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Strengthening the Partnership Model between Conversion Workshops and Vocational High Schools to Accelerate Electric Vehicle Adoption

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Abstract

Accelerating the adoption of electric vehicles in Indonesia still faces various obstacles, including limited technical competency, unstructured relationships between certified conversion workshops and educational institutions, and suboptimal development of business models and consumer education. This community service activity aims to strengthen the partnership model between electric motorcycle conversion workshops and Vocational High Schools (SMK) through technology education, technical training, strengthening business engineering, and implementation assistance. The activity partners are PT Ekolektrik Konversi Mandiri (PT. EKM), an electric-vehicle conversion workshop, and SMK partners in the Solo Raya area. The implementation method used a participatory approach that includes needs analysis, development of training modules, conversion technology and business engineering training, implementation practices, and evaluation and ongoing assistance. This program has succeeded in improving the technical competency and skills of five SMK partners spread across Solo Raya. The most significant surge, exceeding 30%, was observed at the partner SMK in Sragen; more modest gains (3.2% - 6.6%) were observed in Karanganyar, Boyolali, and Klaten, while the result for the partner SMK Muhammadiyah 1 Sukoharjo remained stable at an adequate average level. The implementation of the partnership model developed positions conversion workshops as sources of technical competence, vocational schools as centers for learning and human resource development, and universities as facilitators of knowledge, innovation, and mentoring.

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INTRODUCTION

Climate change and the energy crisis are global issues that have become increasingly serious in recent years. The transportation sector is a major contributor to global carbon emissions. In land transportation, carbon dioxide (CO_2) emissions account for approximately 74% of the transportation sector, which collectively accounts for more than 20% of global emissions (Ehsan et al., 2025).

Various countries, including Indonesia, are striving to reduce emissions to achieve net-zero emissions (Matheus et al., 2023). The Indonesian government is targeting a 31.89% reduction in greenhouse gas (GHG) emissions independently and a 43.20% reduction with support from other countries by 2030, as stipulated in the Enhanced National Determined Contribution (ENDC). The Indonesian government aims to achieve net-zero emissions (NZE) by 2060.

Based on data from the Central Statistics Agency (BPS), the number of motorized vehicles in 2025 is projected to reach approximately 166 million units, with 83% of them being motorcycles. This high use of motorized vehicles makes Indonesia a major contributor to carbon dioxide emissions (Yuniza et al., 2021; Nugroho et al., 2024) and increases the burden of fuel subsidies and compensation that the government must bear. The value of fuel subsidies and compensation in the transportation sector increased from IDR 76.3 trillion in 2021 to IDR 285 trillion in 2022, then to IDR 144.5 trillion in 2023 (AISMOLI, 2025).

This condition encourages the government to accelerate the transition towards lower-emission

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vehicles and away from fuel dependence by adopting Battery-Based Electric Motor Vehicles (KBLBB) and converting fossil-fuel-powered motorcycles into battery-powered electric motorcycles (Widiawati et al., 2024). To support the adoption and diffusion of electric conversion vehicles, the government has issued various regulations, such as Permenhub PM 39/2023 concerning the conversion of fuel-powered motorcycles to electric and Regulation of the Minister of Energy and Mineral Resources Number 3 of 2023 concerning guidelines for government assistance in the conversion program (Fahmi, 2023; Subiantoro & Maharani, 2024).

However, despite the implementation of various policies, the growth of electric vehicles in Indonesia has not been matched by an increase in electric motorcycle conversions. In 2025, the number of electric vehicles in Indonesia is estimated at around 252,000 units, up from around 207,000 in 2024. As of February 2026, the electric motorcycle conversion program has realized only around 2,250 units, still far from the government's target of 200,000 units for the 2023–2024 period (Makki, 2026).

