

The use of material flow cost accounting for process losses reduction

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Abstract — Material Flow Cost Accounting allows you to accurately monitor the physical and monetary value of waste, which increases the visibility of environmental costs and gives managers possibility to identify areas of cost savings. The article discusses the general aspects of Material Flow Cost Accounting and a comparative analysis of methods for the evaluation of the cost of irrecoverable waste in Material Flow Cost Accounting and traditional cost accounting. In order to increase the usefulness of the information generated within Material Flow Cost Accounting, it is proposed to use this method in the whole chain of product delivery to the final customer. Material Flow Cost Accounting (MFCA) is a powerful tool for environmental management that can be applied to any organization, regardless of industry. Material Flow Cost Accounting helps companies to increase the transparency of information on technological losses, thus to reduce the level of environmental pollution and increase the efficiency of business running.

Keywords — MFCA, material flow cost accounting, environmental management, environmental performance, material flows, eliminated waste)

I. INTRODUCTION

combining the environmental and economic performance through the implementation of environmental management accounting, has become Japan. As a result, the ISO/TC207/WG8 (Japanese standard for MFCA) was created in Japan in 2008. Material Flow Cost Accounting was developed as a tool to improve the efficiency of materials' use

in the production process. It became well known because of its use in Japan as a useful tool for the assessment of technological losses in physical and monetary terms. This method involved a detailed view of material and energy flows in an organization where these costs are identified and taken into account at all stages of production, but where at the same time the cost of irrecoverable waste was not included into the cost of the final product [Nakajima et al., 2015].

In order to improve economic and environmental performance of organizations, MFCA standard was developed in Germany as the official international standard ISO 14051:2011 "Environmental management – Material flow cost accounting – General framework". MFCA method can be applied in manufacturing to assess production losses due to inefficient use of resources and identify possible savings that can bring economic and environmental benefits [Abdel-Kader, 2011].

In Russia, the standard GOST R ISO 14051-2014 "Environmental management. Cost accounting for material flows. General principles", entered into force only in 01.01.2016 and fully corresponds to the international standard.

The purpose of this article is to study the advantages and possibilities of Material Flow Cost Accounting application into business organizations' practice.

II. MATERIALS AND METHODS (MODEL)

International standard for MFCA establishes the main objectives and principles of cost accounting for material flows of an organization, and at the same time it can be spread to other companies which are in the same production chain. The main elements of Material Flow Cost Accounting are the accounting points, material balance, cost calculation and model of materials flow.

Material Flow Cost Accounting enables you to track material flows in physical and monetary terms and to identify technological losses. The traditional cost accounting system, in contrast to the MFCA, does not evaluate the costs of irrecoverable waste and costs from unproductive processes [Sygulla et al., 2015]. In traditional cost accounting, all the material and technological costs are transferred to the cost of goods [Kulikova and Gafieva, 2014]. Waste elimination control cost also can be included into the cost of goods or taken into the account of the overhead [Aletkin, 2014]. Therefore, this method of cost accounting cannot provide information about the costs of technological loss and ineffective processes.

Material Flow Cost Accounting, in turn, allows you to highlight technological losses and to assess accurately their costs. And later the cost of materials and cost of recycling (energy and system costs) are transferred to the technological losses on the basis of the appropriate criteria for costs' transfer, and waste elimination control costs are fully assigned to the waste.

From the point of view of availability of information, Material Flow Cost Accounting looks like a traditional cost accounting system, but the latter is not able to provide the necessary information for decision-making. The traditional cost accounting system monitors the cash flows and identifies them as the cost of the final product [Rieckhof et al., 2015]. It focuses on the accuracy of formation of the cost of each product in each process and draws attention to the correspondence between the indicators of final products' costs and production costs based on accounting data.

Material Flow Cost Accounting primarily checks material balances of input and output streams of each technological process. Normally, organizations know how many materials are implemented into production and how much production is produced from these materials. However, the lack of data on the amount of irrecoverable waste in every process of production is a common phenomenon [Fakoya and Margaretha, 2013]. And loss values are known on major departments or company level. Consequently, the identification and evaluation of technological losses in each production process is an important step in improvement of production management. Similar problems arise regarding auxiliary materials and energy costs. And also the necessary information is available only on high levels of the company.

The main methods used in this research are the comparison method, methods of analysis and synthesis.

Below we consider the main differences between the traditional system of cost accounting and Material Flow Cost Accounting on a numerical example.

Suppose that in one accounting point there is 50 kg initial material stock of 1.9 million RUB value and later 230 kg of materials worth of 10 million are received. After processing, the cost of which was 2 million RUB., output streams were generated: the product (200 kg) and irrecoverable waste (50 kg). The balance of unused materials, accordingly, is equal to 30 kg worth of 1.3 million RUB (the average cost). At the same time processing costs are divided into energy costs (0.3 million RUB), system costs (1.2 million RUB) and waste elimination control costs (0.5 million RUB). From the above listed costs the waste elimination control costs completely depend on the technological losses.

