Indonesian Journal of Community Engagement
Jurnal Pengabdian kepada Masyarakat
Vol. 9, No. 4, December 2023, Page. 219-226
DOI: http://doi.org/10.22146/jpkm.87170

Community Service Training on Material Flow Cost Accounting (MFCA) for Micro, Small, and Medium Enterprise (MSME) Entrepreneurs

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Submitted: July 22nd 2023; Revised: October 29th 2023; Accepted: November 13th 2023

Keywords:
Material flow cost accounting
Micro, small, and medium enterprises
Resources efficiency
Sustainable business practices

Abstract In the last two decades, concern for environmental issues has become a regulatory concern at the international and national levels. Many methods have been developed to reduce negative impacts on business activities, including Material Flow Cost Accounting (MFCA) technology that shows an increasing trend among companies and Micro, Small, and Medium Enterprises (MSMEs) in developing countries. The benefit of MFCA technology is its superiority in identifying material losses (harmful products) during production. At the same time, this is known at the end of the process in the conventional accounting system. Then, by implementing MFCA technology, business people can take the initiative to reduce material losses and achieve resource efficiency. In addition to efforts to reduce material losses, MFCA technology will encourage business-enhancing practices by reducing costs, reducing carbon emissions, and increasing operational efficiency. This Community Service Program aims to provide training on sustainable business principles by applying MFCA technology for MSME Entrepreneurs at Bina Amanah School of Entrepreneur Cordova in South Tangerang, Banten Province, and using the problem-based learning (PBL) and research method that constructively increases participants' knowledge after the training.

1. INTRODUCTION

The National Determined Contribution (NDC) submission to the United Nations by the Government of the Republic of Indonesia emphasizes the imperative of accelerating the transition to a low-carbon economy. In response, business entities, including Micro, Small, and Medium Enterprises (MSMEs), are urged to align their operations with resource efficiency (Sulong et al., 2014). MSMEs, typically businesses with 5 to 250 employees, constitute a substantial proportion of global business entities, ranging from 85% to 99% (Ciliberti et al., 2008). This sector significantly contributes to the global GDP, accounting for at least 70% (Natarajan & Wyrick, 2011). There were 53.3 million MSMEs in Indonesia in 2020, contributing 60.3% to the country's GDP (Azzahra & Wibawa, 2021). Despite this notable contribution, there is potential for further optimization, and MSMEs have historically served as a crucial social safety net during economic crises, such as the 1997/1998 monetary crisis and the 2008/2009 global crisis, highlighting the need to enhance their competitiveness (Lantu et al., 2016).

Material Flow Cost Accounting (MFCA) is a crucial methodology within environmental management systems (EMS) (Kokubu & Tachikawa, 2013). It tracks the movement of materials throughout the production process, encompassing both positive and negative product outcomes (Herzig et al., 2012). This approach involves a detailed quantification of materials, energy, and associated costs, and its applicability is versatile, extending from specific

ISSN 2460-9447 (print), ISSN 2541-5883 (online)
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processes or products to entire supply chains (ISO, 2011).

MFCA is instrumental in pinpointing material inefficiencies within a company, offering insights into areas where losses occur. Organizations can reduce waste, enhance productivity, and reduce costs by identifying and resolving these issues. The method's ability to reveal significant material losses positions it as a valuable tool for improving environmental and economic performance. Beyond its operational advantages, adopting MFCA can contribute to a positive corporate image (Sulong et al., 2014).

Material flow cost accounting (MFCA) is a valuable tool for optimizing material usage across manufacturing and non-manufacturing sectors (Jasch, 2009). The successful implementation of MFCA is contingent on various organizational factors that can either facilitate or impede its effectiveness. Factors promoting technical excellence in MFCA implementation include the availability of relevant data, management commitment (Lee et al., 2005), and alignment with existing management systems (Nakajima, 2008).

