

# **Reconstruction of the Management Accounting System based on Material Flow Cost Accounting (MFCA) and Throughput Accounting (TA): Expansion of the Concept of Opportunity Cost<sup>1)</sup>**

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## **Overview**

There is a discrepancy between cost information in the existing standard cost accounting system and cost reduction caused by process improvement among companies that utilize material flow cost accounting (MFCA) and throughput accounting (TA). In this study, we examine the cause of this discrepancy. Furthermore, as a first attempt, we examine the loss due to material losses and bottlenecks by employing the concept of opportunity cost and discuss the potential for new management accounting information to directly contribute to corporate profits.

Keywords: material flow cost accounting (MFCA), throughput accounting (TA), theory of constraints (TOC), standard cost accounting, material loss, constrain (s), opportunity cost, improvement of corporate profit

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## I. Introduction

Companies in Japan have long practiced material flow cost accounting (MFCA) and throughput accounting (TA)<sup>2)</sup> in the theory of constraints (TOC). Considering the cases of manufacturing companies in Japan, the authors identify the gaps between the existing (standard) cost accounting information and the analysis data by MFCA or TA, as well as inconsistencies with the existing (standard) cost accounting information when promoting improvements based on MFCA or TA. This study aims to address the gaps and inconsistencies and explore why such discrepancies occur, even though the existing cost accounting information also serves as management accounting information aimed at contributing to corporate profits by reducing waste and loss in the production process. The authors also aim to explore ways to match and systemize existing cost accounting information, MFCA, and TA as a management accounting method to achieve the same goal.

Japanese companies have been using MFCA and TA in corporate practices to help improve corporate profits. The authors have investigated the potential for these methods to improve a company's management ability and generated concrete results. Existing researches have presented new management methods to the existing management, while showing concrete results through corporate practices on MFCA and TA (e.g., Nakajima and Kokubu 2008; Kokubu and Nakajima 2018; and Goldratt Consulting Japan 2018).

However, despite the positive impact of MFCA and TA on cost reduction and corporate profits, these methods have not yet exerted a significant impact on existing cost management practice such as standard cost management. Manufacturing companies in Japan continue to plan and implement cost reduction at the factory level through factory improvement activities (small group activities such as QC circle), based on standard cost information or actual cost information of existing cost accounting system.

Since numerous factories have been set up as profit centers in Japan in recent years, cost reduction has become crucial for increasing corporate profits. Such factories practice MFCA and TA, consequently contributing directly to increasing corporate profits by reducing material loss and entirely exploiting bottleneck, for example. However, even when such outcomes are realized concretely, in reality, the cost reduction activities based on existing cost accounting information seem

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2) This study focuses on the examination of TA from practical experiences. For an academic summary on the role of TA and its significance in management accounting, please see Mizuno (2001), for example.

to continue almost without any change. MFCA and TA are often implemented briefly as projects similar to special cost studies.

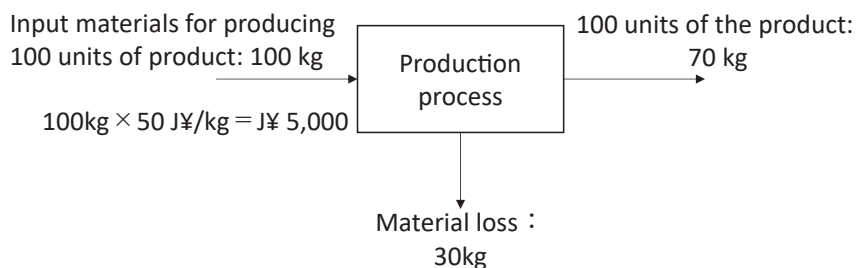
As a result, new perspectives and information obtained from MFCA and TA on the existing cost accounting information remain only as additional and supplemental information for the purpose of cost reduction or are not associated with the existing cost information. The authors believe resolving these current challenges and expanding cost information can directly contribute to increasing corporate profits among companies.

## II. MFCA and TA for Cost Reduction in Corporate Projects

### 1. Cost Reduction by MFCA

With MFCA, the loss against the input material is quantified and this material loss is reduced by taking appropriate measures (Nakajima and Kokubu 2008; ISO14051 2011). As a result, input material may be reduced when producing the same product subsequently (e.g., the next production lot) as shown in Figure 1.

