

Artificial Intelligence as a Catalyst for Sustainable MSME Development in the Halal and Green Economy

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ABSTRACT

Micro, small, and medium enterprises (MSMEs) serve as the backbone of Indonesia's national economy, particularly in Bandung Regency, home to over 47,000 MSMEs. However, MSMEs face major challenges including limited marketing skills, low product quality due to insufficient digital access, limited awareness of halal certification, and environmentally unsustainable practices. This community service initiative addressed these issues by implementing an Asset-Based Community Development (ABCD) approach through workshops, technical assistance, and Penta helix collaboration involving academia, government, communities, and media. The program focused on enhancing digital literacy, introducing Artificial Intelligence (AI) for business efficiency, promoting Islamic finance, and fostering a halal and green economic ecosystem. The results show a significant increase in business actors' interest and awareness in adopting AI and digital tools, especially in creating AI-generated social media content for marketing. Moreover, participants demonstrated improved understanding and capacity to pursue halal certification and eco-friendly packaging. The key outcome of the program is the establishment of a cross-sectoral coordination forum and the organization of an MSME exhibition as a sustainable effort to strengthen MSEs competitiveness.

Keywords: Strengthening MSMEs; Artificial Intelligence (AI); Digital Technology; Halal & Green Economy; Technical Assistance

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INTRODUCTION

Micro, Small, and Medium Enterprises (MSMEs) are the backbone of Indonesia's national economy, which are contributing significantly to GDP and employment. However, their competitiveness remains low due to structural and operational

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barriers. The key constraints include limited financial literacy, low employee competencies, poor access to monetary capital, and the inability to effectively highlight product uniqueness (Bestari, 2024). In Bandung Regency, several specific challenges faced by MSMEs are identified by Didin Syahidin (Head of the Cooperative and MSME Office, 2025), which include the lack of knowledge and skill for designing competitive and attractive packaging, weak marketing communication, limited access to the expansive halal market, and the lack attention to environmentally friendly processes and outputs (Rachmiatie et al., 2024).

Despite these obstacles, MSMEs in Bandung Regency have shown remarkable growth, particularly post-COVID-19, with over 47,000 micro-enterprises by the end of 2024. This surge is largely attributed to a labor shift from the formal to the informal sector during the pandemic, indicating a positive trajectory for regional economic development. However, three persistent challenges remain: (1) limited access to technology and digital adoption—only about 12% of Indonesian MSMEs have effectively implemented digital tools; (2) financial constraints, despite government initiatives such as a Rp70 billion zero-interest revolving loan program aimed at reaching Rp10 million per business actor by 2025; and (3) ongoing marketing difficulties, even with successful partnerships with retailers and tourism centers (Hamza & Agustien, 2019; Rizkinaswara, 2024). Additionally, poor product packaging design and a lack of awareness of sustainable packaging remain widespread issues, with studies showing that 66% of MSMEs are unaware of its importance (Fadhilah & Pratiwi, 2021).

To address these complex, multifaceted problems, the *Pusat Layanan Usaha Terpadu Usaha Mikro, Kecil, dan Menengah* (PLUT/ Integrated Business Service Center) for MSMEs was established by the local government of Bandung Regency. It supports 47,000 MSMEs through five core services: (1) institutional support (licensing, halal certification), (2) production (raw materials, national standards, packaging design), (3) marketing (market access, promotion, networking), (4) human resources (capacity building), and (5) financing (business planning, funding access). However, a critical ongoing challenge for PLUT is the MSMEs 'disconnection' from industrial supply chains, market certainty, and vital technology transfers, particularly digital technology (Rachmiatie, Turmudi, et al., 2023).

In this context, it is crucial for MSME owners and entrepreneurs to be aware of, understand, and become skilled in using digital technology and Artificial Intelligence (AI). Therefore, academic stakeholders, within the Penta helix collaboration model, must play an active role in providing capacity-building programs through workshops and technical assistance.

The integration of digital technology and AI is a key catalyst for empowering MSMEs in Bandung Regency to overcome existing challenges and seize emerging opportunities. Moreover, it is also important to address market expansion strategies and human resource development to accelerate business transformation toward sustainable development under the frameworks of the halal economy and green economy, which are increasingly demanded at national and global levels.

The AI can directly address digital divides and marketing inefficiencies by enabling AI-driven digital promotion, allowing MSMEs to precisely target consumers, optimize ad placement, and personalize marketing messages (Astuti, 2021).