The electric motorcycle conversion business still faces several challenges, including the high cost of conversion technology, which can reach IDR 17 million per unit; limited supporting infrastructure (such as the small number of conversion workshops and limited testing facilities for conversion results); and a lack of skilled technicians both in conversion workshops and in other supporting sectors such as conversion kit suppliers, after-sales service distributors, and battery and charging station providers (Fahmi, 2023; Firmansyah et al., 2022; Hendrawan et al., 2025). On the consumer side, obstacles remain, including low public awareness and limited purchasing power. Furthermore, public expectations for conversion results to be equivalent to internal combustion engine (ICE) motorcycles or new electric motorcycles also pose a challenge (Ananda, 2021; Aqidawati et al., 2022; Rahmawati et al., 2022; Yuniaristanto et al., 2023).

Competency issues are becoming increasingly important because electric vehicle technology requires different knowledge than ICE vehicles. Technicians need to understand batteries, Battery Management Systems (BMS), electric motors, controllers, DC-to-DC converters, charging systems, electrical systems, and testing and safety procedures (Firmansyah et al., 2022; Habibie et al., 2021). Therefore, developing human resources capable of understanding the technical, marketing, and business aspects of electric vehicles is an important prerequisite for the sustainability of the electric vehicle ecosystem.

Vocational High Schools (SMK) have significant and strategic potential to support the development of these human resources. Generally, vocational schools with vehicle technology programs already have adequate workshop facilities, teaching staff, and students, enabling them to participate in the electric vehicle ecosystem. However, this potential has not been fully integrated with certified conversion workshops and industry players. The relationship between conversion workshops and vocational schools is often sporadic and lacks a structured partnership model.

As part of efforts to encourage the strengthening of the electric vehicle industry, the Center for Excellence in Electrical Energy Storage Technology, Universitas Sebelas Maret (PUI TPEL UNS), and the Industrial Engineering and Techno-Economic Research Group (RG-RITE) of the Industrial Engineering Study Program have assisted with a startup fostered by UNS, namely PT. Ekolektrik Konversi Mandiri (PT. EKM). This company has obtained certification from the Ministry of Transportation and is registered on the Ministry of Energy and Mineral Resources' digital platform. However, in practice, EKM still faces several challenges in trade, including limited production capacity, limited human resources, and a lack of business innovation. To overcome these problems, RG-RITE has provided PT. EKM with business consulting so that PT. EKM can collaborate with SMK in Central Java, especially those with Vehicle Technology Departments.

Prevously, RG-RITE gained experience through a conversion technology training program for 40 students and teachers at SMK Muhammadiyah 1 Solo, which successfully increased technical understanding by 35% and entrepreneurial interest by 60%. However, initiatives at a single school are not sufficient to address the low adoption of electric vehicles in Central Java. This challenge is further compounded by a general lack of foundational knowledge regarding electrical systems, as well as the need for stronger collaboration with certified workshops (Sutopo et al., 2025). Consequently, the program should be expanded to include more vocational high schools across the Solo Raya region. Such an expansion would help establish a regional-scale teaching factory ecosystem and provide more comprehensive data to evaluate the technology's acceptance. This type of cross-school mapping serves as a crucial foundation for refining the business model's design.

Based on the analysis of the problems faced by PT. EKM with SMK in establishing business relationships, several main obstacles need to be resolved to strengthen the Electric Motorcycle Conversion Workshop Business Engineering Model, including: (i) minimal understanding and technical skills in electric two-wheeled vehicle conversion technology, especially in the aspect of checking the feasibility of converted components; (ii) the absence of

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standardization in business processes, which has an impact on low work efficiency and productivity. As a result, the relationship between the conversion workshop and its workshop partners still experiences wasted time and resources, which has the potential to hinder optimal business operations; (iii) limited business volume and low market demand, caused by the ineffective implementation of consumer education patterns. In fact, if there is a good cooperation model, the SMK community (including students, teachers, and employees) can become a potential captive market. In addition, opportunities to utilize cooperation through fieldwork practices, industrial programs, competency tests, and distribution and sales have not been fully maximized. Therefore, this activity aims to strengthen the partnership model between electric vehicle conversion workshops and vocational schools through technology education, technical training, business engineering development, and implementation assistance. Specifically, this activity aims to increase partners' capacity, build a more structured business relationship model, and strengthen the role of vocational schools within the electric-vehicle education and diffusion ecosystem.

