भारतीय मानक

Indian Standard

IS 18885 : 2024
ISO 14053 : 2021

पर्यावरणीय प्रबंधन — सामग्री प्रवाह लागत लेखांकन — संगठनों में चरणबद्ध कार्यान्वयन के लिए मार्गदर्शन

Environmental Management — Material Flow Cost Accounting — Guidance for Phased Implementation in Organizations

ICS 13.020.20

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Environmental Management Sectional Committee, CHD 34

NATIONAL FOREWORD

The Indian Standard which is identical to ISO 14053 : 2021 ‘Environmental management — Material flow cost accounting — Guidance for phased implementation in organizations’ issued by the International Organization for Standardization was adopted by the Bureau of Indian Standards on the recommendation of the Environmental Management Sectional Committee and approval of the Chemical Division Council.

This standard gives practical guidelines for the phased implementation of material flow cost accounting (MFCA) that organizations, including small and medium-sized enterprises (SMEs), can adopt to enhance their environmental performance and material efficiency.

This document provides:

a) common terminologies;

b) principles;

c) a calculation approach, analysis and improvement; and

d) an application of the MFCA implementation result.

This standard provides basic calculation procedures to analyse saving potentials by avoiding material losses. Detailed calculation procedures or information on techniques for improving material or energy efficiency are out of the scope of this document

The text of ISO standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words ‘International Standard’ appears referring to this standard, they should be read as ‘Indian Standard’; and

b) Comma (,) has been used as a decimal marker, while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

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Introduction

Achieving the Sustainable Development Goals (SDGs) established by the United Nations in 2015 has become a high priority for society. In particular, Goal 12 requires both governments and private sectors to ensure sustainable consumption and production patterns. Companies of all sizes need to achieve improvements in material and energy efficiency for sustainable production.

A number of International Standards provide guidance on material flow cost accounting (MFCA), which is an approach to assess material efficiency within an organization (see ISO 14051) and to enhance material efficiency in cooperation with supply-chain partners (see ISO 14052). While organizations are encouraged to implement MFCA based on ISO 14051, depending on levels of operations, they may prefer a more simplified approach to MFCA. To address this need, this document provides guidance for organizations to initiate a phased implementation of MFCA. This approach focuses on the most relevant production process to enhance material efficiency along with cost reductions, possibly leading to additional business opportunities (e.g. a green supply chain).

This document can be used independently of ISO 14051 and ISO 14052. However, the basic philosophy of MFCA as well as the terms and definitions are the same as in ISO 14051. In addition, this document has been designed to help organizations to identify new business opportunities regarding material and energy efficiency. Large organizations can also use this document as a starting point for their implementation of MFCA in a specific department or process.

This document provides:

— common terminologies;

— principles;

— a calculation approach, analysis and improvement;

— an application of the MFCA implementation result.

Annex A gives a case example of an MFCA implementation in organizations.

Indian Standard

ENVIRONMENTAL MANAGEMENT — MATERIAL FLOW COST ACCOUNTING — GUIDANCE FOR PHASED IMPLEMENTATION IN ORGANIZATIONS

1 Scope

This document gives practical guidelines for the phased implementation of material flow cost accounting (MFCA) that organizations, including small and medium-sized enterprises (SMEs), can adopt to enhance their environmental performance and material efficiency.

The phased approach provides flexibility that allows organizations to develop their MFCA activities at their own pace, according to their own circumstances. The resulting information can act as a motivator for organizations to seek opportunities to simultaneously generate financial and environmental benefits by reducing material losses and energy consumption.

This document is applicable to any organization, regardless of its level of development, the nature of its activities, or the location at which these activities occur.

This document provides basic calculation procedures to analyse saving potentials by avoiding material losses. Detailed calculation procedures or information on techniques for improving material or energy efficiency are out of the scope of this document.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purpose of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
energy cost
cost for electricity, fuels, steam, heat, compressed air and other like media

Note 1 to entry: Energy cost can be either included under material cost or quantified separately, at the discretion of the organization.

