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Integrating Vocational Education and Industry through Public Policy: Towards Excellent and Competitive Human Capital

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ABSTRACT

Vocational education plays a strategic role in developing excellent and competitive human resources (HR) amidst the dynamics of the Fourth Industrial Revolution (Industry 4.0) and Society 5.0. However, challenges such as the mismatch between graduates' competencies and industry needs, the limited involvement of industry in curriculum development, and weak institutional synergy remain major obstacles. This study aims to examine the ideal form of integration between vocational education and the industrial sector, the role of public policy in supporting this integration, and its contribution to the creation of competent and adaptive human resources. A descriptive qualitative approach was employed through literature review and policy analysis. The findings indicate that effective integration can be achieved through five key approaches: co-design, co-teaching, co-training, co-assessment, and co-recruitment. Public policy plays a crucial role as both facilitator and regulator in establishing a collaborative and labor market-oriented vocational–industry ecosystem. The implementation of policies such as Presidential Regulation No. 68/2022, the Center of Excellence Vocational High School (SMK PK) program, and the Pre-Employment Card (Kartu Prakerja) initiative has shown positive impacts on improving graduate quality and workforce absorption. This integration also contributes to enhanced employability, digital literacy, innovative capabilities, and global work readiness. The study concludes that strengthening vocational–industry integration, supported by adaptive and sustainable public policies, is key to building excellent, productive, and globally competitive human resources in Indonesia.

INTRODUCTION

Studies on vocational education have been widely conducted in various countries, with diverse focuses depending on policy contexts and local needs. In Norway, (Ogard, Hillen, & Wuttke, 2025) emphasized the importance of using thematic assignments to bridge school learning and workplace practices through the concept of boundary learning. In Germany, (Busse & Maue, 2025) highlighted the effectiveness of pre-vocational programs in supporting students' transition into vocational education through internships and mentoring. Meanwhile, (Yirga & Beshir, 2025) in Ethiopia examined the impact of Total Quality Management practices on innovation in agricultural vocational colleges. Globally, (Iliescu, Greiff, & Ion, 2025), through the OECD's PISA-VET initiative, stressed the need for international measurement of specific vocational skills to foster collaboration and policy reform. In China, (Li, 2025) evaluated vocational education programs in preventive medicine aimed at addressing shortages of public health workers in rural areas. In Nigeria, (Nwadi, 2025) explored the application of cognitive-behavioral therapy and mindfulness to reduce exam anxiety among vocational students, positively impacting well-being and academic performance. These diverse studies reveal that vocational education is a complex and strategic field, with evolving approaches to address both global and local challenges.

The key distinction between the international studies mentioned above and the study titled "Integration of Vocational Education and Industry in the Public Policy Perspective: Realizing Excellent and Competitive Human Resources" lies in their perspectives, approaches, and policy focus. Most recent literature tends to address vocational education from technical, pedagogical, and micro-level standpoints. In contrast, conceptual and normative contributions from a public policy perspective—such as the integration of vocational education and industry in Indonesia—remain limited. Therefore, the position of this study is to complement and strengthen the strategic policy framework for developing a competitive vocational education system that can adapt to the challenges of 21st-century industry.

In facing the Fourth Industrial Revolution and Society 5.0, Indonesia is challenged to improve the quality of human resources capable of adapting to digital transformation, automation, and changes in the global economic structure. Industry 4.0 is marked by the integration of technologies such as the Internet of Things (IoT), artificial intelligence, cyber-physical systems, and big data into various aspects of life and industry. These changes have shifted the demand for competencies, no longer focusing solely on conventional technical skills, but also requiring mastery of soft skills and digital literacy (Setiono, 2020) (Meditama, 2021). This condition calls for an urgent transformation of the

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education system to produce graduates who are adaptive, creative, and globally competitive.

Vocational education is considered strategic in addressing these challenges due to its emphasis on practical skills and job readiness. However, vocational education cannot operate in isolation—it requires robust public policy support and active engagement from the industrial sector. Collaboration among vocational institutions, the government, and industry forms the foundation for an integrated human resource development policy. Research shows that a pentahelix synergy—involving academia, businesses, government, the community, and media—can accelerate vocational education's adaptation to Industry 4.0 demands (Hartanto, Rusdarti, & Abdurrahman, 2019). Furthermore, this integration must be facilitated by progressive and responsive public policies to establish a learning ecosystem aligned with labor market needs and sustainable economic growth (Pendriana, Raharjo, Pramono, & Yulianto, 2022).