Furthermore, AI can automate the creation of engaging social media content, which will greatly enhance marketing communication. In the context of halal economy, AI can streamline the halal certification process and support in-depth market analysis to uncover untapped opportunities. For the green economy, AI can optimize production to reduce waste and energy usage and assist in designing attractive, eco-friendly packaging.

By utilizing AI to improve MSME competencies in financial management, digital marketing, halal certification, and sustainable practices, this program aims to foster not only momentary growth, but also long-term, inclusive development (Rachmiatie et al., 2022). The Penta helix collaboration involving government, academia, communities, businesses, and media—as emphasized in the situational analysis—is critical for sustaining this catalytic transformation (Rachmiatie, Setiawan, et al., 2023).

Accordingly, the objectives of the workshop and mentoring activities for MSME actors in Bandung Regency are:

- (1) to provide knowledge, awareness, and practical skills regarding AI as a transformative agent to empower MSMEs in achieving resilient and sustainable growth;
- (2) to raise awareness and capabilities in halal processes and products, given the considerable market potential; and
- (3) to develop competencies in environmentally friendly production and packaging practices aligned with the green economy paradigm.

METHOD

The program adopted an Asset-Based Community Development (ABCD) approach to address the previously outlined challenges. The target group consisted of micro and small business actors affiliated with the Integrated Business Service Centre (PLUT) of Bandung Regency, which encompasses 47,000 entrepreneurs. The implementation method employed a “link and match” strategy, i.e. an integrated synergy between academics and practitioners, through mini-workshops and targeted mentoring for MSME participants and stakeholders.

ABCD is a sustainable development methodology based on the existing assets, strengths, and potentials of a community. Its implementation involves mobilizing all forms of resources, skills, and experiences already present within the community as the foundation for improving quality of life across multiple. ABCD can be viewed as an approach, a set of community mobilization techniques, and a strategy for community-driven development dimensions (Ansori et al., 2021).

Community-driven development requires stimulation from within, i.e. the community members themselves must take initiative, demonstrate creativity, and actively engage in building better neighborhood dynamics. ABCD emphasizes two pathways to improve community welfare: a need-based approach that addresses existing gaps and challenges, and an asset-based approach that focuses on strengthening the community’s inherent capacities.

Asset-based community activism exists as a vehicle for democratic change by encouraging inclusive participation aimed at fostering social welfare. The

democratization process depends on the foundation of communal awareness, promoting justice by providing meaningful opportunities for public involvement in planning, implementing, and monitoring change. The stages include: (1) building awareness through positive understanding, (2) identifying existing community potential, and (3) valuing communal assets. According to Coady Institute, the core of the ABCD approach lies in developing the following dimensions: community development, stories of success, acknowledging the power of collaboration and social capital, appreciation and mobilization of existing community assets, stimulating an opportunity-seeking mindset, and social entrepreneurship.

The program's strategy began with identifying micro-enterprise communities, followed by mapping their existing assets, challenges, and priority needs. Capacity-building efforts were carried out in stages. The first priority was human resource development, aimed at enhancing entrepreneurs' awareness, understanding, and technical skills in managing their businesses. This included raising awareness that their businesses still had potential for production improvement, quality enhancement, and market expansion, as well as building confidence in their products' unique competitive advantages. The second priority was to increase competitiveness, boost sales, and improve business turnover through training and mentoring in halal-oriented and environmentally conscious business practices. These areas were emphasized as key differentiators and strategic value propositions for the development of their products in line with the principles of the halal economy and green economy.

RESULTS AND DISCUSSION

As an initial step in this Community Service Program (PKM), interviews and field observations were conducted with key personnel at the Integrated Business Service Center (PLUT) of Bandung Regency, who are the Head of UPTD, Dewi Windiani, and Institutional Development Facilitator, Astri Meyndra Puspita. The results from this fact-finding process and situational analysis include:

- (1) the presence of business actors operating at micro, small, and medium scales, categorized based on their annual sales volume;
- (2) the wide variety of MSME products, with the majority focusing on culinary goods, fashion, and various types of cleaning products;
- (3) the range of business experience, including long-established businesses over 20 years old, moderately experienced ones with 5–10 years operation time, and new enterprises that have been active for approximately one year.

The identification and analysis aimed to uncover the factors influencing the sustainability of micro-enterprises across various aspects, including managerial capacity, marketing, financing, and the adoption of digital technologies. Several key challenges emerged from these discussions:

1. A lack of understanding and limited access to digital technologies and Artificial Intelligence (AI) for business management and product marketing.
2. Financing constraints and limited access to capital, with continued reliance on informal funding sources which also act as predatory lending schemes.