Organizations with prior experience in MFCA implementation often possess readily available data for materials analysis, streamlining the process and reducing the administrative burden of handling extensive datasets. This advantage becomes a critical consideration in the investment decision-making process for adopting MFCA in cross-functional organizational settings (Lee et al., 2005). Additionally, the compatibility of MFCA with a company's existing technological infrastructure plays a pivotal role in its likelihood of adoption. Case studies have demonstrated that higher compatibility can facilitate the integration of MFCA into broader quality management initiatives such as total quality management (TQM).

Perception-related challenges, teamwork dynamics, performance assessment, technical knowledge, and training represent critical obstacles in adopting MFCA innovations (Burritt, 2004; Burritt, 2005; Lee et al., 2005; Nakajima, 2008). Analyzing the relationship between these variables and the adoption level at the organizational or individual level aligns with the Diffusion of Innovation theory proposed by (Rogers, 2003). This theory categorizes adopters into five groups: innovators, early adopters, early majority, late majority, and laggards. Sulong et al. (2014) delved into the influencing variables to identify driving and inhibiting factors, namely (1) perceptions of innovation attributes, (2) types of innovation decisions, (3) communication channels, (4) nature of the social system, and (5) the effort level exerted by the new technology promotion agent.

The first set of variables concerning perceived innovation attributes encompasses the relative advantage of MFCA compared to prior technologies, compatibility, complexity, trialability, and observability. Compatibility gauges the consistency of MFCA with existing values and experiences. Complexity assesses the perceived difficulty in understanding and using MFCA. Trialability measures the extent to which MFCA can be tested for feasibility. Observability considers how the results of MFCA can be observed and communicated (Rogers, 2003).

The second set of variables pertains to the type of innovation decision. Individual decisions are optional and independent of other social system members' decisions, while collective or authoritative decisions are more prevalent within organizations. Collective decisions involve consensus, whereas authoritative decisions are made by individuals with higher power, social status, or technical expertise (Rogers, 2003).

The third set of variables involves communication channels. Communication with groups sharing similar beliefs, education, and socio-economic status influences the degree of adaptation. The fourth set of variables focuses on the nature of the social system, referring to units with a common goal. If MFCA aligns with the existing social system or the system can adapt to its requirements, implementation becomes more straightforward (Rogers, 2003). The fifth set of variables concerns the efforts of change agents in promoting innovation. The relationship between change agent efforts and innovation adoption rates may not be direct and linear (Rogers, 2003). To drive innovation adoption, they must first gain acceptance from opinion leaders within the organization.

This community service program (CSP) aims to provide training on MFCA technology application and explore its potential implementation in micro, small, and medium enterprises (MSMEs). The diffusion of innovation theory is utilized to elucidate supporting and inhibiting factors for MSME actors at the Bina Amanah Entrepreneurship School (SKBA) Cordova, situated in Pondok Aren, South Tangerang, Banten.

Established in 1997 with an operational permit from the Ministry of Education, SKBA Cordova offers a free learning program for skill development among entrepreneurs. Despite the challenges posed by the COVID-19 pandemic, there was a notable surge in interest among MSME entrepreneurs in the Pondok Aren area. Responding to this demand, SKBA Cordova collaborated with the Faculty of Economics and Business at Universitas Trisakti.

2. METHOD

The community service program (CSP) on MFCA training is held using the Problem-based learning (PBL) method, which is a student-centered pedagogy. Students learn a subject through problem-solving experiences. Efforts to find solutions will enable skills development, including acquiring knowledge of collaboration and group communication (Wood, 2004). The PBL method is expected to encourage MSME players to share experiences and learn something new constructively.