One of the major challenges in Indonesia's vocational education system is the mismatch between graduate competencies and the actual needs of the industry. Despite being designed to produce work-ready graduates, many still fail to meet the expected technical and non-technical standards. Data from the Ministry of Manpower indicate that approximately 58% of vocational graduates do not meet the specific skill requirements of businesses and industries (Pendriana, Raharjo, Pramono, & Yulianto, 2022). This issue is exacerbated by the low involvement of the industrial sector in curriculum planning, implementation, and evaluation, resulting in educational content that does not fully reflect labor market dynamics. Consequently, graduates struggle to find placement in formal and productive employment. Addressing this requires structural alignment through ongoing collaboration between vocational institutions and industry in designing curricula, training, and internship schemes that are relevant and responsive to industrial development (Hartanto, Rusdarti, & Abdurrahman, 2019).

The low level of industry participation in vocational education remains a serious barrier to effective integration between education and labor market needs. In many cases, industrial involvement is limited to providing internship placements or short-term training, without substantial engagement in curriculum development, learning evaluation, or graduate recruitment. Yet, active participation from the industrial sector is essential to ensure that the competencies taught align with real-world technologies, standards, and needs. Research indicates that weak synergy between industry and vocational institutions results in a mismatch between graduate profiles and employer expectations (Hartanto, Rusdarti, & Abdurrahman, 2019). The lack of formal collaboration hinders the development of industry-based curricula and weakens the feedback system from employers (Pendriana, Raharjo, Pramono, & Yulianto, 2022). Strengthening industry participation through co-design, co-teaching, and co-evaluation mechanisms is crucial to advancing a more responsive and adaptive vocational education system.

Public policy plays a highly strategic role in building a collaborative ecosystem between vocational education and industry. It serves as a guide, facilitator, and connector between educational institutions and the real needs of the labor market. Without integrated policies that align competencies with market demands, vocational education will struggle to meet the challenges of Industry 4.0 and Society 5.0. The government has a critical role in designing regulations, incentives, and partnership schemes that enable sustainable collaboration between vocational institutions and industry players (Pendriana, Raharjo, Pramono, & Yulianto, 2022). Effective public policy should promote a triple helix approach (government–industry–academia), and establish systematic link and match mechanisms—from curriculum planning and industry-based training to workforce absorption facilitation. Studies also show that policies responsive to labor market dynamics are instrumental in strengthening national HR competitiveness and promoting inclusive economic growth (Zulkarnaen, 2024).

The Indonesian government has prioritized vocational education as a strategic agenda in national human resource development through comprehensive revitalization policies. A tangible example is the implementation of the Link and Match concept between vocational education institutions and the business and industrial sectors. This strategy aims to bridge the gap between graduate competencies and the real needs of the job market, while enhancing curriculum relevance. Through initiatives such as strengthening teaching factories, certified industrial internships, and the involvement of industry practitioners in learning processes, the government encourages synergy between education and the economy (Hartanto, Rusdarti, & Abdurrahman, 2019) (Meditama, 2021). This revitalization effort is backed by national strategies like Making Indonesia 4.0 and vocational-related regulations that reinforce the government's role as a facilitator of multi-stakeholder integration in developing competent, adaptive, and globally competitive human resources (Setiono, 2020).

Improving human resource quality through vocational education is increasingly vital in facing the challenges of Industry 4.0 and Society 5.0. However, several structural and implementation barriers still hinder the realization of synergy between vocational education and industry. One of the main issues is the suboptimal institutional and curricular integration between vocational education institutions and the real demands of the business and industrial sectors. Targeted and sustainable public policy involvement is essential to create an education ecosystem that is responsive to labor market dynamics. Based on this context, the study formulates three main research questions: 1. What is the ideal model of integration between vocational education and the industrial sector?, 2. What role does public policy play in fostering vocational–industry synergy?, 3. How can such integration contribute to the creation of excellent and competitive human resources?.

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LITERATURE REVIEW

Vocational education is an educational track designed to equip students with practical and professional skills that can be directly applied in the workforce. Unlike academic education, which focuses on theoretical and foundational knowledge, vocational education emphasizes practice-based learning, technical skills, and job readiness (Iliescu, Greiff, & Ion, 2025). The main characteristics of vocational education include a competency-based curriculum, strong alignment with industry needs, as well as project-based and production-based learning approaches (Ogard, Hillen, & Wuttke, 2025). Vocational education also highlights competency certification as a key graduation requirement to ensure graduates meet standardized job qualifications (Li, 2025).

The concept of Link and Match refers to a strategic alignment between the world of education and the world of work, where curricula, teaching methods, and graduate competencies are adjusted to meet the real demands of businesses and industries (Direktorat Jenderal Pendidikan Vokasi, 2020) (Busse & Maue, 2025). To achieve this effectively, the Triple Helix approach is implemented, involving three key actors: the government as the regulator and provider of facilities; industry as both the end-user of graduates and a learning partner; and educational institutions as producers of human capital (Etzkowitz & Leydesdorff, 2000). The synergy among these three actors creates an educational ecosystem that is adaptive, inclusive, and responsive to labor market dynamics and economic transformation (Iliescu, Greiff, & Ion, 2025).

