

Environmental Management Accounting for Cleaner Production: Systematization of Material Flow Cost Accounting (MFCFA) into Corporate Management System

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The purpose of this research is to consider the structure of a management system which supports countermeasures for the environment in the manufacturing process by Environmental Management Accounting and particularly by Material Flow Cost Accounting (MFCFA) and the features of its management system.

Key words: Material Flow Cost Accounting (MFCFA), Cleaner Production, Corporate Management System

1. Introduction

This study has discovered the definition of management which constructs environmental management accounting for cleaner production by MFCFA, based on previous theoretical and case studies concerning MFCFA both in and outside Japan.

As shown in Figure 1-1, introduction of MFCFA by a corporation and the reduction of material loss discovered by a corporation using MFCFA analysis can be said to be management activities to discover the usefulness of MFCFA by the corporation itself, and material loss reduction management by MFCFA which supports environmental management accounting for cleaner production. However, management by MFCFA is far from being generalized yet, and usage of MFCFA by corporations is temporary as it is the early stage of introduction of MFCFA, and can be labeled as the so-called special cost studies into management accounting.

By the way, MFCFA is used as such a temporary management technique by a corporation. Is this a management development where the substance of MFCFA is understood?

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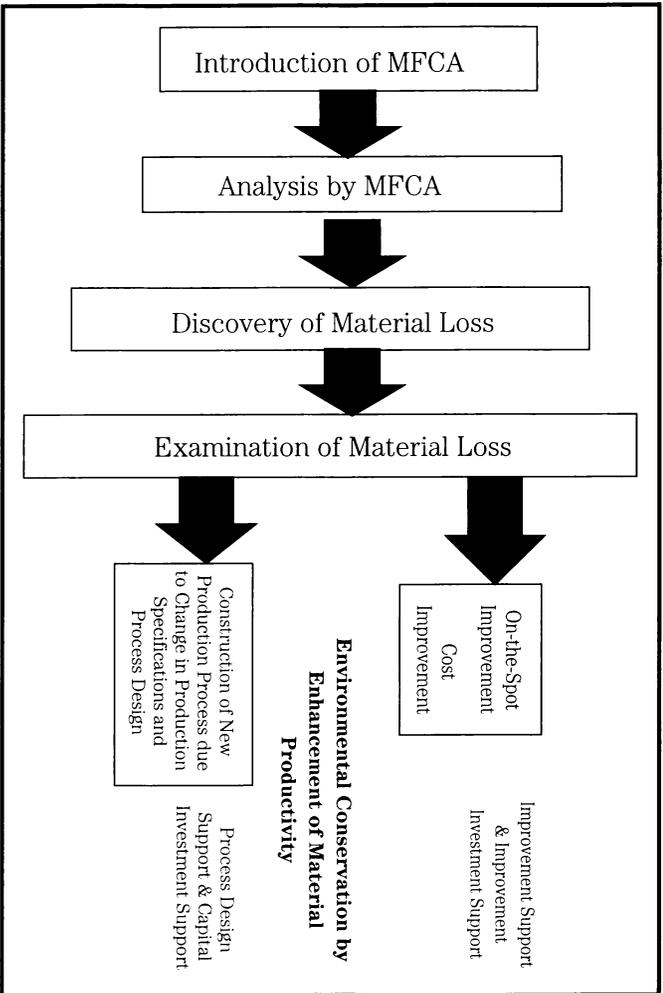


Figure 1-1 Utilization of MFCA supporting Environmental Management Accounting for Cleaner Production (Nakajima, 2010 E, p.48, revised)

This paper will examine issues of management systematization of MFCA particularly by carrying out general research analyses on case studies.

2. Management Issues of MFCA seen in Case Studies

In this material loss reduction management, the first step is the utilization of MFCA which supports conversion to environmental management accounting for cleaner production by material loss reduction on the assumption of the present manufacturing process as shown on top right in Figure 1-1 above. In this case, it is defined as on-the-spot improvement (material loss reduction) activities supported by MFCA, and short-term improvement targets are set up in many cases. As shown on bottom right in Figure 1-1 above, in the subsequent second step, it is MFCA which supports the change to environmental management accounting for cleaner production which is a non-material-loss producing (ultimate minimization of material use) manufacturing process.

By the way, the construction of a management system which enables improvement of the whole manufacturing process being seen as one thing using MFCA is

important to substantially support environmental management accounting for cleaner production. Material loss reduction in on-the-spot improvement activities shown in the first step in the above is in almost all the cases ascribed to material loss reduction caused by failure, etc. in manufacturing work. On the other hand, and fundamental and structural material loss reduction ascribed to production processes, etc. are not included in subjects of MFCA management at this stage in many cases. However, some corporations fully understand and utilize the two aspects of material loss information of MFCA. For example, in cases (Nakajima & Kokubu, 2008; Anjo, 2006 and 2007b; Furukawa, 2006; Numata, 2006, 2007a and 2007b) of Canon, Nitto Denko, Sekisui Chemical, etc., joint usage of information of material loss quantities and costs are carried out, and specification of occurrence causes and improvement of occurrence causes of material loss are labeled as all intra-company activities, and on-the-spot improvement and capital investment between other divisions are carried out.