3. Difficulties in expanding market reach, particularly in developing effective digital marketing strategies and improving product packaging for greater competitiveness.
4. Low awareness of halal certification and environmentally sustainable business practices, despite their potential as value-added factors for enhancing competitiveness.

The insights from this situational analysis serve as the foundation for designing more targeted technical assistance programs aligned with the actual needs of MSMEs. By identifying these points, we can develop more effective mentoring and training interventions, including workshops on the use of AI for digital marketing, technology-based financial literacy, and strategies for improving product quality and market networks.

This initial stage is a critical component in building a data-driven and needs-based development strategy for MSMEs. It ensures that the solutions offered are both relevant and impactful in enhancing the competitiveness and sustainability of local enterprises.

The second stage involved defining the appropriate “treatment” to improve the knowledge, understanding, and technical skills of MSME actors. This included a participant selection process based on specific criteria: expressing willingness to participate through a written statement, preparing a laptop or smartphone for practicing digital promotion techniques, and bringing product samples for direct review by the facilitators—particularly in terms of packaging, presentation, and taste (in the case of culinary products).

The third stage consisted of implementing a mini workshop with selected MSME participants under PLUT Bandung’s guidance. This activity aimed to gather direct insights from business actors regarding their current operational conditions, the challenges they face, and the opportunities they perceive within their respective sectors.



The workshop was held on Tuesday, February 11, 2025, at PLUT Building in Bandung Regency. A total of 25 MSME participants from the region attended the event. Five expert speakers were invited, each delivering materials aligned with their respective fields of expertise.

Participants were introduced to the significance of halal product assurance, a matter of considerable importance for Muslim consumers who are obligated to ensure that food, beverages, pharmaceuticals, and cosmetics they consume comply with Islamic

law (sharia). In this context, halal certification serves as a crucial instrument for providing certainty and trust to consumers regarding the halal status of products.



The obligation to consume halal products is firmly rooted in Islamic teachings, as emphasized in the Qur'an, particularly in Surah Al-Baqarah verse 168, which commands humanity to consume what is lawful (halal) and good (thayyib) and not to follow the footsteps of Satan. This verse reflects that the concept of halal encompasses not only religious dimensions but also concern over the quality and safety of consumer products.

The enactment of Indonesia Law No. 33 of 2014 on Halal Product Assurance reinforces the urgency of addressing halal compliance throughout the entire chain of production, distribution, and consumption (Pusat, 2014), where previously halal certification was voluntary and administered by the Indonesian Ulema Council (Majelis Ulama Indonesia or MUI). Today, the increasing awareness of halal principles benefits not only consumers but also businesses, enabling them to improve their competitiveness in both domestic and global markets.

With the enforcement of stricter regulations and the improved accessibility of halal-related information, it is expected that the public will become more conscious of the importance of consuming products that align with the principles of halalan tayyiban (lawful and wholesome) on a daily basis.



In addition to the understanding of halal certification, workshop participants were also provided with insights on production waste management. Waste handling has become one of the most pressing challenges faced by modern society. However, behind this challenge lies a substantial opportunity. Waste, if managed effectively, can be transformed into a valuable resource. Many individuals still adhere to the mindset that waste is something to be discarded, with no economic or environmental value.

Public awareness regarding the importance of responsible waste management remains low. While in reality, properly handled waste can serve as an economically valuable resource that benefits both the environment and local communities. Current waste management practices in many areas remain conventional, involving a linear system of collecting, transporting, and dumping waste into final disposal sites (landfills). Unfortunately, this method not only burdens the environment but also poses significant risks, as illustrated by the Leuwigajah landfill disaster in 2005. This tragedy underscores the need for a paradigm shift, from waste disposal to waste valorization through reuse, recycling, and conversion into higher-value products.

Effective waste management yields many benefits that extend beyond environmental protection; it also offers opportunities in business development and food security. Waste-derived products, such as compost fertilizers made from "bata terawang" (a type of biodegradable substrate) and bioconversion outputs using black soldier fly larvae, can serve as nutrient sources in agriculture and livestock sectors. These innovations open opportunities for MSMEs to engage in circular economy-based businesses, where previously worthless waste is converted into profitable commodities.

This comprehensive perspective emphasizes that waste is not merely a problem but can become a blessing if properly managed. With innovation in waste management practices and collaborative efforts between academia, communities, and government, greater public awareness can be cultivated around environmental stewardship. When implemented through appropriate strategies, waste management can contribute not only to environmental sustainability but also to the creation of broader economic opportunities for local populations.