The CSP activities began with a preliminary study of the SKBA Cordova location on Tuesday, November 15, 2022, to gain an initial understanding of the MSME actors who will participate in the training. The study was conducted based on a survey and semi-structured interviews with 19 (nineteen) MSME players in the culinary, fashion, and mini-market sectors. We chose one of the MSMEs in the fashion

Table 1 . MSMEs entrepreneur cordova profile

No	Field of Business	Numbers of MSME Entrepreneurs	Business Age	Revenue per month
1	Culinary	14	< 2 years	IDR2,500,000 – IDR7,500,000
2	Fashion	3	< 5 years	IDR15,000,000 – IDR30,000,000
3	Mini mart	2	< 5 years	IDR5,000,000 – IDR15,000,000
	Total Participants	**19**		

Sources: Data processed from the survey and interviews with MSMEs entrepreneur

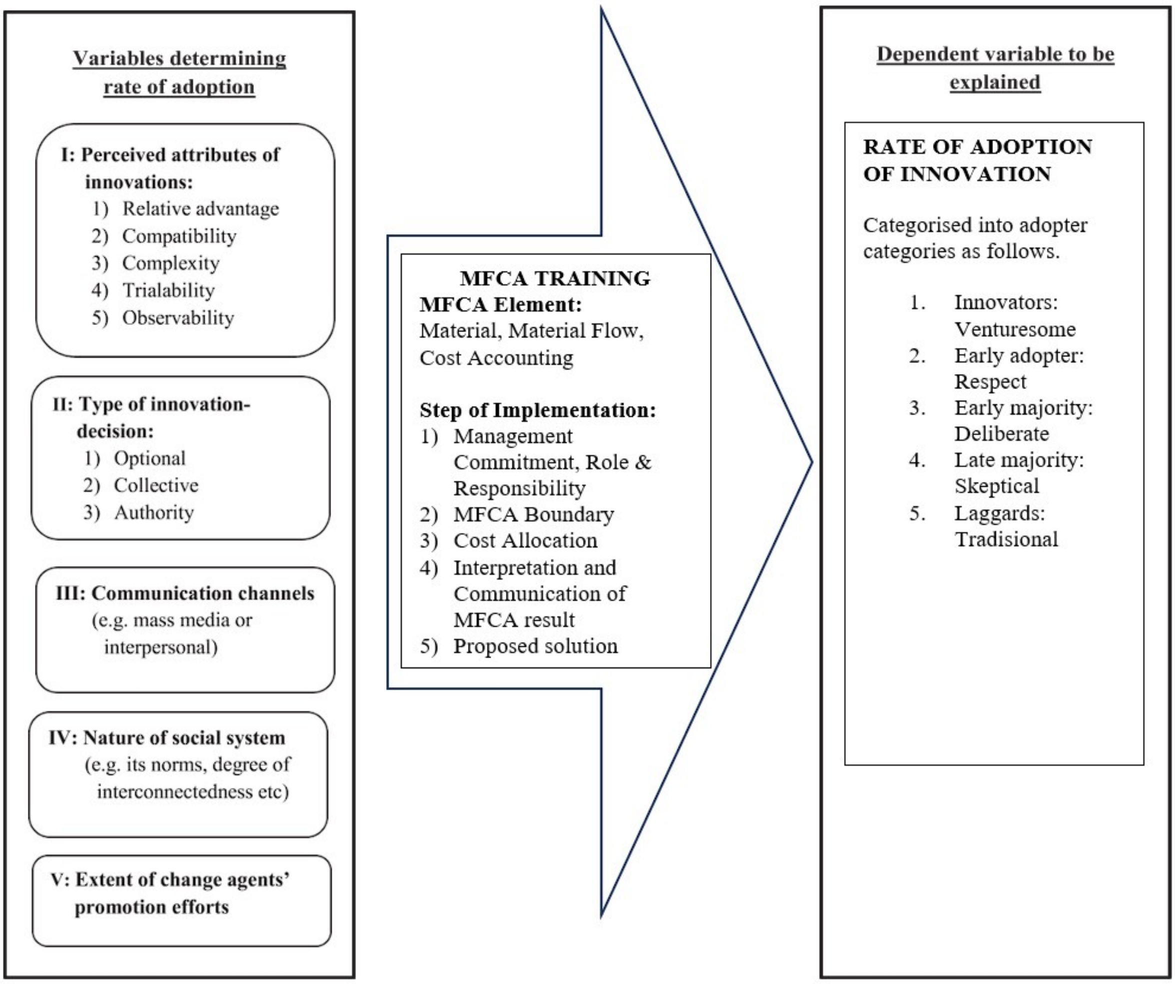

Figure 1 . Research method of community service training on MFCA technology

sector called Kania Fashion as training case study material. Mrs. Siti Aminah owns this MSME and has been operating since 2014. Training activities were held on Monday, December 11, 2022, from 9:00 to 16:00 WIB at SKBA Cordova Pondok Aren Tangerang. The participant profile is presented in Table 1. The framework for implementing community service training and research is as follows in Figure 1.

The training material covered essential elements of MFCA technology, including materials, material flow, and cost accounting, as well as steps for implementing MFCA technology.

1. Management commitment to determine the roles and responsibilities of employees in the production process
2. Determining process boundaries and material flow models
3. Cost allocation
4. Interpretation and communication
5. Discussion and search for solutions.

3. RESULT AND DISCUSSION

3.1 Case study of the application of MFCA in SKBA Cordova

Kania Fashion has 11 employees and produces T-shirts, Jackets, and Sportswear with an annual revenue of IDR360,000,000. Production waste in the form of rags (patchwork) has yet to be managed. MFCA training specifically designed for T-shirt products as follows.

Step 1: Determination of roles and responsibilities by management.

The ISO 14501 manual requires that the determination of roles and responsibilities by management is essential in order production process runs under the capabilities of the work unit. Kania Fashion management appointed one employee for each of functional coordinator; Operational, Technical, Quality control, Environment and Cost accounting.

Step 2: Determination of MFCA Boundary

MFCA boundaries are determined by creating a material flow model at the cutting, screen printing, sewing, and packing process quantity centers as follows:

1. The cutting process requires one machine with 4.4 kWh of energy to cut 285 meters of Cotton Combed 30s into a T-shirt pattern. The process is carried out by 2 (two) employees. The output of this process is 250 meters of Cotton Combed 30s positive product and 35 meters of harmful product in the form of patchwork.
2. The screen printing process uses 250 meters of Cotton Combed 30s fabric and five employees for one machine with an energy of 13,84 Kwh. The screen printing process produced 243 meters of positive products of Cotton Combed 30s fabric and 7 meters of harmful products resulting from uneven screen printing.
3. The Side Knitting process uses 243 meters of Cotton Combed 30s ready for sewing, ten rolls of Polyester Thread, two employees, a machine with 4 kWh energy, and 1 one employee. The process produces 100% favorable products.
4. The overdeck sewing process uses 243 meters of Cotton Combed 30s fabric and eight dozen Sewing Threads. Overdeck sewing is done on the sleeves and bottom of the t-shirt, requiring two employees and two machines with 4 kWh of energy. The process produces 100% positive products.
5. The Chain Knitting process for the neck and shoulders uses one machine with 2 (two) kWh of energy and one employee. The process produces 100% positive products.
6. The finishing process is carried out on the Cotton Combed 30s fabric and has been produced into a T-shirt. In this process, three employees carry out packaging and check the product's suitability.

Step 3: Cost allocation

Cost allocation is carried out in three categories; namely, Cotton Combed 30s material costs with a unit price of IDR25,000, electrical energy costs are IDR1,467.28/Kwh, and system costs (direct labor). The cutting process uses a total input of 285 meters of Cotton Combed 30s fabric with a unit price of IDR25,000 per meter, so the total cost for raw materials is IDR7,125,000. The positive product of Cotton Combed 30s fabric is 250 meters divided by the total input of 285 meters and multiplied by the total cost for raw materials. The cost allocation for positive output is IDR6,250,000. The negative product of raw materials at this stage of the production process is 35 meters in rags (patchwork). The estimated 35 meters of patchwork is divided by the total input of raw materials, then multiplied by the total input cost of all raw materials so that the allocation of negative product costs in this process is IDR875,000. Polyester thread and sewing thread are only used for positive products. The allocation of material costs, energy costs, and system costs is also carried out in the MFCA process model, as presented in Table 2, Table 3, and Table 4.