While many corporations understand and locate MFCA as a tool which visualizes new losses in on-the-spot improvement activities and utilize it as a supplementary and temporary analytical technique of existing management system, research should be carried out into why some corporations can carry out management systematization of MFCA which derives such breakthrough to utilize it. In short, only presenting new material losses in on-the-spot improvement is not sufficient in supporting environmental management accounting for cleaner production. Measurement of material loss ascribed to production technique and production facilities of one's own company or, further, material losses ascribed to the structure of product life cycle (supply chain including customers) is necessary. To utilize MFCA by reducing discovered material losses means the construction of a management system which supports environmental management accounting for cleaner production. Furthermore, introduction of MFCA is made by the construction of MFCA not only to discover material losses which had not been recognized in the conventional on-the-spot improvement but also to contribute to development as a material productivity evaluation management tool.

Where constructing environmental management accounting which 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 trial 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

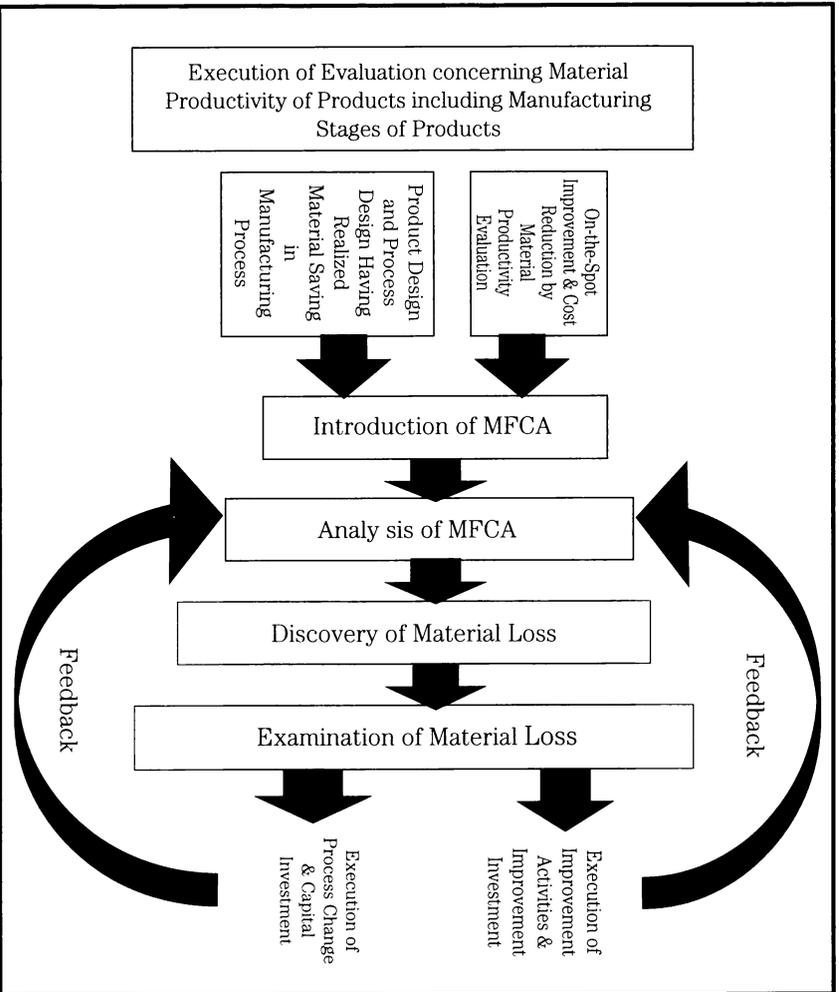


Figure 1-2 Environmental Management Accounting for Cleaner Production Management (Nakajima, 2010 E, p.50, revised)

company, based on data of MFCA while carrying out improvement investment & capital investment, process change, etc. In this paper, a model for a management system to realize environmental management accounting for cleaner production by MFCA will be shown and future issues in addition to its usefulness and possibilities will be discussed.

3. Change Concerning Premises of MFCA Introduction

The concrete and important target issue for corporations which profess environmental management is countermeasures for the reduction of greenhouse gas and material exhaustion. Environmental management has been conceptually defined as corporate management which can manage to cope with both the environment and economy. However, it has not been necessarily defined as a concrete

target. For example, whether or not enhancement of material productivity can be conducive to environmental management has been judged by each corporation. It can therefore be considered that material productivity has not been deemed to be necessarily a more important issue of corporations than anything else. However, a term, exhaustion of resources, has been paid attention to as environmental conservation due to rapid hike in the raw material price experienced by Japanese corporations in 2009 and the estimate of international supply shortages and price rise in rare metals in accompaniment to that, and corporations have started to show greater interest in material consumption, and material productivity information has been changed to be the most important information.

For example, in the questionnaire survey on cost accounting and environmental management accounting in Japan (for the responding period from 26th January to 10th March in 2010)¹⁾, three-fourths of the respondent companies (89 companies out of 117 companies) have answered that material productivity index is an important index for market competition.

Additionally, greenhouse gas reduction relating to energy consumption, which had been a general management issue concerning “paper, rubbish and electricity”, has started to draw attention, when the Japanese government has set a global warming reduction target. In this scenario, reduction of energy consumption within companies is directly linked with greenhouse gas reduction. However, as part of the cost reduction, energy saving activity in illumination, waiting for electric power, etc. has already been carried out and is no longer a new technique. Amid such change, what is marked is that greenhouse gas reduction relating to energy consumption in manufacturing processes has started to be labeled also as a management issue.

