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# MFCA Management as Sustainable Management

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## ABSTRACT

Material Flow Cost Accounting (MFCA) has been developed into Sustainable Management since it was introduced to Japan in 2000, when MFCA was first used as a new process improvement tool known as Kaizen in Japanese companies. Nowadays, MFCA has become popular in Japanese companies for helping to improve material inefficiency in the production process. But we find that many companies have not tried to reduce any material losses. According to our research in Japanese companies, there are two types of material losses as far as MFCA is concerned. One is the material loss to be reduced by relatively simple Kaizen, the other is the material loss to be reduced by relatively difficult innovation and investment in the medium- and long-terms. In some companies, the former is easy to reduce by taking action to improve the management, while the latter is difficult and impossible to reduce through Kaizen. This research shows some subjects and approaches to developing MFCA into MFCA management that can help to make process innovation in a company.


**Keywords:** Material Flow Cost Accounting (MFCA), Environmental Management Accounting, Sustainable Balanced Scorecard (SBSC), Sustainable Management

## 1. Introduction: Subjects of Material Flow Cost Accounting (MFCA)

As shown in Figure 1, when a company makes an introduction of MFCA and analyzes the material in-efficiency of a production process by MFCA methodology, the company will find some material losses for each quantity centre in the process. After then, the company examines ways to reduce each material loss. Usually the company starts to reduce some material losses through a relatively easy improvement known as Kaizen. Which means that the factory leaders and workers can decide to make an improvement in the process generally without any investment. In Figure 1, it is defined as on-the-spot improvement (material loss reduction) activities. The targets of short-term improvement are included into the Kaizen activity in many Japanese case examples. (Nakajima, 2010 and 2011)

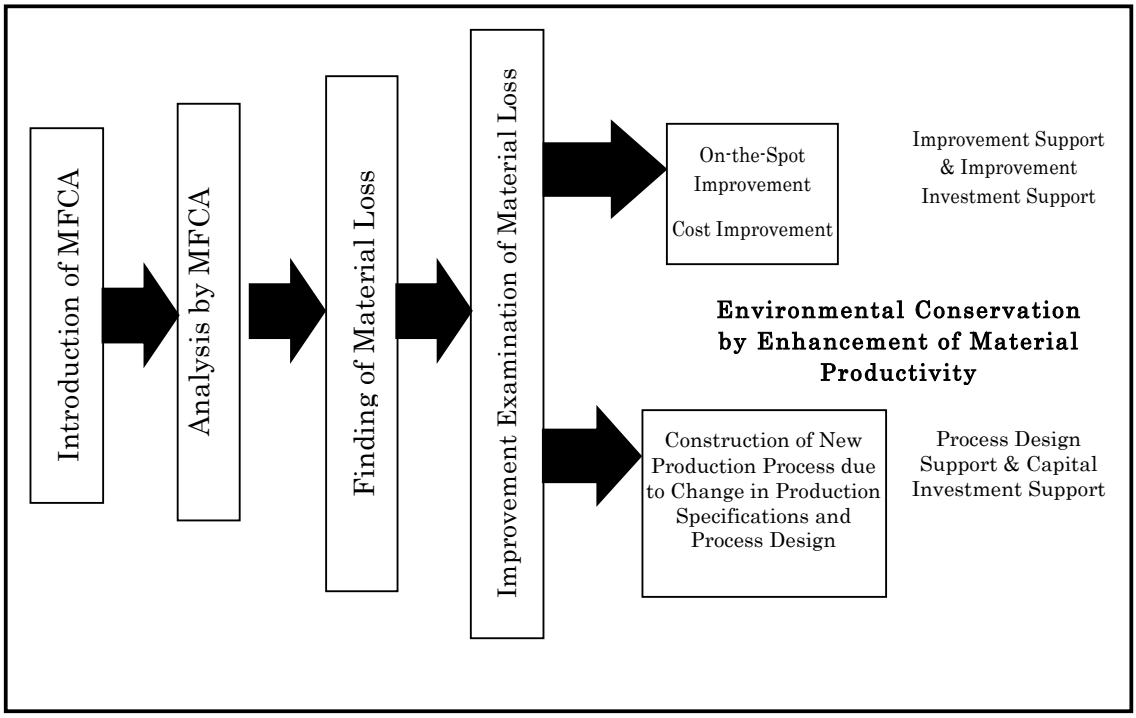


Figure 1: Two Types of Material Losses in Process (Nakajima, 2010, p.48, revised)

But some material losses are removed from the management target of material loss reduction in practice because the company can't find any feasible ways within allowable investment. When the company tries to reduce the material losses, a budget to examine ways to reduce them in medium- or long-terms is needed. (Nakajima, 2010 and 2011)

We had some interviews with some companies which told us that they wanted to challenge relatively difficult improvement, but most of them couldn't start to examine it. According to our research (Nakajima and Kimura, 2012a), the following are what we have found out;

(1) Kaizen can't expand to innovative improvement with medium- and long-term investment. Kaizen is a useful activity in a process with worker level, but it doesn't have a channel or way to contact directly with higher management level or other

functional sections. For example, product planning, R&D, corporate planning and so on.