[SOURCE: ISO 14051:2011, 3.4]

3.2
energy use
application of energy

EXAMPLE Ventilation; lighting; heating; cooling; transportation; data storage; production process.

Note 1 to entry: Energy use is sometimes referred to as “energy end-use”.

[SOURCE: ISO 50001:2018, 3.5.4]

3.3
material
substance that enters and/or leaves a process

Note 1 to entry: Materials can be divided into two categories:

— materials that are intended to become part of products, e.g. raw materials, auxiliary materials, intermediate products;

— materials that do not become part of products, e.g. cleaning solvents and chemical catalysts, which often are referred to as operating materials.

Note 2 to entry: Some types of materials can be classified into either category, depending on their use. Water is one such material. In some cases, water can become part of a product (e.g. bottled water), while in other cases it can be used as an operating material (e.g. water used in an equipment washing process).

Note 3 to entry: Energy carriers like fuels or steam can be identified as materials, at the discretion of the organization.

[SOURCE: ISO 14051:2011, 3.10, modified — "quantity centre" changed to "process".]

3.4
material flow cost accounting summary sheet
MFCA summary sheet
spreadsheet that reflects the *MFCA* (3.6) information for a production process that is treated as a single process

3.5
material cost
cost for a substance that enters and/or leaves a process

Note 1 to entry: Material cost can be calculated in various ways, e.g. standard cost, average cost, and purchase cost. The choice between cost calculation methods is at the discretion of the organization.

[SOURCE: ISO 14051:2011, 3.12, modified — "quantity centre" changed to "process".]

3.6
material flow cost accounting
MFCA
tool for quantifying the flows and stocks of *materials* (3.3) in processes or production lines in both physical and monetary units

[SOURCE: ISO 14051:2011, 3.15]

3.7
material loss
all material outputs generated in a process, except for intended products

Note 1 to entry: Material losses include air emissions, wastewater and solid waste, even if these material outputs can be reworked, recycled or reused internally, or have market value.

Note 2 to entry: By-products can be considered as either material losses or products, at the discretion of the organization.

[SOURCE: ISO 14051:2011, 3.16, modified — "quantity centre" changed to "process".]

3.8
system cost
cost incurred in the course of in-house handling of the *material* (3.3) flows, except for *material cost* (3.5), *energy cost* (3.1) and *waste management cost* (3.9)

EXAMPLE Cost of labour; cost of depreciation and maintenance; cost of transport.

[SOURCE: ISO 14051:2011, 3.21]

3.9
waste management cost
cost of handling *material losses* (3.6) generated in a process

[SOURCE: ISO 14051:2011, 3.22, modified — "quantity centre" changed to "process", notes to entry have been deleted.]

4 Principles

4.1 Understand the basic material flow and energy use

The material flows related to products and energy use, including material losses in the most relevant production process, are identified and quantified as physical data.

4.2 Ensure the reliability of physical data

Physical data on material flows and energy use are collected in consistent measurement units.

NOTE Refer to ISO 14033.

4.3 Estimate and attribute costs to material losses and energy use

The costs associated with material losses and energy use are estimated, and these costs are attributed to the material losses and energy use.

4.4 Link physical and monetary data

Decision-making on environmental and management issues within organizations is supported by linking physical data with associated cost.

5 Cost calculations in a phased approach

5.1 General

Data on material flows and energy use should be translated into monetary units to support decision-making according to the cost calculations. This process consists of one preparation-phase, four calculation-phases and one analytical phase. Organizations can incrementally implement MFCA as indicated in 5.2 to 5.7.

5.2 Preparation phase — Identification of the most relevant production process in the organization

The organization should identify its most relevant production process. If there is a single production process in the organization, all of the material losses and energy use should be examined. If multiple processes are present, the organization can select either the most relevant production process or multiple processes as one single production unit for calculation.

A selection approach for the most relevant production process should be divided into two steps:

a) assess the magnitude of the different material losses and energy use;

b) select the process with a high raw material unit cost, large volume of material losses and defective products, etc. as the most relevant production process.