Stable supply for manufacturing is considered to be more important in energy consumption in these manufacturing processes, which is rarely examined in relation to losses in manufacturing. Visualization of energy loss in MFCA has been within the scope of the subject of MFCA from the initiation of its introduction as materials theoretically include energy. However, it is necessary to define and measure energy loss to visualize energy loss.

It is not understood in Japan that all input energy is defined as material loss. In addition, it is difficult to measure energy and especially input power by individual machine & production direction at present, as preparation of measurement

1) Please see Nakajima, Kokubu, and Kitada, 2010.

equipment is not perfect²⁾. As a result, electrical power expense estimated to be used at a structure for heavy machinery are divided pro rata for each quantity centre of materials and are allocated for positive products and negative products at the rate of quantity of materials as energy cost (the total amount of input to the quantity centre of materials). On the other hand, the possibility of visualization of energy consumption in processes in MFCA is discussed in this manner. It is therefore considered that evaluation of energy costs of positive and negative products will be carried out on the basis of the quantity of energy consumption in the future (Nakajima & Kokubu, 2008; Nakajima, 2006; and Kawano, 2006).

In this way, it has been discussed that managing both environment and economy is environmental management. However, for example, material productivity information which has been raised in this paper and energy consumption information within processes have increased importance as management information. In particular, at present, the level of interest in material productivity information directly linked with reduction of manufacturing costs of products and MFCA information has increased, and some companies are attempting to label material productivity information under MFCA as strategic environmental management information.

This study would like to describe and analyze models of management systematization of MFCA in the next section onwards from among corporate cases of the companies which label MFCA as strategic management information.

4. Top Down MFCA Management — Material Productivity Management for All Intra-Company Level

Corporations shown in Figure 1-3 are model companies that carry out top down MFCA management, and have set up the maximization of material productivity with realization of environmental management as the policy of their whole group, among which they set up a numerical target relating to material productivity (waste reduction), thus carrying out systematic management (policy management³⁾) which is evolved in entities and sites within their group. They utilize MFCA

2) "Preparation of measurement equipment is incomplete" means that measuring energy consumption by machine or equipment has not been usual in general excluding some industries, and that companies did not need to make preparation for energy measuring equipment as energy consumption which has been measured by area within a factory such as a structure for heavy machinery or division and by factory had not been relatively important for management.

3) "Environmental management systems – Requirements with guidance for use" of ISO14001 (1996) and "Quality systems – Model for quality assurance in design, development, production, installation and servicing" of ISO9001 (1994) explain that policies should be understood and implemented by all strata of organizations

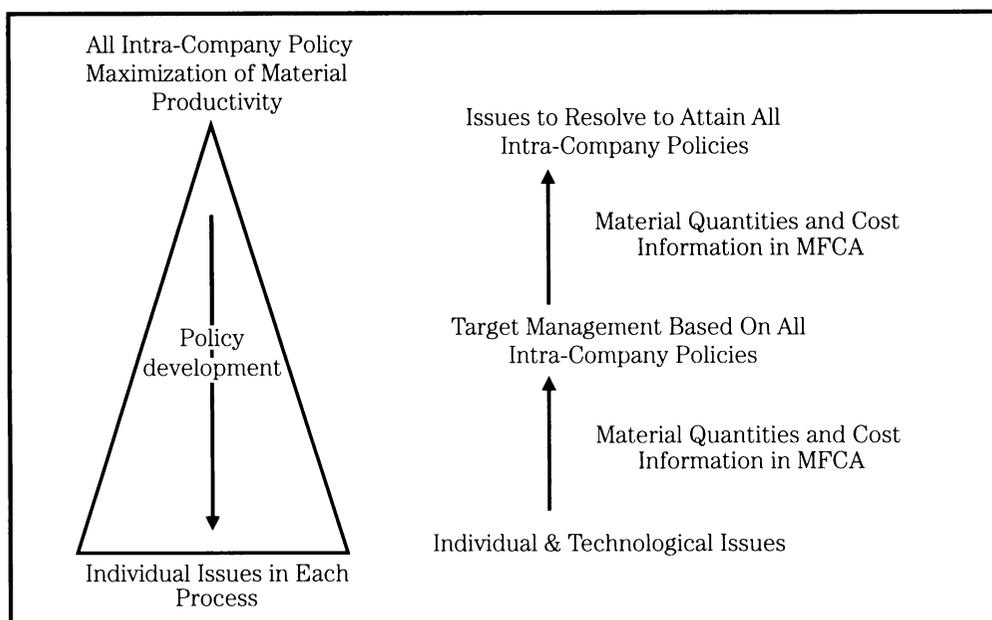


Figure 1-3 Policy Management Using MFCA

as a specific management technique of waste reduction in such management. Targets based on a policy are developed in all strata in organizations on the basis of the policy, “the maximization of material productivity” decided by top management. On setting up such targets, MFCA is utilized, and reduction targets for material loss are set up, based on positive and negative product information. Then, specific reduction activities are carried out. Activity results, for instance, are understood in MFCA by reduction rates and quantities of material losses, and target management will be carried out on the basis of an all intra-company policy. Further, MFCA information will be collected together with information on investment cases where major reduction by MFCA requires decision making by top management, and will be sorted out as top management information.