Production lot at the time of MFCA analysis



Implemented the improvement  
of material loss

Production lot after the MFCA improvement

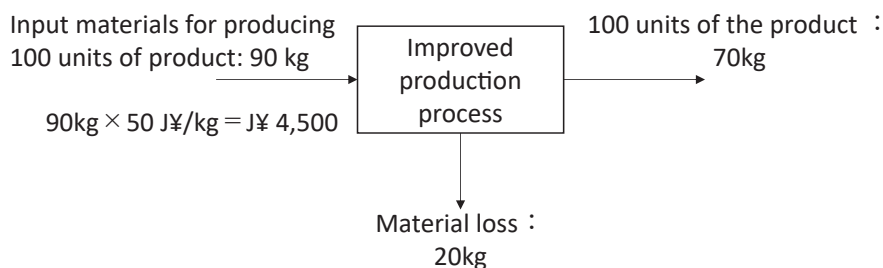


Figure 1: Cost Reduction by MFCA

This reduces the material cost per production to realize cost reduction, improving the profitability of the product.

For example, as shown in Figure 1, initially, a company requires 1 kg of material with a unit cost of J¥ 50 in order to produce the product; thus, for a production volume of 100 units, the input material is 100 kg (100 units  $\times$  1 kg) and the material cost is J¥ 5,000 (100 kg  $\times$  J¥ 50). Subsequently, an improvement in the production process to reduce the material loss identified by the MFCA analysis enables the company to be capable of producing 100 units with 90 kg of input materials (the total weight of the products is the same at 70 kg). As a result, the material required per unit of product is reduced to 0.9 kg (90 kg  $\div$  100 units = 0.9 kg/unit) and the material cost is reduced to J¥ 45 (J¥ 50  $\times$  0.9 kg = 45 J¥/unit). The production of 100 units of the product under this scenario is shown in the lower part of Figure 1.

In this case, the cost reduction effect can be explained as follows: the manufacturing cost per unit is reduced by J¥ 5 as a result of the reduction of material consumption per unit by 0.1 kg (1 kg – 0.9 kg = 0.1 kg) to reduce the material cost by J¥ 5 (50 J¥/kg  $\times$  0.1 kg = J¥ 5). Now, this reduced manufacturing cost can directly increase the sales profit per unit by J¥ 5. The cost reduction effect by reducing material loss in MFCA can directly improve the product profitability at the same time, and this effect can be intuitively understood by corporate staff and workers.

## 2. Cost Reduction by TA

Goldratt (1990) deems, analyzing the following three questions enables an intuitive understanding of what kind of measurement scales are necessary to maximize profits: “How much money is generated by our company?” ; “How much money is captured by our company?” ; “How much money do we have to spend to operate it? Goldratt (1990) states, “the first question ‘How much money is generated by our company?’ is the throughput which is defined as ‘the rate at which the system generates money through sales.’” This implies that cost reduction can be achieved by maximizing the throughput, which in turn leads to maximum profits (Goldratt 1990, 19).

TA is used to calculate this throughput. This approach aims to maximize the throughput shown in the following equation.

$$[\text{Throughput}] = [\text{Sales}] - [\text{True Variable Cost: Direct Material Cost}^3])$$

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3) In TA, some of cost such as custom duty, sales commission which paid on each product are considered as

In order to achieve this objective, it is necessary to optimize “inventory” and “operating expenses.” “Inventory” refers to all the money that a system invests in purchasing items for the purpose of selling, and “operating expenses” refer to all the money that a system spends for the purpose of converting inventory into throughput (Goldratt 1990, 23–30).

Thus, cost reduction activities under TA include those that aim to maximize throughput; specifically, this includes identifying bottlenecks<sup>4)</sup> and entirely exploiting bottlenecks to minimize and optimize inventories and operating expenses. For example, since entirely exploiting bottlenecks would result in the optimized (minimized) number of inventories in the production process, this would allow companies to manufacture with the minimum manufacturing cost.

Figure 2 demonstrates the improvement and cost reduction of the production system based on TA.

