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Industrial Skills Program at Pesantren Quantum Idea Institution: An Introduction to Electrical Welding and Electrical Safety

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ABSTRACT

This community service program was implemented at Pondok Pesantren Quantum Idea, Bekasi, with the goal of equipping students with essential skills in electric welding using the Shielded Metal Arc Welding (SMAW) method and foundational electrical safety. The program addressed key issues such as limited access to vocational education, inadequate safety awareness, lack of proper facilities, and the absence of technical integration into students' economic independence. The program implemented four main stages: socialization, procurement of welding equipment and safety gear, hands-on SMAW welding training, and entrepreneurship development. The results showed a significant improvement in students' technical knowledge, practical welding abilities, and awareness of occupational health and safety (OHS). The students were also able to install basic electrical systems and perform safe maintenance practices. Furthermore, participants demonstrated increased motivation to use their newly acquired skills for entrepreneurial ventures, such as establishing small-scale welding workshops within the pesantren. The program successfully fostered a culture of technical independence and safe work practices, aligning with the pesantren's long-term vision of empowering students with real-world industrial competencies while preserving Islamic values.

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INTRODUCTION

Students at Islamic boarding schools are expected to possess practical skills that can be used as a foundation in the workforce, in addition to a profound comprehension of religious teachings, in the current period of modernization. Pondok Pesantren Quantum Idea is an educational institution that is based on Islamic principles and is dedicated to the development of students' skills in various subjects. It can be found at Jl. Camar No. 101, Jatiraden Village, Jatisampurna District, Bekasi City, West Java. Not only does this pesantren provide its pupils with a solid theological education, but it also provides them with various skills that are applicable to the world of business and industry. According to the preliminary findings, Pondok Pesantren Quantum Idea possesses a significant potential for the development of students' talents, particularly in the area of entrepreneurship that is focused on engineering and light industry. Despite this, there are still several obstacles to overcome, the most significant of which is the restricted availability of structured vocational education, particularly in the fields of electrical engineering and electric welding.

The Shielded Metal Arc Welding (SMAW) process is a pivotal joining technique in both manufacturing and construction, based on the principle of melting base materials and electrode metals using an electric arc. In SMAW, the electrode is coated with flux that serves multiple critical functions. First, this flux disintegrates during the welding process to produce a protective gas that shields the weld zone from atmospheric contaminants, minimizing oxidation and other defect formations (Singh & Singh, 2022). Concurrently, the flux forms a layer of slag on the surface of the molten weld pool, which protects the newly formed weld joint during the cooling stage and contributes to its overall durability and strength (Singh & Singh, 2022; , Anaele et al., 2019).

The mechanism underlying SMAW involves a carefully controlled heat input that creates a localized high-temperature zone, melting both the electrode and parts of the workpiece to form a molten pool. During this process, the electrode’s flux not only provides a physical barrier against the ingress of oxygen and other detrimental atmospheric gases but also promotes smoother metal transfer and improved bead formation (Khamouli et al., 2019). The generation of protective gases through flux decomposition is essential to maintaining optimal weld conditions; without this shielding effect, the weld metal could undergo rapid oxidation, leading to poor fusion and potential structural weaknesses (Singh & Singh, 2022).

When it comes to welding procedures, the relevance of understanding SMAW welding techniques is not restricted to industry professionals; it is also significant for the younger generation, including middle school kids who are working in pesantren contexts. Providing children with opportunities to contribute to the industrial sector in the future can be made possible by beginning the process of introducing and training them in technical skills at a young age. Pesantren kids have been able to effectively participate in welding training thanks to the efforts of multiple community service initiatives(Gunawan et al., 2023). The purpose of the welding training that is being provided to students at Pondok Pesantren Quantum Idea is to provide them with practical skills that can serve as a foundation for either entering the workforce or starting new businesses. The purpose of the welding training that is being provided to students at Pondok Pesantren Quantum Idea is to equip them with practical skills that may be utilized as preparation for entering the workforce or starting their own business. It is possible that the implementation of welding training in the atmosphere of a pesantren might bring dual benefits: not only does it strengthen the technical skills of the students, but it also prepares them to meet the increasingly competitive job market(Salim et al., 2020a). For this reason, the community service program that focuses on providing junior high school students attending Islamic boarding schools with training in SMAW welding is a strategic step toward the goal of molding a young generation that is both talented and competitive in the business. As a result, the community service program that focuses on SMAW welding training for junior

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high school students attending Islamic boarding schools is a significant move toward generating future generations that are skilled and competitive in the business.