MATERIALS AND METHODS

Problem Solving Approach

This community service program uses a Participatory Rural Appraisal (PRA) approach, actively involving partners at every stage of the project. The primary partner is PT EKM, a startup fostered by UNS that specializes in electric vehicle conversions and is certified as a motorcycle conversion workshop. Supporting partners include vocational schools (SMK) in Solo Raya, namely: SMKN 1 Miri Sragen, SMKN 2 Karanganyar, SMK Muhammadiyah 1 Sukoharjo, SMAN 1 Boyolali, and SMAN 1 Karanganom, all of which offer expertise programs and facilities related to vehicle technology.

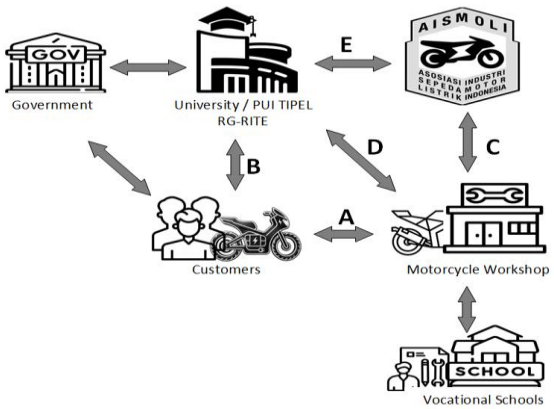


Fig. 1. The Cooperation model offered to energize society

The main problem faced by the partners is related to "Strengthening the Business Engineering Model," which is a continuous process of building relationships between certified conversion workshops (PT. EKM) and SMK, taking into account the dynamics of changes in the market environment, business, and developments in conversion technology. The proposed solution to overcome this problem is shown in Fig. 1 and includes the following steps.

a. Certified conversion workshops (PT. EKM) and vocational schools act as technical service providers, converting ICE motorcycles into electric motorcycles, ensuring safety and roadworthiness, and providing technical information and consultations regarding the converted vehicles. Meanwhile, consumers serve as end users who generate market demand, provide feedback on usage, and act as agents of technology diffusion, spreading the experience of using converted motorcycles to the wider community. This interaction can increase public trust in converted electric vehicles.
b. Consumers (the public) provide data on technology acceptance, user needs, and barriers to adoption to RG-RITE as material for evaluating research and developing educational programs. In turn, RG-RITE provides education, technological literacy, and public awareness of the benefits of electric vehicles to increase awareness and readiness for electric vehicle adoption.
c. AISMOLI provides competency standards, certification, industry networks, and regulatory support to conversion workshops to ensure their businesses operate according to national standards. Conversely, conversion workshops strengthen AISMOLI through field implementation, increased membership, and data on developments in the conversion industry, serving as a basis for policy advocacy.
d. RG-RITE and PUI TPEL-UNS: serve as education and mentoring centers, providing training modules, technician capacity building, and business model innovation for conversion workshops. Conversely, conversion workshops act as implementation partners, implementing technology and business models in the field, while also providing real-world data for research and community service improvements.
e. Government: Provides regulations and support for "Energizing the Community - Education and Action for Electric Vehicles" based on input from RG-RITE as the basis for developing partnership models and training modules. RG-RITE provides scientific studies, policy recommendations, and proven business models that the government (decision-makers) can use to strengthen

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advocacy and development of the national electric vehicle ecosystem.

Stages of Community Service Activities

In general, activities are divided into three stages: the initial, implementation, and evaluation stages (Fig. 2).

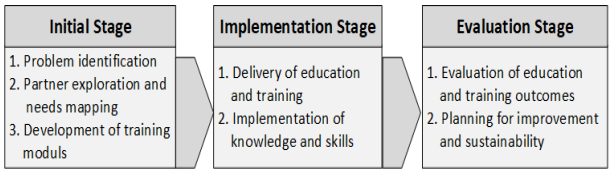


Fig. 2. Stages of community service activities

The initial stage involves identifying problems and mapping partner needs. This stage involves gathering information on the partner's initial conditions, facilities, human resource competencies, business processes, and the need to develop collaboration between the conversion workshop and vocational high schools. Next, training modules are developed. These modules are tailored to partner needs and cover electric vehicle regulations, an introduction to electric vehicle components, battery and BMS technology, electric motors, controllers, charging systems, inspection procedures, safety, and business and marketing aspects.