(2) When a company tries to insert some innovative and higher-technological subjects from MFCA project into medium- and long-term R&D budgeting, the R&D budgeting has already planned for previous medium- and log-terms and there is no space for new viewpoint of MFCA.

As pointed out above, many MFCA trial companies use MFCA as one of the special cost studies on traditional cost accounting. However, some companies, Canon, Nitto Denko, Sekisui Chemical, etc., have made innovative improvement to reduce material loss (Nakajima &Kokubu, 2008; Anjo, 2003, 2004, 2006, 2007a and 2007b; Furukawa, 2001, 2003a and 2003b; Numata, 2006, 2007a and 2007b). Nitto Denko is the first MFCA trail company in Japan. On the basis of MFCA data, Nitto Denko made the investment to reduce material loss when it established a new production line (Nakajima &Kokubu, 2008; Furukawa, 2006). Sekisui Chemical used MFCA as a waste management tool to reduce waste in each process, Sekisui Chemical developed the factory management named "Activities of Material Flow Cost Accounting" over the whole of Sekisui Chemical Group (Nakajima &Kokubu, 2008; Numata, 2006, 2007a and 2007b). Canon introduced MFCA in 2001, and developed it into domestic and global suppliers (Nakajima &Kokubu, 2008; Anjo, 2006, 2007a and 2007b).

It is quite important for MFCA users not to introduce MFCA as a new Kaizen tool, or not to use MFCA as a management tool that automatically makes a new Kaizen activity and innovative improvement. Material loss is generated on factory floors, and production activity generates material loss, so workers usually want to make their responsible for the generation of material loss. But the cause of the generation of material losses lies in their own business flow.

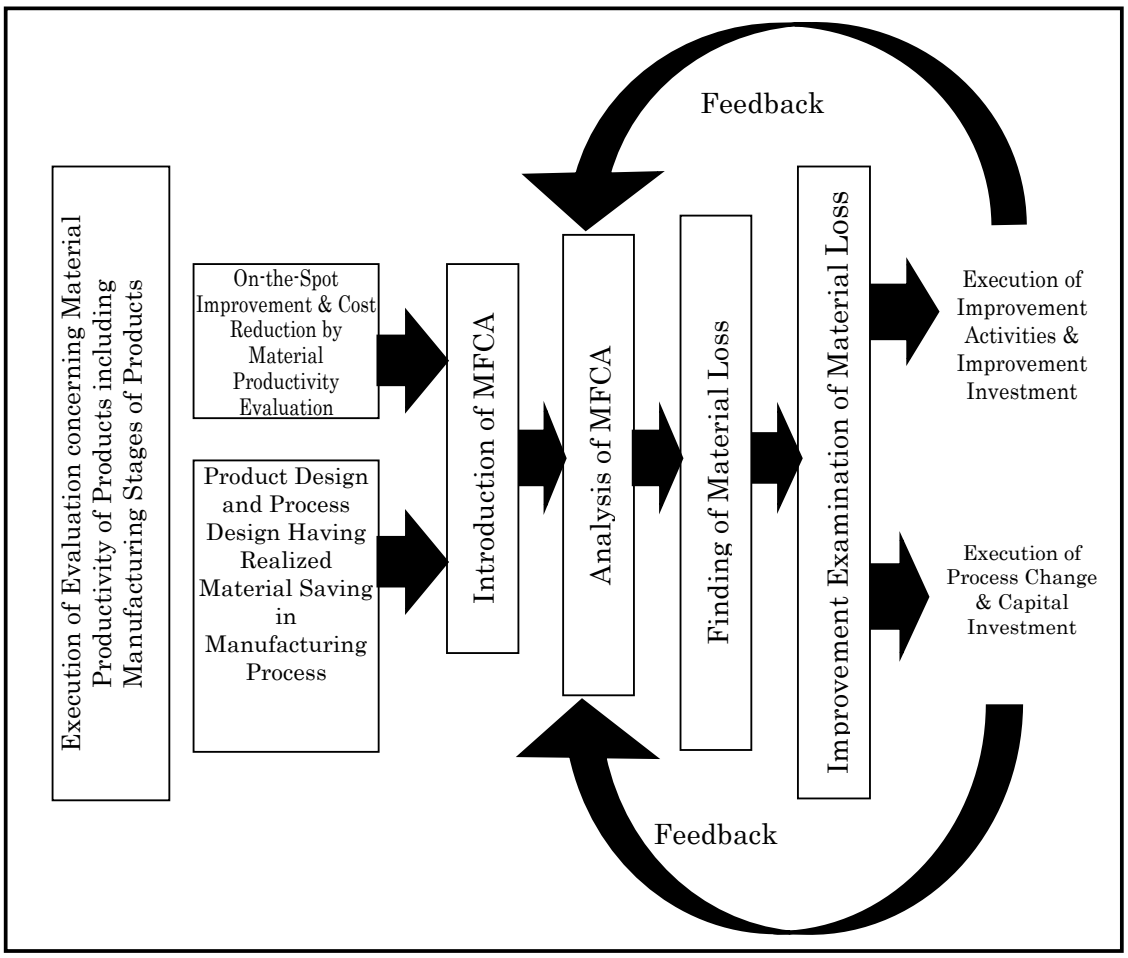


Figure 2: MFCA Management Cycle (Nakajima, 2010, p.50, revised)