A point to be noted is that TA does not improve productivity (e.g., processing time per unit) independently for each production process. The bottleneck in the

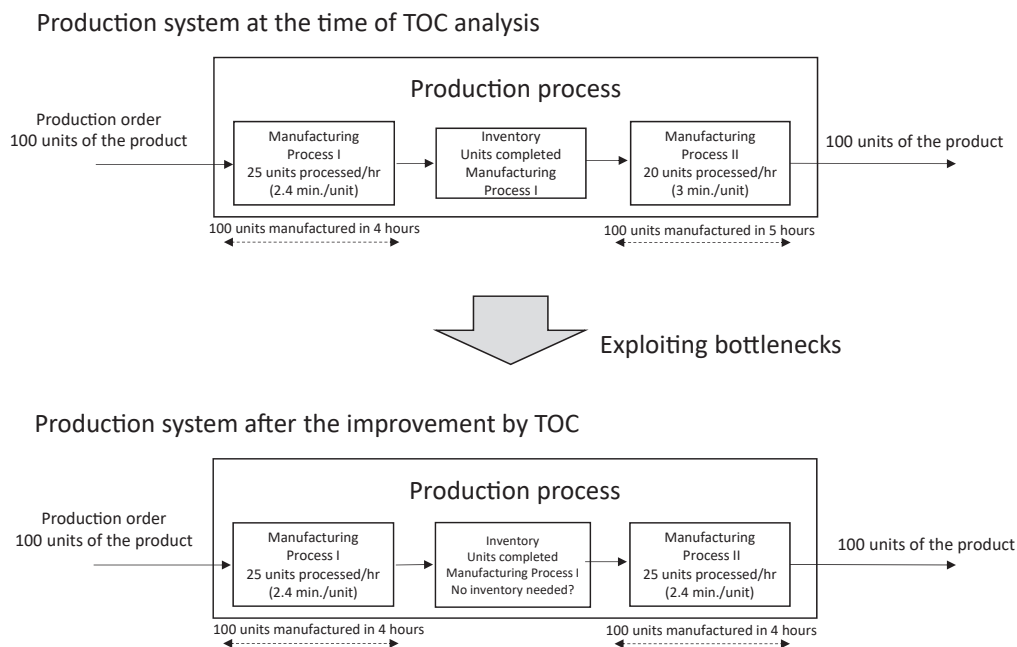


Figure 2: Exploiting Bottlenecks

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True Valuable Cost (TVA), but mainly consisted of direct material cost in manufacturing companies.

4) In TOC, generally “bottleneck” is used when system capacity is identified as constraint.

current production system, as shown in the upper half of Figure 2, is implied in Manufacturing process II (3 minutes per unit), which takes a longer time to process one unit, compared with Manufacturing process I (2.4 minutes per unit). Therefore, the overall manufacturing system is optimized by focusing on Manufacturing process II and improving the processing time to 2.4 minutes as provided by Manufacturing process I.

While it is possible to consider various conditions and cases<sup>5)</sup>, solely exploiting bottlenecks is sufficient; maintaining inventories between Manufacturing processes I and II, for example, may not be necessary. Alternatively, it is possible to simultaneously switch product models in Manufacturing processes I and II or reduce manpower in the production process.<sup>6)</sup>

The effects of such improvements include improved cash flow realized by minimizing inventory and avoided risk of disposal loss of inventories in between processes. The production availability ratio, which is directly linked to sales, would also improve owing to reduced wasteful production. Consequently, the profit margin and turnover rate relative to sales will improve, ultimately leading to increased corporate profits.

Then, how consistent are the measures and effects of cost reduction brought about by MFCA and TA with the existing cost information and measures at the manufacturing site?

### **III. Inconsistent Relationship Between Cost Reduction by MFCA/TA and General Cost Information**

When MFCA is implemented as a corporate project, for example, it aims to realize cost reduction at the manufacturing site. However, if the manufacturing site has not been engaged in any kind of cost reduction activity at all prior to the MFCA project, then cost reduction resulting from MFCA is expected to positively impact the product cost figure in the factory cost accounting.

It should be noted that the manufacturing site does not necessarily perform an MFCA analysis by comparing the standard costs against the MFCA data when a

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5) For details on production process improvement brought about by MFCA and TOC including TA, see Tobita et al. (2013) and Nakajima et al. (2015), for example.

