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Application of Science and Technology to Improve Productivity, Quality, and Marketing of Mocaf Bolen in Semarang City

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ABSTRACT

Micro, Small, and Medium Enterprises (MSMEs) make a significant contribution to economic growth, job creation, community empowerment, and the reduction of economic inequality. By 2023, MSMEs' contribution to Indonesia's GDP is projected to reach 61%, equivalent to IDR 9,580 trillion. The MSME sector absorbs 97% of the national workforce, representing approximately 117 million workers. The number of MSMEs also continues to grow each year, reaching 66 million in 2023, an increase from 65 million in 2022 (KADIN). MSME mentoring is a concrete step in supporting national aspirations, including increasing quality employment, encouraging entrepreneurship, developing creative industries, and supporting infrastructure development. In alignment with the SDGs, this PKM activity helps increase village community income and reduce income disparity. Additionally, MSMEs can apply appropriate technology (TTG) developed through university innovations. In this PKM program, the university's IKU achievements for students and lecturers relate to IKU 2 and IKU 5, aligning with RIRN in the food sector concerning MSME empowerment for local food processing through TTG. The mentoring provides tangible benefits, with Appropriate Technology such as the Automatic Grinding Machine and Automatic Proofer Machine, resulting in a production increase to 500 Mocaf bolen per day from the original 350, reflecting a 42.86% rise. Furthermore, product diversification training was conducted by processing Mocaf flour into higher-value products such as Bolen Mocaf cookies and Mocaf Banana Bread. Digital marketing and business website mentoring were also implemented to strengthen promotional media, enabling products to access broader and potentially global markets.

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A. INTRODUCTION

Micro, Small, and Medium Enterprises (MSMEs) contribute significantly to economic growth, job creation, community empowerment, and the reduction of economic inequality (Herispon, H.; Hendrayani, 2021; Rachmawati, 2020; Riptiono, 2023). The contribution of MSMEs to Indonesia's GDP in 2023 is expected to reach 61%, equivalent to IDR 9,580 trillion. The national labor absorption rate from the MSME sector also reached 97%, or approximately 117 million workers, out of the total Indonesian workforce (Indonesia, 2024). Despite their vital role, the productivity of our partner MSMEs is severely hampered by a technology gap due to the continued reliance on manual and conventional mocaf bolen production methods (Rachmawati, 2020; Riptiono, 2023). This method creates significant inefficiency, as it is highly time-consuming and labor-intensive, evidenced by the 3.5 hours required just for the mixing and filling process. Furthermore, the use of such simple equipment directly impacts product homogeneity and quality, leading to the risk of the product becoming dense and failing to meet quality standards (Rasoki, 2021). Therefore, the implementation of Appropriate Technology (TTG), namely the Automatic Grinding Machine and Automatic Proofer Machine, serves as the definitive solution to address issues of time, labor, and quality, while simultaneously increasing production capacity by up to 42.86%. Over time, the number of MSMEs has continued to grow rapidly each year. Data from the Indonesian Chamber of Commerce (KADIN) shows that the number of MSMEs in 2023 reached 66 million. This number has increased by nearly 1 million, from 65 million (Arwanto, M.; Andajani, E.; Rahayu, 2025; Harahap, S.F.; Marliyah, 2025). MSME assistance is a concrete step in supporting aspirations, one of which is to increase quality employment, encourage entrepreneurship, develop creative industries, and continue infrastructure development. In supporting the SDGs, this PKM activity can increase community income and apply appropriate technology (TTG) resulting from university innovation. In this PKM program, the IKU for students and lecturers is categorized as IKU 2, where students have learning experiences outside the campus, and IKU 5, where lecturers create independently or present works in accordance with university regulations. This service aligns with RIRN in the food sector, focusing on empowering MSMEs that produce processed foods by applying appropriate technology.