Where constructing environmental management accounting supports environmental management accounting for cleaner production, it is important to construct a management cycle where results are freshly analyzed by an MFCA technique by introducing MFCA in a positive manner in order not simply to enhance material productivity, based on results obtained by experimental and temporary introduction of MFCA, but also to enhance material productivity as shown in Figure 1-2, and create measures to enhance material productivity of one's own company, based on data of MFCA while carrying out improvement investment & capital investment, process change, etc. In this chapter, I will create a model for a management system to realize environmental management accounting for cleaner production by MFCA, using corporate surveys that I have so far carried out and will discuss future issues in addition to its usefulness and possibilities.

## 2. Sustainable Management by using SBSC

### 2.1 From BSC to SBSC

Balanced Scorecard (BSC) has started as a medium- and long-term performance measurement system from comprehensive perspective vision incorporating financial

indicators and non-financial indicators in the activities conducted by the companies (Kaplan and Norton 1992). To achieve the vision and strategy, BSC breaks down necessary strategic targets and critical success factors down into four levels to practice specific activity plans. Thus, the framework of BSC is constructed from financial perspective, customer perspective, internal business process perspective, and learning and growth perspective from the upper level (Kaplan and Norton 1996). Financial perspective means: "to succeed financially, how should we appear to our shareholder". Customer perspective means: "to achieve our vision, how should we appear to our customer". Internal business process perspective means: "to satisfy our shareholders and customers, what business processes should we excel at". Learning and growth means: "to achieve our vision, how shall we sustain our ability to change and improve".

Furthermore, as the tool to show the causal chains from the four perspectives clearly, strategy map has been proposed (Kaplan and Norton 2001). The BSC concept has combined with the concept of the more recently strategy map, which can function as a strategic management system (Kaplan and Norton 2001, 2004). The Strategy Map is a framework with a common language that visualizes and communicates a strategy and the corresponding processes and systems necessary to its realizations. It is a direct extension of the BSC as it depicts critical objectives and relationships identified in the BSC process (Schaltegger and Lüdeke-Freund 2011).

The BSC is able to integrate soft, intangible and qualitative aspects, nevertheless it has to be developed further to become an integrated system of corporate sustainability management (Schaltegger and Lüdeke-Freund 2011). To implement environmental management, companies need to decide on an environmental mission and then to develop an environmental vision and strategy to accomplish this mission. To achieve this environmental vision and strategy, companies must establish a management system to implement the environmental strategy efficiently and effectively and evaluate the performance of their environmental activities comprehensively. With the growing attention to global environmental issues, an environmental and sustainability-conscious BSC used to solve environmental and social problems has been developed known as the Sustainability Balanced Scorecard (SBSC). In essence, the SBSC adds environmental and social concerns to the four traditional perspectives of a BSC (financial, customer, internal business process, and learning and growth) to evaluate more comprehensively the performance of medium- and long-term sustainability (environmental, social, and economic) activities (Schaltegger and Wagner 2005; Wagner and Schaltegger 2006; Dias-Sardinha*et al.* 2007; Kaplan and Wisner 2009; Hsu and Liu 2009).

By combining a strategy map, a SBSC can function as a management system that ensures the efficient and effective development and execution of corporate sustainability vision and strategy (Möller and Schaltegger 2005; Hubbard 2009; Hansen *et al.* 2010; Schaltegger 2011). The SBSC helps to address different environmental and social aspects with regard to their

relevance for strategy implementation and execution at the business unit or company level (Schaltegger and Lüdeke-Freund 2011). In this manner, SBSC has not only economic aspects but also environmental, social aspects, a win–win–win relation in accomplishing economic, environmental, and social objectives together.