If the organization wants to assess several relevant processes, adoption of ISO 14051 is recommended.

5.3 Calculation phase 1 — Quantification of material flows in physical units

The amounts of material inputs and outputs should be quantified in physical units such as mass, length, number of pieces or volume, depending on the type of materials. Outputs are divided into products and material losses.

5.4 Calculation phase 2 — Calculation of material costs and waste management costs

Cost calculations should be started with material costs. This includes costs related to the materials used in the most relevant production process which may include raw materials, auxiliary materials, operating materials and intermediate products. The costs of all material inputs are assigned to products and material losses according to the physical quantity. In addition, waste management costs are calculated.

5.5 Calculation phase 3 — Calculation of energy costs

The calculation of energy costs is at the discretion of the organization. When it is determined to be necessary, energy costs should be calculated and allocated to products and material losses according to the physical data quantified in calculation phase 1.

5.6 Calculation phase 4 — Calculation of system costs

The calculation of system costs is at the discretion of the organization. When it is determined to be necessary, system costs should be calculated and allocated to products and material losses according to the physical data quantified in calculation phase 1.

5.7 Analytical phase — Analysis of material loss costs

Along with the phases above, an analysis of cost impacts should be conducted. Material loss costs could be understood as saving potentials for organizations. Material costs assigned to material losses are usually the most important target to be reduced. Additionally, energy costs and system costs can indicate further saving potentials. If multiple processes have been combined as one, it should be ensured that the system costs are actually correlated with the material losses.

6 Calculation methods in a phased approach and development of an improvement plan

6.1 General

This clause explains the calculation methods and gives examples of the templates in which the cost calculations should be made.

6.2 MFCA summary sheet

The MFCA summary sheet is a general template that can be used for MFCA in a phased manner. The template contains information on target materials, products and material losses as illustrated in Table 1. Calculated costs at each phase are summarized in the MFCA summary sheet.

Table 1 — MFCA summary sheet

Fundamental data	
Selected production process(es)	XYZ
Production period or lot size	1 lot
Planned production volume	500 pieces

	Input			Output			
				Product		Material loss	
Target materials	**Unit price** ($/kg)	**Input** (kg)	**Cost** ($)	**Output** (kg)	**Cost** ($)	**Output** (kg)	**Cost** ($)
Material A	–	–	–	–	–	–	–
Material B	–	–	–	–	–	–	–
Material C	–	–	–	–	–	–	–
Subtotal of materials		–	–	–	–	–	–
Waste management for material losses	**Unit cost** ($/kg)		**Cost** ($)			**Output** (kg)	**Cost** ($)
–	–		–			–	–
–	–		–			–	–
–	–		–			–	–
Subtotal of waste management			–			–	–
Energy	**Unit price** ($)	**Input**	**Cost** ($)	**Allocation ratio**	**Cost** ($)	**Allocation ratio**	**Cost** ($)
–	–	–	–				
–	–	–	–				
Subtotal of energy			–	–	–	–	–
System costs	**Unit cost** ($)	**Input**	**Cost** ($)	**Allocation ratio**	**Cost** ($)	**Allocation ratio**	**Cost** ($)
–			–		–		
–			–		–		
–			–		–		
Subtotal of system costs			–	–	–	–	–
Total cost			–		–		–
			Ratio on total costs		–		–

This is a simplified example for a table, more complete and comprehensive tables are provided in ISO 14051.

6.3 Example template for the preparation phase

The organization selects the most relevant production process and material inputs. In this example, XYZ production process and the material inputs “Material A”, “Material B” and “Material C” are assumed to be the most relevant for the organization.

For its implementation of MFCA, the organization decided to collect one lot data, which produces 500 pieces of product as planned. The organization entered the data into an MFCA summary sheet, as shown in Table 2. In the Tables 2 to 7, added information is shaded.

