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Capacity Building and Technology Adoption for Human Capital and Product Quality at BUMDESMA Giri Arjuna Coffee Enterprise

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ABSTRACT
Background: This community service project tackles the issues of variable coffee quality and market limitations, both legal and strategic, that BUMDESMA Giri Arjuna currently encounters.
Purpose of the Study: Its primary objective was to implement an integrated approach emphasizing Capacity Building and Technology Adoption to enhance product value and elevate the enterprise's market preparedness.
Methods: The process commenced with a survey conducted via interviews and observations with BUMDESMA management, followed by an assessment of knowledge through pre- and post-tests. The intervention comprised three modules and included technology transfer, such as a Portable Solar Dryer and video guidance.
Results: The initiative markedly improved human capital of 15 BUMDESMA participants, raising knowledge scores by 18.5% in QC and 11.9% in Downstream Competitiveness. It also led to the creation of labels compliant with BPOM Regulation and the use of professional packaging. Overall, it strengthened technical skills and equipped BUMDESMA with legal and operational tools to boost market competitiveness

Keywords
Capacity Building; Technology Adoption; Market Readiness; BUMDESMA; Coffee

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Introduction

Bumiaji, a district in Batu City, plays a vital role in Arabica coffee farming, located on the slopes of Mount Arjuno at elevations of 1,000–1,500 meters. This region offers a perfect climate for growing high-quality specialty coffee beans (Hanan et al., 2024). Its geographic position not only creates ideal conditions for premium coffee cultivation but also supports environmental sustainability, as the deep roots of the coffee plants help stabilize the soil and prevent landslides on the slopes (Yulnafatmawita et al., 2023). In 2023, four key villages formed the Joint Village-Owned Enterprise (BUMDESMA) Giri Arjuna to manage their post-harvest products and foster regional economic growth through greater cooperation and bargaining strength.

Despite having this organizational structure and high-quality raw materials, BUMDESMA Giri Arjuna faces significant challenges that limit its growth and market penetration. These problems are primarily twofold: internally, issues with quality consistency and human resources; externally, difficulties with market access and regulatory compliance.

Currently, BUMDESMA Giri Arjuna uses traditional sun-drying on open mats for coffee processing. This method is susceptible to weather changes, humidity, and dust, resulting in inconsistent moisture levels and affecting quality (Hu et al., 2023; José et al., 2025). Moreover, members lack knowledge of standardized post-harvest Quality Control (QC) procedures and often package their products with basic materials that lack proper labels, failing to meet regulatory standards. This non-compliance, particularly with BPOM Regulation No. 31 of 2018, limits their ability to compete effectively in the modern retail market.

This project addresses these interconnected challenges through an integrated approach based on two main development theories: Capacity Building and Technology Adoption. Capacity Building focuses on empowering partners by enhancing their knowledge and skills, enabling them to manage resources effectively and achieve their goals sustainably (Sadiq et al., 2025). Meanwhile, the concept of Technology Adoption, especially the Transfer of Appropriate Technology (TTG), underscores the importance of providing appropriate, manageable tools to quickly overcome technical obstacles and maintain product quality (Siswanto et al., 2024).

To implement these theories, this community service project adopted an integrated strategy built around three main pillars: (1) Enhancing Post-Harvest Quality Control (QC) knowledge and marketing techniques; (2) Providing training on regulatory compliance and redesigning packaging and labels; and (3) Transferring Appropriate Technology (TTG) by providing a Portable Solar Dryer. This holistic approach aimed to share technical expertise, provide essential physical tools, and ensure regulatory compliance, enabling immediate use and measurable results. The project outcomes will be shared to evaluate how effectively it has built human capacity, increased product value, and significantly enhanced the market readiness of BUMDESMA Giri Arjuna's coffee products.

Method

The community engagement program was held at the BUMDESMA Giri Arjuna facility from July 2025 to November 2025, involving 10 core members. It employed a Participatory Action Research (PAR) approach to facilitate collaborative problem-solving and promote sustainable technology adoption (Eelderink et al., 2025). The summarized integrated solutions are presented in Table 1 below.