Public policy functions as a guiding instrument in formulating the vision, strategy, and operational framework for integrating vocational education and industry. This role includes developing educational and labor regulations, allocating budgets, providing incentives to industry partners, and building a national certification system (Kementerian Pendidikan dan Kebudayaan, 2020) (Yirga & Beshir, 2025). In the vocational context, public policy is also responsible for creating inter-agency coordination frameworks, providing collaborative platforms, and ensuring the sustainability of integrative programs through structured monitoring and evaluation mechanisms (Meijer, Beartman, Vermeulen, & de Brujin, 2025) (Zhang, Balloo, Hosein, & Medland, 2025).

As a result of integrative policy implementation, collaborative models between vocational education and industry have emerged—known as co-design, co-teaching, and co-assessment (UNESCO-UNEVOC, 2022). Co-design refers to joint curriculum development between educational institutions and industry to ensure that learning content meets labor market demands. Co-teaching involves industry practitioners as guest lecturers or mentors in the classroom, offering direct and contextualized experience to students. Co-assessment is the joint evaluation of students' competencies by both vocational institutions and industry partners to ensure that learning outcomes align with real-world job standards (Ogard, Hillen, & Wuttke, 2025) (Iliescu, Greiff, & Ion, 2025).

This integration model has proven effective in enhancing the relevance, efficiency, and credibility of vocational education in shaping work-ready and competitive human resources (Iliescu, Greiff, & Ion, 2025) (Kementerian Pendidikan dan Kebudayaan, 2020).

METHOD

This study employs a descriptive qualitative approach using library research and public policy analysis. The main focus of the research is to analyze the integration between vocational education and the industrial sector within the framework of public policy in Indonesia. Secondary data were obtained from various sources such as scholarly journals, government policy reports, national regulations, educational strategy documents, and case studies of integrative practices in the field.

The analysis followed three key steps:

1. Secondary Data Collection
   Relevant literature published in the past five years (2019–2024) was reviewed, including international references to compare vocational–industry integration practices across countries.
2. Content and Policy Document Analysis
   National policy documents—such as Law No. 20 of 2003 on the National Education System, Presidential Regulation No. 68 of 2022 on the Revitalization of Vocational Education and Training, the Making Indonesia 4.0 strategy, and the Merdeka Belajar–Kampus Merdeka (MBKM) policy—were analyzed to evaluate the direction, content, and implementation of vocational education policies.
3. Thematic Synthesis
   Data were analyzed thematically based on the study's three main problem formulations: (1) the ideal model of vocational–industry integration, (2) the role of public policy in fostering synergy, and (3) the contribution of integration to the development of excellent human resources.

Data validity was reinforced through source triangulation and by comparing the findings with similar international studies. This approach aims to produce evidence-based and practical policy recommendations, while also enriching the discourse on vocational education within the broader context of developing globally competitive national human resources.

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RESULT

Ideal Forms of Integration between Vocational Education and Industry

Typologies of Ideal Integration between Vocational Education and Industry

To create a vocational education ecosystem that is adaptive and aligned with labor market needs, a systematic and sustainable integration between educational institutions and the industrial sector is required. The ideal integration involves five mutually reinforcing approaches: Co-Design, Co-Teaching, Co-Training, Co-Assessment, and Co-Recruitment. Each approach not only promotes learning efficiency but also enhances the relevance of graduates to real-world workforce demands.

Co-design refers to active collaboration between vocational education institutions and industry partners in curriculum development. In this model, industries provide input on core competencies, technical skills, and soft skills that are genuinely required. The result is a dynamic curriculum that responds to technological advancements and labor market needs. Such co-designed curricula incorporate not only theoretical foundations but also applied industry scenarios. In the Co-teaching model, industry professionals are directly involved as guest lecturers, field instructors, or project mentors. Their presence in classrooms or laboratories adds practical value through real-world experience, actual case studies, and insight into industrial work culture. This collaboration not only strengthens students' competencies but also broadens the perspectives of instructors regarding sectoral developments. Co-training is a form of structured workplace-based learning or internship integrated with the vocational curriculum. In this model, students undergo on-the-job training (OJT) at actual work sites, with agreed durations and learning objectives. This dual system—combining school-based learning and industrial practice—has proven effective in improving graduates' job readiness, productivity, and soft skills. Co-assessment refers to the joint evaluation of student competencies by vocational institutions and industry. Industry representatives may serve as external examiners or portfolio assessors. This collaboration enhances industry trust in the quality of graduates and directs vocational education toward an outcome-based model. Co-recruitment is a graduate placement mechanism facilitated directly through industry partner networks. This model enables graduates to access employment more quickly, while allowing companies to expedite recruitment by hiring workers already prepared according to their needs. This practice is typically supported by job-matching systems, vocational career fairs, or long-term cooperation agreements (MoUs) between educational institutions and companies. These five models of integration form a comprehensive, mutually reinforcing system that positions vocational education as an equal partner in the national human capital development ecosystem. When implemented consistently, these approaches can effectively bridge the skills gap and produce vocational graduates who are excellent, adaptive, and competitive.

