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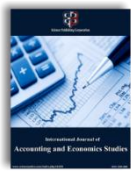

Considerations on Initiatives to Promote The Application of Material Flow Cost Accounting: Evidence from India

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Abstract

Material flow cost accounting (MFCA) has attracted attention as a representative method of environmental management accounting. However, there are many cases in India where companies have stopped applying MFCA after its introduction. This study examines the criteria for the successful application of MFCA. It conducts a comparative analysis of Pacelile, a company that has applied MFCA for a long time, and Saersa Corporation, a company that stopped MFCA after applying MFCA for a certain period, focusing on the process after the introduction of MFCA. The case study will focus on the process after the introduction of MFCA and conduct a comparative analysis of the two companies. Through these case studies, we will explore the desired forms of MFCA implementation and the efforts to realize those forms.

Keywords: *environment, MFCA, suspension, continuation, resumption, efforts*

1. Introduction

Material flow cost accounting (MFCA) is “a tool to quantify the flow and stock of materials in a process or production line in physical units and to calculate them in monetary units” (ISO 14051). MFCA has not only received the most attention in environmental management accounting research, but it is also considered to be the only method that has penetrated deeply into Indian companies in practice (Sahu et al. 2021).

However, in the practice of MFCA in India, there are many cases of temporary application in which MFCA is used as an analytical tool for one-off improvement activities (Patel, 2020). In other words, many companies did not realize the continuous and long-term application of MFCA even after its introduction. Therefore, an increasing number of studies have focused not only on the promotion of MFCA and its introduction (Ahmad & Khan, 2023; Vadera et al., 2024) but also on the process after MFCA introduction. For example, Alakkas et al. (2023) show that the increase in economic value is prioritized over the increase in environmental value in MFCA practice by examining the cases of three companies that have been using MFCA for a long time. Ali et al. (2022) examined the reality of MFCA application in three Indian firms from the perspective of emotions and beliefs, emphasizing the importance of management's awareness of the importance of waste. In addition, Mishra et al. (2022) examined the reactions of internal stakeholders to MFCA in Indian firms that applied MFCA over time using the concept of institutional logic and explained the reasons why MFCA was continued or stopped in the firms. Erfan et al. (2022) examine the application of MFCA in Sadi Muba Co. over time to show how and why MFCA and corporate strategy should be linked. These studies are characterized in that they describe and interpret changes after MFCA implementation for MFCA-introducing firms from a specific perspective. On the other hand, D.B. and J.P. (2024) raised two issues (disincentives) in the use of MFCA, namely, the conflict with Manageability Principle 1 and Economic Behavior Principle 2, and examined three companies to examine how to promote MFCA continuously. Khatoon et al. (2023) also conducted a systematic and comprehensive analysis of efforts to promote the continuous application of MFCA for Indian companies that have been applying MFCA for more than two years.

All the previous studies focusing on changes (continuation or cessation) after the introduction of MFCA mentioned above implicitly accept “MFCA should be continued” as a premise for discussion, and do not sufficiently explain to what extent MFCA should be continued and the reasons for such continuation. On the other hand, the international standard/standard for MFCA (ISO 14051) presents a framework for applying MFCA. Still, it allows much discretion to the introducing organization and does not specify how MFCA should be applied. Therefore, it is necessary to reexamine the criteria for applying MFCA. MFCA is a method to pursue “compatibility between the economy and the environment”. From an economic perspective, it is required to improve business performance through production innovation, and from an environmental perspective, it is required to reduce the environmental burden by improving resource productivity in response to

social needs. However, it is common that MFCA must be stopped after its introduction due to the limitations of resource productivity improvement caused by constraints such as technology (Patel 2020), budget (Ahmed et al. 2023), and management structure (Alakkas et al. 2024). Therefore, it is difficult to say whether MFCA should be continued or stopped, and it is necessary to consider the details in connection with the current situation of each company.