6) TA does not require complicated and difficult improvement. It has been stated that “one of the foundations of running an organization is the ability to judge the impact of a local decision on the bottom line. Try to measure by three or more non-financial measurements, and you have basically lost all control. Non-financial measurements are equivalent to anarchy. You simply cannot compare apples, oranges, and bananas, and you definitely cannot relate them to the bottom line! The goal is to make money. Every measurement must, by definition, have the dollar sign in it.” (Goldratt 1990, 55–56)

corporate MFCA or TA project is conducted. However, since the purchase price of material per unit under MFCA is extracted from the financial accounting data, this could be related to the standard cost information. Certainly, the effect of material loss reduction realized by MFCA analysis and the effect of optimization realized by TA should appear as cost reduction effects on the financial accounting information.

However, standard cost accounting, which is introduced to corporate practice prior to MFCA and TA analyses, is used (usually over a period of time) with cost management objectives.

Usually, general cost accounting encompasses “providing cost documentation required to manage costs to each level of business management. Here, cost management involves establishing and instructing the standards for costs, calculating and recording the actual accrued cost, comparing it to the standard, analyzing the reasons for the variance, providing a report on this to the business management, and taking effective measures to improve cost efficiency” (Business Accounting Council 1962, Chapter 1 Purpose of Cost Accounting and General Criteria for Cost Accounting, 1. Purpose of Cost Accounting (3)).

In addition, it has been argued that the most important objective of standard cost accounting is “to set a standard cost as the standard of cost for effective cost management” (Business Accounting Council 1962, Chapter 3 Calculation of Standard Costs, 40. Purpose of Standard Cost Calculation (1)).

Furthermore, in terms of the difference between the standard cost and the actual cost, it has been argued that “when there is a cost variance, calculate and record the magnitude and analyze it. The purpose is to properly process the cost variances for financial accounting to confirm the cost and profit/loss of product and, at the same time, to help manage the cost by providing the analysis results to each level of business management” (Business Accounting Council 1962, Chapter 4 Calculation and Analysis of Cost Variance, 44. Calculation and Analysis of Cost Variance).

However, there is often a deadlock and limitation to cost reduction based on standard cost information at manufacturing sites.

For example, occasionally, identifying a specific theme (task) for cost reduction or a theme with a new viewpoint is not possible. Furthermore, with respect to labor expenses in Japan, for example, it is difficult to reduce costs beyond the current state because personnel expenses are practically fixed costs and manpower savings have already been implemented. As for facility expenses (e.g., as depreciation cost), it is difficult to achieve cost reduction since product varieties may increase and the volume might decrease to increase the initial setup,

even if improvement in productivity is desirable.

Under such circumstances, when the manufacturing department obtains the cost variance information based on the standard cost accounting system, the reason for the variance is often already obvious in the sense that it was already expected before they were notified. Furthermore, in many cases, measures to eliminate the cause of the variance are already implemented by the time they receive the variance information or the matter is such that it cannot be addressed. Today, Japanese companies often consider the standard cost as a cost that is set up with an aim to meet a uniform cost reduction rate (e.g., as a percentage of the previous year) rather than as a figure based on some kind of waste or loss; therefore, manufacturing sites have no viable measures to undertake.

From this perspective, there may be no waste or loss that can occur at the manufacturing site; however, MFCA and TA generate outcomes to bring relatively large cost reductions from new viewpoints. Moreover, such cost reduction occurs in terms of the manufacturing costs that are subject to standard cost management.

Why does a manufacturing site implement standard cost management, MFCA, and TA, among others, simultaneously, which makes the process seemingly inefficient and duplicative?

#### **IV. Limitations of On-site Cost Reduction based on Existing Profit Calculation Formulae**

The premise of cost information aiming to increase profit at the manufacturing site is as follows.

In order to increase profit on the premise of “(Sales) – (Cost of Sales) = (Gross Profit),” the manufacturing site would reduce the cost of sales. More specifically, the site works based on a production process target (performance scale) based on the extent of cost reduction from the standard cost, by driving the actual cost down to the standard cost, the latter being the manufacturing cost included in the cost of sales.

In addition, this cost of sales is broken down to variable costs and fixed costs, which is followed by the production process and turned into a cost reduction target. Although the cost categories for fixed cost reduction vary by company, costs such as labor and facility expenses are established as the fixed expenses incurred in each period. Therefore, companies seek to reduce these fixed costs



per unit by improving productivity.

With these cost reduction methods in place, no attention is being paid to reducing direct expenses included in the variable cost and material loss such as the auxiliary material costs included in the fixed cost; therefore, cost reductions are achieved by complying with standardized operations and not by identifying item loss such as quality defect. In this sense, material cost is not viewed as a cost to be reduced since it is assumed to occur inevitably.