Implementation Models of Vocational–Industry Integration

The implementation of integration between vocational education and industry requires not only a conceptual approach but also practical application. Several integration models have already been implemented in Indonesia, demonstrating the effectiveness of collaborative strategies in preparing competent and job-ready human resources. The following models represent concrete examples of best practices in establishing sustainable connections between vocational education and the business–industrial sectors.

1. Best Practice Case: Industry-Sponsored Vocational Schools and Polytechnics

Vocational high schools (SMKs) or polytechnics directly supported by large industries have become successful examples of vocational–industry integration. For instance, SMKs sponsored by PT Astra International, PT Toyota Motor Manufacturing Indonesia, and PT Indofood have developed educational systems standardized to meet the needs of their industry partners. This form of integration includes joint curriculum development, teacher training provided by industry, long-term student internships, and graduate placement through direct recruitment. At the applied higher education level, institutions such as Astra Manufacturing Polytechnic and ATI Makassar Polytechnic have adopted Germany's dual vocational training model, which has proven effective in significantly reducing graduate unemployment rates.

2. Teaching Factory (Tefa) as a Practical Integration Medium

Teaching Factory (Tefa) is a learning model based on real production processes designed to simulate industrial working environments. This model integrates educational activities with actual production of goods or services, allowing students not only to learn theory but also to engage in practical tasks directly related to their vocational fields. Tefa strengthens technical skills and work attitudes through authentic work experience in educational settings that replicate industrial conditions. Successful examples of Tefa implementation can be found at SMK Negeri 1 Singosari (automotive sector), Bandung State Polytechnic (manufacturing), and Bali Tourism Polytechnic (hospitality sector).

3. Center of Excellence (CoE) as a Hub for Applied Research and Industry Training

A Center of Excellence (CoE) is a strategic unit developed to serve as a flagship in applied research, technical training, and vocational innovation. CoEs act as bridges between education and industry, particularly in national priority sectors such as manufacturing, digital technology, renewable energy, agribusiness, and logistics. These centers also function as platforms for teacher training, adaptive curriculum development, and testing of new technologies through

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vocational–industry research collaborations. The Ministry of Education, Culture, Research, and Technology has developed CoEs across various public and private polytechnics—such as Batam State Polytechnic and Jember State Polytechnic—which have contributed to improving graduate quality and alignment with labor market demands.

Through the implementation of these three models—industry-sponsored SMKs/polytechnics, Teaching Factories, and Centers of Excellence—vocational–industry integration has moved beyond theoretical frameworks into real, systematic, measurable, and outcome-oriented practices. These models demonstrate that well-designed collaboration can produce human resources who are not only qualified on paper but also ready to compete in a dynamic and competitive global workforce.

The Role of Public Policy in Promoting Vocational–Industry Synergy

Normative Framework and National Policy

The integration of vocational education and the industrial sector in Indonesia is firmly grounded in a range of legal foundations and strategic policies formulated by the government. These measures represent a systematic effort to build an educational ecosystem that is adaptive, collaborative, and responsive to labor market demands. This normative framework serves as a critical foundation to ensure the legality, policy direction, and consistency in the implementation of vocational programs integrated with the business and industrial sectors (commonly referred to as DUDI in Indonesia).

Law No. 20 of 2003 on the National Education System

This law serves as the primary legal foundation for the administration of national education in Indonesia, including vocational education. Article 15 states that vocational education refers to secondary or higher education that prepares students to work in specific occupational fields. The law mandates that education must be relevant to the needs of society, the labor market, and national development—thereby opening space for active collaboration with the industrial sector in the implementation of vocational education.

Presidential Regulation No. 68 of 2022 on the Revitalization of Vocational Education and Training

This presidential regulation explicitly strengthens the synergy between the government, industry, and educational institutions in building a national vocational system. The revitalization includes curriculum alignment, improvement of teacher/instructor competencies, development of teaching factories and Centers of Excellence (CoEs), and the establishment of a national competency certification system. The regulation also encourages active involvement from industry as a key partner in providing training sites, recruiting graduates, and enhancing the quality of the vocational workforce.