Table 2 . Cost allocation, positive and negative product

Material	Cost Allocation	Positive Product	Negative Product
Cotton combed 30s	IDR7,125,000	IDR6,250,000	IDR875,000
Polyester thread	IDR360,000	IDR360,000	-
Sewing thread	IDR216,000	IDR216,000	-
Total	**IDR7,701,000**	**IDR6,826,000 (88.6%)**	**IDR875,000 (11.3%)**

Sources: Data processed from the survey and interviews with MSMEs entrepreneur

Table 3 . Energy cost allocation

Production Stage	Energy	Energy need	Unit	Unit Price (IDR)	Cost Allocation (IDR)	Positive Product (%)	Cost of Positive Product (IDR)	Negative Product (%)	Cost of Negative Product (IDR)
Cutting	Electricity	4.4	kWh	1,467.28	6,456	88.6	5,720	11.3	729
Screen print	Electricity	15.8	kWh	1,467.28	23,242	97.2	22,591	2.8	650
Side knitting	Electricity	4	kWh	1,467.28	5,869	100	5,869	0	-
Overdeck	Electricity	4	kWh	1,467.28	5,869	100	5,869	0	-
Chain knitting	Electricity	2	kWh	1,467.28	2,935	100	2,935	0	-
Finishing	-	-	-	-	-	100	-	0	-
		Total			**44,373**	**97.2**	**42,984**	**2.8**	**1,389**

Sources: Data processed from the survey and interviews with MSMEs entrepreneurs

Table 4 . System cost (direct labor cost) allocation

Production Stage	Number of employees	Need (Dozen)	Wages/ Dozen (IDR)	Cost Allocation (IDR)	Positive Product (%)	Cost of Positive Product (IDR)	Negative Product (%)	Cost of Negative Product (IDR)
Cutting	2	25	5,000	250,000	88.6	225,000	10	25,000
Screen print	5	10	25,000	1,250,000	97.2	1,225,000	2	25,000
Side knitting	2	25	3,000	150,000	100	150,000	0	-
Overdeck	2	25	5,000	250,000	100	150,000	0	-
Chain knitting	1	50	3,000	150,000	100	150,000	0	-
Finishing	2	25	3,000	150,000	100	150,000	0	-
				2,200,000	97.7	2,150,000	2.3	50,000

Sources: Data processed from the survey and interviews with MSMEs entrepreneurs

Table 5 . MFCA result interpretation

Component	Direct Material (IDR)	Energy Cost	System Cost/Direct Labor (IDR, %)	Total Cost (IDR)
Product	6,826,000	42,984	2,150,000	9,018,984
Material Loss	875,000	1,389	50,000	926,389
Total	IDR7,701,000	IDR44,373	IDR2,200,000	IDR9,945,373

Sources: Data processed from the interviews with MSMEs entrepreneurs

Table 6 . Material, overhead, and director labor cost under MFCA

	Quantity	Unit Price (IDR)	Total (IDR)
Material Cost			
Bisband webbing	3 roll	25,000	75,000
Sewing thread	1 Dozen	13,500	13,500
Textile coloring	1 Dozen	48,000	48,000
		Total	**136,500**
Overhead Cost			
Energy cost (Knitting)	4.4 kWh	1,467	6,456
		Total	**6,456**
Direct labor cost			
Direct labor cost	2 persons	87,500	175,000
		Total	**175,000**

Table 7 . Cost-benefit analysis of MFCA implementation

Material cost	IDR136,500
Overhead cost	IDR6,456
Direct labor cost	IDR175,000
Cost of production	IDR311,956
Cost of goods sold per unit (210 Unit)	IDR1,486
Mark up cost	IDR5,000
Profit per unit	IDR3,514
Overall Profit (210 Unit)	IDR743,940

Step 4: Interpreting and communicating the MFCA results

The MFCA results based on the cost flow matrix can be classified into part of the product cost of positive and negative product as shown in Table 5.