Likewise, the problem becomes even worse from the perspective of TA when each production process individually improves productivity. If we consider the case in Figure 2 shown above, inventories in between both production processes could increase when Manufacturing process I further increases its productivity, even though it was higher than that of Manufacturing process II. The company would underestimate the fixed cost per unit of product because of the improved productivity. Furthermore, even though the fund (cash) would be tied up, it would be assumed that the product cost will decrease and the corporate profit will increase. Therefore, in this scenario, the holistic optimization by TOC is not carried out and maximization of throughput or cost reduction is not realized.

Then, why is it not possible for the existing cost accounting information to obtain opportunities for cost reduction or profits similar to MFCA and TA? How can MFCA and TA be useful as cost reduction methods at manufacturing sites within the framework of corporate profit calculation on the premise of the existing cost accounting system? The authors address these questions in the following section.

## **V. Opportunity Cost as a New Fundamental Concept of Cost Reduction**

Based on our research so far, the authors believe that management accounting information is necessary for increasing profits in the immediately next period, and that cost reduction from the viewpoint of “(Sales) – (Cost of Sales Reflecting the Past Cost of Opportunity) = (Expected Profit)” is important. MFCA and TA<sup>7)</sup> can be used to measure this opportunity cost.<sup>8)</sup>

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7) According to the documents stored at Goldratt Consulting, Dr. Goldratt discussed the importance of opportunity cost in measuring the results of TOC implications in his keynote speech at the TOCICO (TOC International Certificate Organization) 2010 held in Las Vegas, NV from June 19 to June 22, 2010.

8) Hiiragi and Kazusa (2016; 2017) define “the amount of improvement effect” as [the amount of cost reduction + the amount of opportunity loss] and propose accounting for onsite improvement. Since it is similar to the idea (employing the concept of opportunity cost) in this study, we hope to examine and theoretically

In general, “opportunity cost” is explained as “a cost concept used in the special cost studies conducted provisionally for the purpose of management decision making,” and “it is the return of an abandoned alternative plan and considerably differs from the outlay cost measured by monetary expenditure” (Kobe University Accounting Laboratory 2007, 259).<sup>9)</sup> Mitsuoka (1981) also discussed how the concept of opportunity cost evolved over the course of the development of accounting—management accounting in particular—and explained how it was developed as a fundamental cost concept in decision-making accounting. Furthermore, studies on opportunity cost discuss the concept in the context of future management decision-making in a similar manner.<sup>10)</sup>

In this study, the authors develop a new concept of opportunity cost under management decision-making, utilize MFCA and TA in terms of opportunity cost, and systemize the process. In addition to “making decisions about alternative plans for the future,” which was considered as a prerequisite in previous opportunity cost studies, the authors further expand on the idea “the concept of opportunity cost aims to recognize and measure the overall relationship between the aforementioned decision-making, cost, and outcome, explain each relationship (Nagasaka 1980, 276)”, and consider MFCA and TA as methods to present a framework to show the return (opportunity) that was foregone and continues to be foregone today due to management decisions.

As shown in Figure 3, material loss and bottlenecks seem to represent a situation in which the opportunity cost based on past decisions continues to persist even today.

For example, MFCA can be considered as a method to show how a production method decided in the past as shown on the left in Figure 3 reached the present time and, as a result, opportunity cost continues to persist against the absolute resource productivity called “zero material loss.” As for TA, as shown in Figure 2, it can be utilized as a method to show how a production system installed in the

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summarize the difference between the two. For example, there is a discussion about the application of management accounting that separates opportunity cost and opportunity loss (Oshita 1988).

9) Other accounting dictionaries and management accounting textbooks (Heymann and Bloom 1990; Ando et al. 2007, 272; Law 2016; Kobayashi et al. 2017) also provide examples of special cost study applications by explaining opportunity cost as “if there are plans A and B, for example, and when one is chosen, we assume you choose the alternative plan by abandoning the return of not choosing the other and recognize that amount of return as opportunity cost.”

10) For example, in his examination on opportunity cost, Nagasaka (1981a) mentions that traditional cost accounting cannot be fully applied in management decision-making. Nagasaka (1981b) and Miyasaka (1980; 1981) also argue that the concept of opportunity cost is not necessarily consistent. Takahashi (2012) reexamined the decision-making support by opportunity cost proposed by Horngren (1967) while referring to Okamoto (1967), and noted the possibility that the variance analysis based on physical material might have a modern meaning.