The National Strategy of Making Indonesia 4.0 and Human Resource Competitiveness

Making Indonesia 4.0 is a national roadmap aimed at accelerating industrial transformation in response to the Fourth Industrial Revolution. One of its five main pillars is the enhancement of human resource quality through vocational education integrated with industry needs. The strategy emphasizes the importance of technology, innovation, and digitalization in all aspects of vocational education, while also promoting cross-sector collaboration as a key approach to strengthening national competitiveness.

Merdeka Belajar–Kampus Merdeka (MBKM) Policy and Link-and-Match 8+i Framework

The MBKM policy, launched by the Ministry of Education, Culture, Research, and Technology, offers vocational students the opportunity to learn beyond the classroom—through industrial internships, collaborative research projects, and entrepreneurship programs. The Link-and-Match 8+i framework, which underpins vocational policy, highlights eight indicators of alignment between education and industry, such as joint curriculum development, industry-based teaching, competency certification, and recruitment commitments. The "+i" stands for innovation, making this policy a comprehensive and progressive blueprint for vocational–industry integration.

These normative and national policy frameworks demonstrate that the integration of vocational education and industry in Indonesia is not merely a practical necessity—it has become an integral part of the national development strategy to produce excellent, productive, and globally competitive human resources.

The Strategic Role of Public Policy in Vocational–Industry Synergy

Public policy plays a central role in creating and maintaining an ecosystem that supports the synergy between vocational education and the industrial sector. This role is not merely administrative but also strategic in unifying the vision among the state, educational institutions, and industry actors. To achieve the goal of improving the quality and competitiveness of human resources, public policy serves five key functions: coordinative, normative, facilitative, regulative, and promotive.

The coordinative role is realized through the provision of formal platforms and regulatory mechanisms that connect the key stakeholders: government, industry, and educational institutions. Both central and local governments may establish vocational–industry communication forums, cross-sector working groups, and triple helix networks. With

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systemic coordination, multi-stakeholder collaboration becomes structured, focused, and mutually reinforcing in achieving human resource development goals. As the authoritative body, the government plays a normative role in setting national standards that guide both education and industry. This includes developing the Indonesian National Work Competency Standards (SKKNI), competency-based national vocational curricula, and the Indonesian National Qualifications Framework (KKNI). These standards ensure that vocational graduates possess widely recognized competencies relevant to the world of work. To encourage active industry participation in vocational education, the government offers both fiscal and non-fiscal facilitative incentives. Fiscal incentives may include tax reductions for industrial investment in vocational training, while non-fiscal incentives may involve regulatory ease, recognition and awards, or access to government-partnered training programs. This role encourages the private sector to act not just as a recipient of graduates, but as a strategic partner in human capital development. Through technical regulations and quality assurance systems, public policy also performs a regulative role in directing vocational education implementation in accordance with industry standards. Accreditation of educational institutions and industry-based competency certifications are regulatory instruments that help ensure quality outcomes. With proper regulation, the learning process becomes more accountable, measurable, and internationally comparable. The promotive role of public policy is reflected in the spatial and sectoral development of the vocational ecosystem—for example, through the establishment of vocational-based industrial zones, regional vocational centers (PVK), and the expansion of Teaching Factories. The government also promotes the dissemination and replication of successful vocational–industry partnership practices across regions. These efforts aim to broaden the reach of integration nationwide and ensure equitable implementation across regions. By fulfilling these five strategic functions, public policy acts not only as a guide but also as a catalyst in building strong connections between education and the labor market. Consistent and sustainable policy implementation will accelerate the development of high-quality, productive, and innovation-ready human resources in the knowledge-based economy.

The success of vocational–industry integration relies heavily on public policies that are concrete, systematic, and adaptable to evolving needs. In Indonesia, the government has launched a number of initiatives as part of its commitment to strengthening vocational education through industry partnerships. Several flagship programs that serve as best practice models include the SMK Center of Excellence (SMK PK), the Pre-Employment Card (Kartu Prakerja) program, and collaborative vocational training between polytechnics, vocational training centers (BLK), and industry.

The SMK Center of Excellence (SMK PK) is an initiative by the Ministry of Education, Culture, Research, and Technology that aims to transform vocational schools into institutions that are responsive to labor market needs. The program emphasizes the *link and match* approach through project-based learning, teacher competency enhancement, and structured partnerships with industry. A key feature of SMK PK is the development of Teaching Factories (TeFa)—school-based production units that simulate real industrial work environments. Through this model, students gain not only theoretical knowledge but also practical skills and real industrial work culture. Many SMK PKs have established partnerships with leading companies in the automotive, agriculture, and hospitality sectors.

The Pre-Employment Card (Kartu Prakerja) is a national program launched in response to the need for workforce upskilling, particularly for individuals without stable employment. It targets the productive-age population by providing government-funded, skills-based training—both online and offline—aligned with relevant industrial sectors. In addition to training, participants receive financial incentives and access to job vacancies via a digital platform. With over 17 million beneficiaries since its launch, Kartu Prakerja has become a modern, data-driven vocational training model that is responsive to labor market dynamics.