The Electric Welding Techniques and Electrical Safety Program for Pesantren Students aims to equip students at Pondok Pesantren Quantum Idea with essential electric welding skills, thereby improving their employability or facilitating self-employment. This curriculum aims to enhance students' understanding of electrical safety, allowing them to operate electrical equipment securely and proficiently. This course aims to provide light industry skills within a pesantren environment. The curriculum will enhance the learning environment's relevance and facilitate the santri's financial independence by equipping them with practical skills applicable in the real world. This curriculum integrates technical education with the ideas of the pesantren, allowing students to develop skills while preserving their Islamic identity.

PROBLEMS AND SOLUTIONS

Pondok Pesantren Quantum Idea, a collaborator in this community service initiative, is committed to equipping its students with the necessary skills to promote economic self-sufficiency. Attention is required for a multitude of critical challenges in the development of industry-specific skills, particularly in the context of electrical welding processes. Discussions and observations with the pesantren identified five primary issues that impede students' acquisition of electric welding abilities and comprehension of electrical safety.

1. Restricted Availability of Electrical Welding Proficiencies

   The limited access that students have to receiving education in electrical welding procedures is one of the most significant challenges that they face. As a result of the fact that the pesantren's skill-building programs continue to be primarily focused on traditional and religious education, they do not include any industry-based technical training. When it comes to the employment market, electrical welding skills have a substantial amount of potential. The industrial sector can utilize these talents as a foundation for independent business operation.

2. Insufficient Comprehension of Electrical Safety

   The majority of students are not fully aware of electrical safety regulations, especially while operating high-power electrical equipment such as welding machines. Improper usage of this equipment may increase the risk of workplace accidents, such as electric shocks, fires, or injuries caused by exposure to high temperatures during the welding process.

3. Constraints of Facilities and Infrastructure for Welding Technique Instruction

   The pesantren now lacks enough facilities to support the education of electric welding techniques. Insufficient equipment and appropriate workspace are the principal obstacles to implementing technology-based operations in the Pesantren environment.

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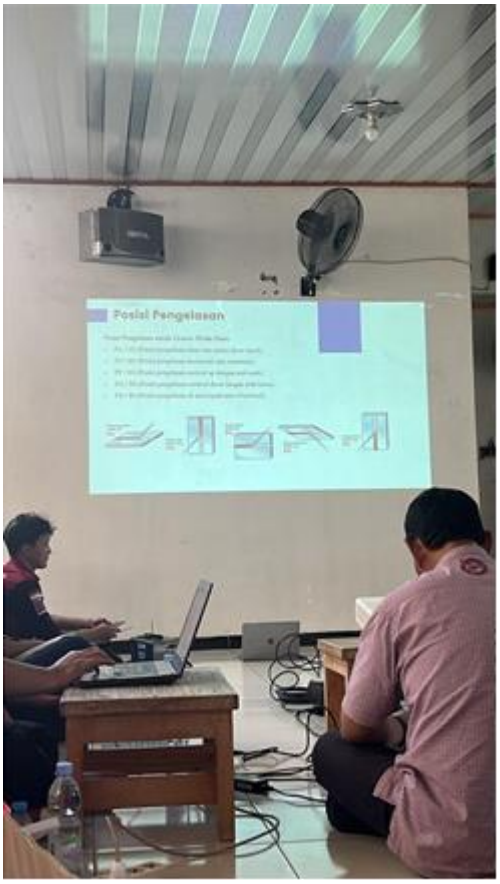

FIGURE 1. Material Presentation On Welding Techniques
Source: Personal Documentation

Figure 1 illustrates the importance of mastering electric welding techniques for boarding school students to enhance their technology-based industrial skills. The limited availability of equipment and work areas that do not meet technical standards are the main obstacles in the implementation of this technology-based welding practice activity. As a result, the development of student competence in welding techniques cannot be carried out optimally, so efforts need to be made to improve facilities to achieve these learning objectives.

4. Insufficient Integration of Technical Skills with the Economic Autonomy of Santri

Despite the pesantren's objective of economic independence, technical skills in fields like electric welding have not been highlighted in the strategy to enhance students' economic empowerment. However, with appropriate guidance, these attributes can create prospects for students to initiate their enterprises or engage in the industry following their education at the pesantren.