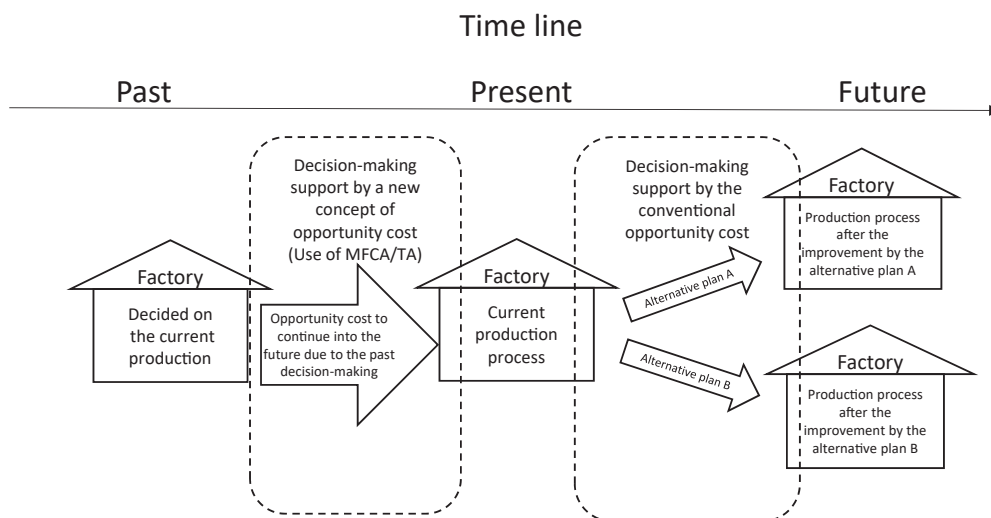


Figure 3: New Development of the Concept of Opportunity Cost

(Source) Prepared by the authors

past functions under the current situation with the restriction (opportunity cost due to past decision-making) that products can be manufactured only at 3 minutes per unit while maintaining inventories as the entire production system, even though a process design to manufacture at 2.4 minute per unit without having inventories in between processes was possible. Needless to say, it is also possible for MFCA and TA to support the decision-making shown in the dashed enclosure on the right in Figure 3.

Nevertheless, as shown by the current factory, also in the dashed enclosure in Figure 3, the right and left decisions by opportunity cost are based on the standard cost, which is the current cost information. Mitsuoka (1981, 200) focused on ASOBAT,<sup>11)</sup> which was published in 1966 and had a significant impact on management accounting, and stated that “the scope of accounting will include the measurement and communication of materials representing the past, current, and future social economic activities” as the accounting theory is extended.

As shown in Figure 4 below, the authors believe the management accounting system that applies the concept of opportunity cost to integrate these three dimensions can be developed by employing MFCA and TA and further advance

11) ASOBAT refers to *A Statement of Basic Accounting Theory* (ASOBAT, 1966) published by the American Accounting Association.

management accounting.

The management accounting information that directly contributes to corporate profits as shown in Figure 4 can be formulated based on the following relationship.

$$[\text{Profit (that can be realized at the end of the period)}] = [\text{Sales (current)}] - [\text{Cost of Sales Reflecting the Opportunity Cost based on MFCA/TA analysis}]$$

The management accounting shown in this formula aims to use the existing accounting information by MFCA and TA as basic information and provide management accounting information to support decision-making for realizing ideals in the future. The authors believe that management accounting, which utilizes opportunity cost, can be further developed by linking various methods in addition to MFCA and TA. For example, social goals for the future at individual companies have become essential in the environmental management accounting that contributes to management information and the realization of sustainability in a green supply chain. In order to achieve this goal, the authors believe to identify new potentials by employing the concept of opportunity cost.