The implementation phase is the main stage of community service, namely education and training. This phase includes material delivery, discussions, demonstrations, practical exercises, and evaluation. During the technical training session, participants gained hands-on experience in converting ICE motorcycles into electric motorcycles. To ensure the sustainability of knowledge transfer beyond the training, each partner school received a grant for a converted motorcycle, which serves as a learning resource and a tool for independent practical exercises. These converted vehicles were provided through a Corporate Social Responsibility (CSR) funding scheme from PT PLN (Persero). Overall, the activities aim to integrate technical knowledge and business engineering aspects. Next, partners are mentored in applying the acquired knowledge and skills, including developing work processes, utilizing facilities, and developing business relationships between certified conversion workshops and vocational schools.

The final phase focuses on evaluation and program sustainability planning. The evaluation aims to identify changes in partners' knowledge and skills, implementation readiness, and potential for partnership development. Program sustainability planning takes into account partners' ability to apply their knowledge and skills to operational activities and business development, including using modules as learning media, developing technical services, and engaging in commercial activities, in accordance with regulations and existing capacity.

RESULTS AND DISCUSSION

Initial Stage

The initial problem-identification results indicate that developing an electric vehicle ecosystem requires strengthening the linkages among technical competency, business capacity, and market access. PT. EKM, as a standardized conversion workshop, possesses competence and experience in conversion technology but faces limitations in human resources and business network development. Meanwhile, vocational high schools (SMK) possess potential facilities and human resources but require strengthening their competencies and access to the latest developments in electric vehicle technology.

Addressing these issues cannot be achieved through technical training alone. A program is needed that integrates technology transfer with partnership model development and business engineering. This approach is crucial for applying the training to sustainable activities.

To support the program's effective implementation, educational and training modules were developed. These modules serve as learning aids that connect the basic concepts of electric vehicles with technical applications, as well as market and business opportunities. The modules cover electric vehicle technology; batteries and charging infrastructure; electric vehicle conversion; electric vehicle adoption; electric vehicle marketing strategies and business models; and policies and regulations related to electric vehicles.

The development of educational and training modules has two main benefits. First, the modules help standardize materials because educational activities are conducted in five different schools (Sragen, Karanganyar, Sukoharjo, Boyolali, and Klaten). Second, the modules can be reused by partners as learning references in their respective schools. Module development supports program sustainability because knowledge is not transferred solely through face-to-face activities. The documented materials can serve as references for teachers, students, laboratory assistants, technicians, and other interested parties.

Implementation Stage

In the implementation stage, the community outreach program focused on two primary agendas: education and technical training. Educational sessions on electric vehicles were conducted via a roadshow across five partner schools located in the regencies of Sragen, Karanganyar, Sukoharjo, Boyolali, and Klaten, while the technical training was held centrally at FT UNS. A detailed breakdown of the number of participants involved in these activities is presented in Table 1. In the training session, each

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school was represented by two teachers and eight students. Substantively, these educational and technical training sessions on conversion technology were designed to build a comprehensive understanding of the architecture and component integration within an electric vehicle system. Through these sessions, participants gained in-depth knowledge of the functions and operational principles of batteries, Battery Management System (BMS), electric motors, controllers, DC-to-DC converters, charging systems, and various other supporting components.

Table 1. Detail on number of participant

Regions	Educational Roadshow	Technical Training
Sragen	142	10
Karanganyar	124	10
Sukoharjo	109	10
Boyolali	200	10
Klaten	131	10

The learning approach integrates theory, demonstration, and practice. The theory is used to build conceptual understanding, while demonstrations and practice enhance application skills. This approach is relevant for participants from vocational high schools (SMK) because vocational education emphasizes the link between knowledge and skills (Sutopo et al., 2025). Fig. 3 shows the educational activities, and Fig. 4 shows the motorcycle conversion training activities.