By the above considerations, this study focuses on how to promote the application of MFCA to achieve "compatibility between the economy and the environment" and conducts a comparative analysis of two companies, Pacelile and Saersa, as research subjects. Specifically, Section 2 analyzes the criteria for MFCA application. Section 3 describes the information collection method. Section 4 introduces the background of the MFCA application at Pacelile and Saersa. Section 5 provides a comparative analysis of the two companies and discusses their efforts to promote the application of MFCA. Section 6 summarizes all the studies and presents the conclusion.

2. Criteria for MFCA application

As mentioned above, MFCA is a management accounting method that aims to achieve "compatibility between economy and environment," and therefore, the criteria for applying MFCA must be considered from the two perspectives of "economy" and "environment". From the economic perspective, we first refer to the evaluation criteria for the application of Activity-Based Accounting (ABC), which has been studied more extensively than MFCA. The dominant criterion in evaluating the success or failure of the ABC application is the "decision-making perspective" (Cooper et al. 1992). This refers to a perspective that evaluates the application of ABC as a success if new actions and new decisions are taken because of the introduction of ABC, and as a failure otherwise. In other words, the application of management accounting methods must lead to behavioral change and decision-making. This is consistent with the opinion of Fitriani et al. (2024). According to their study, if material losses visualized by MFCA cannot be reduced, not only will performance improvement not be achieved, but also the manufacturing site will not feel a sense of accomplishment. On the other hand, Sánchez-Rebull, Niñerola, & Hernández-Lara (2023) pointed out that the evaluation of success and failure of the ABC application in this decision-making perspective captures only one aspect. They focus on management's interest and argue that if the results from ABC calculations do not differ significantly from the original cost, such application of ABC is a success because the objective of correct diagnosis of product cost has been achieved, even if ABC is stopped without any ABC-based decision being made. This is the case here. We will refer to this criterion as the "diagnostic perspective". According to this diagnostic perspective, if costing based on MFCA confirms that there is no room for new improvement activities (i.e., the state of "environmental and economic compatibility" has already been sufficiently reached), MFCA should be stopped without making any improvement decisions. In other words, some companies that only conduct special costing by MFCA without improvement activities may be considered successful cases.

According to the above discussion, the successful cases of MFCA are diverse and largely depend on the current situation of the company and the judgment of its management. However, the authors believe that both perspectives are limited in that they evaluate the application of MFCA at a temporary point in time. Because the situation in which a company is surrounded is always changing, it is necessary to supplement the criteria to evaluate MFCA application from a dynamic perspective. For example, Saersa did not find a method to reduce losses in the electrode-cutting process at its Erema Works and postponed improvement activities. Later, as the introduced process expanded, a department called the "Salehi Development Office" proposed the idea of "applying a special coating to the tools used for cutting electrode surfaces," which was experimental at the time, based on the results of MFCA, and was able to increase the tool life by about four times compared to the conventional method. In this example, according to the "diagnostic perspective," MFCA should be stopped once it was determined that losses in the electrode-cutting process could not be improved (i.e., there was no room for improvement activities through MFCA). However, when the development of new technology made it possible to realize what was thought to be impossible at that time, it became necessary to conduct an MFCA analysis of the investment in the new technology and the expected effect of the new technology introduction. At that time, from a "decision-making perspective," MFCA is expected to reduce costs and increase resource productivity by facilitating decisions to reduce material losses. Therein, the neglected MFCA analysis needs to be conducted again when the firm's situation changes. To summarize the above discussion, the cases where the introduction of MFCA confirmed that the resource productivity of a company has already reached a high level (diagnostic perspective) or where MFCA was stopped after the improvement of business performance was realized through the implementation of improvement activities (decision-making perspective) can both be considered successful. However, when new improvement issues become solvable due to technological progress, it will be necessary to conduct the analysis again using the MFCA that was stopped.