Table 2 — Identification of most relevant materials

Fundamental data	
Selected production process(es)	XYZ
Production period or lot size	1 lot
Planned production volume	500 pieces

	Input			**Output**			
				Product		**Material loss**	
Target materials	**Unit price** ($/kg)	**Input** (kg)	**Cost** ($)	**Output** (kg)	**Cost** ($)	**Output** (kg)	**Cost** ($)
Material A	–	–	–	–	–	–	–
Material B	–	–	–	–	–	–	–
Material C	–	–	–	–	–	–	–
Subtotal of materials		–	–	–	–	–	–
Waste management for material losses	**Unit cost** ($/kg)		**Cost** ($)			**Output** (kg)	**Cost** ($)
–	–		–			–	–
–	–		–			–	–
–	–		–			–	–
Subtotal of waste management			–			–	–
Energy	**Unit price** ($)	**Input**	**Cost** ($)	**Allocation ratio**	**Cost** ($)	**Allocation ratio**	**Cost** ($)
–	–	–	–				
–	–	–	–				
Subtotal of energy			–	–	–	–	–
System costs	**Unit cost** ($)	**Input**	**Cost** ($)	**Allocation ratio**	**Cost** ($)	**Allocation ratio**	**Cost** ($)
–			–		–		
–			–		–		
–			–		–		
Subtotal of system costs			–	–	–	–	–
Total cost			–		–		–
			Ratio on total costs		–		–

6.4 Example template for calculation phase 1

The organization quantifies the input volume and outputs as products and material losses. The input amount of Material A is 250 kg. Material flow into the products is 220 kg and material losses are 30 kg. Data on Materials B and C are quantified in the same way based on the mass, as illustrated in Table 3.

Table 3 — Quantification of material flows

Fundamental data	
Selected production process(es)	XYZ
Production period or lot size	1 lot
Planned production volume	500 pieces

	Input			**Output**			
				Product		**Material loss**	
Target materials	**Unit price** ($/kg)	**Input** (kg)	**Cost** ($)	**Output** (kg)	**Cost** ($)	**Output** (kg)	**Cost** ($)
Material A		250		220		30	
Material B		150		120		30	
Material C		100		10		90	
Subtotal of materials		500		350		150	

6.5 Example template for calculation phase 2

The organization uses data on the unit costs of Materials A, B and C. Material costs are calculated by multiplying the unit costs and the volume. The waste management cost is also estimated. Calculation phase 2 is illustrated in Table 4. If the waste management cost per material is unavailable, only an aggregated cost should be indicated.

Table 4 — Calculation of material costs and waste management costs

Fundamental data	
Selected production process(es)	XYZ
Production period or lot size	1 lot
Planned production volume	500 pieces

	Input			**Output**			
				Product		**Material loss**	
Target materials	**Unit price** ($/kg)	**Input** (kg)	**Cost** ($)	**Output** (kg)	**Cost** ($)	**Output** (kg)	**Cost** ($)
Material A	20	250	5 000	220	4 400	30	600
Material B	10	150	1 500	120	1 200	30	300
Material C	8	100	800	10	80	90	720
Subtotal of materials		500	7 300	350	5 680	150	1 620
Waste management for material losses	**Unit cost** ($/kg)		**Cost** ($)			**Output** (kg)	**Cost** ($)
of Material A	0,8		24			30	24
of Material B	0,5		15			30	15
of Material C	0,5		45			90	45
Subtotal of waste management			84			150	84

6.6 Example template for calculation phase 3

When the organization identifies data on energy use associated with the process, the energy cost used for the product and material loss are allocated by ratio per material inputs in the physical quantity. The physical quantity of the product is 350 kg (70 %) and the material loss is 150 kg (30 %) out of the

material inputs of 500 kg (100 %). Based on the subject ratios, electricity cost is calculated to be $ 280 ($ 400 x 70 %) and $ 120 ($ 400 x 30 %). The calculation phase 3 is illustrated in Table 5.

Table 5 — Calculation of energy costs

Energy	Unit price ($)	Input	Cost ($)	Allocation ratio	Cost ($)	Allocation ratio	Cost ($)
Electricity	0,4	1 000 kwh	400				
-	-	-	-	-	-	-	
Subtotal of energy			400	70 %	280	30 %	120

6.7 Example template for calculation phase 4

When the organization identifies data on system costs associated with the process, the system costs for product and material loss are allocated by ratio per material inputs in the physical quantity. The physical quantity of the product is 350 kg (70 %) and the material loss is 150 kg (30 %) out of the material inputs of 500 kg (100 %). The calculation phase 4 is illustrated in Table 6.