Table 1. Solution of Dedication

No.	Problem	Solution	Output
1.	Human Capital Competency and Knowledge	Capacity Building Training (QC, Labeling, and Marketing Modules).	Measurable Knowledge Increase (Quantified by Pre-test & Post-test scores).
2.	Coffee Bean Drying Equipment	Provision of Post-Harvest Drying Equipment (Portable Solar Dryer and video guide).	Portable Solar Dryer Unit.
3.	Product Packaging and Labeling	Redesign of Packaging and Labeling to comply with BPOM Regulation No. 31 of 2018.	Final Packaging and Label Prototype (Standing Pouch with Degassing Valve).

Building on this dedicated solution, the program's implementation was organized in a sequential, cohesive manner. The activity flow emphasized a comprehensive transformation, ensuring that technical knowledge was quickly reinforced through technology transfer and the development of market-ready products. The procedural steps were clearly divided into three distinct phases, covering the entire project from start to finish.

The flowchart below illustrates the systematic stages of program implementation, beginning with the preparation phase, followed by the implementation phase, and concluding with monitoring and evaluation activities. Each phase was designed to ensure the effective transfer of knowledge and technology, strengthen participants' competencies, and support the sustainability of the program outcomes through continuous assistance and evaluation.

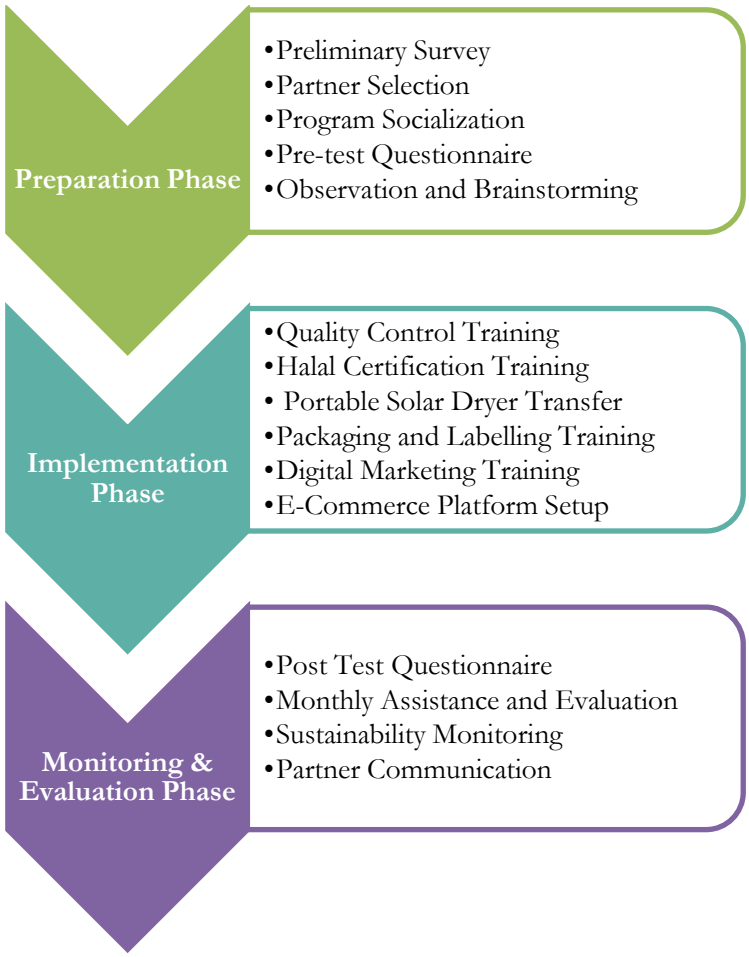


Figure 1. Flowchart of Program Implementation

The initial Preparation Phase emphasized identifying partners and planning activities. It began with a preliminary survey at the location, using interview and observation methods with BUMDESMA management to select a suitable partner and determine specific needs. Subsequently, program socialization was carried out. To establish a baseline of participants' skills, a knowledge and competency questionnaire was administered to members of BUMDESMA "Giri Arjuna" (pre-test). This pre-test provides a quantitative method for measuring initial knowledge levels and monitoring improvements resulting from the training (Stojny & Misiarczyk, 2023). Additionally, early tasks included observing the partner's current coffee bean-drying techniques and conducting separate brainstorming and socialization sessions to discuss future product design, packaging, and marketing strategies.