The inability of MSME players to meet standards, combined with low productivity and profitability (Hasnidar, H.; Jusri, J.; Sultan, S.; Adi, A.; Rahman, S.; Febriyanti, 2024). Umitri Berkah Food Jaya (Bolen Mocaf Umitri), an MSME located at Jl. Bukit Cemara Indah BO 18, Meteseh, Kec. Tembalang, Semarang City, also experiences these problems. Umitri's production focuses on bolen. Limited production tools and machinery result in a lack of business effectiveness and efficiency. Meanwhile, Umitri Berkah Food Jaya's production capacity reaches 300-350 pieces of bolen per day. Therefore, the total time required for mixing the dough and filling the bolen with bananas alone takes 3.5 hours per day. This time does not include the subsequent processes/stages. For every 1 kg of dough, 20% Mocaf flour is required. Mocaf flour was chosen as the main raw material for production by Umitri Berkah Food Jaya because it can replace wheat flour, contains more carbohydrates, and has a lower gel content (Awa et al., 2024). In addition, Mocaf flour has a longer shelf life (added value) (Yunianto, A.E.; Lusiana, S.A.; Haya, M.; Sari, C.R.; Yuliantini, E.; Faridi, A.; Syafii, F.; Rasmaniar, R.; Budiastutik, I.; Dana, Y.A.; Pasaribu, 2021). Cassava has various high proximate contents (Rasoki, T.; Asnamawati, L.; Nurmalia, 2021; Salim, n.d.). Without this machine, it becomes “bantet” (Sidehabi, S.W.; Buwarda, S.; Qalbi, 2023). The function of the

proofer is more effective and efficient (Drastiawati, N.S.; Muhaji, M.; Susanti, N.A.; Wibowo, 2023).

PROBLEM

In the analysis of existing conditions that has been carried out, the food processing sector, especially Mocaf (cassava) flour, has become a priority for MSME development, in accordance with the roadmap for developing MSMEs as productive and sustainable. In terms of production, one of the MSMEs engaged in the food processing industry, Umitri Berkah Food Jaya, produces various types of mocaf-based products, including bolen, which is the most popular and preferred by consumers. Bolen made with Mocaf flour has a savory taste and a softer texture. The production process, particularly the mixing, banana filling, and dough development, is still conventional without the use of Appropriate Technology (TTG). The dough mixing and banana filling are done manually by hand, and producing fifty bolen takes almost half an hour longer. Umitri's production capacity, which can produce 300 to 350 bolen per day, requires three and a half hours for the mixing and banana filling processes. This situation is very concerning because it is not only ineffective and inefficient.

Figure 1. The process of mixing the dough and filling the conventional banana bolen

The process of making bolen dough is still very simple (see Figure 1). Umitri Berkah Food Jaya employs a method of placing the dough in a basin and then covering it tightly with plastic for over an hour (see Figure 2). The small capacity of the basin is a problem when using a dough developer or proofer, as it takes longer, and other problems arise. Business opportunities cannot yet be optimally exploited because the main constraint is the limited availability of production tools and machinery.

Figure 2. Conventional Dough Development Technique

In terms of quality, production issues will affect it. As is well known, SNI (Indonesian National Standards) determines the quality of mocaf bolen products. This is based on the moisture content requirements for semi-moist products (SNI 01.3840-1995), with a maximum

content of 40% (Dwiani, A.; Yuniartini, 2022). In addition, certification must be upgraded to a higher level.

In terms of marketing, there are still significant limitations. Distribution is limited to the city of Semarang (see Figure 3). The potential for mocaf flour-based food processing presents a unique opportunity (Aprianoputri, A.; Aliefia, S.P.; Atikah, R.; Alfariz, M.D.; Nurkholis, K.M.; Emilda, E.; Lazuarni, 2023). In addition to having a distinctive flavor and softer texture, Mocaf food products have better nutritional content than other types of flour (Dina, R.A.; Kamila, R.R.; Wassalwa, U.S.; Kurniawati, N.; Yuniar, R.; Dewi, 2023). The marketing constraints faced by Umitri Berkah Food Jaya lie in its limited product diversification and innovation capacity, as well as its minimal digital marketing adoption capabilities. By utilizing mocaf flour to produce various products, such as brownies, nastar cookies, cendol, and chips, Umitri Berkah Food Jaya can expand its business by incorporating mocaf flour processing as its primary raw material.

Figure 3. Business promotional media are still simple

PROBLEM SOLUTION

Based on the partners' problems, concrete actions are needed to find solutions, as outlined in Table 1.