### 2. 2 SBSC Research in Europe

Since first SBSC introduction by Centre for Sustainability Management, Leuphana University (Figge*et al.* 2002, 2003), many normative researches, case studies and action researches of SBSCs have been undertaken. The government-level research projects in helping to build momentum for the introduction of SBSCs into business activities are as follows; the Responsive Business Scorecard (RBS) by the European Commission (Van der Woerd and Van den Brink 2004), the SIGMA Sustainability Scorecard by the Department of Trade and Industry (DTI 2003b) in UK, and SBSC by BundesministeriumfürUmwelt, Naturschutz und Reaktorsicherheit (BMU 2002) in Germany. SBSC corporate case studies and action researches include Ito *et al.*(2001) (Ricoh and Takara), Bieker *et al.* (2002) (Volkswagen AG), Guerrero *et al.* (2002), Shaltegger and Dyllick (2002), Zingales*et al.* (2002) (Shell), Guerrero *et al.* (2002) (Flughafen Hamburg GmbH) Zingales and Hockerts (2003) (Novo Nordisk, Shell), Dias-Sardinha and Reijnders (2005), Schaltegger and Lüdeke-Freund (2011).

In the European Union (EU) alone, many studies of SBSCs have been undertaken. Among these, the European Commission (EC), the United Kingdom (UK), and Germany have conducted the most important government-level research projects in helping to build momentum for the introduction of SBSCs into everyday business activities. To start with, over three years of starting in 2001, the EC launched a combined international industry–government–academia research project known as the European Corporate Sustainability Framework. This sustainability framework is a management model to tackle complicated issues such as corporate sustainability and corporate responsibility, and to support business organization, through the development of the Responsive Business Scorecard (RBS) as a form of SBSC. The RBS system integrates stakeholder's requests into the program to improve and evaluates the 3Ps performances of sustainability, that is, profit, people, and planet. Although the most important factor of the conventional BSC approach is profit, the RBS approach grants equal consideration to people and planet (Woerd and Brink 2004).

In the UK, the SIGMA Project, conducted mainly by the Department of Trade and Industry (DTI) since 1999, published *The SIGMA Guideline: Putting Sustainable Development into Practice—A Guide for Organizations* in 2003. The main objective of the SIGMA Project was to provide ideas and tools to contribute to sustainability management in business. One output was the development of the SIGMA Sustainability Scorecard as a form of SBSC. The SIGMA Sustainability Scorecard covers an expanded set of stakeholders by

including corporate, environmental, and social aspects, such as customers, suppliers, governments, local communities, and nature. This is because the ultimate objective of SIGMA Sustainability Scorecard is to improve performance from a sustainability perspective whereas the ultimate objective of a traditional BSC is to improve performance from a financial perspective.

In Germany, the Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (BundesministeriumfürUmwelt, Naturschutz und Reaktorsicherheit: BMU) and Stefan Schaltegger of the Centre for Sustainability Management at Leuphana University of Lüeneburg conducted most of the German government's research on sustainability management. The resultant research report published in 2002, *Sustainability Management in Business Enterprises: Concepts and Instruments for Sustainable Organization Development*, recommends business enterprises to employ the SBSC to ensure them (BMU 2002, 115):

(i) identify the environmental and social aspects relevant to success,
(ii) create a causal link between the environmental and social aspects and the company's economic results,
(iii) enable management of all environmental and social aspects in line with their strategic relevance,
(iv) develop appropriate indicators and measures, and thereby,
(v) result in the integration of environmental and social management in conventional economic management.

In this manner, a SBSC has not only economic aspects but also environmental and social aspects, and makes clear the process in accomplishing economic, environmental, and social objectives together. However, no empirical research has done to investigate the process.

### 2.3 SBSC Framework

The development of the SBSC comprises a horizontal causal chain, including objectives, measures, targets, initiatives, and a vertical causal chain for each perspective. In Table 1, there are the following three types of SBSCs as a way to show the causal chains to connect corporate environmental or sustainable performance and corporate financial performance (Figge*et al.* 2002; Oka 2010):

(i) the subsumption type of SBSC: the subsumption of environmental and social aspects into the four traditional BSC perspectives (Kaplan and Norton 2001, 2004),
(ii) the addition type of SBSC: the addition of a fifth environmental and social perspective to the four traditional BSC perspectives (BMU 2002), and
(iii) the integration type of SBSC: the setting of four or five new perspectives that completely differ from the four traditional BSC perspectives (DTI 2003a, 2003b; Woerd and Brink 2004).

Table 1: Classification of BSC and SBSC

**Three Types of SBSC from Previous Researches**

| Type | Previous researches | Perspectives | | | | |
|---|---|---|---|---|---|---|
| **Traditional BSC** | Kaplan and Norton 1992, 1996 | Financial | Customer | Internal Business Process | Learning and Growth | |
| **Subsumption SBSC** | Kaplan and Norton 2001, 2004 | Financial | Customer | Internal Business Process | Learning and Growth | |
| | Novo Nordisk (Case) | Financial | Customer and Society | Business Process | Human and Organization | |
| | Shell (Case) | Financial Results | Customer | Human | Sustainable development | |
| **Adition SBSC** | Germany BMU | Financial | Customer | Internal Business Process | Learning and Growth | Non-market |
| | Ricoh (Case) | Financial | Customer | Internal Business Process | Learning and Growth | Environemntal Protection |
| | Takara (Case) | Financial | Customer and Products | Process | Corporate Culture and Human Resource | Social and Environmnetal Activities |
| **Integration SBSC** | EU EC | Financiers and Owners | Customer and Suppliers | Internal Process | Employees and Learning | Society and Planet |
| | UK DTI | Sustainability | External Stakeholder | Internal | Knowledge and Skills | |