Such development of MFCA can be called MFCA management where top down approach is introduced. Specific processes and steps in the development of MFCA vary, but simplified models will be shown in this study.

It is important to make policy development from an all intra-company policy by top management to a theme (individual issues) in each process as shown in Figure 1-3. in this MFCA management where the top down approach is introduced.

under the responsibility of top management and that top management must carry out management where PDCA cycle is continually operated.

Strategic environment management is located as a company policy, and the maximization of material productivity is set up as a specific management target. For example, each manufacturing workplace has a target of waste reduction, and sets up a numerical target of reduction quantity. On the other hand, sub-organizations sort out individual and technological issues by MFCA analysis, and classify them into short-term targets and medium- and long-term targets, and policy development takes place within the sub-organization. In this way, it is important to carry out policy development of waste reduction to each corporate division & on-the-spots by developing corporate targets (environmental targets), and positive and negative product information by MFCA will be utilized as the management indices of their targets.

In this case, understanding MFCA at the worksite which can be seen in many corporate cases using MFCA is not necessarily required, but it develops as part of policy development in existing corporations. On the other hand, MFCA is required to be understood by top management. However, it can be considered that there is an opinion that top management should understand MFCA on the premise of understanding the actual state of the worksite. However, if a means of understanding MFCA is only a trial introduction of MFCA to a factory, etc., for whom the project is created, to understand and make decisions in relation to the introduction of MFCA is the most important thing. It is essential for corporate top management to understand MFCA and decide whether or not MFCA is useful to introduce to its corporation.

The bottom up MFCA management is basically difficult. The reason is that it can be considered that proposing a management system from the worksite and making it a management system either for the whole corporation or for the whole workplace is not a process acceptable by managers in top management. Information may be bottom up to make top management understand problems at the bottom (at the worksite). However, for example, it is difficult for the people at the worksite to construct management of the PDCA cycle of MFCA. Furthermore, it is more difficult for them to report that there is material loss which is structurally ascribed to management of its company within material loss reported from the worksite to top management. People at a worksite do not have such a function in on-the-spot improvement.

Accordingly, many corporate cases show that bottom utilization type MFCA management is not carried out as a bottom-up approach. In such management, trial introduction of MFCA to the worksite is made, and the usefulness of MFCA is discovered, and MFCA is developed in improvement activities or TPM activities at

the worksite of a production organization. How is development towards new material loss reduction activities located in the step towards systematization of MFCA management?

5. Bottom Utilization Type MFCA Management — On-the-Spot Management by MFCA

For example, in the corporate case in Figure 1-4, an angle of a view of MFCA is introduced into on-the-spot improvement activities, and is utilized for reduction of chips, etc. Management is carried out by utilizing MFCA as an on-the-spot management tool and understanding the state of the whole process with respect to the occurrence rate and reduction rate of negative products.

In this instance, firstly, a manager, who understands MFCA well and considers that MFCA is useful at such corporation or in its manufacturing processes is needed. As Figure 1-4 shows, this person who understands MFCA well will play a role to liaise the worksite with the upper management stratum. Furthermore, to make MFCA spread and become established within a company, increasing the

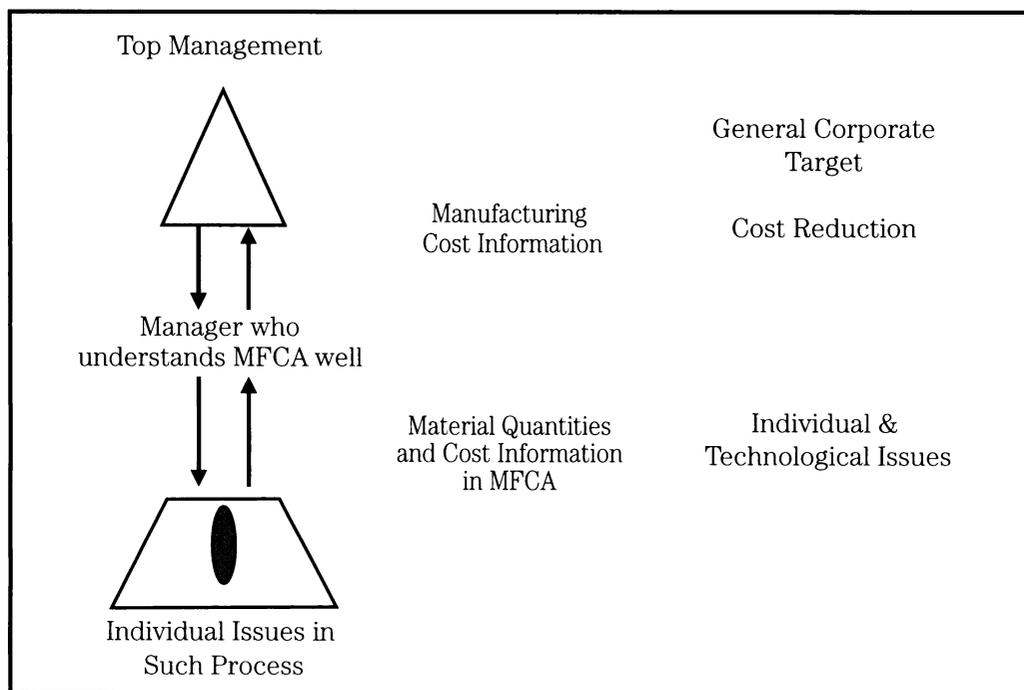


Figure 1-4 Bottom Utilization Management System of MFCA

number of “MFCA fans (strong supporters)” will become an important issue for this person who understands MFCA well. Accordingly, corporations will experience cases of success within themselves like corporate cases in the past, and will develop key persons for the development of MFCA (MFCA experts) in parallel. Such key persons at that time are desirable to possess basic knowledge in the scope of environmental management (waste related), technology (production technology related) and management (internal adjustment).