Table 1. Problem Solutions and Target Outcomes

No	Problem Aspect	Identify Problem	Solution	Output Target
1	**Production Aspect**	• The mixing and filling processes of the pisang bolen dough were still performed manually, resulting in production that was neither effective nor efficient, as conventional hand-based	• The development and assembly of Appropriate Technology (AT) equipment were carried out. • The design and construction of an automatic noodle-making machine, an automatic electric proofer, as well as dough-sifting and	• One unit each of the noodle-making machine, automatic electric proofer, dough-sifting machine, and dough-mixing machine was produced. • Production

		methods continued to be used. • The dough-development technique was carried out through a very basic procedure in which the dough was placed in a bowl and left to rest for a period of time while being tightly covered with plastic.	mixing machines were completed.	capacity was increased by 100%. • A minimum of 30% additional workforce absorption was achieved
2	**Quality Aspect**	• The quality of Bolen Mocaf had not met the standards as a result of using simple equipment. • Quality testing of Bolen Mocaf had not been conducted	• The AT machines/equipment that had been developed were applied, and testing was carried out.	• The Bolen Mocaf produced by the partner was in accordance with SNI and HACCP quality standards.
3	**Marketing Aspect**	• Innovation and creativity of business actors were limited. • Product diversification of mocaf-based food products was limited only to banana bolen. • Digital marketing had not been applied optimally by the partner. • Business expansion and marketing coverage were still limited.	• Optimal assistance in business and operational management was provided. • Collaboration and distribution channels were expanded through the optimization of digital technology. • Intensive assistance related to digital marketing was provided. • Assistance in the diversification of mocaf-based processed products was carried out.	• A minimum of two social media platforms for global-scale marketing was created. • The national market was reached at least within the scope of Central Java Province. • Sales turnover was increased by a minimum of Rp 50 million per month. • A minimum

				of five types of product diversification was created.

B. METHODS

Without a proofer machine, the production process is only able to produce 200–300 bolen per day with a drying time of 2–3 hours. However, with the use of a proofer machine, the production capacity increases to 600–900 bolen per day, as the drying process can be accelerated to just 20–30 minutes. This is possible because the proofer machine creates a controlled environment with optimal temperature and humidity. This is in line with the results of implementing the use of Appropriate Technology, namely by using automatic grinding machines and automatic proofer machines, which are more efficient and effective. Based on the problems, solutions, and output targets of community service activities, it is necessary to implement systematic, integrated, and sustainable steps with community service partners for lecturers. Several methods will be used, as shown in Table 2.

Table 2. Activities, Methods, Participation, and Outputs

No	Activity Stages	Activities	Partner Participation
1	**Socialization**	The implementation team provided an explanation to the partners (members of Bolen Mocaf Umitri) regarding the purpose of implementing the community service and empowerment program (PKM), the expected outputs, and the benefits for both the partners and the implementation team/university.	The venue and necessary equipment for the meeting/socialization attended by all Bolen Mocaf Umitri members were provided by the partner. Consumption for all participants attending the socialization was also provided by the partner.
2	**Training**	Training related to production and marketing aspects was provided by the implementation team. For production, partners received an explanation on how to optimize production processes using Appropriate Technology (AT), including the automatic noodle maker, automatic electric proofer, dough-sifting machine, and dough-mixing machine. For marketing, partners received knowledge and training on the importance	The partner actively participated in training activities related to both production and marketing. Questions were asked by the partner if something was unclear, and practical sessions were conducted under the guidance of the implementation team.

		of digital marketing, negotiation and lobbying techniques, improving consumer engagement, and other marketing strategy materials. Training, demonstrations, and hands-on practice regarding these marketing materials were also provided.	
3	**Technology Implementation**	The implementation team provided the partner with production machines and equipment, consisting of 5 units of AT machines: an automatic milling machine, a dough-sifting machine, a dough-mixing machine, and a dough oven machine. These machines were then applied by the partner for real production activities. If any operational obstacles arose, improvements or adjustments were made.	A designated area for installing the machines/equipment was provided by the partner. The partner also provided necessary materials and supporting supplies, including Mocaf flour, electricity, LPG fuel, and others.
4	**Assistance and Evaluation**	Assistance was provided to the partner by the implementation team throughout the program. The assistance aimed to ensure that the partner understood the machine/equipment functions and became skilled in operating them. Evaluation was also conducted to determine whether the predetermined outputs had been achieved, including machine application, production improvement, marketing, and partner income.	The partner actively participated in the assistance activities conducted by the implementation team, both in production and marketing aspects. If any part was not yet mastered, questions or requests for further guidance were expected. The partner also contributed to the evaluation and provided suggestions to help achieve the expected outputs.
5	**Program Sustainability**	The implementation team provided an explanation regarding the importance of mastering both theoretical and practical skills in operating production machines and equipment. The partner was equipped with knowledge on how to maintain and troubleshoot machine/equipment issues.	The partner actively participated in all program activities. Training was provided to enable the partner to become skilled in all aspects of the activities, encompassing theory, practice, production, and marketing. The partner was expected not only to master machine operation but also to maintain and troubleshoot the equipment.