In summary, MFCA successfully documented total costs amounting to IDR9,945,373, breaking into favorable product costs of IDR9,018,984 (90.6%) and material loss of IDR926,382 (9.3%). The material loss, constituting 9.3%, originated from materials (11.3%), energy costs (2.8%), and direct labor or system costs (2.3%). Addressing and converting this material loss into valuable products through Reduce, Reuse, and Recycle principles should be a focal point for management attention to enhance future business practices.

Step 5: Recommendation for MFCA implementation

The MFCA implementation results were communicated to Kania Fashion MSME owners along with recommendations for optimizing the production process. The suggestion involves utilizing patchwork production waste to create a valuable product, specifically the Hot Pot Holder. A comprehensive cost and benefit analysis of processing this product is presented in Table 6 and Table 7.

Based on the cost and benefit analysis, the conclusion is that the recommendation to create Hot Pot Holders from patchwork would be profitable for Kania Fashion. The material loss of IDR875,000 can generate additional revenue of IDR743,940 with extra production costs amounting to IDR311,956. In comparison to selling without processing at a price of IDR15,000 per kilogram, the additional revenue from 42 meters of material loss (total weight: 10 kilograms) would only be IDR150,000. Therefore, this recommendation is expected to have a positive impact on Kania Fashion.

3.2 Enablers of MFCA implementation in MSMEs businesses

The results of the material flow analysis from the first group of variables, perceived attributes of innovations, provide relevant information for directing management attention to crucial issues. Calculating the cost equivalent to material loss demonstrates the relative advantage of MFCA technology, likely promoting adoption. Additionally, MFCA technology is perceived as compatible with traditional business processes that typically overlook savings. The complexity of MFCA is well understood, given that the training material is based on MSME business practices.

Regarding the attribute of "traceability," MSME actors comprehend that accepting new technology involves "trial and error." The emphasis is not on the trial's success but on its extent and on the new technology's relevance to their business, which serves as the basis for decision-making. Meanwhile, the observability attribute is improving as MSME players gain a better understanding, aided by training materials that include successful examples of MFCA.

3.3 Barriers of MFCA implementation in MSMEs businesses

The implementation of MFCA by MSMEs may encounter obstacles, particularly related to the performance management system (PMS), key performance indicators (KPI), performance evaluation, and bonus distribution. PMS has the potential to pose challenges as it has not been covered in the outlined steps for MFCA activities. Addressing these issues is crucial for maintaining employee motivation, as emphasized by three of the five interviewed MSME actors who were previously employees o MSMEs.

Another potential obstacle arises when MSMEs receive special orders requiring different materials. Obtaining supplier approval before production is essential, and agreements must be reached, considering the impact on the stock of previous orders. These constraints are factored into new production planning, highlighting the importance of intensified communication between the work team and suppliers. Both obstacles are integral components of the social system, significantly influencing the success of innovation—implementation across various industries and MSMEs.

3.4 Evaluation

The CSP training occurred on Monday, December 11, 2022, from 9:00 to 16:00 WIB, serving as an initial step in sustainable business training for MSME entrepreneurs. This activity is anticipated to be followed by MFCA training encompassing a larger MSME business scale with increased participation. An evaluation of training effectiveness is conducted post-training to assess the retention of MFCA knowledge among the 19 MSME participants.