As shown in Figure 1-4, MFCA information is not naturally embedded in existing management information. MFCA information is utilized by a person who understands MFCA well. Accordingly, systematization and linkage of MFCA information with existing management information will become particularly important to utilize MFCA as management information of organizations. Many corporate cases have clarified that where MFCA is used, cost of material loss is evaluated and corporations will be motivated to reduce such costs, depending on the amount. However, if cost information is at the level of on-the-spot improvement, and staff related to or the section in charge of (part organization) such on-the-spot improvement understand and agree to the contents of such cost information, on-the-spot improvement will be carried out on the basis of cost-effectiveness analysis using cost information of MFCA. Investment cost for on-the-spot improvement is generally a small amount and is often nil according to past data, and decision making by people ranked higher than top management, etc. is therefore not required.

Compared to this, the renewal of the production method and production facilities are necessary for reduction of material loss in many cases. Management of a production system, which is the basis of manufacturing companies, is required for improvement of material productivity by “making process change & capital investment” as in the PDCA cycle shown at the bottom in Figure 1-2 above, and only temporary management information (cost evaluation of material loss) is not sufficient. In other words, it is necessary to analyze the relation to the cost accounting system which traditionally provides cost information in the manufacturing industry. Accordingly, firstly, whether or not it is possible to produce an amount of cost evaluation of material loss using the existing cost accounting system is examined. Under the general cost accounting system, material loss is included in products as consumption value. It is therefore necessary to separately measure or confirm material loss. In addition, where such corporation adopts standard cost accounting, in many cases the variance between standard cost and actual

cost is either included in material loss of MFCA or understood or examined⁴⁾. However, the material loss in MFCA is the difference between input (actual material quantity) and output (actual material quantity) of material, and not the difference between the standard quantity and actual quantity. The material yield will therefore be derived from the design value. It is therefore necessary to freshly prepare differential information and cost information on the basis of a MFCA system.

This is treated at the same level as that of other cases in the existing decision making process as shown in Figure 1-4, and at this stage the characteristics of MFCA will be lost in a sense. The reason is that improvement in loss (reduction of waste, etc.) is made in existing management, and it is understood that a proposal of loss improvement using different management information is considered to be a duplication. A person who understands MFCA well has to explain the difference between material loss of MFCA and loss in existing management and persuade upper management to understand that to enable them to make decisions on such issues. However, in reality, if a manager himself or herself comes to understand the difference from the variance between material loss in MFCA and that by standard cost accounting and becomes a person who understands MFCA well, it is considered to be difficult for him or her, who is a person who understands MFCA well, to report to an upper manager as “MFCA information” with a special meaning. The reason is that ultimately top management must understand MFCA fully for themselves.

Because there are such issues, reduction of material loss becomes trial MFCA activities only for a certain area as a result, and they tend to be treated as only a temporary improvement activity, MFCA being understood only as a personal principle. Accordingly, it is therefore important to know how to report the usefulness of MFCA to top management who can make decision on incorporating MFCA into the corporate management system and shift to the development to top down MFCA.

Then, so long as top management understands MFCA and develops top down MFCA, does that company succeed in incorporating MFCA into its management? What does the understanding of top management mean? The next section will discuss a scenario of management systematization of MFCA with an awareness of

4) In the questionnaire survey, “Questionnaire survey on cost accounting and environmental management accounting in Japan” shown above, the number of companies which considered that information provided by MFCA can be provided by standard cost accounting, actual cost accounting and cost variance analysis was 39 out of the 58 companies which responded to the questionnaire items.

such issues.

6. Scenario of Management Systematization of MFCA

From the general view of the past corporate cases, reduction of material loss by MFCA will end at the level of the worksite as one of the on-the-spot improvement techniques, which is a new visualized tool, if it is classified as reduction simply as a loss, and will not function as management information of a corporation. In conclusion, it is important to recognize the material productivity index as one of the KPIs (key performance indicators)⁵⁾ and decide to adopt MFCA as a management tool to measure its material productivity. It is important to define that recognition that MFCA is main management information will lead to “developing products” which maximize material productivity in production processes.

Figure 1-5 shows a model showing how management systematization of a corporation is led from the introduction of MFCA by a corporation, which have been discovered from the general view of the past corporate cases.

