2022) findings on effective internship design incorporating competency-based orientation and real industry cases. Alternative implementation models address common Indonesian vocational education challenges. Hayes & Cejnar, (2020) non-placement WIL options and Rampersad, (2020) competency-based assessment methods offer solutions for schools struggling with internship logistics. Dieck-Assad et al., (2021) Teaching Factory Plus model presents a comprehensive framework integrating projects with certification - particularly relevant for Indonesia's priority sectors like automotive and electronics. Clarke et al., (2020) standards-based approach and the Belgian model of industry partnership demonstrate how continuous learning can be systematically integrated into vocational curricula. These international innovations share key characteristics making them adaptable to Indonesia's context: scalability across diverse regions, flexibility for different vocational fields, and emphasis on sustainable industry partnerships. Their implementation could significantly enhance the quality and relevance of Indonesia's vocational education while addressing specific challenges like uneven industry distribution and resource limitations. The integration of these approaches with Indonesia's existing teaching factory initiative and link-and-match policy could create a distinctive, context-appropriate model of industry-based vocational learning.

Implications for the Development of Vocational Education in Indonesia

The comprehensive review of international best practices reveals transformative approaches for enhancing Indonesia's vocational education system through industry-based learning. Work-Integrated Learning (WIL) models (Rampersad, 2020; Yong et al., 2024) demonstrate significant potential in developing critical workplace competencies while offering innovative solutions to conventional internship limitations. These approaches align well with national initiatives like Kampus Merdeka and Teaching Factory 4.0, particularly through their emphasis on project-based curricula that foster higher-order thinking skills and creativity. Structural improvements to vocational training emerge as a consistent theme across studies. Sutiman et al., (2022) propose a comprehensive internship framework incorporating industrial culture orientation, authentic projects in key sectors like automotive, and targeted soft skills development. This aligns with Billett et al., (2024) advocacy for meaningful workplace learning experiences and flexible curricula that nurture student innovation. The effectiveness of demonstration methods in technical fields (Inderanata & Sukardi, 2023) further reinforces the value of practical, industry-aligned instruction. Project-based methodologies feature prominently in the literature as mechanisms for bridging the education-industry divide. Salvador et al., (2023) highlight cross-tier collaboration models, while Hayes & Cejnar, (2020) present adaptable frameworks suitable for Indonesia's diverse vocational schools. Specialized approaches like the i-Semester program (Dieck-Assad et al., 2021) and Challenge-Based Learning (Vilalta-Perdomo et al., 2022) offer sector-specific solutions, particularly for strategic industries such as automotive and manufacturing.

Digital transformation emerges as another critical dimension, with Hassan et al., (2023) and Mei et al., (2023) emphasizing data-driven curriculum alignment and digital competency development. This technological focus extends to teaching methodologies, as demonstrated by Attard et al., (2021) STEM-based inquiry models and Akimov et al., (2023) Open Innovation frameworks. The integration of green skills (Clarke et al., 2020) and sustainable construction standards further illustrates the evolving nature of industry-relevant competencies. Effective implementation of these models requires robust industry engagement frameworks. Mahfud et al., (2022) identify key partnership indicators, while Véchot et al.,

(2022) demonstrate successful adaptation strategies for strategic sectors. Kopczynska & Ferreira, (2021) caution against direct transplantation of foreign models, advocating instead for context-sensitive approaches that consider Indonesia's unique industrial infrastructure.

Teacher professional development surfaces as a critical success factor, with Zhou et al., (2022) and Chatterjee et al., (2021) emphasizing continuous upskilling programs and industry exposure. Beer & Mulder, (2020) further highlight the need for digital pedagogy training to prepare students for automated workplaces. Policy recommendations focus on creating enabling environments through fiscal incentives (Piatkowski, 2020), infrastructure investment, and flexible regulatory frameworks. The collective findings suggest that Indonesia's vocational education transformation requires coordinated multi-stakeholder efforts, contextual adaptation of international best practices, and sustained commitment to industry-aligned competency development. Ultimately, the international experience demonstrates that vocational education modernization is not about importing foreign models wholesale, but rather systematically adapting their core principles to local conditions. For Indonesia, this means creating hybrid approaches that combine global best practices with indigenous innovation, ensuring vocational graduates possess both the technical proficiency and adaptive capabilities needed in today's rapidly evolving job market.

CONCLUSION

The systematic review of global best practices in industry-based learning for vocational education highlights several key insights that are highly relevant to Indonesia's context. Various countries have successfully implemented innovative models—such as non-placement Work-Integrated Learning (WIL), digital competency frameworks, challenge-based learning, and dual vocational training systems—to bridge the gap between education and industry needs. These approaches emphasize robust industry collaboration, practical skill development, and adaptive learning structures, which are essential for preparing students for Industry 4.0 demands. For Indonesia, the findings suggest that adopting and adapting these models can address critical challenges, including geographical constraints, uneven industry distribution, and technological integration. Successful implementation requires contextual adaptation, ensuring alignment with national policies like Kampus Merdeka and Teaching Factory 4.0, while fostering multi-stakeholder collaboration among educators, industries, and policymakers. The study underscores that vocational education modernization in Indonesia should focus on hybrid models that combine global best practices with local innovations to enhance graduate employability and industry relevance.

To improve vocational education, Indonesia should implement flexible Work-Integrated Learning (WIL) models like virtual teaching factories and remote projects, supported by digital tools to expand access to industry experience, especially in remote areas. Technological integration should be accelerated through VR/AR simulations, AI-based curriculum adjustments, and digital skills assessments, while applying the TAM3 model to boost technology adoption in schools. Strengthening industry ties is crucial through dual VET systems and innovation platforms, supported by incentives like tax benefits to encourage active industry participation in curriculum development. The curriculum should emphasize project-based and challenge-based learning, particularly in key sectors like automotive and green technology, while fostering interdisciplinary collaboration between schools, universities, and industries. Vocational teachers need regular industry immersion and training in digital teaching methods to stay updated with Industry 4.0 demands. Policymakers should establish national competency standards based on international models and promote multi-stakeholder cooperation for sustainable reforms. Finally, vocational programs must integrate sustainability principles and ensure equitable access through improved digital infrastructure in rural areas. By adapting global best practices to local needs, Indonesia can develop a vocational system that effectively prepares students for future workforce demands.

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