The introduction of Artificial Intelligence (AI) applications was also delivered to participants, recognizing AI as a major opportunity for business actors to enhance efficiency and competitiveness. AI enables the automation of various business processes, ranging from marketing and customer service to more intelligent data processing. However, the implementation of AI in MSMEs (Micro, Small, and Medium Enterprises) also encounters several challenges, such as limited technological understanding, lack of access to digital infrastructure, and resistance to operational changes.



Several AI-based tools have been developed to support MSMEs in managing their businesses more effectively. For instance, ChatGPT can offer marketing strategy suggestions, provide insights into market trends, and assist in planning promotional

campaigns. Its ability to analyze customer data and sales trends helps MSMEs design more targeted marketing approaches. In the realm of design and branding, applications like Canva, with its AI features, allow entrepreneurs to quickly and professionally create promotional materials such as posters, infographics, and social media content. Meanwhile, DALL-E offers the capability to generate AI-based images that visually support product marketing. To enhance the quality of presentations and digital marketing, Murf.AI provides AI-generated voiceovers, allowing MSMEs to produce promotional videos without the need for a professional recording studio. On the customer service front, ManyChat supports automation via AI-powered chatbots that can be deployed on platforms such as Instagram, reducing administrative workload and improving customer responsiveness.

The adoption of Artificial Intelligence in MSME development represents a significant innovation that can help business actors boost efficiency and competitiveness in the digital era. MSMEs contribute significantly to the national economy, accounting for 60.5% of Indonesia's Gross Domestic Product (GDP). Despite this contribution, MSMEs still face various obstacles, including limitations in marketing, operations, production efficiency, and market access.

AI emerges as a viable solution to these challenges. With its ability to analyze data, recognize patterns, and automate processes, AI empowers MSMEs to improve operational efficiency. Everyday applications of AI include virtual assistants like Siri and Google Assistant, product recommendation systems on Netflix and Spotify, and automated customer service chatbots. In the context of MSMEs, AI can support various business operations. For instance, clothing store owners who struggle to respond to customer inquiries can use AI chatbots like ChatGPT to provide instant replies and improve customer satisfaction, potentially increasing sales by up to 20%. In the culinary sector, AI can help food vendors manage inventory more effectively by using data analysis to predict peak customer times, reducing waste and increasing profits.

To start integrating AI, MSMEs need to follow several steps. First, they should identify their business needs, whether for marketing, customer service, or operations. Next, they must select accessible and user-friendly AI tools, such as Canva AI for promotional design. Business actors are then encouraged to learn through online tutorials or short training programs. The implementation of AI should begin on a small scale and be gradually evaluated and refined to maximize results.

Beyond theoretical understanding, participants also received hands-on training in creating AI-assisted social media content, facilitated directly by a digital media practitioner. In the rapidly evolving digital landscape, social media content strategy has become a crucial element for MSMEs to broaden market reach and increase sales. Content serves as a communication bridge between entrepreneurs and their target markets, enabling closer interaction and building consumer trust in the offered products. However, many MSME actors face challenges in content creation, such as lack of confidence, limited editing skills, and inconsistency in uploading promotional materials.

In reality, anyone can now produce content, and delaying content creation only leads to falling behind in an increasingly competitive market. Entrepreneurs are therefore encouraged to start producing content without fear of mistakes or imperfections. In digital marketing strategy, the structure of sales video content is a

critical aspect in capturing audience attention. Effective content should feature a strong hook within the first 3–5 seconds to retain viewer interest. This should be followed by a clear explanation of the product or service and concluded with a call to action directing the audience to take specific steps such as making a purchase, following the account, or sharing the content. In addition to pre-recorded videos, live selling content has proven to be an effective strategy in digital marketing. By broadcasting live, MSME actors can interact directly with prospective customers, answer questions in real time, and foster stronger engagement with their audience.

To evaluate the effectiveness of the training session conducted on February 11, 2025, a statistical test was conducted to assess whether participants' knowledge significantly increased. The evaluation compared pre-test and post-test scores to measure the knowledge gained. Pre-test scores reflected participants' baseline knowledge, while post-test scores measured the improvement after the training intervention. The detailed data from the pre-test and post-test assessments is presented in Table 1.