The Implementation Phase focused on capacity building and technology transfer across three main areas. For improving product quality, training sessions on Quality Control (QC) for Arabica coffee, including powder, roast, and green beans, were conducted, along with Halal certification procedures, culminating in the transfer of the Portable Solar Dryer. This transfer adhered to the Transfer of Appropriate Technology (TTG) principle, ensuring the equipment effectively addressed the partner's needs to stabilize post-harvest quality issues (Fernandes, 2024). Meanwhile, the Product Design and Packaging area involved training on packaging and labeling in accordance with BPOM Regulation No. 31 of 2018, consulting a designer, and adopting new packaging technology. The Product Marketing area was supported through training on digital marketing strategies, such as setting up an e-commerce platform to boost product visibility.

The final Monitoring and Evaluation Phase included assessing the program's effectiveness through the final knowledge and competency questionnaire (post-test). Ongoing activities involved

monthly assistance and evaluation. Program sustainability was maintained via communication and agreements with partners, with continuous monitoring for potential challenges for up to one year after the program ended.

Result

Quality Control, Labelling, and Marketing Training



Figure 2. Quality Control Training



Figure 3. Labeling and Marketing Training

Capacity-building activities focusing on training in Quality Control, Labeling, and Marketing Strategy took place from July to August 2025. The effectiveness of these sessions was evaluated quantitatively, primarily in two areas: Post-Harvest Quality Control (QC) and Downstream Competitiveness (Labeling & Marketing). Detailed participant results for each module are presented in Figures 4 and 5. In addition to competency assessment, participant attendance and engagement were monitored throughout the activities to evaluate the overall implementation process. The overall attendance rate across the training sessions reached 93.3%. Participant attendance increased during the second session, which achieved full participation.

