Curriculum Alignment of Technical and Vocational Education and Training (TVET) for Indonesia's Electric Two-Wheeler Transition

Introduction

Indonesia, through Minister of Industry Regulation No. 6 of 2022, has set ambitious targets for transport electrification, including the deployment of up to 12 million electric two- and three-wheelers by 2035 as part of its national electric vehicle roadmap. Electrifying the transport sector is expected to significantly reduce fossil fuel consumption and could lower CO_2 emissions by approximately 7–8 million tons (IESR, 2025), positioning electric mobility as a key pillar of Indonesia's energy transition and green industrial strategy. However, after government purchase incentives ended in 2025, electric motorcycle sales declined by more than 80 % relative to sales levels during the subsidy period in 2024 (IESR, 2025). This downturn has created a temporary market freeze, and market projections suggest that total electric two-wheelers adoption may reach only 1.7–2 million units by 2030 (ENTREV, 2025).

An additional layer of uncertainty arises from the government's strategy to accelerate electrification through the conversion of existing ICE into BEV motorcycles. The Indonesian government has promoted motorcycle conversion as a key policy instrument to expand EV adoption, supported by incentives of around IDR 10 million per converted unit (ESDM, 2024). However, the implementation framework for the program, including financing mechanisms, incentive structures, and operational targets remains under development. Government officials have indicated that funding arrangements and conversion targets are still being discussed and finalized (ESDM, 2025). As a result, the extent to which conversion programs will contribute to national EV deployment targets remains uncertain. This evolving policy landscape complicates projections of future demand for EV-related skills, particularly in areas such as battery systems, electric drivetrains, and digital vehicle diagnostics.

This uncertainty has raised questions about the urgency of aligning Technical and Vocational Education and Training (TVET) curricula with EV technologies. Nevertheless, curriculum reform in vocational education typically requires around three to six years to produce graduates with updated competencies (Liu et al. 2025). This suggests that delaying alignment could lead to future skill shortages as technology adoption accelerates. In particular, aligning TVET curricula with Battery Electric Vehicle (BEV) competencies should therefore be acknowledged as a long-term workforce preparedness strategy, given the sector's demand for integrated electrical, digital, and systems skills.

This strategic direction is consistent with Indonesia's Green Jobs Roadmap 2025-2045, which aligns with the National Long-Term Development Plan (RPJMN). The roadmap is intended to guide stakeholders across the ecosystem in preparing Indonesia's workforce for emerging green sectors (Bappenas, 2025). At the same time, reforms must avoid overspecialization in a still-developing labor market. This is particularly important as programs such as Motorcycle Engineering (*Teknik Sepeda Motor*) already enroll more than 651,000 students across 5,810 schools (Kemendikdasmen, 2025). While the open unemployment rate among vocational graduates remains 9.6 %, underscoring the need for a balanced and flexible approach to vocational training (BPS, 2025).

These dynamics highlight a key policy challenge. While Indonesia's EV targets signal the need to prepare a future-ready workforce, market volatility and uncertainty surrounding the scale of motorcycle conversion programs complicate decisions about the timing and scope of vocational curriculum reform. Delaying alignment risks future skill shortages as EV adoption accelerates, while premature specialization could create labor market mismatches. A balanced approach is therefore required to gradually integrate EV-related competencies into existing vocational

programs while maintaining flexibility to adapt to evolving industry demand. The following recommendations outline strategies to strengthen workforce preparedness amid this uncertainty. …

Recommendation 1: Strategic Curriculum Alignment for EV Competencies

Curriculum alignment should be framed as a strategic effort to modernize TVET rather than as a narrow response to immediate labor demand for EVs. The objective is not to prepare all vocational graduates as EV specialists, but rather to build a balanced skills ecosystem that includes both specialized and generalist competencies. In this context, specialists refer to workers with advanced technical expertise in EV-specific systems such as battery technologies, electric drivetrains, and digital diagnostics. Meanwhile, generalists refer to graduates with broader mechanical, electrical, and digital foundations that enable them to work across both conventional and emerging vehicle technologies while adapting to evolving industry needs.

A realistic approach is to prepare approximately 4–10% of vocational graduates as EV-ready specialists. With around 125,000 vocational graduates annually, this amounts to roughly 12,700 EV-ready graduates. This level of specialization remains consistent with projected workforce needs, estimated to range from 27,000 to 63,500 EV-related workers by 2030 across different market scenarios. Currently, however, the number of EV-ready graduates remains extremely limited, with only 341 graduates per year possessing EV-related competencies.

The majority of vocational graduates should instead be trained as *multi-skilled generalists*, referring to workers with a broad combination of mechanical, electrical, and digital competencies that allow them to perform across multiple technical tasks and adapt to different technologies. Such competencies overlap with EV technologies while remaining relevant across multiple sectors. This approach reflects broader labor market transformations driven by automation and digitalization. Recent projections suggest that Indonesia may lose around 23 million jobs by 2030, particularly in routine and manual occupations such as conventional manufacturing and low-skill service roles. At the same time, the economy could create 27–46 million new jobs in emerging sectors, including digital services, advanced manufacturing, renewable energy and other green technologies (Bappenas, 2025). These trends underscore the importance of adaptable and transferable skills in vocational education.

To support this balance, vocational education should gradually transition from a single-competency training model toward a multi-competency structure. Under this model, EV-related knowledge can be integrated into core learning modules, while schools retain flexibility to offer elective pathways that include both EV-specific and non-EV specializations. Such an approach enables vocational institutions to prepare both specialists and generalists while ensuring that curriculum reforms remain adaptable to future technological and market developments.