The Introduction to Electric Welding Techniques and Electrical Safety Program for Pesantren Students for Industrial Abilities has been developed to address the challenges faced by Pondok Pesantren Quantum Idea in electrical engineering skills and electric welding. To guarantee the proper operation of this program and provide enduring benefits for both students and faculty, the proposed solutions have been systematically arranged based on the significance of the issues.

The situational analysis undertaken identifies four key challenges that must be addressed promptly in the education and skill development process for students. This program provides several solutions, including infrastructure and facility provision, workplace safety enhancement, technical skill development, and the integration of skills with economic independence via entrepreneurial initiatives.

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1. Enhancing the availability of opportunities to develop electrical welding skills.
2. A rise in the level of understanding regarding the electrical safety of welding
3. Provision of infrastructure and facilities for the instruction of welding techniques.
4. The integration of Santri's technical expertise into the region's broader economic autonomy

This program designs each solution to significantly enhance students' abilities and prepare them for the industrial sector. We anticipate that students will produce market-value electric welding products, allowing the pesantren to establish a light industrial business model. The students will receive training in technical business management, equipping them with both technical abilities and an understanding of managing an independent firm in the welding sector. Furthermore, we anticipate an enhancement in the competency and autonomy of students, giving them a competitive edge in the engineering job market. In the long term, the pesantren can autonomously establish training programs in electrical engineering and electric welding, ensuring that the advantages of this initiative persist beyond the conclusion of the service program.

METHOD

In light of the above-stated issues, the execution of this community service initiative employs a participative approach and practical training methods for the students of Pondok Pesantren Quantum Idea. The methodology is structured into four principal stages, including preparation and socialization, procurement of facilities, technical training, and entrepreneurial skill integration. Each stage is systematically organized to enhance both the technical and entrepreneurial competencies of the participants, as outlined in Figure 2.

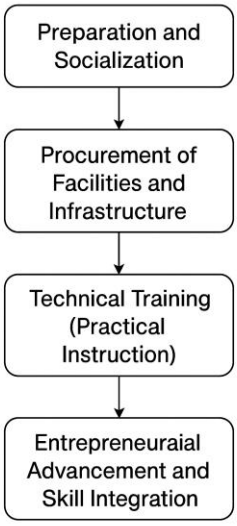

FIGURE 2. Principal Stages Flowchart
Source: Personal Documentation

The employed methodology comprises four principal stages, specifically:

1. **The preparation and Socialization Phases**

At this juncture, the implementation team will execute a program socialization for the entire academic community of Pondok Pesantren Quantum Idea, particularly targeting the junior high school pupils engaged in the training.

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FIGURE 3. Socialization Of SMAW Electric Welding Techniques
Source: Personal Documentation

This activity aims to provide a basic understanding of the advantages, objectives, and expected outcomes of SMAW electric welding method instruction and electrical safety. To increase participants' motivation, we conducted the socialization activities through interactive lectures, open discussions, and multimedia presentations, as shown in Figure 3.

2. **The procurement Stage of Facilities and Infrastructure**

Since the pesantren has limited resources, the next step is to get welding equipment that meets industry standards, including inverter-type SMAW welding machines that can handle up to 200 amperes, various types of electrodes (like E6013), and complete personal protective equipment (PPE) such as automatic welding helmets, gloves, heat-resistant aprons, and safety goggles. A temporary workspace that follows safety rules will also be built or provided, featuring good air ventilation, enough lighting, and portable fire extinguishers. We will construct or supply a temporary workspace that complies with safety standards, equipped with proper air ventilation, sufficient lighting systems, and portable fire extinguishers.

3. **Technical Training Phase (Practical Instruction)**

Practical sessions and strategically structured training modules will complement the training delivery. We employ demonstration approaches and individual or group practices to ensure proficiency in fundamental to advanced procedures in SMAW welding.