Figure 1-5 shows a step of introduction cases of MFCA in general. Firstly, let's assume an example of “introducing a new technique called MFCA as a trial”. As a

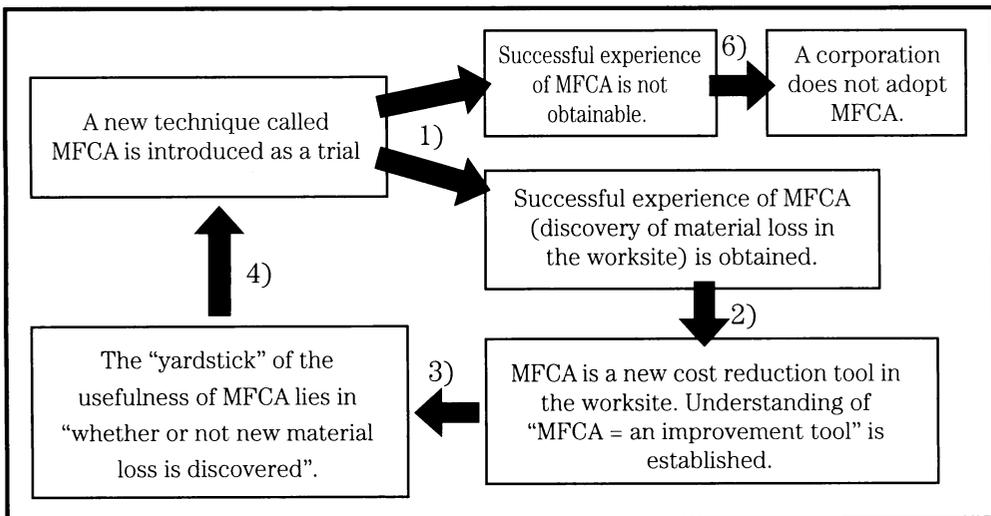


Figure 1-5 Loop of MFCA Introduction in the Previous General Cases

5) Professor C. Saka of Kwansai Gakuin University suggested materials concerning the possibility of linkage of MFCA with financial indices & cash flow indices. I consider that an important suggestion to consider MFCA data utilization as KPIs. I would like to attempt to utilize MFCA as a KPI but not as a financial index. I would like to make them all future research issues.

result, as the lower arrow at 1) in Figure 1-5 indicates, MFCA is considered useful if “a successful trial result of MFCA is obtained”. However, as the arrow at 2) shows, MFCA is understood as an improvement tool. As a result, the yardstick of the usefulness of MFCA will become “whether or not any new material loss will be discovered” as shown in the arrow at 3). For the purpose of further spread and development, as shown by the arrow at 4) the loop will return to “introducing a new technique called MFCA as trial”, and whether or not a case of success will be obtained will become important. However, MFCA is not necessarily a technique to discover a major material loss as it is a diagnostic technique of material productivity. Accordingly, as indicated by an upper arrow at 1), in some cases “no successful result is obtained” and the result is that as indicated by the arrow at 6), MFCA will be ended without MFCA being adopted as management system information by the corporation.

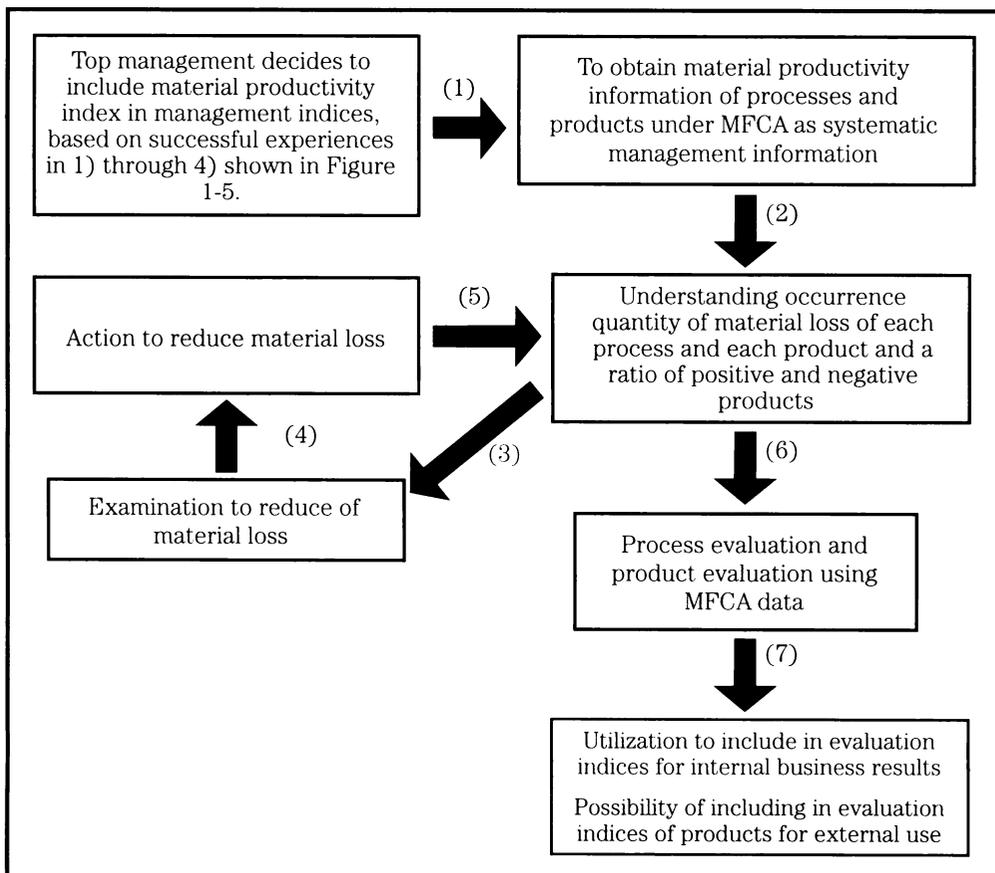


Figure 1-6 Scenario for MFCA Management Systematization

Although a “person who understands MFCA well” in the above has discovered the usefulness of MFCA as corporate management information, he or she will go round following this loop to find a case of success, fearing when he or she will fail in order to obtain as many people who understand MFCA well as possible in a sense⁶⁾.