Collaborative vocational training between polytechnics, vocational training centers (BLK), and industry has been widely implemented across regions to enhance local workforce competencies. For example, demand-driven training in the manufacturing, construction, and logistics sectors has been delivered through partnerships between state polytechnics, BLKs under the Ministry of Manpower, and industry partners. This model facilitates technology transfer, instructor capacity building, and competency certifications recognized by industry. It also leverages the BLK's role in delivering short technical courses, while polytechnics develop applied curricula and industry serves as a training and recruitment site.

These three examples demonstrate that collaboratively designed and consistently implemented public policies can produce effective and impactful models of vocational–industry integration. Looking ahead, stronger institutional coordination, digital monitoring systems, and greater empowerment of local governments will be essential to ensuring the long-term sustainability of these strategic programs.

Challenges in Implementing Vocational–Industry Integration Policies

Despite the launch of various public policies aimed at strengthening the synergy between vocational education and industry, implementation on the ground still faces numerous structural and operational challenges. These obstacles reduce policy effectiveness and hinder the continuity of national vocational programs that are intended to produce excellent and competitive human resources.

Key challenges in the implementation of integration policies include fragmented coordination, misalignment between national and regional planning, low industry participation, and weak evaluation and monitoring systems. One fundamental challenge is the lack of a solid coordination mechanism among relevant ministries and agencies, such as

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the Ministry of Education, Culture, Research, and Technology (Kemendikbudristek), the Ministry of Manpower, the Ministry of Industry, and the Ministry of State-Owned Enterprises. Differences in policy direction, program priorities, and databases often result in overlapping initiatives and duplicated activities. This fragmentation leads to inefficient budget use and confusion among implementers at both regional levels and within vocational education institutions. Vocational education policies are often formulated in a top-down manner, without strong coordination with local governments—despite the fact that they are directly responsible for on-the-ground implementation. As a result, many vocational programs tend to be short-term and are not integrated into regional development plans (RPJMD). This misalignment hinders budget harmonization, infrastructure support, and the development of local industries as vocational education partners in their respective areas. Although industries are expected to actively engage in training, curriculum development, and graduate recruitment, their participation remains relatively low. One of the reasons is the lack of economically attractive incentive schemes for industry to become involved in vocational partnerships. Many businesses—particularly micro, small, and medium enterprises (MSMEs)—view participation in vocational programs as an added burden rather than a long-term investment. The absence of formal recognition or appreciation also acts as a disincentive. Furthermore, the implementation of vocational–industry integration policies is not yet supported by strong, data-based evaluation and monitoring systems. Many programs are carried out without clear success indicators, making it difficult to assess their impact on graduate quality or workforce absorption. Additionally, reporting by educational institutions or industry partners is often not digitized, which hampers real-time monitoring and evidence-based policy adjustments. To address these challenges, a stronger and more measurable integration governance system must be developed, accompanied by enhanced incentives for industry participation, and the formulation of a national–regional vocational–industry integration roadmap. Without fundamental improvements in institutional capacity and policy execution, vocational–industry integration risks becoming a sporadic and unsustainable initiative.

The Contribution of Integration to the Development of Excellent and Competitive Human Resources
Characteristics of Excellent and Competitive Human Resources

In the era of globalization and technological disruption, human resources (HR) have become a strategic national asset that plays a central role in determining a country's competitiveness. Excellent and competitive HR are not only defined by their knowledge and technical skills, but also by their ability to adapt, innovate, and contribute within interdisciplinary work ecosystems. The integration between vocational education and industry serves as a critical foundation for shaping the human capital needed to meet the demands of the 21st century. Excellent human resources refer to individuals who possess both technical and non-technical competencies relevant to their field of work and who are able to compete productively in both national and global labor markets. These individuals are expected to be: Competent (mastering professional skills), Adaptive (able to respond to technological and market changes), Innovative (capable of generating new solutions in the workplace), and Ethical (demonstrating responsibility, integrity, and professional commitment). Vocational education that is closely linked with industry can cultivate graduates who reflect these four pillars through contextual and application-oriented learning approaches.