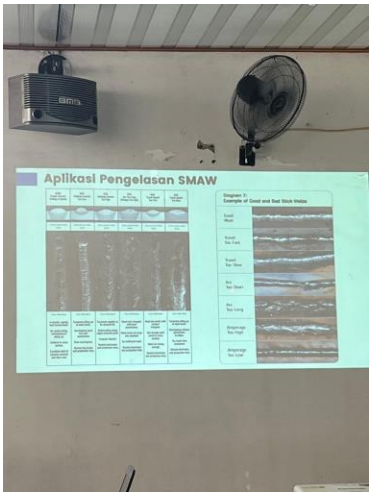

FIGURE 4. SMAW Welding Instruction
Source: Personal Documentation

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The practical material includes basic welding positions (flat, horizontal, vertical), the best settings for electrical current, how to choose electrodes, and how to use welding equipment safely as shown in Fig. 4. The training will encompass specialized content on electrical safety in the workplace, addressing tool usage protocols, strategies to prevent workplace accidents (including electric shocks, explosions, and fires), and an awareness of workplace safety regulations (K3) pertinent to the welding process.

4. **Phase of Entrepreneurial Advancement and Skill Integration**

The suggested training program embodies a comprehensive strategy that merges technical welding expertise with fundamental entrepreneurship instruction. The curriculum seeks to enhance participants' economic competencies in conjunction with their technical skills by providing additional teaching in essential entrepreneurship, business management, and marketing strategies. This dual emphasis is corroborated by Nguyen et al. (2021), who illustrate that entrepreneurship education can substantially augment entrepreneurial intention among technical students when integrated with skill-based training. Nchu et al. (2023) assert that integrating entrepreneurial education into non-business fields, such as welding, provides students with adaptable abilities that extend beyond conventional technical positions.

The promotion of creating simple yet economically feasible products, including iron shelves, study tables, and minimalist fences, is significant. By concentrating on products that meet the immediate requirements of the neighboring pesantren community, students can utilize their welding abilities to fulfill local market demands and concurrently promote community development. Yulianti et al. (2023) demonstrate that effective communication and entrepreneurial literacy are essential for engaging community stakeholders, a critical factor in ensuring products are well-received and sustained in the local market. The deliberate choice of product types exemplifies "santripreneurship," a concept that integrates entrepreneurial zeal with traditional pesantren values, as articulated by Hannan (2019).

Combining technical education with business skills is expected to improve entrepreneurial abilities, helping participants move from being skilled workers to economic players who can address the needs of pesantren communities. Kamala and February Kamala & Pebruary, 2021, present empirical evidence indicating that targeted entrepreneurship education positively impacts the cultivation of entrepreneurial character in pesantren environments. The course promotes economic independence and resilience by integrating technical training with fundamental business and marketing tactics. This comprehensive training methodology enhances participants' immediate employability and self-sufficiency while also fostering wider socioeconomic transformation in their communities (Nguyen et al., 2021; Kamala & Pebruary, 2021; Yulianti et al., 2023).

Furthermore, the curriculum aims to cultivate a sustainable business attitude by integrating important entrepreneurial skills necessary for today’s dynamic economic environment. Research indicates that the integration of technical education with entrepreneurial training enhances participants' readiness to establish innovative start-ups and micro-enterprises that invigorate local economies (Nchu et al., 2023). The program aims to integrate technical proficiency in welding with strategic business acumen, empowering students to realize their full potential as adept tradespeople and proactive economic contributors, thus promoting long-term community development and economic sustainability (Nguyen et al., 2021; Kamala & Pebruary, 2021; Hannan, 2019).

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RESULTS AND DISCUSSION

The implementation of the electric welding training program using the Shielded Metal Arc Welding (SMAW) method, combined with electrical safety education at the Islamic boarding school, has yielded positive outcomes. Students demonstrated a significant improvement in their technical knowledge. Those who initially had limited understanding of basic welding techniques and workplace safety were, by the end of the training, able to answer theoretical questions accurately and grasp essential concepts. In terms of practical skills, the students successfully mastered basic manual arc welding techniques, particularly in the 1F and 2F positions. They were able to perform metal welding independently, producing clean and structurally sound welds. During the practical sessions, the participants followed the welding procedures as outlined in the training module and by the instructor while consistently adhering to safety protocols by using appropriate personal protective equipment (PPE) as seen in Figure 5.

FIGURE 5. Participants Use Personal Protective Equipment Before Performing The Welding Process
Source: Personal Documentation

Discipline in following Occupational Health and Safety (OHS) protocols demonstrates the participants' increased awareness of safety aspects during the welding process. (Khalid et al., n.d.) reported similar findings, demonstrating that training that integrates K3 material effectively enhances the awareness and safe work attitudes of the participants. The students now understand the importance of using PPE, identifying potential hazards, fire prevention, and handling hazardous materials in the welding workshop environment. The implementation of a positive K3 culture is believed to ultimately enhance productivity and the quality of work results. In addition to welding skills, this program also equips students with basic electrical knowledge and safety while using electrical equipment. This material is important considering that the environment of Islamic boarding schools often faces limitations in facilities and potential electrical

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hazards. (Barusman et al., 2024) reported that electrical training in pesantren can enhance the students' ability to perform simple maintenance and repairs on electrical equipment while also reducing dependence on external technicians.