		This was intended to ensure that, after the PKM program ended or when the implementation team was no longer present, the partner could continue utilizing the machines independently. Post-program monitoring was also conducted regularly by the team, including assistance for HACCP certification submission.	Continuous improvement of knowledge and skills, as well as innovation, was expected from the partner to remain competitive and adapt to technological and market developments. The partner also provided active involvement and support in the HACCP certification submission.

The success of this activity will be clearly evident by comparing the conditions before and after the Community Service program for Lecturers. The activity implementation team consists of three faculty members with different disciplines/expertise (multidisciplinary) to comprehensively and integrally address the partner's problems, as well as three students who will be involved in activities on campus and in the field, and will be counted as internships/MBKM.

C. RESULTS AND DISCUSSION

The application of the TTG proofer machine in the mocaf bolen making process ensures that the proofing and drying of the dough surface takes place evenly and efficiently, so that production time is reduced, the texture of the puff layer is more consistent, and the level of moisture retention is more controllable (Krissetiana et al., 2020). This is in line with the results of implementing the use of Appropriate Technology, namely by using automatic grinding machines and automatic proofer machines, which are more efficient and effective.

Applied science and technology are used to increase the productivity and quality of Umitri's Mocaf bolen products by utilizing Appropriate Technology (TTG) as an alternative solution. This not only supports production but also enhances efficiency and improves product quality. Documentation of the activities is presented in Figures 5 and 6. Meanwhile, training and assistance in digital marketing were carried out by a team member, Anindya Ardiansari, S.E., M.M. (See Figures 9 and 10).

Table 3. Results of Appropriate Technology Utilization

Method Stages	Daily Production (Bolen)
Initial (Conventional)	350
Final (with TTG)	500

As shown in Table 3, the assistance provided in this community service activity has resulted in benefits, namely the use of appropriate technology in the form of automatic grinding machines and automatic proofers, which can produce 1,000 bolen per day, up from only 350 bolen per day previously. This indicates a 42.86% increase, as shown in Figure 4.

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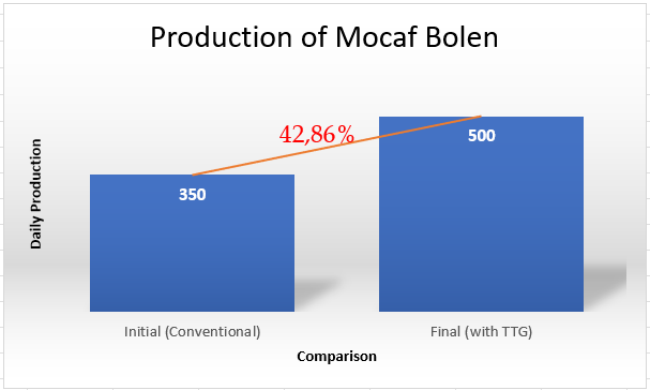

Figure 4. Graph of Bolen Mocaf Production Increase

Meanwhile, in terms of production, the implementation of TTG is supervised by Dr. Eng. Aldias Bahatmaka, the team leader. Meanwhile, another member, Fidia Fibriana, S.Si., M.Sc., Ph.D., trains in product diversification to add value and economic benefits (see Figures 7, 8, 9, 10, 11, 12, 13, and 14).