Fig. 3. Educational activities and actions of electric vehicles for a clean future at SMK Miri Sragen

The developed partnership model positions the conversion workshop as a center of technical competence and the vocational high school (SMK) as a partner in human resource development and a learning facility. Universities are positioned as knowledge facilitators, model developers, and mentors. This relationship can be described as a three-way collaboration model. Conversion workshops provide technological knowledge, process standards, and industry experience. The vocational high school provides human resources, facilities, and a learning environment. The university provides research, modules, mentoring, and evaluation.



Fig. 4. Conversion motorcycle training activities

One important aspect of the developed model is the utilization of the captive market within the vocational school environment. Students, teachers, educational staff, and the surrounding community can be potential users of electric vehicles. Utilizing the captive market allows for simultaneous educational and marketing activities. As the school community gains knowledge about electric vehicles, it will increase their understanding and trust in the technology. Furthermore, the experience of using electric vehicles can serve as an effective medium for the diffusion of technology within the wider community. The vocational high schools can serve as educational centers and starting points for market development. The conversion workshop gains access to potential users and potential workers, while the vocational high school has the opportunity to develop project-based learning and industry relationships.

Evaluation Stage

The evaluation of partner capacity development was conducted by measuring improvements in participants' knowledge and skills through a comparison of pre- and post-test scores. The pre-test was administered before the series of activities began, while the post-test was conducted 14 days after the completion of the community service program to assess participants' retention of understanding.

Base on the boxplot visualization (Fig. 5) and descriptive statistical analysis (Table 2), the education and training program proved effective in enhancing post-test outcomes, both in terms of the mean score and the consistency of understanding among participants. This is evidenced by an increase in the mean score accompanied by a decrease in

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the standard deviation across nearly all partner schools, except for the partner in Sukoharjo, where the mean score and standard deviation remained constant at 79 and 21, respectively. These descriptive findings are reinforced by the results of an inferential analysis using a paired-samples t-test (Table 3), which yielded a 95% confidence interval for the mean difference ranging from -8.56243 to -5.25317, with a significant p-value of 0.000 ($p<0.05$). In the aggregate, these results indicate a statistically significant increase in scores, ranging from 5.25317 to 8.56243 points, following participants' completion of the program.



Fig. 5. Box Plot of pre-test and post-test scores

The degree of improvement varied across the partner regions. The SMK partner in Sragen recorded the largest increase in scores, exceeding 30%. Conversely, the SMK partner in Sukoharjo showed no statistically significant change between pre-test and post-test (95% confidence interval of difference: -5.39436 to 5.742987; $p>0.05$). Meanwhile, partner schools in the other three areas- Karanganyar, Boyolali, and Klaten experienced relatively moderate percentage increases (ranging from 3.2% to 6.6%). This is attributable to a ceiling effect, as the participants' pre-test scores in these areas were already very high (above 90).

The variability in the effectiveness of the education and training program across the partner institutions is influenced by three primary factors : (1) Characteristics and quality of the student intake: differences in the students' initial academic backgrounds. Participants from public schools generally demonstrated a higher level of foundational conceptual readiness compared to those from private schools; (2) Variation in material delivery by instructor: although all sessions utilized standardized teaching modules, the use of different instructors at each roadshow location introduced variations in communication styles and delivery methods, which affected participants' level of information absorption; (3) Cognitive fatigue and academic burden: the highly intensive schedule of activities carries the risk of causing burnout and fatigue among participants. This was clearly observed at SMK Muhammadiyah Sukoharjo partner, where the program schedule coincided directly with the student's final semester examination period. The evaluation results of this community service program also show changes in the partners, as presented in Table 4.