Then, what should be done to enable management systematization of MFCA? One is to continue to make a case of success until top management realizes and understands the usefulness of MFCA in the loop in Figure 1-5 mentioned above. However, it is extremely difficult and that it will depend on luck and good chance. In many cases, the necessity and difficulty of obtaining a success case is discussed and how to continue this loop in MFCA systematization is pointed out in conversation with a person who understands MFCA well with a corporation which has introduced MFCA. On the other hand, as Figure 1-6 shows, a new scenario for the construction of MFCA management is required.

In other words, as Figure 1-6 shows, the most important issue is not to maintain the loop to make a success index but that “top management decides to include material productivity index as management index, based on successful experiences from 1) to 4) in Figure 1-5”. Many companies now pay attention to material productivity, having shifted from discussion about exhaustion of resources. However, corporations do not possess many indices relating to this material productivity, if any. The first step is to make a decision on measurement and systematization of this material productivity information as shown in the arrow at (1) in Figure 1-6. Following this step, “occurrence ratios of material loss and ratios of positive and negative products in each process & each product”, etc. will be measured and understood as basic information of MFCA as shown by the arrow at (2). As shown by arrows at (3) and (4) based on this management index, reduction of material loss is carried out as a management issue, and its results shown by the arrow (5) will be reflected in MFCA basic information, and will be systematized as management information.

Furthermore, MFCA basic information is used not only for reduction of material loss but also as performance evaluation index concerning material productivity in its own process and that of products created in such process. In this way, basic information of MFCA will become possible to be evolved as performance evaluation of internal organizations of one’s own company and product performance evaluation index for external use by using basic data of MFCA as a material productivity index, as shown by the arrow at (7).

6) One case of success can make a person who understands MFCA well (a fan of MFCA), but one failure example will make many anti-MFCA persons.

In this system, it is not systematization of management information only for the purpose of reduction of material loss, but management systematization for material productivity management. Accordingly, in the above case of success, results of management will be raised as an issue, but in material productivity management system, there is no significance in the existence of the system, where the purpose is purely the reduction of material loss.

7. MFCA Information as New Material Productivity Index

In this research, systematization where MFCA is considered lightly. In addition, MFCA is an environmental management accounting technique, and it is a corporate internal management technique and is not for information provision to outsiders. However, it is a management technique which attempts to reform the development of products from the viewpoint of material productivity. MFCA information may be used to evaluate and utilize improvement and reform within one's own company but may be used as evaluation for external use. For example, it means that MFCA adds material productivity to quality, which is product competitiveness, as an environmental aspect. As the following Figure 1-7 shows, there is cost as the past product competitiveness. Assuming that both A and B manufacture the same product (a product with the same function) and where the same product is manufactured in the production process of one's own companies, Company A requires cost of 1,000 yen, and Company B requires cost of 800 yen. Then, it is naturally evaluated that Company B has greater competitiveness in the product. This is cost competitiveness, and manufacture in a place where less expensive management materials can be obtained will be sought, even for a small difference.

Compared to this, as shown in the following Figure 1-8, where MFCA analysis is introduced and comparison between companies becomes possible, another aspect of competitiveness between the above mentioned Company A and Company B will be visualized. MFCA is a management technique to promote reduction of material loss by actualizing material loss in producing a unit output (a product), and the result of improvement will be attained in reduction of input material quantity against a unit output. Corporations will aim for and realize the minimization of input material using MFCA information. As a result of MFCA analysis, for example, it can be recognized that Company A inputs 800kg of material to manufacture a unit of the same product (700kg), while Company B inputs 1,200kg of material. This means a difference in respective production processes and the ability of developing products. This information is a numerical value example solely for explana-