The competitiveness of human resources can be measured through several key indicators, including: 1) Employability – the extent to which graduates possess industry-relevant skills and can be readily absorbed into the labor market, 2) Digital literacy – the ability to understand, use, and create information technology in a productive and secure manner, 3) Innovation capacity – the ability to generate ideas and new solutions to workplace challenges and to create added value, 4) Cross-sector collaboration – the capacity to work effectively in cross-functional and multicultural teams, both locally and globally. According to data from the Global Competitiveness Index (GCI) and the Human Capital Index (HCI), Indonesia's workforce competitiveness still lags behind several other Asian countries. In the 2019 GCI report published by the World Economic Forum, Indonesia ranked 50th out of 141 countries, with low scores in workforce skills and technology readiness. Similarly, the 2020 Human Capital Index released by the World Bank rated Indonesia at 0.54 (on a scale of 0–1), indicating that children born today are expected to achieve only 54% of their productive potential if they receive optimal education and healthcare. These findings underscore the urgent need to reform the vocational education system and strengthen its integration with industry as a strategic path toward improving the quality of human capital. Without concrete actions to develop excellent and competitive human resources, Indonesia's demographic dividend risks becoming a liability rather than a driver of national development.

The Contribution of Integration to Enhancing Human Resource Competence

The integration of vocational education with the industrial sector has a direct impact on improving human resource (HR) competence—technically, socially, and culturally. Through systematic collaborative mechanisms, education is no longer focused solely on theoretical mastery but also on the development of applied skills and professional values that align with the dynamic demands of the modern workplace. The following are four key forms of contribution from this integration toward strengthening human resource competence:

1. **Industry-Aligned Curriculum Development**
   Vocational–industry integration enables the development of flexible, adaptive, and competency-based curricula. Curricula co-designed with industry stakeholders not only address specific technical challenges but also anticipate the rapidly evolving needs of the labor market. This alignment ensures that students acquire job-

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specific skills while also promoting interdisciplinary and problem-based learning. As a result, the educational process becomes more relevant and contextualized.

2. **Collaborative Learning through Co-Teaching and Industrial Internships**
   Involving industry practitioners in the learning process through co-teaching schemes offers added value to students by enabling direct learning from real-world professionals. Structured and certified industrial internships allow for the transfer of hands-on workplace experience into the educational environment. Direct exposure to industrial work culture fosters work ethic, discipline, adaptability, and social skills—key components of a holistic, excellent human resource profile.
3. **Utilization of Industry Facilities for Advanced Technical Training**
   Many vocational institutions face limitations in accessing modern equipment and training infrastructure. Collaboration with the industrial sector creates opportunities for students to access the latest technologies, including production machinery, research laboratories, and digital industrial systems. First-hand experience within professional work ecosystems exposes learners to actual operational standards, safety practices, and relevant technologies—critical factors for enhancing workforce competitiveness in the Industry 4.0 era.
4. **Joint Competency Certification (Joint Assessment)**
   Through joint assessment schemes, students are evaluated by combined teams from vocational institutions and industry partners. This process provides direct validation of both technical and soft skills acquired by graduates and ensures that educational outcomes meet real-world job standards. Industry-based certification not only boosts employer confidence but also strengthens graduates' positions in both national and international recruitment markets.

Through these contributions, vocational–industry integration plays a vital role in developing human resources that are technically competent, mentally prepared for the workforce, and professionally outstanding. Well-designed and continuously implemented collaboration will serve as a foundation for transforming vocational education into a system that is adaptive, inclusive, and future-oriented.

The Impact of Integration on Workforce Performance and Competitiveness

The integration of vocational education with industry contributes not only to improving technical competencies but also yields broader impacts on individual performance and the overall competitiveness of the national workforce. When the education process is designed to align with real-world labor demands, graduates become more job-ready and bring added value in terms of productivity, flexibility, and innovation. Below are four key dimensions of the impact of this integration:

1. **Increased Individual Productivity and Labor Absorption**
   Vocational graduates who are directly exposed to industry throughout their education tend to adapt more quickly to actual job responsibilities. Equipped with job-ready skills, they require less retraining and can make productive contributions sooner in the workplace. On the industry side, active involvement in the recruitment process boosts employment absorption rates, as graduate competencies are already aligned with employer needs. This has a direct positive impact on workforce efficiency and the productivity of related economic sectors.
2. **Reduction of Skill Mismatch and Open Unemployment among Vocational Graduates**
   One of the longstanding challenges of vocational education in Indonesia is the high level of mismatch between graduate skills and labor market demands. Industry integration helps solve this issue by ensuring that curriculum content, teaching methods, and competency assessments are aligned with labor market standards. As a result, open unemployment among vocational graduates can be significantly reduced, as they possess skills that are both in demand and valued by employers. In this way, integration becomes a strategic solution to maximize Indonesia’s demographic bonus.
3. **Improved Workforce Readiness for Global, Regional, and National Labor Markets**
   Through industry-based training and both national and international competency certifications, vocational graduates from integrated programs achieve greater labor mobility. They are able to compete not only in domestic job markets but also within ASEAN (e.g., under the Mutual Recognition Arrangement framework) and globally. Exposure to industrial technologies, professional work culture, and cross-sector collaboration enhances their readiness to face uncertainty and transformation in the global labor landscape.
4. **Strengthening Innovation and Independence through Industry-Based Entrepreneurship Learning**
   Integration between vocational education and industry also opens avenues for strengthening entrepreneurial mindsets. Through project-based learning, production activities (teaching factories), and business training, students are encouraged not only to become workers but also to become job creators. Collaboration with industry provides real-world business experience and introduces them to principles of efficiency, product innovation, enterprise management, and market adaptation—all essential tools for developing competitive young vocational entrepreneurs.