(Oshika*et al.*, 2013)

As a rule, the subsumption type of SBSC is most useful for organizations already using BSC when adding environmental and social aspects. The addition type of SBSC can clearly demonstrate the motivation and interest of top management in sustainability, and makes the underlying concept more understandable for employees, though it complicates the causal relations with the existing four perspectives with the inclusion of a fifth perspective. The integration type of SBSC equally considers all economic, environmental, and social aspects, whereas the subsumption and addition types of SBSC set financial perspectives in the top-most position and thereby incorporate the concept of the triple bottom line[1] more deeply into the BSC.

[1]The concept of the tripple bottom line was first coined by John Elkington, cofounder of the business consultancy SustainAbility,and states that companies should prepare three different bottom lines: a traditional bottom line (or "profit"), an environmental bottom line (or "planet"), and a social bottom

BSC advocates Kaplan and Norton (2001, 2004) integrate environmental and other social indicators into the four traditional perspectives of BSC, thereby providing the subsumption SBSC. In their earlier study, Kaplan and Norton (2001) emphasized the importance of being a good corporate citizen and introduced the "regulation and environmental process" of internal business process perspectives. In Kaplan and Norton's (2004), they set "regulation and social process" as a substitute for "regulation and environmental process" with four factors—not just "environment" but also "safety and health", "employment practice", and "investment for local community". The cases of Novo Nordisk and Shell represent the subsumption SBSC.

BMU in Germany adds a fifth perspective, "Non-Market Perspective", to the four traditional BSC perspectives; the addition SBSC. The purpose of including "Non-Market Perspective" is to integrate any strategyrelated to environmental and social aspects, such as an activity's flexibility, legitimacy, and legality (Figge*et al.* 2002, 279–280). The cases of Ricoh and Takara represent the addition of SBSC.

Representative examples of the integration SBSC is the RBS developed by the EC and the SIGMA Sustainability Scorecard developed by the UK DTI. RBS consists of five different perspectives: a financier and owner perspective, a customer and supplier perspective, an internal business process perspective, an employee and learning perspective, and a society and planet perspective. The SIGMA Sustainability Scorecard consists of four perspectives: a sustainability perspective, an external stakeholder perspective, an internal perspective, and a knowledge and skills perspective. These models emphasize nonfinancial or sustainability perspective, although the most important perspective of the traditional BSC is profit.

For the most part, the extant SBSC research mainly employs normative, case, and action research methods (Figge et al. 2002; Schaltegger and Dyllick 2002; Dias-Sardinha and Reijnders 2005; Möller and Schaltegger 2005; Schaltegger and Wagner 2005; Wagner and Schaltegger 2006; Dias-Sardinha et al. 2007; Hansen et al. 2010; Kawai and Otomasa 2011; Hubbard 2009; Schaltegger 2011).

Through these researches in this section, we could find the potentials to integrated MFCA with SBSC in Figure 3. Figure 3 is clearer relationship between MFCA information, management information chain and responsibility of management. When a company introduces CO2 management based on SBSC, organizational structure and MFCA information as Figure 3, MFCA Database gathers material, energy and CO2 emission data on physical units from Production and Logistic areas. MFCA Database could make MFCA costs and assess the amount of CO2 emission. The CO2 Management department can collect the management data from MFCA Database and make management reports, and give these management reports to Environmental Department and Sustainability Department, they can report the sustainable performances to higher management. Moreover, the CO2 Management department reports to Legal Affairs department, which operates environmental management

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line (or "people").

based on ISO14001 and ISO14051.