Figure 5. Coordination of PKM Program Implementation

Figure 6. Handover of Equipment (TTG) Automatic Grinding Machine and Proofer

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Figure 7. Explanation of the use of the TTG Automatic Proofer Machine

Figure 8. TTG Automatic Grinding Machine Trial

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***Figure* 9.** Creation of a TTG user guide leaflet

Figure 10. Explanation of mocaf processed product diversification

Figure 11. The result of Mocaf product diversification is Mocaf Bolen Cookies

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Figure 12. The result of Mocaf's product diversification is Mocaf Chocolate Banana Bread

(a) (b)

Figure 13. Mocaf Bolen Dough: (a) dough is rolled out conventionally, (b) dough is rolled out using TTG (Automatic Rolling Machine)

Figure 14. Mocaf results after using TTG (Automatic Proofer)

This community service activity has produced several outputs. The first output is an online mass media publication on kompasiana.com related to this community partnership empowerment activity. Evidence of the output in online mass media can be seen in Figure 15.

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Figure 15. Online Media Output on suaramerdeka.com.

Link: https://www.suaramerdeka.com/pendidikan/0415997920/bantu-umkm-naik-kelas-tim-akademisi-terapkan-teknologi-tepat-guna

We have then submitted this community service activity for intellectual property rights in the form of a video documenting the community service activity. The application process has been completed, and a Copyright Registration Certificate has been issued by the Minister of Law and Human Rights, the Director General of Intellectual Property, and the Director of Copyright and Industrial Design, with registration number "EC002025142381". Proof of IPR output is shown in Figure 16.

Figure 16. Intellectual Property Outputs (TTG Booklet, Recipes, and Digital Marketing)

Link: https://drive.google.com/file/d/1aBgyar4Z-aCcHVn69m4szV8zBWj3HipA/view?usp=sharing

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Another output that has been achieved is a poster in Figure 17. Documentation of the community service implementation is presented in the form of a video. Evidence of the video production is visible in Figure 18.

Figure 17. Community Service Poster Output

Figure 18. Video Output

Link: https://drive.google.com/file/d/1rsrNral0N5hLNMQ-f55Hy5XJAiROMXi7/view?usp=sharing

D. CONCLUSION

Technology and innovation transfer to target partners, including assistance with production equipment such as Automatic Grinding Machines and Automatic Proofer Machines. This means that not only is Appropriate Technology (TTG) assistance provided,

but product diversification training is also conducted at Umitri Bolen Mocaf. The aim is not only to empower MSMEs, but also to increase productivity, quality, and marketing of Mocaf flour-based food products, thereby producing competitive products with high selling value and variety.

Product diversification training and digital marketing assistance have also been provided, enabling partners to create digital promotional content, build business websites, and utilize digital technology automation to effectively market Umitri Bolen Mocaf products. A suggestion for this program is to strengthen its partnerships and stakeholder engagement so that the scope of collaboration, assistance, and monitoring and evaluation is more complex, systematic, and sustainable.

E. ACKNOWLEDGEMENTS

We would like to express our gratitude to the Directorate of Research and Community Service, the Directorate General of Research and Development, the Ministry of Higher Education, Science, and Technology, and the Institute for Research and Community Service (LPPM) of Semarang State University (UNNES) for providing the opportunity and support that enabled this community service activity to be carried out and run smoothly. Additionally, we would like to thank our partner, Mrs. Tri Drajat, as the partner of Umitri Bolen Mocaf Semarang, for her willingness to collaborate, as well as all members of the UNNES community service team for their support and excellent cooperation, which ensured the smooth running of the program.

F. AUTHOR CONTRIBUTIONS

As explained in this article, all team members actively contributed in every stage of the Community Service Activity through the Application of Science and Technology to Improve Productivity, Quality, and Marketing of Mocaf Bolen in Semarang City. As team leader, Aldias Bahatmaka coordinated with partners, planned activities, addressed science and technology needs, and conducted practical demonstrations. Fidia Febriana and Effelie Dewi Mayangsadi conducted the testing process for product hygiene and diversification of Mocaf Bolen products. Meanwhile, Anindya Ardiansari and Linda Sari conducted training on digital marketing strategies. Indra Nurul Hidayat, together with Tegar Oka Prasdika, provided training on the use of tools to partners. And Fajar Rizqi Sandi Pratama assisted Aldias Bahatmaka in compiling reports and writing journals. This collaborative effort ensured the program's success, from identifying needs to evaluating its impact, as detailed in this article.

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