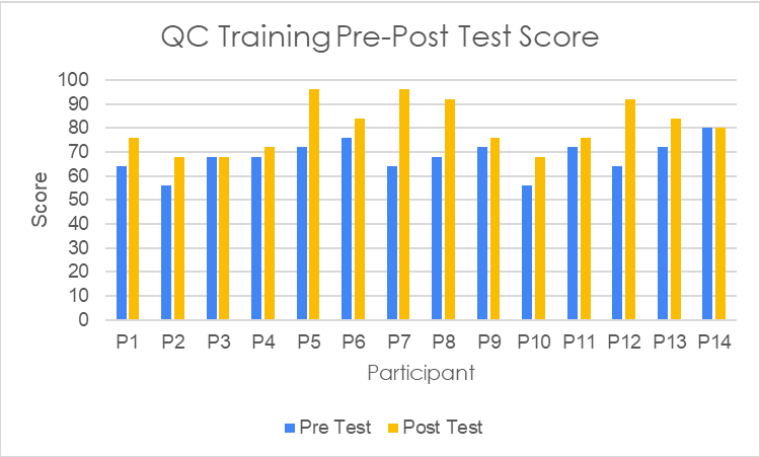


Figure 4. QC Training Pre-Post Test Score

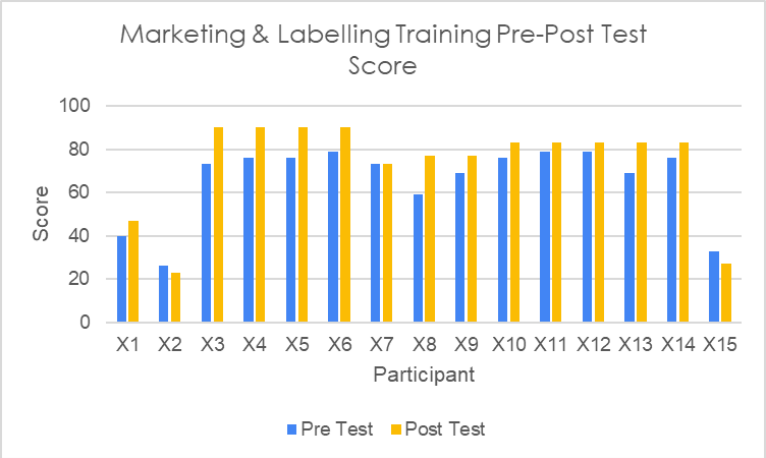


Figure 5. Labelling and Marketing Training Pre-Post Test Score

The Post-Harvest Quality Control (QC) Training was conducted over approximately four hours of intensive training activities. Figure 4 (QC Training Pre-Post Test Score) shows the individual results from the Post-Harvest Quality Control (QC) Training. The data reveal a notable increase in participants' knowledge, with the average score climbing from 68.0 before training to 80.6 afterward, representing an 18.5% improvement. The module focused on improving participants' understanding of coffee bean handling, drying techniques, quality grading, and post-harvest management practices. During the training activity, participants initially appeared somewhat hesitant and less active in discussions, likely due to their unfamiliarity with the learning environment and the training format.

Similarly, the Downstream Competitiveness Training (Labeling and Marketing) conducted with a total duration of approximately four hours. Figure 5 (Marketing & Labelling Training Pre-Post Test Score) illustrates the participant performance in the Downstream Competitiveness Training (Labeling and Marketing). This session also proved effective, with the mean score rising from 65.5 pre-training to 73.3 post-training, a knowledge gain of 11.9%. The training covered product packaging design, labeling requirements in accordance with BPOM regulations, branding strategies, and the use of digital marketing platforms to increase product visibility. During the implementation process, participants demonstrated strong enthusiasm and active involvement throughout the activity. As many participants were already familiar with the training environment, discussions developed in a more interactive and engaging manner, with participants actively asking questions and sharing their perspectives related to product marketing and packaging strategies. Notably, the QC module consistently succeeded, with all 14 participants improving their scores.

Label and Packaging Design



Figure 6. Process of Label and Packaging Redesign

The intervention highlighted the practical application of regulatory knowledge, including design consultation and prototyping, carried out throughout October 2025. A significant result in product development was the successful creation of a new, compliant packaging and label design. The Regulatory Compliance Training resulted in a revised, finalized packaging label that fully adheres to BPOM Regulation No. 31 of 2018. This label includes all mandatory information, follows standardized formats, and is correctly positioned. Additionally, the packaging for BUMDESMA coffee has been greatly improved, now featuring a standing pouch with a one-way degassing valve, transforming its appearance from simple commodity packaging to a more specialized retail presentation.

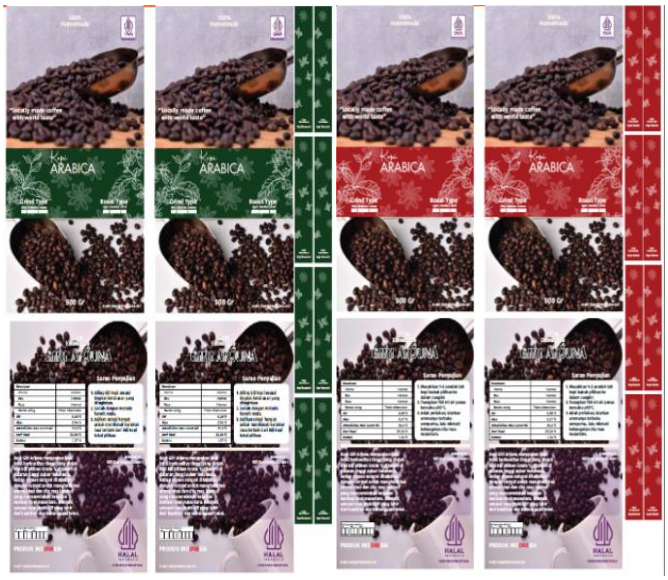


Figure 7. Prototype of New Label Design

Portable Solar Dryer Handover



Figure 8. Assembly of Portable Solar Dryer



Figure 9. Handover of Portable Solar Dryer

The technology transfer, including the handover of the Portable Solar Dryer, was completed in August 2025. This introduced an appropriate technology (TTG) to mitigate the main quality risk: inconsistent drying caused by high ambient humidity, which is often exacerbated by traditional open-air methods. The process involved providing video tutorials to assist with operation, giving BUMDESMA members clear instructions for their first use.