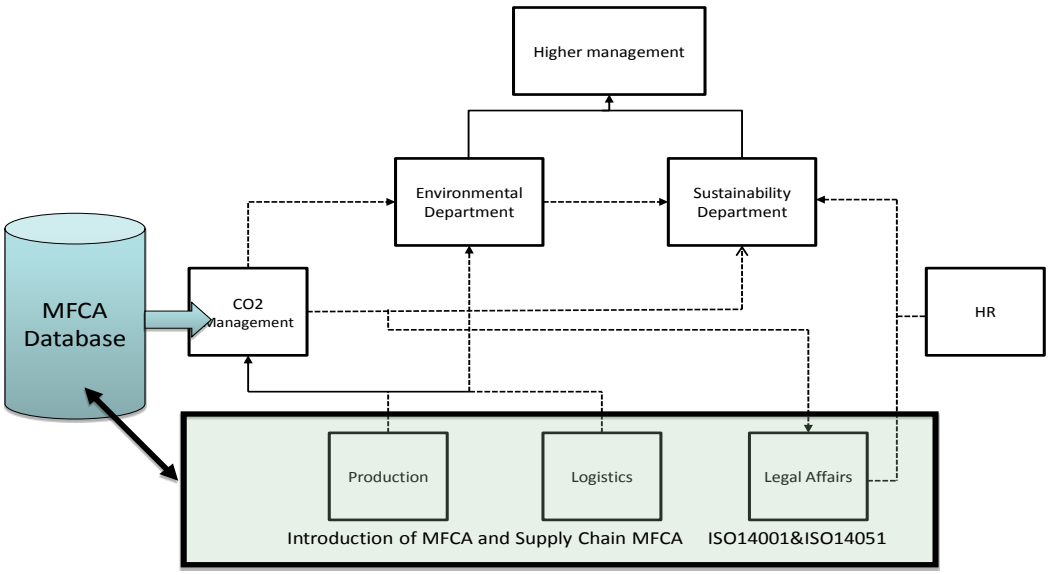


Figure 3: An example of an interactive chain of sustainable management with MFCA Database (original figure from Burritt *et al.*, 2011, p.92, added some parts by authors)

The organizational framework of sustainable management with MFCA will be developed, but we need a common understanding that MFCA information is useful in general management or in supplying chain management.

## 3. MFCA in Supply Chain based on Questionnaire Research

We have considered SBSC and MFCA database in the previous section. Then we will focus on the construction of MFCA database for introducing MFCA into SC from a strategic viewpoint. To bring MFCA into an organization adequately, a company must make strategic use of it. We assume a MFCA leader will introduce it into SC. Though the MFCA leader could be a buyer as well as a supplier, we assume he/she is the buyer here.

It is necessary to make a supplier understand the significance of MFCA in order to introduce it into SC smoothly. The MFCA leader explains it to a supplier proactively and must obtain his/her agreement. Generally, the supplier feels resistance in offering all information to the buyer when a buyer and a supplier collaborate for the purpose of cost reduction. However, in introduction of MFCA, a supplier does not necessarily have to give a buyer cost information (Higashida, 2010). There is a possibility that MFCA causes less uneasiness for suppliers in comparison with a conventional tool. We decide to investigate the relations between buyer and supplier from the viewpoint of the buyer to consider whether the MFCA leader introduce MFCA into SC in cooperation with a supplier.

We designed the questionnaire to assess the status of the relationship between buyers and suppliers. The main purpose of this questionnaire is to understand information-sharing between buyers and suppliers because it is difficult to have a reliable relationship without information-sharing. To research their relationship, we asked the following questions. First, how well do buyers know the strength and depth of information-sharing with suppliers on product development? Second, how well do they share information with suppliers?

We sent a set of questionnaires by post to managers or persons in charge of purchasing departments in all the listed manufacturing companies in Japan, a total of 1,561 companies/sites, in February 2012. As a result, we received 356 responses, a rate of 22.8%. We could not find non-response bias in the companies that responded. Table 1 gives a breakdown of the companies by industry.

Table 2: Category of industry and companies

| Category of industry | Number of responses | | Number of mailings | |
|---|---|---|---|---|
| | Number | Ratio | Number | Ratio |
| Transportation Equipment | 26 | 7.3% | 104 | 6.6% |
| Non-Ferrous Metals | 8 | 2.2% | 38 | 2.4% |
| Electric Appliances | 73 | 20.5% | 283 | 18.1% |
| Electric Power & Gas | 3 | 0.8% | 22 | 1.4% |
| Iron & Steel | 9 | 2.5% | 54 | 3.5% |
| Textiles & Apparel | 7 | 2.0% | 58 | 3.7% |
| Oil and Coal Products | 2 | 0.6% | 13 | 0.8% |
| Precision Instruments | 15 | 4.2% | 50 | 3.2% |
| Foods | 19 | 5.3% | 131 | 8.4% |
| Metal Products | 24 | 6.7% | 94 | 6.0% |
| Machinery | 70 | 19.7% | 236 | 15.1% |
| Chemicals | 54 | 15.2% | 210 | 13.4% |
| Pharmaceuticals | 7 | 2.0% | 56 | 3.6% |
| Pulp & Paper | 5 | 1.4% | 24 | 1.5% |
| Other Products | 19 | 5.3% | 107 | 6.9% |
| Rubber Products | 6 | 1.7% | 19 | 1.2% |
| Glass & Ceramics Products | 9 | 2.5% | 64 | 4.1% |
| Total | 356 | 100.0% | 1563 | 100.0% |

### 3-1. Present condition of purchasing department and information-sharing on product development

This section gives an outline of the information-sharing situation when a buyer revises a

procurement cost. First, we have to know about the purchasing department's target. They prefer to avoid a rise in procurement cost because they have selected "procurement cost increase" as a factor that prevents an objective from being met (Table 2). However, while constant cost is important, when selecting suppliers, they base their decisions foremost on quality (Table 3).