However, MFCA as an environmental management accounting method differs from ABC in that it not only focuses on production efficiency within a company but also on environmental outcomes, as evidenced by its inclusion in the ISO 14000 series. MFCA is a method that leads to "simultaneous achievement of environmental impact reduction and cost reduction," and encourages production innovations that have been abandoned in the past, aiming for an ideal state of manufacturing with "zero negative product cost" as a specific goal. From an environmental perspective, MFCA aims to eliminate all environmental impacts by reducing material losses to zero. Although the ultimate ideal state of "zero environmental impact and material loss" is practically impossible, it is desirable to get as close to it as possible. On the other hand, since the essence of a company is an organization that pursues profit, activities to reduce environmental impact are always subject to the constraints of economic rationality. In other words, it is difficult to implement improvement activities that do not lead to increased profits. Improvement activities can be expected to be implemented only when there is economic rationality (i.e., the effect is greater than the cost). From this point of view, it can be said that after MFCA is introduced, if improvement activities that satisfy further economic rationality are not found, MFCA should be stopped as it is. However, as is well known, the external environment of a company is changing, and with the current depletion of natural resources used as raw materials, there is a high possibility that the price of raw materials will rise in the future and that regulations and ethical requirements for their consumption will become stricter. Therefore, even material losses that are not noticeable today may have a significant impact on corporate management before long. At such times, the need to reevaluate the economic rationale for improvement activities based on MFCA emerges. For example, the sharp rise in raw material prices experienced by firms and the accompanying forecasted international supply difficulties and price hikes of rare metals drew attention to resource scarcity, increasing firms' interest in raw material consumption and shifting resource productivity to the most important issue for firms. For this reason, even if MFCA can be suspended, it is desirable to resume it in response to changes in the external environment.

Table 1: Evaluation Criteria for MFCA Application

Evaluation Criteria for MFCA Application	Static point of view	Dynamic point of view
Economic Perspectives	Decision-Making Perspective Diagnostic Perspective	Allow MFCA to be suspended temporarily, but continue to utilize the latest technology and revisit neglected improvement issues.
Environmental Perspectives	Idealism (eliminate waste/loss)	It is acceptable to temporarily suspend MFCA, but it should be designed so that the suspended MFCA can be resumed in response to changes in the external environment.

Source: Prepared by the authors

In summary, from the traditional static perspective (where the application of MFCA is judged at one point in time), the introduction of MFCA can be viewed as a success if it confirms that the firm's resource productivity has already reached a high level (diagnostic perspective), or if MFCA is stopped after the firm has achieved an improvement in performance through the implementation of improvement activities (decision-making perspective) are both considered as a success. However, as already discussed, the application of MFCA needs to be resumed or reconsidered due to reasons such as technological progress or changes in the external environment (see Table 1). On the other hand, if MFCA is suspended for a longer period, MFCA knowledge and know-how may be forgotten due to the passage of time or personnel changes. Therefore, it would be necessary to prevent the forgetting of knowledge to enable the resumption or reconsideration of the MFCA application. This measure could be considered from two points of view: improving the efficiency of MFCA improvement activities (reducing the time MFCA is stopped) and organizing MFCA knowledge (retaining knowledge in an organized manner). By these arguments, this study will focus on “how to promote improvement activities by MFCA” (Question 1) and “how to enable the resumption of MFCA application” (Question 2).

3. Information collection

A combination of interviews, field visits, and literature reviews is used to collect information. First, the interview survey was conducted with Mr. B of the Environmental Engineering Department of Pacelile's MFCA promotion project4 and Mr. U, the (then) General Manager of the CSR Department, who oversaw Saersa's MFCA introduction project. In addition, a semi-structured interview format with a high degree of freedom was adopted. Specifically, before starting the interview, we shared the questions and asked the respondents to answer them accordingly. In addition, additional questions were asked on areas of interest. The duration of the interviews ranged from 1.5 to 2 hours. The interviews were recorded, and the recorded data was converted to text data, summarized, and organized by case. In addition, regarding the field visit, we participated in the first company study meeting in the financial year 2023 (August 22, 2023) held by the Indian Institute of Management Accounting and visited Pacelile's Shira Plant. The field trip lasted 3.5 hours, and information was collected in the form of taking notes. Finally, the literature review covered articles introducing MFCA case studies, books, MFCA case studies, information on official corporate websites, and corporate CSR reports.