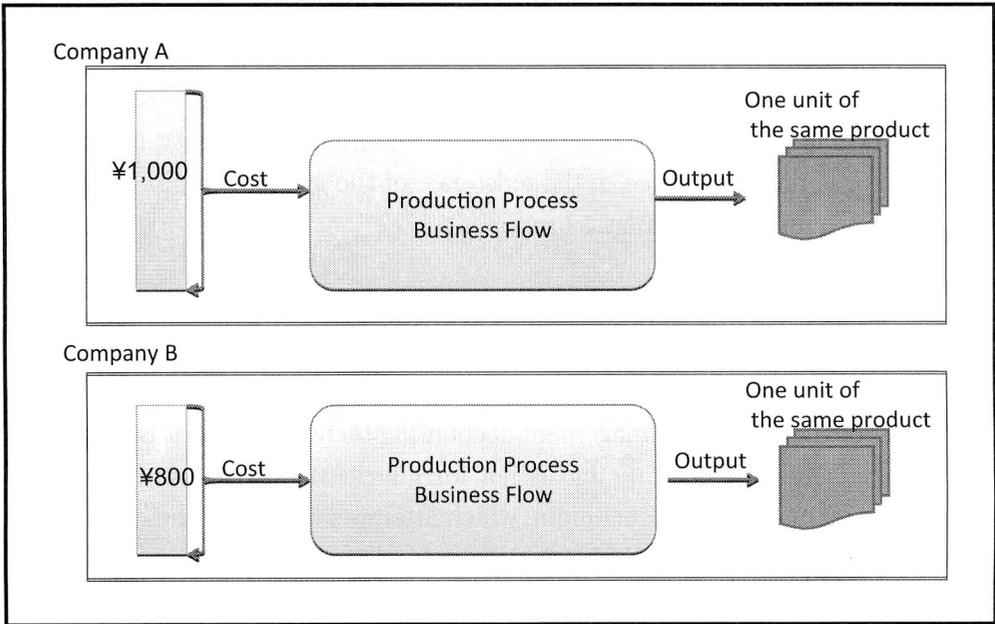


Figure 1-7 Traditional product indicator by cost

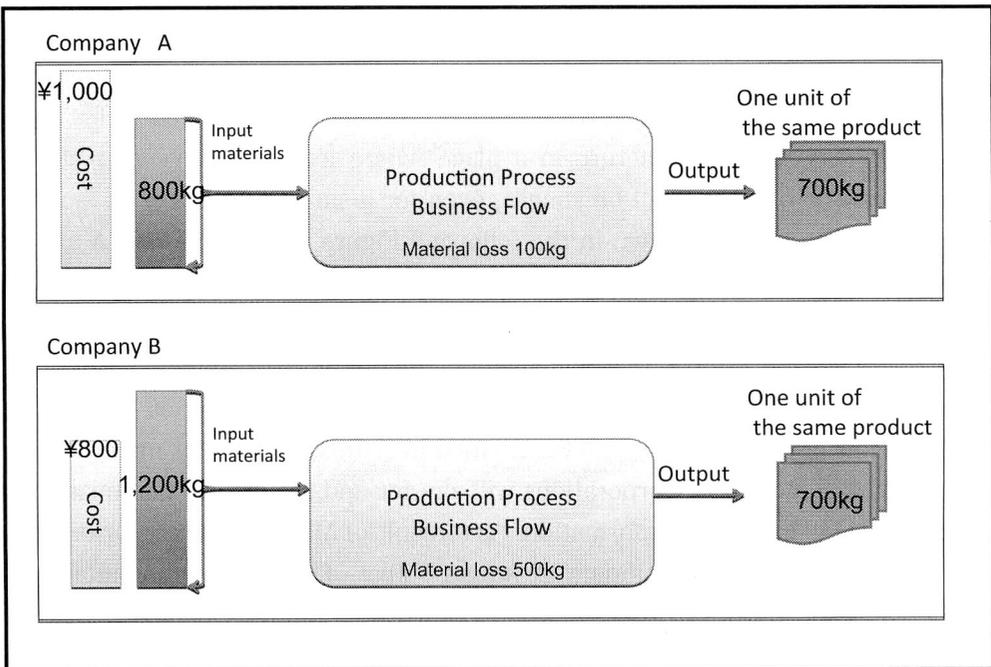


Figure 1-8 Possibility of new product indicator by MFCA

tion, but where material productivity is considered from the viewpoint of global exhaustion of resources, material productivity information by MFCA may be labeled as information showing products in the environmental age, quality and competitiveness of corporations.

The enhancement of manufacturing method and production facilities to maximize material productivity of input material and the on-the-spot ability to put this into specific practice are required more than anything else. Developing products in Japan enables the realization of such environmental management accounting for advanced cleaner production. Not only cost performance but also material productivity index by MFCA will contribute also to technological evaluation of developing products in the world as well as developing products in Japan.

8. Conclusion

This paper has examined the nature of management systematization of MFCA. As a result, patterns and issues of management systematization of MFCA which have been discovered among the accumulated corporate cases have firstly been clarified. Then, this paper has shown a model and scenario of management systematization of MFCA. There is a method of utilizing MFCA as temporary management technique where special cost studies tends to be carried out, but there is also a method of management systematization. However, on the other hand, the significance and issues of management systematization of MFCA have similarly been discussed. This paper explained the importance and significance of management systematization of MFCA. On the basis of such significance and importance, MFCA would be systematized as a management system, and simultaneously, it is important to construct corporate cases which will further develop corporate management by MFCA which is systematized as a management system.

In addition, this research considers that management by MFCA will enable evaluation of corporate technological ability, product ability, on-the-spot ability and their results by reduction of material loss by looking at the previous corporate cases of success. Corporations will make knowledge accumulated for staff at one's own company formalized knowledge and, in addition, it is considered that the results of analysis of MFCA will enable accumulation of formalized knowledge. Because product manufacturing processes are seen through as one thing under MFCA, communication concerning the whole corporation which is made between departments that are involved in production system is promoted, and joint ownership of such knowledge and experience are also promoted. It considers that utiliza-

tion of MFCA has been a success, where the concept of consideration of environment into on-the-spot improvement among Japanese companies has been adopted. Specifically, this means the execution of improvement activities of promotion and realization of material saving in manufacturing processes.

Lastly, as future issues, it is important to carry out theoretical arrangements of improvement information of MFCA by clarifying the difference from the conventional management accounting techniques by carrying out surveys on corporate cases. Furthermore, examination of fusion with new environmental information such as energy information, carbon foot print, lifecycle concept, etc. is also a future issue.

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