The results of this service are consistent with the report: the participating students are now skilled in installing simple electrical systems with the correct and safe procedures. They are also more confident in handling everyday electrical problems, such as fixing loose electrical connections or replacing fuses, while prioritizing safety. This increase in competence directly contributes to the reduction of electrical accident risks in the pesantren environment. The participants recognize the importance of electrical practices that meet safety standards, such as avoiding overloads and ensuring good cable insulation, which thereby minimizes potential hazards like short circuits. From an empowerment perspective, this training has a long-term impact on the students and the pesantren community. The welding and electrical competencies acquired serve as a foundation for entrepreneurship skills and economic independence after the students graduate. According to (Masnu'ah et al., 2023), the vocational skills program at the pesantren is strategically aimed at fostering the entrepreneurial spirit of the students, enabling them to create their own job opportunities and open up job markets for the surrounding community.

The training outcomes at Pesantren Quantum Ide, illustrated in Figure 6, indicate that several students have expressed interest in establishing a small-scale welding workshop within the pesantren after seeing the SMAW welding process firsthand.

FIGURE 6. Enthusiasm Of SMAW Welding Trainees
Source: Personal Documentation

This information is in line with the findings of (Salim et al., 2020), which reported that basic welding training for Ponorogo students successfully produced skilled workers expected to initiate independent welding workshop businesses in the pesantren community. With the ability to weld simple structures (such as making iron shelves or repairing fences) and the safety knowledge they possess, the students can contribute to the maintenance of the pesantren facilities independently. Before the training, the partner Pesantren did not even have welding personnel or equipment, so every repair relied on external

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parties. Now, the situation has changed; the students can perform basic welding tasks without having to wait for external technicians, which means time and cost efficiency for the pesantren.

From the discussion above, it is clear that the integration of vocational technical training with safety education in the pesantren environment yields comprehensive results. The students not only acquire new theoretical knowledge but also practical, applicable skills and a work attitude oriented toward safety. This combination is important to prepare the younger generation of pesantren to face the challenges of the modern workforce without abandoning the ingrained values of discipline. The participants' enthusiasm during the training and their satisfaction with the material taught indicate that the extension and practical methods used were on target.

FIGURE 7. Photo With All Participants Of The Activity
Source: Personal Documentation

This community service program effectively accomplished its objective of enhancing students' skills in electric welding and electrical safety. Figure 7 illustrates that all participants and teachers exhibited enthusiasm for this activity.

The success of this program aligns with (Kyew, 2023) study, which emphasizes that K3-based training in welding significantly enhances work safety skills and participants' awareness of risks. Thus, the output of this activity is not only an increase in individual competence but also the creation of a culture of safety and independence within the pesantren environment. This new culture is expected to continue and spread so that the pesantren can become a community that is technically independent, safe in working, and productive in creating for the wider society.

CONCLUSION

When it comes to addressing the skill gaps and safety concerns that exist within the pesantren learning environment, the adoption of the SMAW welding and electrical safety training program at Pondok Pesantren Quantum Idea has proven to be both relevant and effective. It was evident that the students had made significant progress in both their theoretical comprehension and their actual execution of welding procedures and electrical installation. Comprehensive skill development and an increased awareness of workplace safety were both made possible by the structured learning stages, which ranged from socialization to instruction by means of practical application. Students were equipped with the tools necessary to apply their technical knowledge and examine sustainable economic options, such as the

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establishment of welding-based micro-enterprises, as a result of the incorporation of entrepreneurship training into the curriculum. The creation of a fundamental welding facility within the pesantren is a significant step toward achieving greater technological autonomy. The enthusiastic participation and proactive involvement of the students and teachers in the program provides further evidence of its positive impact. This community service effort has made a substantial contribution to establishing a foundation of industrial competence, safety culture, and entrepreneurial awareness among pesantren students. As a result, it has supported the students' readiness for future work and self-sufficiency.

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