Table 2: Most problematic factor for target achievement

| | Number of Answers | Ratio |
|---|---|---|
| Delay of delivery date | 45 | 12.6% |
| Procurement cost increase | 230 | 64.6% |
| Non-constant quality | 65 | 18.3% |
| Environmental damage | 3 | 0.8% |
| Others | 10 | 2.8% |
| No response | 3 | 0.8% |
| Total | 356 | 100% |

Table 3: Most important factor in choosing suppliers

| | Number of Answers | Ratio |
|---|---|---|
| Environment | 4 | 1.1% |
| Delivery | 13 | 3.7% |
| Price | 104 | 29.2% |
| Quality | 225 | 63.2% |
| No response | 4 | 1.1% |
| Total | 356 | 100% |

Second, we discuss revising or negotiating their procurement cost. Table 4 shows how many times a year companies revise prices. All the companies that responded to our questionnaire revise their costs once or more times[2].

Table 4: Number of times procurement cost is revised per year

| | Number of Answers | Ratio |
|---|---|---|
| 1 | 132 | 37.1% |
| 2 | 94 | 26.4% |
| 3 | 6 | 1.7% |

[2] In addition, we must be notice that 13.5% of companies revise the cost more than 5 times.

| | | |
|---|---|---|
| 4 | 26 | 7.3% |
| Over 5 | 48 | 13.5% |
| No response | 18 | 5.1% |
| Total | 356 | 100% |

The collaboration does not occur if a buyer focuses only on procurement cost. In that case, they will convey to suppliers their requirement definition on their given cost. We understood that 62.1% (Table 5) of buyers let a supplier participate in definition of requirements.

Table 5: Negotiating Criteria

| | Number of Answers | Ratio |
|---|---|---|
| Negotiate only price | 115 | 32.3% |
| Discuss requirement definition | 221 | 62.1% |
| No response | 8 | 2.2% |
| Others | 12 | 3.4% |
| Total | 356 | 100% |

In addition, we consider cost revision and requirement definition. In the case of the revision of the procurement price, the sales and marketing department often participates (Table 6, 92.1%). It is natural that they would participate in the first step about the procurement price.

Table 6: Negotiating department for procurement cost

| | Numbers of Answers | Ratio |
|---|---|---|
| Sales & marketing | 328 | 92.1% |
| Production | 6 | 1.7% |
| Production engineering | 0 | 0.0% |
| Production management | 7 | 2.0% |
| Product design | 1 | 0.3% |
| Target costing | 1 | 0.3% |
| Accounting | 0 | 0.0% |
| Product planning | 1 | 0.3% |
| Others | 7 | 2.0% |
| No response | 5 | 1.4% |
| Total | 356 | 100% |

Next, we assumed that production, production engineering, and product design departments

account for most participation in requirement definition, but the responses showed otherwise. In the case of the definition of requirements, they participate 89.6% of the time (Table 7).

Table 7: Department of suppliers attending requirement definition meeting

| | Number of Answers | Ratio[3] |
|---|---|---|
| Sales & marketing | 198 | 89.6% |
| Production | 54 | 24.4% |
| Production engineering | 82 | 37.1% |
| Production management | 8 | 3.6% |
| Product design | 148 | 67.0% |
| Target costing | 3 | 1.40% |
| Accounting | 0 | 0.0% |
| Product planning | 12 | 5.4% |
| Others | 7 | 3.2% |
| No response | 3 | 0.6% |
| Total | 515 | |

### 3-2. Level of information-sharing for cooperative activity with suppliers

Here we look the level of information-sharing. We asked how information is shared with suppliers. Nearly half of the companies know a supplier's material yield ratio (41.0%), and the remaining ones do not know it (55.6%). Next, many companies try to improve the ratio for suppliers.

Table 8: Acquaintance with your supplier's material yield rate

| | Number of Answers | Ratio |
|---|---|---|
| Known | 146 | 41.0% |
| Not known | 198 | 55.6% |
| No response | 8 | 2.2% |
| Invalid | 4 | 1.1% |
| Total | 356 | 100% |

When we look at a breakdown, 134 companies perform an improvement activity, whereas 146 companies know the ratio. However, 17 of 134 companies do not know it. In other words, in the collaborating companies, they do not conduct information-sharing and may require only the ratio improvement.

[3] These ratio's denominators are 220 that the number is quantity of response, because this question was multiple answers allowed.

Table 9: Implementation of cooperation to improve material yield for suppliers

| | Number of Answers | Ratio |
|---|---|---|
| Yes | 134 | 37.6% |
| No | 213 | 59.8% |
| No response | 7 | 2.0% |
| Invalid | 2 | 0.6% |
| Total | 356 | 100% |

In addition, only 8.7% of companies grasped the CO2 emissions of the supplier (Table 10). In the preliminary interview of buyers' companies, they replied about their selection criteria for suppliers. Buyers confirmed that suppliers obtained ISO14001 or underwent an environmental consideration procedure on the production process.