At the end of the program, an evaluation of technology acceptance was conducted to measure participants' intentions to adopt electric motorcycle conversion technology and the factors that determined them. A total of 139 participants responded, with the distribution of results summarized in Tabel 5. The findings indicate that 81% of respondents were willing to convert their motorcycle, primarily motivated by environmental awareness, followed by lower operating costs (71.22%) and access to more modern vehicle technology (57.55%). These empirical findings confirm that increased technology literacy and practical skills are positively correlated with a high level of acceptance of conversion technology. Furthermore, this outcome validates the strategic position of the partner SMK as a potential captive market for the development of an electric-vehicle conversion business ecosystem.

Table 2. Descriptive statistics analysis

Respondents	N	Mean		Std. Deviation		Std. Error Mean	
		Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
Sragen	142	66.007	88.45	22.7580	15.213	1.9098	1.2766
Karanganyar	124	90.903	93.73	12.8831	11.224	1.15692	1.0080
Sukoharjo	109	79.651	79.48	21.1176	21.220	2.0227	2.0325
Boyolali	200	93.265	96.26	10.9377	7.3778	0.7734	0.5217
Klaten	131	91.649	97.41	11.1755	5.2371	0.9764	0.4576

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Table 3. Paired sample t-test results

Respondens	95% Confidence Interval of the Difference		t	df	Sig.(2 tailed)
	Lower	Upper			
Sragen	-27.24982	-17.6375	-9.232	141	0.000
Karanganyar	-5.98623	0.34107	-1.766	123	0.080
Sukoharjo	-5.39436	5.74298	0.062	108	0.951
Boyolali	-4.70085	-1.27915	-3.446	199	0.001
Klaten	-7.99389	-3.51756	-5.088	130	0.000
Overall	-8.56243	-5.25317	-8.197	705	0.000

Table 4. Impact of changes on partners based on activity results

Initial Condition	Intervention	Condition Change
Lack of understanding and technical skills in conversion technology	An education and training program that integrates technology transfer with partnership model development and business engineering.	There was an increase in knowledge and technical skills regarding conversion technology among SMK partners.
There is no standardization in business processes through partnerships.		New knowledge was gained in establishing partnerships between conversion workshops and vocational schools.
Limited business volume and low market demand		Opening of a captive market in the vocational school environment (students, teachers, education staff, and the community around the school)

The implementation of this program faces several obstacles, including a short implementation time and differences in students' basic understanding of electrical theory and skills, which can hinder learning progress. To address these challenges, ongoing mentoring programs and advanced training in electric vehicle technology, including battery technology, battery management systems, control systems, and more, can be implemented.

Table 5. Factors driving partners' willingness to adopt conversion technology

Factors	Amount	Percentage (%)
Lower operating cost	99	71.22
More environmentally friendly	113	81.29
More modern vehicle technology	80	57.55
Support for the government program regarding electric vehicle conversion	53	38.13
Vehicle maintenance is relatively simple	50	35.97

However, the program's success is not determined solely by increased knowledge and skills. Sustainability must be seen in the partners' ability to apply this knowledge in operational activities and business development. The program's sustainability is driven through three mechanisms. First, the use of modules as a medium for ongoing learning. Second, regular mentoring by the community service team and conversion workshops. Third, replicating the partnership model in vocational schools or other workshops.

CONCLUSION

This community service activity aims to strengthen the partnership model between the electric vehicle conversion workshop (PT. EKM) and vocational high schools (SMK) by integrating technology education, technical training, business engineering, and implementation support. Overall, the program has successfully enhanced the technical competence and skills of five partner schools in the Solo Raya region. The most significant improvement in competence and skill (exceeding 30%) was achieved by partner SMK ini Sragen; more modest gains (3.2% - 6.6%) were observed in Karanganyar, Boyolali, and Klaten, while the result for the partner SMK Muhamadiyah 1 Sukoharjo remained stagnant at a reasonably adequate average level.

The implementation of the developed partnership model positions conversion workshops as sources of technical competence, vocational schools as centers of learning and human resource development, and universities as facilitators of knowledge, innovation, and mentoring. However, this program faces several obstacles, including a short implementation period and differences in

students' understanding of fundamental electrical principles, which can hinder learning progress. To address these issues, ongoing mentoring programs and advanced training in the latest electric vehicle technologies, such as battery technology, battery management systems, and control systems, can be implemented.

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