Table 6 — Calculation of system costs

System costs	Unit cost ($)	Input	Cost ($)	Allocation ratio	Cost ($)	Allocation ratio	Cost ($)
Labour			3 000				
Depreciation			1 000				
Others			300				
Subtotal of system costs			4 300	70 %	3 010	30%	1 290
Total cost			12 084		8 970		3 114
			Ratio on total costs		74,2 %		25,8 %

6.8 Example template for the analytical phase

The organization compiles the data of the phases above and completes the MFCA summary sheet as illustrated in Table 7.

Table 7 — Completed MFCA summary sheet

Fundamental data	
Selected production process(es)	XYZ
Production period or lot size	1 lot
Planned production volume	500 pieces

	Input			Output			
				Product		Material loss	
Target materials	**Unit price** ($/kg)	**Input** (kg)	**Cost** ($)	**Output** (kg)	**Cost** ($)	**Output** (kg)	**Cost** ($)
Material A	20	250	5 000	220	4 400	30	600
Material B	10	150	1 500	120	1 200	30	300
Material C	8	100	800	10	80	90	720
Subtotal of materials		500	7 300	350	5 680	150	1 620
Waste management for material losses	**Unit cost** ($/kg)		**Cost** ($)			**Output** (kg)	**Cost** ($)
of Material A	0,8		24			30	24
of Material B	0,5		15			30	15
of Material C	0,5		45			90	45
Sub total of waste management			84			150	84
Energy	**Unit price** ($)	**Input**	**Cost** ($)	**Allocation ratio**	**Cost** ($)	**Allocation ratio**	**Cost** ($)
Electricity	0,4	1 000 kwh	400				
Others	–	–	–				
Subtotal of energy			400	1	280	0	120
System costs	**Unit cost** ($)	**Input**	**Cost** ($)	**Allocation ratio**	**Cost** ($)	**Allocation ratio**	**Cost** ($)
Labour			3 000				
Depreciation			1 000				
Others			300				
Subtotal of system costs			4 300	70 %	3 010	30 %	1 290
Total cost			12 084		8 970		3 114
			Ratio on total costs		74,2 %		25,8 %

Based on the MFCA summary sheet (see Table 7), the organization identifies material and energy inefficiency as material loss costs of $ 3,114 (25,8 % of total input costs) for the saving potentials. This information can be the starting point of a communication within the organization, involving employees from purchasing, production, controlling and environmental management. This communication can lead to improvement plans for enhancing material efficiency as well as environmental performance. Furthermore, this activity can result in financial benefits through cost reductions.

6.9 Development of an improvement plan

Once an MFCA analysis has been completed and has assisted the organization to better understand the magnitude, consequences, and drivers of material use and loss, the organization can seek opportunities to improve environmental and financial performance. Material uses and losses are linked with direct and indirect environmental impacts and should be reduced as much as possible. MFCA should be applied to support the identification of relevant impacts. The measures taken to achieve these improvements can include a substitution of materials, a modification of processes, production lines or products, and intensified research and development activities related to material and energy efficiency. MFCA data can support the cost-benefit analysis of proposed measures, both those with additional investment and those with little or no initial investment.

7 Extended approach

If the organization has more than one process with a significant material loss, the procedure according to Clauses 5 and 6 can be applied to each process. Dependencies and links among those processes should not be considered due to the simplified implementation of MFCA.

If dependencies between the material losses in several processes are to be considered, ISO 14051 should be applied instead of this document. Likewise, when organizations have many production processes with significant material losses, MFCA implementation based on ISO 14051 should be considered.

Annex A
(informative)

Example of a phased MFCA implementation by an organization

A.1 Company profile

Company A is a small family-owned enterprise and a manufacturer of press parts for automobiles. It has one production facility and an administrative office.