Table 10: Acquaintance with your supplier's CO2 emissions

| | Number of Answers | Ratio |
|---|---|---|
| Yes | 31 | 8.7% |
| No | 318 | 89.3% |
| No response | 5 | 1.4% |
| Invalid | 2 | 0.6% |
| Total | 356 | 100% |

However, they do not grasp the CO2 emissions related to the component they purchase. Nevertheless 38.2% of them want to reduce cooperatively the supplier's CO2 emission, there is only 6.5% companies that they implement to reduce cooperatively supplier's CO2 emission (Table 11 and 12).

Table 11: Expectation of reducing cooperatively the CO2 of the Suppliers

| | Number of the Answers | Ratio |
|---|---|---|
| Yes | 128 | 38.2% |
| No | 180 | 53.7% |
| No response | 26 | 7.8% |
| Invalid | 1 | 0.3% |
| Total | 335 | 100% |

Table 12: Implementation of cooperation to decrease CO2 emission for suppliers

| | Number of the Answers | Ratio |
|---|---|---|
| Yes | 23 | 6.5% |

| | | |
|---|---|---|
| No | 320 | 89.9% |
| No response | 12 | 3.4% |
| Invalid | 1 | 0.3% |
| Total | 356 | 100% |

To improve the recognition of MFCA may resolve the above problem. As it stands now, most companies have not introduced MFCA; furthermore, many are unaware of the concept. The recognition of MFCA is very high in the environmental department, but more than 70% of the companies responded that they are unaware of the concept (Table 13 and 14).

Table 13: Recognition of MFCA

| | Number of Answers | Ratio |
|---|---|---|
| Yes | 88 | 24.7% |
| No | 262 | 73.6% |
| Invalid | 6 | 1.7% |
| Total | 356 | 100% |

Table 14: Introduction of MFCA

| | Number of Answers | Ratio |
|---|---|---|
| Introduced | 7 | 2.0% |
| Not introduced | 241 | 67.7% |
| Not introduced but interested in | 28 | 7.9% |
| Not introduced but considered | 10 | 2.8% |
| Unclear | 64 | 18.0% |
| No response | 5 | 1.4% |
| Invalid | 1 | 0.3% |
| Total | 356 | 100% |

MFCA is a tool that can help to achieve the two purposes of environmental load reduction and cost reduction. If purchasing departments with authority to choose a supplier recognize MFCA, it may help improve MFCA introduction.

It is necessary to make the buyer company recognize that MFCA is a tool contributing to both environmental load reduction and cost reduction in order to introduce MFCA into SC. As a result of the above considerations, the purchasing department and the sales department operate at the point of contact between buyer and supplier, and they take a central role in negotiations.

The buyer chooses a supplier based on quality, but procurement cost is important as well. We must let the purchasing department of the buyer understand the effect of MFCA to

introduce MFCA into SC.

## 4. Conclusion

The Section 1 of Introduction shows the present important subjects to make sustainable management with MFCA, based on many Japanese case examples and research works. Many companies accept MFCA as a new Kaizen tool, this result has both of good and bad aspects to establish MFCA management. In good aspect, MFCA has become popular especially in Japanese companies, but in bad aspect MFCA user has generally limited to manufacturing section. In order to develop MFCA to MFCA management as Sustainable management, we have to examine integration MFCA with the existing management tool as BSC, and show the usefulness of MFCA data to other management section. In Section 3, we try to analyze relationship between buyer and supplier, from the viewpoint that MFCA is relevant to supply chain management.

And we show the potentials to integrated MFCA and BSC/SBSC to establish sustainable management with PDCA management cycle in Section 2. BSC basically focuses on financial and non-financial aspects to manage corporate management. At the present, BSC has developed to SBSC, which includes environmental issues as one of non-financial aspects. We suggest to integrated MFCA with SBSC on the basis of MFCA Database. MFCA has tried to be expanded the whole of company from the front line, and BSC has covered the whole of company from top management. This integration is more useful for company to establish totally sustainable management system.

In Section 3 of our questionnaire research, we explain that there are some needs of cooperation between buyers and suppliers. However, the cooperation between buyers and suppliers hasn't always been actualized in practice yet. For example, around 40% of buyers would like to reduce CO2 emission in supplier's process collaboratively with suppliers, but only 6.5% of buyers can make a collaborative action with suppliers in practice. The reason why the cooperation between buyers and suppliers hasn't always been actualized in practice could be because the suppliers haven't understood such thinking of buyers. And 8.7% of buyers answered that they know the amount of CO2 emission in the supplier's process. If MFCA Database is completed, buyers and suppliers could reach a common understanding of CO2 emission in the supply chain. MFCA Database will be able to contribute an establishment of green supply chain in practice.

This research may consist of individual research works, but each research result will be a closely related piece to making a sustainable management in practice.

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