Table 1 presents the final product cost calculation by using the traditional cost accounting system, which, for example, allows not calculating the cost of irrecoverable waste, and all the costs are included in the final product cost price [Kulikova et al., 2014].

TABLE 1 OUTPUT COST CALCULATION (TRADITIONAL COST ACCOUNTING SYSTEM)

Indicators	Amount, mln. Rub.
1. Initial stock of materials in the cost accounting point	1,9
2. Materials received to cost accounting point during the period	10
3. The final balance of materials in the cost accounting point	1,3
4. The processing cost	2,0
5. The cost of output (p. 1+p. 2 -p. 3+p. 4)	12,6

Material Flow Cost Accounting separately calculates the cost of technological losses:

$$CTL = L + C, \quad (1)$$

where CTL - the cost of technological losses;

L – expenditure due to technological losses;

C – distributed costs of cost accounting point.

Meanwhile distributed costs of cost accounting point are calculated in physical terms proportionally to the material flows into the cost accounting point:

$$C = (TC - L) / (FG + W) \times W, \quad (2)$$

where TC – total costs of cost accounting point;

FG – final goods of cost accounting point in physical terms;

W – waste of cost accounting point in physical terms.

Table 2 presents the cost calculation of output and technological losses by using Material Flow Cost Accounting.

The calculations show that the cost of irrecoverable waste is 2 920 thousand RUB, i.e. 23.2% of all production costs. That means that the company does not use rationally its resources and the measures to reduce and optimize costs have to be carried out.

So, by using Material Flow Cost Accounting we managed to figure out how inefficiently are used company resources, as 23.2% of all production costs are irrecoverable waste, and it

can be defined within the traditional cost accounting. Figure 1 and 2 show that unlike Material Flow Cost Accounting, within the traditional accounting all the costs incurred are related only to the production cost and the production efficiency is difficult to determine, as waste is expressed only in physical terms.

TABLE 2 OUTPUT AND TECHNOLOGICAL LOSSES COST CALCULATION
(MATERIAL FLOW COST ACCOUNTING)

Indicators	Amount, mln. Rub.
1. Initial stock of materials in the cost accounting point	1,9
2. Materials received to cost accounting point during the period	10
3. The final balance of materials in the cost accounting point	1,3
4. The cost of all processing, including	2,0
4.1. Energy costs	
4.2. System costs	0,3
4.3. Waste elimination control cost	1,2
	0,5
5. Total costs of cost accounting point (p. 1+p. 2-p. 3+p. 4)	12,6
6. Output, kg	200
7. Irrecoverable waste, kg	50
8. The irrecoverable waste cost (p. 4.3+(p. 5-p. 4.3)/(p. 6+p. 7)* p.7)	2,92
9. Output cost (p. 5-p. 8)	9,68

The example illustrates that with Material Flow Cost Accounting the company receives complete information about the number and value of technological losses, which cannot be obtained by using the traditional cost accounting. Due to Material Flow Cost Accounting management can identify the causes of technological losses and take measures to prevent them. Technological losses cost can serve as an indicator for improvement of the production process. Therefore, the cost reduction potential is in the lack of production losses. As a result, the money savings will be definitely higher with MFCA, than if the company estimates its waste cost based only on the materials used [Nakajima et al., 2015]. The international standard offers several stages for implementation of Material Flow Cost Accounting in organization. The level of detailing and complexity of MFCA depends on the size of the organization, its occupation, manufacturing products and number of technological processes. These conditions make MFCA flexible tool that can be applied practically in any organization, regardless of the environmental management system [Christ and Burritt, 2015].

Many Japanese companies understand Material Flow Cost Accounting, as a new "Kaizen". Usually, they collect information based on the assessment of the real production situation and then visualize the current situation. This requires assistance of the various functional departments, for example, of the manufacturing department, engineering department, Division for Management Accounts, environmental safety department and others. And as a rule, if the information is taken from the accounts management system, the separate cost estimation of each workshop is not done [Doorasamy, 2016]. However, in this case, inconsistencies in management accounting can be non-defined and consequently the technological losses can be evaluated wrongly. Therefore, companies must pay attention on the accuracy and relevance

of available information, and the importance of collection and cost estimating procedures.

An important aspect of the method of Material Flow Cost Accounting is an analysis of product cost formation chain, which consists of a number of technological operations. The advantage is that the obtained information about the technological losses cost in the different production processes leads to increased transparency of material flows. Analysis of product cost formation chain has similarities with the methods of analysis in environmental management, for example, with the method of life cycle assessment, which contains information about the technological chain of products and semi-finished products manufacturing [Prox, 2015].