It has a total of twenty employees. It has two steel press machines, manufacturing ten different products. The material flow model is shown in Figure A.1.

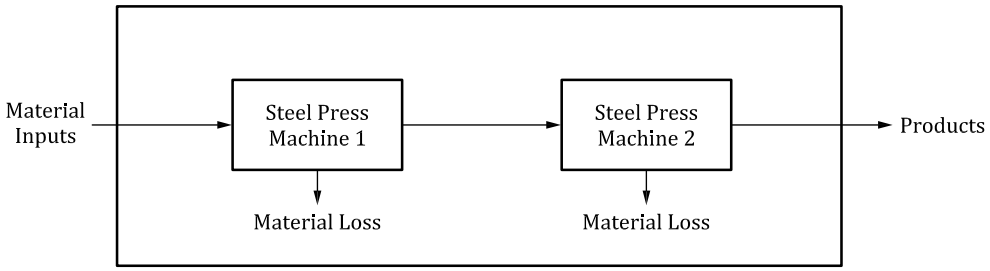

Figure A.1 — Material flow model of company A

A.2 Issue

Company A desires to reduce costs to enhance competitiveness. The company also plans to develop its environmental management to be more sustainable. In addition, the company faces a waste management issue because its volume of scrap has been increasing and has almost exceeded the capacity of its scrap yard.

A.3 Decision to implement a simplified MFCA

The company owner, production manager and environmental manager share responsibility for enhancement of its competitiveness and control of the on-site waste management issue. The environmental manager proposes the implementation of a simplified MFCA on a trial basis to the company owner and production manager, and this proposal is approved.

A.4 Preparation phase — Identification of the most relevant production process

The project team, which consists of a production manager, an environmental manager and some subordinates, reviews the monthly data of input materials for the two steel press machines. The review results are shown in Table A.1.

Table A.1 — Volume and type of input materials

Period: 1 Month (April 20XX)		
Materials	**Input** (kg)	**Unit cost** ($/kg)
Material A	1 207	13
Material B	600	8

Table A.1 *(continued)*

Period: 1 Month (April 20XX)		
Materials	**Input** (kg)	**Unit cost** ($/kg)
Material C	120	30
Material D	602	20
Material E	180	36

The production process consists of two processes that use the steel press machines 1 and 2 as shown in Figure A.1. The project team decides to recognize these multiple processes as one single production unit for the MFCA calculation in order to reduce the difficulties of the calculation.

A.5 Calculation phase 1 — Quantification of material flows in physical units

The project team assesses the material flows and confirms the amount of the products, as illustrated in Tables A.2.

Table A.2 — Fundamental data

Selected production process(es)	All processes
Production period	1 month (April 20XX)
Planned production volume	2 000 pieces

The project team quantifies the material losses from each input material as well as the use of machine oil. The results are illustrated in Table A.3.

Table A.3 — Data of input, products and material losses

Materials	Input (kg)	Products (kg)	Material losses (kg)
Steel sheet A	1 207	896	311
Steel sheet B	600	223	377
Steel sheet C	120	88	32
Steel sheet D	602	455	147
Steel sheet E	180	135	45
Machine oil	28	-	28

A.6 Calculation phase 2 — Calculation of material costs and waste management costs

The project team calculates the material costs by multiplying the unit costs and the volume, and adding the waste management costs. The results are illustrated in Table A.4.

Table A.4 — Input and output of each item

Fundamental data	
Selected production process(es)	All processes
Production period	1 month (April 20XX)
Planned production volume	2 000 pieces

	Input			Output			
				Product		Material loss	
Target materials	**Unit price** ($/kg)	**Input** (kg)	**Cost** ($)	**Output** (kg)	**Cost** ($)	**Output** (kg)	**Cost** ($)
Steel sheet A	13	1 207	15 691	896	11 648	311	4 043
Steel sheet B	8	600	4 800	223	1 784	377	3 016
Steel sheet C	30	120	3 600	88	2 640	32	960
Steel sheet D	20	602	12 040	455	9 100	147	2 940
Steel sheet E	36	180	6 480	135	4 860	45	1 620
Machine oil	2	28	56			28	56
Subtotal of materials		2 737	42 667	1 797	30 032	940	12 635
Waste management for material losses							
of scrap steel etc.			365				365
Subtotal of waste management			365				365

A.7 Calculation phases 3 and 4 — Calculations of energy costs and system costs

After their understanding of material costs and waste management costs, the project team computes the energy costs and system costs of the process. The project team adds the subject energy costs and system costs to the products and the material losses, as illustrated in Table A.5.