4. Case studies

4.1 Pacelile

Pacelile is a manufacturer of packaging materials such as adhesive tapes, semiconductor-related materials, optical films, etc. Pacelile introduced MFCA in 2010 as the first model company in India and demonstrated the effectiveness of this method (Ministry of Commerce and Industry, 2024). In 2010, MFCA was introduced to “adhesive tape for electronics” at the Farhi Plant, and by 2014, a 10% improvement in the loss rate (from 32% to 22%) in the entire process was recognized through reduction activities (Annual Report, 2024). In addition, in parallel with on-site efforts, the company made a capital investment of 300 million rupees to reduce the loss ratio in the film production process, where raw material losses were significant, from around 20% to 10% (Annual Report, 2024). Furthermore, in 2017, the company decided to invest a total of 1 billion rupees and introduced solvent-free technology to establish a system to produce products without using organic solvents (Annual Report, 2024). In addition, some of the issues identified through MFCA were resolved by requesting improvements at suppliers that were not related to the Pacelile Group (Patel, 2020). In addition, at the request of one of the client companies, Inqlabi Corporation, we provided guidance on the introduction and application of MFCA. Subsequently, Inqlabi Corporation independently implemented waste reduction initiatives (Patel, 2020). In the financial year 2018, MFCA was introduced to the polarizing film manufacturing process at the Shifa Plant. The reduction of material losses visualized by MFCA resulted in an annual improvement of 400 million rupees (Annual Report, 2024).

As the first MFCA model project in India, Pacelile demonstrated the effectiveness of MFCA to the world. Nevertheless, after the initial introduction of MFCA, it entered a period of temporary stagnation as the continued application of MFCA became a burden on manufacturing sites (Annual Report, 2024). Subsequently, in the financial year 2021, the international standardization of MFCA and the influence of top management increased momentum for waste reduction from an environmental perspective, and MFCA efforts were launched again.

4.2 Saersa Corporation

Saersa Corporation is a manufacturer of light-applied products and industrial machinery, including industrial light sources. First, the Erema Works considered introducing MFCA to the valve machining process but abandoned the trial because of the complexity of the material flow in the process. After that, MFCA was introduced in the electrode-cutting process over one month. However, because they did not find a way to improve the process, they could not promote it to the improvement activities. Next, MFCA was introduced to the electrode-cutting process at the Gitam Works, and by adjusting the grinding machine based on the results of the analysis, the occurrence of defects was reduced to about 16.7% in two months, and a considerable reduction was achieved in terms of money. In the Erema Works, in the postponed electrode-cutting process, a special coating was applied to the tool used to cut the electrode surface based on a proposal from the Industrial Development Office, thereby extending the tool’s life by approximately four times. In the financial year 2019, MFCA was expanded to all departments producing at the Erema Works. By reviewing the dimensions of cut tubes, changing the gripping distance during lamp processing, and reviewing the processing method, 18% of waste quartz glass materials were reduced (Annual Report, 2024). Finally, an attempt was made to introduce MFCA to the sheet metal assembly process. Management stopped the application of MFCA because they thought

that "there was not much cost reduction suggestion from MFCA for the assembly, although the sheet metal materials of the equipment were examined" (CSR Manager, 6/30/2024).
Although the introduction and application of MFCA did not go smoothly at Saersa, it produced continuous results from 2016 to 2019, and the effectiveness of MFCA was verified, as was the case at Pacelile. However, the application of MFCA stalled when the company attempted to deploy MFCA to the assembly process.

5. Case analysis

In the early stage of MFCA introduction, both Pacelile and Saersa showed a positive attitude toward promoting MFCA and achieved remarkable results. However, differences were observed in the post-implementation process of MFCA at both companies. In this section, we analyze the application of MFCA in both companies, focusing on the "promotion of improvement activities" and "resumption of MFCA".