Discussion

Quality Control, Labelling, and Marketing Training

The consistent rise in positive scores across all participants clearly evidences the effectiveness of the Capacity Building goal (Bourke et al., 2024), affirming the success of the integrated training modules. This broad achievement in technical knowledge acquisition aligns with the Experiential Learning Cycle, which states that practical, targeted training results in measurable skill growth (Dowson, 2019), as the content was immediately relevant and applicable. However, a closer examination of the Marketing and Labelling module (Figure 4) shows that, while most participants improved, one participant (X15) experienced a slight decline in score. This exception highlights the need for ongoing monitoring to ensure knowledge retention. Additionally, a better understanding of marketing and labeling strengthens BUMDESMA members' capacity to approach retail and regulatory compliance more strategically. Overall, this training success confirms that targeted, integrated capacity-building is the most effective way to enhance BUMDESMA's human resources and foster shared understanding—both of which are essential for sustained growth and a strong market position (Saputra et al., 2024).

Label and Packaging Design

This professional packaging solution significantly enhances the product's perceived value, which plays a crucial role in consumer decision-making (Mehta et al., 2024; Schifferstein et al., 2021). Importantly, all visual elements on the new label, such as graphics and illustrations, are original artwork created exclusively with the partner, protecting the product's intellectual property and boosting brand strength. This sets it apart from competitors who may rely on generic stock images (Jin, 2025). The redesign served two primary purposes: ensuring regulatory compliance and positioning the packaging as a symbol of quality and professionalism. Additionally, adopting the degassing valve technology is vital, as it preserves flavor and extends shelf life, thus reinforcing the product's quality signal and market readiness (Cowell, 2018; Fernandez-Rosillo et al., 2025; Grumezescu & Holban, 2019).

Portable Solar Dryer Handover

The Solar Dryer is positioned as the key technological component that guarantees quality stability, complementing the QC training. This equipment transfer followed the principle of Transfer of Appropriate Technology (TTG), ensuring the tool directly addressed the partner's needs to stabilize post-harvest quality issues (Fernandes, 2024). The enclosed design of the Solar Dryer offers two key benefits: protecting coffee beans from external contaminants such as dust, insects, and rain exposure, while also enabling a more controlled and uniform drying process. These advantages are particularly important for maintaining consistent moisture content and reducing the risk of microbial contamination during post-harvest handling. In addition, the improved drying efficiency helps minimize quality degradation caused by unpredictable weather conditions, which is a common challenge in traditional open-sun drying methods (Meja et al., 2025, 2026). The resulting consistency and cleanliness from the enclosed design are essential for securing regulatory approval (P-IRT/BPOM) and positioning the coffee to meet the higher price expectations of specialty products (As et al., 2025; Oria, 2022).

Conclusion

The integrated strategy to boost BUMDESMA Giri Arjuna's competitiveness involved an initial needs assessment, data collection through pre- and post-tests, and the implementation of three capacity-building modules along with technology transfer via a Portable Solar Dryer. This effort's primary, measurable impact is the notable improvement in human capital, demonstrated by an 18.5% increase in Quality Control knowledge (from 68.0 to 80.6) and an 11.9% rise in Downstream Competitiveness (from 65.5 to 73.3), complemented by the development of a BPOM-compliant label and packaging prototype. Nevertheless, these immediate results are limited by the lack of confirmed long-term effects on sales volume and the absence of official BPOM registration. To address these gaps, future activities should include intensive follow-up to ensure completion of formal regulatory processes. Additionally, future work should explore how technology adoption impacts actual moisture content variation in the coffee and assess the profitability of new market strategies.

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Conflicts of Interest

The authors declare that there is no conflict of interest regarding this community service.

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