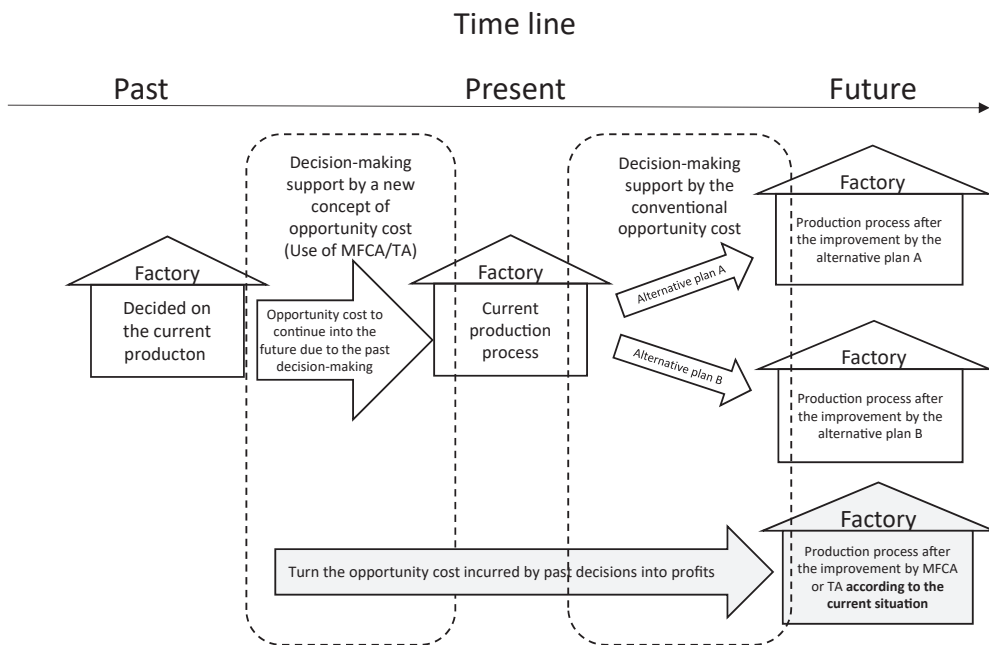


Figure 4: New Management Accounting Information that Employed MFCA/TA

(Source) Prepared by the authors

## VI. Conclusion

In this study, the authors used our experience in MFCA/TA-based corporate projects and examined the consistency between the cost information and reduction based on the existing standard cost accounting and the cost information and reduction based on new MFCA and TA. While the objectives of both standard cost accounting and MFCA/TA agree on the point regarding increasing corporate profits by optimizing and streamlining process, they don't seem to agree on cost information. It seems that this situation is caused by the fact that a standard cost is calculated by standardizing the cost based on the relatively recent past expenditure,<sup>12)</sup> and that cost reduction is implemented by monitoring whether the actual cost is incurred according to that expectation (plan). In contrast, MFCA and TA can be considered as methods that not only support decision-making for the future but also quantify in absolute terms the opportunity cost incurred due to the past decisions implemented over the course of creating the present state. Since it is difficult to combine the existing framework of standard cost with the opportunity cost concept, standard cost management and MFCA/TA should be evaluated as different cost reduction methods.

In addition, it is desirable under the MFCA/TA-based management accounting to determine the future action of the company based on the decision-making information on opportunity cost; the latter is useful in evaluating alternatives. So far, while special cost studies were solely considered when supporting decision-making based on opportunity cost, MFCA and TA can systemize it as new day-to-day management accounting information as well as decision-making information that expands the concept of opportunity cost.<sup>13)</sup>

Furthermore, to systemize this kind of new management accounting based on MFCA and TA, the perspective of “measurement and communication of materials representing socio-economic activities in the future” noted earlier in the expansion of the accounting theory of ASOBAT (AAA 1966) becomes important. The new management accounting for sustainability will be established by more relevant sustainability information based on MFCA and TA, such as maximizing

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12) It is defined as “ ‘Standard cost’ used under the standard cost accounting system and refers to the realistic standard cost or normal cost. ‘Realistic standard cost’ is a standard cost that is expected to be feasible under a good efficiency.” (Business Accounting Council 1962, Chapter 1 Purpose of Cost Accounting and General Criteria for Cost Accounting, 4. Various Concepts of Cost (1) Actual Cost and Standard Cost, 2).

13) For example, Kosugi (2012) discusses the use of opportunity cost in quality cost calculation. Sonoda (1998; 1999) also discusses the feasibility of measuring opportunity cost by using non-financial scales in strategic management accounting.

resource productivity and optimizing the entire management system.

As for specific systematization of this kind of new management accounting that contributes to sustainability, the authors would like to consider it as a future research topic.

#### **[Additional Remark]**

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