Table A.5 — MFCA summary sheet

Fundamental data

Table A.5 *(continued)*

Selected production process(es)	All processes
Production period	1 month (April 20XX)
Planned production volume	2 000 pieces

	Input			**Output**			
				Product		**Material loss**	
Target materials	**Unit Price** ($/kg)	**Input** (kg)	**Cost** ($)	**Output** (kg)	**Cost** ($)	**Output** (kg)	**Cost** ($)
Steel sheet A	13	1 207	15 691	896	11 648	311	4 043
Steel sheet B	8	600	4 800	223	1 784	377	3 016
Steel sheet C	30	120	3 600	88	2 640	32	960
Steel sheet D	20	602	12 040	455	9 100	147	2 940
Steel sheet E	36	180	6 480	135	4 860	45	1 620
Machine oil	2	28	56			28	56
Subtotal of materials		2 737	42 667	1 797	30 032	940	12 635
Waste management for material losses							
of scrap steel etc.			365				365
Subtotal of waste management			365				365
Energy	Unit price ($)	Input	Cost ($)	Allocation ratio	Cost ($)	Allocation ratio	Cost ($)
Electricity			1 660	66,3 %	1 101	33,7 %	559
Others	-	-	-				
Subtotal of energy			1 660		1 101		559
System costs	Unit price ($)	Input	Cost ($)	Allocation ratio	Cost ($)	Allocation ratio	Cost ($)
Labour			45 000	66,3 %	29 835	33,7 %	15 165
Depreciation			58 000		38 454		19 546
Others			15 000		9 945		5 055
Subtotal of system costs			118 000		78 234		39 766
Total cost			162 692		109 367		53 325
			Ratio on total costs		67,2 %		32,8 %

A.8 Interpretation of the MFCA summary sheet

The result of the MFCA summary sheet shows a material loss cost of $ 53,325 and a ratio of the material loss cost of $ 53,325 divided by the total cost of $ 162,692 equalling 32,8 %. This is interpreted as saving potentials for Company A. There are two main findings from the sheet:

a) the highest ratio of the material loss per the input (mass) comes from losses of steel sheet B; the ratio associated with the material loss is calculated by 377 kg/600 kg (i.e. 62,8 %);

b) the highest ratio of the material loss cost per the input (monetary) comes from losses of steel sheet B; the ratio associated with the material loss is calculated by $ 3,016/$ 4,800 (i.e. 62,8 %).

A.9 Development of the improvement plan

Based on the results above, Company A considers an improvement plan. The main objectives of improvement are steel sheet A and steel sheet B. Examining the process, they find that the cause of the material loss of steel sheet A is a problem with the shape of the purchased material, and the cause of the material loss of steel sheet B is in the layout of the design of the press dies. For the former, Company A could purchase materials with less material loss by negotiating with suppliers. For the latter, it is necessary to change the layout of the production process. By comparing the cost required to change the layout and the amount of the cost reduction resulting from reducing the material loss, the project team calculate how much layout change is allowed. As a result, Company A makes a plan for the layout change.

Subsequently, Company A decides to introduce ISO 14051 in order to implement a more comprehensive MFCA as a result of the analysis above and the effect of the improvements. In the future, they plan to deploy the MFCA in the supply chain based on ISO 14052.

Bibliography

[1] ISO 14051:2011, *Environmental management — Material flow cost accounting — General framework*

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[3] ISO 50001:2018, *Energy management systems — Requirements with guidance for use*

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