Table 1 Pre-Test and Post-Test Score of The Workshop Participants

No	Name	Age	Education	Pre-Test (%)	Post-Test (%)	Difference
1	WS	39	Elementary School	67	67	0
2	RA	44	Diploma	80	80	0
3	FFZ	20	Vocational high school	93	100	7
4	AR	51	Elementary School	67	100	33
5	CS	45	High school	47	60	13
6	SHH	30	Middle school	80	80	0
7	N	47	Vocational high school	67	73	7
8	DK	55	Middle school	60	67	7
9	SM	31	High school	73	73	0
10	MN	21	High school	73	80	7
11	TK	47	High school	53	47	-7
12	MAI	45	Diploma	60	80	20
13	ES	51	High school	60	73	13
14	DWT	52	Diploma	87	80	-7
15	H	55	Diploma	87	93	7
16	RK	53	Diploma	87	93	7
17	RR	44	High school	60	73	13
18	N	50	High school	80	93	13
19	BP	56	S1	87	80	-7
20	WN	26	S1	67	80	13
21	M	42	High school	60	60	0
22	S	47	High school	87	93	7
23	RM	46	High school	87	80	-7
24	EJ	55	High school	67	80	13

25	AN	47	High school	60	80	20
			Average	$\mu_{pre} = 72$	$\mu_{post} = 79$	$\mu_{diff} = 7$

Based on the data presented in Table 1, the majority of participants demonstrated an increase in their scores following the training, with an average improvement of 7 points and the highest individual gain reaching 33 points. However, a number of participants showed no change in their scores, and some even experienced a decline. Therefore, a statistical test is necessary to determine whether the observed improvement in scores is statistically significant.

Before testing the significance, it is important to check the normality of the pre-test and post-test score difference data. To test the significance and the normality, the confidence level of 95% is used. Since the data size is small ($n < 50$), the Shapiro-Wilk normality test will be used with the following hypothesis.

H_0 : The data is normally distributed.

H_1 : The data is not normally distributed.

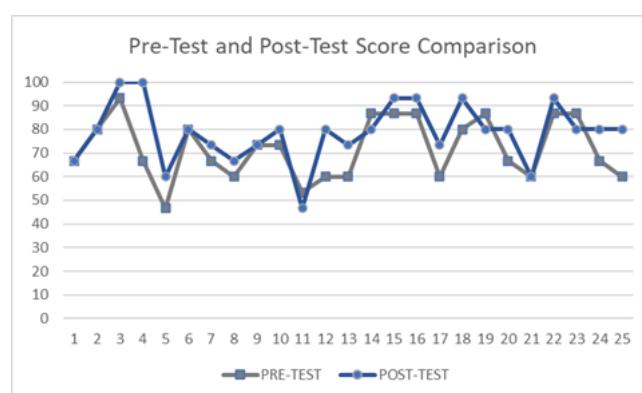
The calculation result showed that the statistics test score is 0.932 with p-value of 0.095. Since the p-value is greater than 0.05, it is verified that the data of pre-test and post-test difference is normally distributed.

Since the data is normally distributed, the significance of the score improvement will be tested using the one-tailed paired t-test with the following hypothesis.

H_0 : There is no increase, or there is even a decrease, in the post-test score compared to the pre-test score ($\mu_{post} \leq \mu_{pre}$).

H_1 : There is an increase in the post-test score compared to the pre-test score ($\mu_{post} > \mu_{pre}$).

According to the calculation result, the t-statistics score is 3.503 with (one-tailed) p-value of 0.00091. Since $p < 0.05$, the hypothesis H_0 is rejected. Thus, there is a significant increase in participants' scores after the training intervention.



CONCLUSION

The empowerment program for micro, small, and medium enterprises (MSMEs) can yield significant impact if supported by continuous interventions such as training, workshops, and dedicated mentoring, particularly involving academic institutions.

Quantitative results of this program indicate improvements in knowledge, understanding, and preliminary skills related to Artificial Intelligence, halal-oriented MSME products, environmentally friendly production processes, and creative strategies for product content design on e-commerce platforms and social media. Accelerating knowledge and skills acquisition, alongside business expansion, becomes a priority by leveraging digital technology and Artificial Intelligence as essential transformative agents to empower MSMEs in Bandung Regency.

Evaluation through pre-test and post-test assessments revealed a significant increase in participants' knowledge, awareness, understanding, and skills concerning the use of digital technology and AI, particularly for online promotion and marketing. Additionally, participants developed a deeper awareness of the importance of halal compliance and environmental sustainability in processing, producing, and distributing their products. This includes practices such as waste management and sustainable material selection, in alignment with the principles of a green economy.

As a sustainable follow-up to the program, a multi-stakeholder coordination forum involving local government, academics, business actors, and community members will be established, alongside active participation in regional MSME exhibitions in West Java. These outcomes, i.e. the establishment of a cross-sectoral coordination forum (Penta helix collaboration) and the organization of MSME exhibitions, represent strategic efforts to continuously enhance the competitiveness of the MSME sector.

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