However, in practice there might be situations when due to the low vertical depth of production, many production chains are distributed among various companies. This means that intermediate products are distributed between the providers before the consumer gets the final product. Accordingly, the material damage in the form of technological losses has to be applied to the entire production chain and preventing actions need to be taken in all companies involved in products manufacturing. But it requires a high level of trust between the companies. Therefore, it is recommended to integrate this method of accounting and analysis in the full product supply in order to improve MFCA system.

Japanese company of lenses production can be taken as an example of such implementation. According to the traditional production and management accounting, which was used in the company, the ratio of produced products was considered effective and was 99% because from 100 released lenses only 1 was defective. But as a result of the MFCA analysis, it was discovered that the cost of irrecoverable waste (residue generated during the glass processing; the sludge from other materials; coating materials, not applied on the lens; substandard products) made up 32% of all production costs. So, the traditional cost accounting system of the company was not able to evaluate correctly the production efficiency. After conducting MFCA analysis, the Japanese company took steps to improve the manufacturing process and to reduce technological losses in conjunction with the provider of materials for lenses (glass) manufacturing. As a result, company developed a new form of glass, which allowed reduction of technological losses by 80%. Thus, both companies have obtained environmental benefits in the form of irrecoverable waste reduction and economic benefits in the form of reduced cost of production [Chompu-Inwai et al., 2015].

III. RESULTS AND DISCUSSION

To increase efficiency of implementation of Material Flow Cost Accounting, i.e., to use it as regular, systematic and comprehensive tool for analysis in the system of company management, data collection must be necessarily done by existing accounting system. In practice, there are situations when an organization is considering Material Flow Cost Accounting as a supplementary tool, applied only when necessary, or organization does not find it necessary to expand the existing information management system, since there are

already a sufficient number of efficient performance indicators. But it should be noted that the use of Material Flow Cost Accounting requires its integration into the existing information system [Rieckhof et al., 2015].

Literature offers to implement Material Flow Cost Accounting gradually in order to adapt the existing information system. As an initial step Material Flow Cost Accounting can be used in a separate calculation or in environmental management system in order to obtain information about the possibility of further integration of MFCA and enterprise information system. In the case of complex production systems, while using MFCA one can initially focus on processes with significant environmental and economic impacts in the activities of the organization [Sygulla et al., 2015]. Further, for making economic and environmental improvements in manufacturing processes and products, it is necessary to continue to evaluate how the Material Flow Cost Accounting is applied in order to avoid the information duplication in data collection. Literature also offers the integration of MFCA in the existing system of information depending on the size of the company [Lang and Beucker, 2004]. For example, small and medium-sized companies can integrate Material Flow Cost Accounting using an existing database. Large organizations are advised to merge MFCA with the information system, for example, the existing SAP R/3 with the environmental management system in order to create synergy in the database.

Integration of ERP system and environmental management system requires adaptation in the structure of the database and accounting system, and the change in the reporting according to the MFCA requirements. In this way, the movement of materials and losses must be reported individually and allocated to cost centers to determine causal link and to define the responsibility for each stage of production [Lang et al., 2014]. Synergy in information gathering and transparency can be increased by elimination of data discrepancy, which is a result of incorrect data or the detection of intentional entering of false information into the database. Integration of Material Flow Cost Accounting can also be basis for more detailed documentation of the manufacturing process and can increase awareness about the losses caused by high turnover [Rieckhof et al., 2015]. Furthermore, MFCA can also serve as a basis for interactive use within the management system by further development of network technology [Lang and Beucker, 2004]. Based on the gradual improvement of data collection through the integrated information system, an additional step can be defined for the integration of MFCA with traditional cost accounting.

IV. CONCLUSION

The complexity of the implementation of Material Flow Cost Accounting into the Russian companies depends on the availability of such systems as EMS (environmental management system) or ERP (enterprise resource planning). The use of these systems facilitates the process of MFCA introduction in the organization and reduces the initial costs of integration. In Russia the majority of large companies have

full-fledged management system of enterprise resources. Small and medium-sized companies, in their turn, use similar, but more specialized functional components [Markaryan and Snetkova, 2015]. This fact proves that Russian companies can use the existing ERP or EMS systems as the basis for the integration of MFCA method, but on the condition that the benefits of its usage exceed the costs of its implementation.

At the moment MFCA is actively implemented by the world's largest companies. For example, large pharmaceutical company in Germany was able to integrate Material Flow Cost Accounting into the existing ERP system within one year. As a result the discrepancy of 10 million euros was revealed between the input and output flows, and there was taken decision to prepare regular reporting on material flows tracking [Kokubu and Kitada, 2015]. Accordingly, the use of Material Flow Cost Accounting in the Russian enterprises can contribute to rational use of resources, costs reduction and financial performance improvement.

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