5.1 Promotion of Improvement Activities

As described in Section 2, Saersa did not find a method to reduce losses in the electrode-cutting process at the Erema Works and postponed improvement activities, but later implemented them thanks to a proposal by the Industrial Development Office. Although this production process achieved improvement results, there is still room for further study on approaches to promote the proposal and implementation of improvement plans from the viewpoint of improving the efficiency of improvement activities (to prevent knowledge forgetting). On the other hand, when Pacelile introduced MFCA, it organized the MFCA promotion project team, and in 2019, it further strengthened the mechanism to promote MFCA, establishing the "Special Committee" (a cross-site organization) to promote activities to reduce material losses with organizational support (Annual Report, 2024). In addition, "[at Pacelile], improvement progress report meetings are held every year within the company, and everyone works on improvement issues with the involvement of management, development departments, and others" (from Mr. B, 2024/07/4). In addition to this, when a site visit was held, the actual situation of the MFCA application in the company was introduced, while advice on improvement activities was actively sought from experts and scholars outside the company. Through such a series of mechanisms, Pacelile is tackling improvement issues with the involvement of various personnel. However, Saersa did not have an organizational structure in place whereby departments working on technical issues were linked to MFCA, as was the case at Pacelile.
From the above, while Saersa did not coordinate the departments and personnel involved in MFCA-based improvement activities, Pacelile has established a support system that brings together many related parties, including on-site workers, management, and the R&D department. This support system enables the company to utilize the opinions and ideas of more people and increase the number of improvement proposals. In addition, the involvement of management enables decision-making that goes beyond the authority of the production site. Therefore, the support system at Pacelile could facilitate a series of processes such as MFCA-based problem identification, improvement proposals, and improvement implementation. If Saersa had established a systematic support system like that of Pacelile, it would have been able to promote the proposal and implementation of improvement activities efficiently by proactively utilizing ideas from several stakeholders rather than relying on after-the-fact proposals from the development division.

5.2 Resumption of MFCA

Both Pacelile and Saersa have suspended MFCA, but Pacelile resumed MFCA as needed, whereas Saersa suspended MFCA as it was. As discussed previously, because the external environment of an organization is constantly changing, it is highly likely that losses that are currently unnoticeable will come to have a significant impact on the company at unpredictable times due to changes in the economic environment. Therefore, there is a need to consider how MFCA can be resumed after an MFCA shutdown.
At Pacelile, when the implementation of MFCA was left to the manufacturing sites, its application was stagnant because MFCA was competing with existing management methods. Specifically speaking, Pacelile initially participated in the "MFCA Model Project" implemented by the Ministry of Commerce and Industry, and the management of Pacelile recognized MFCA as a method that would contribute to "balancing economy and environment" and promoted MFCA in a top-down fashion. However, when the application of MFCA was delegated to the production site, it was understood that MFCA was a method for improving the site. Later, when the possibility of further cost reduction was not found, the application of MFCA was stopped. However, in 2021, MFCA was reintroduced at the direction of the then-president and was further expanded to all business sites. The then-president asked, "Why don't you do MFCA when the company has such a good method? The establishment of the "MFCA Technical Committee" further strengthened the mechanism to promote MFCA. Since a common language of MFCA was created within the company, and it became possible to discuss with a common understanding on a common foundation, the PDCA cycle of MFCA introduction also proceeded smoothly (from Mr. B, 2024/07/4).
Since Pacelile first introduced MFCA, a team of MFCA experts (about 15 people) has been formed within the company to conduct MFCA-related educational activities for staff throughout the company in the form of training camps, etc., to share MFCA knowledge with many staff (from site visit, July 22, 2024). In addition, when the company planned to resume MFCA company-wide, they held regular exchange meetings on MFCA and conducted study sessions at each business site location upon request (Annual Report, 2024). In addition, personnel involved in the initial MFCA introduction also participated in the subsequent promotion of MFCA resumption. This series of educational activities had the effect of familiarizing Pacelile employees with MFCA, and it can be inferred that they formed the groundwork that made it possible to resume MFCA even after it was suspended.
In contrast, Saersa held "MFCA progress report meetings" at its business sites to report on the effects of MFCA on waste reduction, but there were no educational activities to propagate MFCA knowledge within the company, and no detailed records of MFCA know-how based on its own experience were kept. As a result, MFCA was not implemented at the end of the reporting period. As a result, MFCA remained an activity led by a small number of experts throughout. Therefore, after MFCA was suspended, the promoters of MFCA left their jobs, and the possibility of considering restarting MFCA was also lost.