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Overall, the impact of vocational–industry integration illustrates a shift in education strategy—from merely producing graduates to building human resources who are excellent, productive, and competitive across all levels of the labor market. As such, strengthening this integration must be viewed as a **strategic investment** in long-term national development.

DISCUSSION

The findings of this study indicate that the integration between vocational education and industry through five main approaches—co-design, co-teaching, co-training, co-assessment, and co-recruitment—is an effective strategy for bridging the gap between graduates and labor market needs. These findings align with the Triple Helix theory (Etzkowitz & Leydesdorff, 2000), which emphasizes the importance of synergy among government, industry, and educational institutions in fostering innovation and producing high-quality human resources. The collaborative practices identified in this study also support international literature, such as the works of Ogard et al. (2025) and Iliescu et al. (2025), which assert that direct involvement of industry in curriculum development and teaching enhances the relevance, effectiveness, and credibility of vocational education in a global context.

The main strength of vocational–industry integration practices in Indonesia lies in the progressive national policy support, such as Presidential Regulation No. 68 of 2022, the Center of Excellence Vocational School (SMK PK) program, and the Pre-Employment Card initiative. The implementation of Teaching Factories and Centers of Excellence serves as tangible examples of industry-based integration that successfully create learning environments that closely resemble real workplace conditions. However, challenges remain, particularly in terms of the limited capacity of vocational institutions in rural areas, the low participation of micro, small, and medium enterprises (MSMEs), and regional disparities. Many vocational institutions still face difficulties in establishing long-term strategic partnerships and lack adequate access to modern infrastructure and digital reporting systems.

From a policy implementation perspective, the most prominent challenge is the lack of coordination among ministries and agencies, such as the Ministry of Education, the Ministry of Manpower, and the Ministry of Industry. Misalignment between national policies and regional development plans (RPJMD) results in fragmented and unsustainable vocational programs. Moreover, incentives for businesses to engage in vocational education remain limited, leading to suboptimal participation from the industrial sector, particularly MSMEs. As a result, without strengthened governance of vocational–industry integration, national strategies to improve human resource competitiveness risk falling short of the demands of Industry 4.0 and global economic transformation. Therefore, there is a pressing need to modernize monitoring and evaluation mechanisms through digital platforms and to delegate greater authority to local governments to design integration models tailored to regional potential.

Based on these findings, several policy recommendations can be proposed. First, the government should strengthen incentive schemes for industries actively involved in curriculum development, training, and recruitment of vocational graduates, through both fiscal incentives and institutional recognition. Second, managerial capacity building in vocational institutions must be enhanced to support sustainable, outcome-based industrial partnerships. Third, the engagement of MSMEs as partners in vocational education can be expanded through collaborative programs facilitated by local business associations and cooperatives. Fourth, the development of a national digital system for curriculum integration, collaborative assessment, industry needs mapping, and job-matching platforms is crucial for creating a modern and efficient vocational education ecosystem. Fifth, each region should formulate a locally specific roadmap for vocational–industry integration to ensure that vocational education meaningfully contributes to regional economic development. With the right policy strategies and consistent implementation, vocational–industry integration can serve as a driving force for developing Indonesian human resources that are excellent, adaptive, and globally competitive.

CONCLUSION

The integration of vocational education and industry is a key strategy in addressing the challenges of human capital development in the era of the Fourth Industrial Revolution and Society 5.0. This study finds that the ideal model of integration comprises five core approaches—co-design, co-teaching, co-training, co-assessment, and co-recruitment—which together form a synergistic learning ecosystem that is responsive to labor market demands. Public policy plays a central role as a catalyst, facilitator, and regulator in promoting collaboration between educational institutions and the business sector through regulations, incentives, and strategic programs such as the SMK Centers of Excellence and the Pre-Employment Card initiative.

The contribution of this integration is evident in increased graduate employability, reduced skills mismatch, and strengthened workforce productivity and competitiveness. Nevertheless, implementation challenges such as fragmented coordination, low industry participation, and weak evaluation systems must be addressed as a priority. Going forward, improving the governance of vocational–industry integration and ensuring policy consistency will be crucial for developing a world-class workforce capable of competing globally and responding to the demands of national economic transformation.

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