Recommendation 2: Piloting EV Curriculum Alignment through Decentralized Implementation

Indonesia's decentralized education governance structure provides an opportunity to implement curriculum alignment through targeted pilot initiatives led by regional education authorities (*Suku Dinas Pendidikan*) and individual schools. Rather than imposing uniform reforms nationwide, EV curriculum alignment can be introduced gradually through experimental programs that allow schools and regional education authorities to adapt learning frameworks to local economic contexts.

Vocational schools can begin this process by conducting joint analyses of learning outcomes with industry partners. This process ensures that educational content aligns with evolving competency standards, such as the Indonesian National Work Competency Standards (SKKNI) and relevant certification schemes. Through this process, schools and industry stakeholders can collaboratively develop learning objectives and instructional pathways that reflect emerging and projected occupational roles within the EV ecosystem.

Strengthening Training Need Assessments (TNA) is also essential in this process. While the Ministry of Manpower (Kemnaker) plays a key coordinating role in identifying workforce skill requirements, the assessment process should not rely solely on government initiatives. International experience shows that skills needs assessments are typically updated annually, while medium-term skills forecasting exercises are conducted every two to four years to inform education and training policies (OECD, 2016; OECD & ILO, 2022). In this context, vocational schools and private sector actors should adopt proactive industry engagement and demand-driven skills identification approaches by regularly monitoring labor market developments and consulting with industry partners. Periodic reviews being conducted annually through industry consultations and every three to four years through structured curriculum evaluations can help ensure that training programs remain aligned with evolving skill requirements in the EV ecosystem.

In addition to technical competencies, the learning process should incorporate occupational mapping and career-pathway information. In Indonesia, such information is reflected in national occupation maps (*Peta Okupasi*) developed through collaboration among the Ministry of Manpower, Bappenas, the National Professional Certification Agency (BNSP), and industry stakeholders, which outline occupational roles, competency requirements, and potential career progression within specific sectors. These maps serve as a reference for aligning education, training, and certification systems with industry needs and national competency standards such as the Standar Kompetensi Kerja Nasional Indonesia (SKKNI).

Integrating occupational mapping into classroom instruction enables students to better understand potential job trajectories within the EV ecosystem, including entry-level technician roles, advanced diagnostic specialists, and supervisory positions in EV maintenance and battery systems. Presenting this information within the learning process can strengthen career awareness, student motivation, and contextualized learning, consistent with the student-centered and competency-based learning approaches promoted by the Ministry of Primary and Secondary Education.

Pilot programs can initially be implemented at selected *SMK Pusat Keunggulan* institutions, which serve as "champion schools" for curriculum experimentation. The selection of pilot regions should be based on (i) economic indicators; (ii) the broader EV ecosystem potential, including projected charging infrastructure deployment, the presence of EV-related manufacturing facilities, regional adoption projections for electric motorcycles, and (iii) the availability of vocational institutions and graduates.

Recommendation 3: Strengthening SMK–Industry Partnerships across Supply, Demand, and Ecosystem Levels

Successful curriculum alignment ultimately depends on strong partnerships among vocational schools, government, and industry actors. Strengthening these partnerships requires coordinated efforts across the education system, industry stakeholders, and the broader institutional ecosystem.

On the education side, stronger incentives are needed to encourage sustained collaboration with industry. These incentives may include performance-based funding, recognition within school accreditation and evaluation systems, and policy support for industry partnership programs that reward schools actively engaging with employers. School performance evaluation systems should incorporate partnership indicators, including the quality of industry collaboration, the number of real-world learning projects, and graduate employment outcomes. TVET program expansion should also be guided by labor market analysis to ensure that new programs reflect regional economic needs. Expanding Teaching Factory models can further strengthen practical learning by allowing students to work on real industry projects and gain exposure to professional work environments. School leadership also plays a critical role in this process, and principals should be encouraged to serve as strategic leaders responsible for building partnerships and connecting educational institutions with labor market opportunities.

At the same time, industry participation must be strengthened through more robust incentives and institutional engagement. Firms should be encouraged to contribute to curriculum development, apprenticeship programs, and training initiatives. Existing Matching Fund schemes can be expanded beyond tax reductions to include co-financing for training programs, equipment provision, and apprenticeship support. Importantly, industry actors must also provide clearer signals regarding future skill requirements. Because curriculum design increasingly follows a backward design approach based on competency requirements for recruitment, industry foresight is essential to anticipate future workforce needs. Without such anticipatory signaling, the structural lag in education systems may produce a three- to six-year mismatch between training supply and labor demand. Industry associations can serve as important intermediaries between the private sector and government, helping to design training programs, certification systems, and align TVET curricula with emerging green industry standards.

The government plays a critical role as a facilitator of cross-sector collaboration, ensuring that partnerships between industry and education institutions function effectively. Strengthening policy and regulatory frameworks can also support the development of nationally and internationally recognized green competency standards and certification systems for workers and companies that comply with environmental standards.

The importance of coordinated policy implementation is also evident in programs such as the national initiative to convert gasoline motorcycles into electric vehicles, managed by the Directorate General of New and Renewable Energy and Energy Conservation under the Ministry of Energy and Mineral Resources of Indonesia. Through the official conversion platform, vehicle owners can register for conversion services at certified workshops, where technicians verify vehicle documentation, assess technical feasibility, and carry out the conversion process supported by government subsidies.

Programs such as these illustrate the expanding ecosystem of skills required for EV adoption, including certified conversion workshops, trained technicians, and standardized testing and certification procedures. The implementation of these initiatives will require adequate and sustainable funding. The Indonesia Green Jobs Roadmap 2025–2045 notes that vocational training and green workforce development programs can be supported through national and regional budgets (APBN and APBD) in accordance with Law No. 17 of 2003 on State Finance, which allows public funding to support workforce training in renewable energy and green technologies.

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