Table 8 . Cost-benefit analysis of MFCA implementation

No.	Questions	SCORE
1	In running a business, financial considerations are the main priority.	10%———-100%
2	Raw material costs are a cost component that is very difficult to save.	10%———-100%
3	Considering environmental issues (e.g. reducing production waste) will incure additional costs to our business.	10%———-100%
4	Considering environmental issues (e.g. recommendations to reduce plastic use) does not affect our business.	10%———-100%
5	Electricity costs are something that is very difficult to save on.	10%———-100%
6	Production waste can be processed further to produce something of value.	10%———-100%
7	There should be awards for employees who succeed in finding ways to save money in business practices.	10%———-100%
	Average Before training	34.21%
	Average Score after training	65.15%

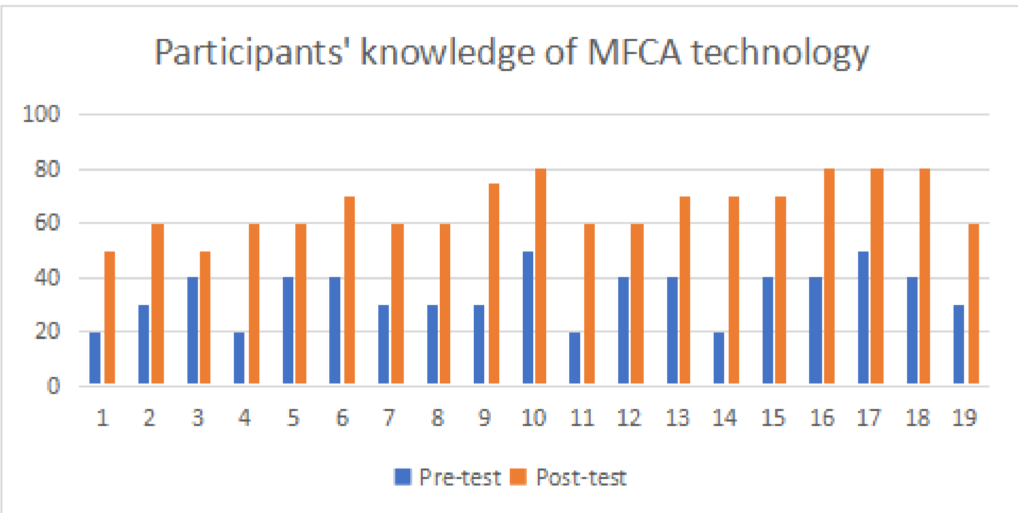

Figure 2 . Changes in participants' knowledge scores before and after the MFCA training Sources

Sources: Data processed from the survey and interviews with MSMEs entrepreneurs

Figure 3 . Photo of the MFCA training for MSME Entrepreneurs

Table 8 illustrates the seven-question questionnaire administered to participants before and after the training. Figure 2 indicates a 90.46% increase in Knowledge Scores related to MFCA technology, with scores rising from 34.21 before training to 65.15 after training. Concurrently, Figure 3 showcases the activity during MFCA training at SKBA Cordova. This outcome suggests a heightened likelihood of MFCA adoption in the future, emphasizing the necessity for broader MSME engagement and targeted training in areas linked to resource efficiency.

4. CONCLUSION

The future outlook appears promising based on the preliminary and post-training evaluations of MFCA implementation in MSMEs. The case study demonstrates that MFCA can simultaneously contribute to achieving economic and environmental goals within businesses. Success is likely elevated when management is committed to ISO-based best practice standards, guided by evidence-based awareness.

Perception poses a primary challenge in MFCA implementation, as MSME players often uphold a traditional paradigm, viewing economic and environmental goals as mutually exclusive. Additional training and knowledge-sharing sessions are recommended to address this perception challenge. Another challenge concerns performance assessment issues, necessitating careful handling through proper planning and open discussions. Determining scope, boundaries of responsibility and authority, performance indicators, and individual and departmental performance targets is crucial.

ACKNOWLEDGMENT

This community service activity is supported by funding from the Unit of Research and Community Service Faculty of Economics and Business, in collaboration with the Institute of Research and Community Service Universitas Trisakti.

CONFLICT OF INTERESTS

The author states there is no conflict of interest in organizing this community service activity.

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