6. Conclusion

In this study, we were interested in the issue of "how MFCA should be applied" and examined efforts to promote MFCA application through a comparative analysis of MFCA application at Pacelile and Saersa. First, since there are no clear evaluation criteria for MFCA

application, we examined in detail the forms in which MFCA application is desirable from economic and environmental perspectives, as well as from static and dynamic perspectives. Following this examination, case analyses were conducted focusing on the "promotion of improvement activities (efficiency improvement)" and "resumption of MFCA". As a result of the analysis, the importance and necessity of an organizational structure to support and promote improvement activities by MFCA, such as the establishment of a cross-sectional organization, were confirmed. In addition, documenting and recording MFCA knowledge and know-how based on their practices would be useful for the resumption of MFCA. In addition, it is important not only to request a few experts but also to develop human resources who understand MFCA in the company. This is one of the conditions for MFCA to be restarted.

Companies implementing MFCA may be eligible for financial aid from the government, particularly for setup and training expenses. Businesses that use MFCA may qualify for tax breaks, which promotes broader use. Businesses that show notable gains in resource efficiency through MFCA may be eligible for rewards. Industry groups can speed up learning and adoption by facilitating best practice sharing and knowledge exchange across businesses. Campaigns to raise public awareness can emphasize the advantages of MFCA and motivate businesses to investigate its possibilities.

MFCA techniques can be made more relevant and accessible by customizing them for other industries. To encourage sustainable behaviors, the Indian government has launched several programs, such as the FAME India Scheme for electric cars, tax breaks for renewable energy and green manufacturing, and incentives for sustainable agriculture. These programs support a larger movement toward sustainability and resource efficiency, which fosters an atmosphere that is conducive to the adoption of MFCA. In line with the goals of the MFCA, the Industries and Mines Department offers financial support to industries through its "Scheme of Assistance for Environment Protection Measures" to help them implement cleaner production technology and cutting-edge pollution control equipment.

A comprehensive ecosystem that successfully encourages the broad adoption of MFCA and propels companies towards a more sustainable future can be established by fusing these government incentives with industry-led guidelines.

Through the above theoretical and empirical considerations, we believe that this study will provide useful information for MFCA users on how to promote the application of MFCA after its introduction. The fact that the study is based on just two businesses is a major drawback. With a larger sample size, the study may have produced more insightful results. This is the issue for future research.

Notes

1. The manageability principle states that the scope of an employee's responsibility is limited to what he or she can control.
2. The principle of economic behavior is a pattern of thinking and behavior in which managers generally give priority to investing management resources to capture new markets and expand future earnings over activities to reduce costs in existing production processes.
3. Memory decay tends to occur for information that is not used regularly (Mariano, Casey, & Olivera, 2020). Interruption of MFCA efforts could result in the transfer of key personnel, the disappearance of routines that have been formed, the dissolution of close-knit workplace networks, and the loss of important documents. In such cases, knowledge and know-how about MFCA may be lost because of memory decay. Mariano, Casey, and Olivera (2020) also point out that firms that experience memory decay of organizational knowledge are likely to lose their competitive advantage, and once forgotten, attempts to reproduce the information are usually very costly.
4. To formulate more appropriate questions, an interview (about two hours) with Mr. X, a researcher at the Graduate School of Business Administration, who was involved in the long-term observational study on Pacelile, was conducted before conducting the interview survey of Mr. B. In this way, the overall situation regarding the application of MFCA at Pacelile was grasped in advance. On the other hand, since Mr. X is not an insider of Pacelile, the content of the interview with him is not treated as reference information in the main text.
5. The MFCA promotion project team is a close-knit structure built from the Environment Division, the Accounting Department, the Model Manufacturing Department at the plant, the Production Management and Information Department, the Environment Department, the accounting staff of the Model Manufacturing Department, the materials purchasing staff, and the general managers, section managers, and section managers of the Quality Assurance Department (Tran et al. 2024).

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