
**Environmental management —
Material flow cost accounting —
Guidance for practical implementation
in a supply chain**

*Management environnemental — Comptabilité des flux matières
— Lignes directrices pour la mise en application pratique dans une
chaîne d'approvisionnement*



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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 207, *Environmental management*.

Introduction

The aim of this document is to provide guidance for the practical application of material flow cost accounting (MFCA) in supply chains. MFCA is an environmental management accounting tool that assists organizations in creating a better understanding of their material and energy uses, the losses and the associated costs caused by material inefficiencies. The application of MFCA within an organization is explained in ISO 14051. Extending the scope of MFCA to multiple organizations in a supply chain will enable them to develop an integrated approach to more efficient use of materials and energy. This can result in various economic and environmental benefits for different organizations in the supply chain. These include reducing total material losses (main materials, energy and auxiliary materials) and thereby providing common opportunities to reduce costs, enhance environmental performance (e.g. GHG reduction and higher material/energy efficiency) and increase trust, collaboration, and fruitful business relationships. A trusted relationship between the different organizations in the supply chain and the increased common understanding of their own situation promotes collaboration. This can also be an incentive for long-term contracts through mutual MFCA-cooperation.

In order to achieve the benefits of an MFCA project extended to the supply chain for all organizations, it is a precondition that the collaborating organizations are committed to share information on processes and related material and energy flows to create a comprehensive understanding of the production system for the effective implementation of MFCA.

When applied in the supply chain, MFCA can improve existing supply chain management information sharing, communication mechanisms and management practices between suppliers and the purchasing department of organizations, which is the key connector between suppliers and customers. MFCA can complement existing environmental management and management accounting practices.

In addition, a thorough assessment of the material flows and energy use along all stages of the supply chain can also serve as a basis for comprehensive sustainability management. For example, MFCA information can be used for monitoring environmental indicators, or help in identifying and mitigating risks in the supply chain.

This document provides guidance on the following topics:

- the significance of integrating MFCA between organizations;
- a general approach for enhancing material and energy efficiency in the supply chain;
- steps for implementing MFCA in the supply chain.

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Environmental management — Material flow cost accounting — Guidance for practical implementation in a supply chain

1 Scope

This document provides guidance for the practical implementation of material flow cost accounting (MFCA) in a supply chain. MFCA fundamentally traces the flows and stocks of materials within an organization, quantifies these material flows in physical units (e.g. mass, volume) and evaluates the costs associated with material flows and energy uses. MFCA is applicable to any organization that uses materials and energy, regardless of its products, services, size, structure, location, and existing management and accounting systems. In principle, MFCA can be applied as an environmental management accounting tool in the supply chain, both upstream and downstream, and can help to develop an integrated approach for improving material and energy efficiency in the supply chain.

This document is based on the principles and general framework for MFCA described in ISO 14051.

The MFCA framework presented in this document includes scenarios for improving material and energy efficiency in a supply chain, principles for successful application of MFCA in a supply chain, information sharing, and practical steps for the implementation of MFCA in a supply chain.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 14050, *Environmental management — Vocabulary*

ISO 14051, *Environmental management — Material flow cost accounting — General framework*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 14050, ISO 14051 and the following apply.

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

- ISO Online browsing platform: available at <http://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1

energy efficiency

ratio or other quantitative relationship between an output of performance, service, goods or energy, and an input of energy

3.2

initiating organization

organization in the supply chain that introduces the MFCA process to its supplier(s) and/or customer(s) for the purpose of having a collaboration in reduction of material and energy losses

3.3 material efficiency

ratio or other quantitative relationship between an output of performance, products or service and an input of material

3.4 supply chain

sequence of activities or parties that provides products or services to the organization

Note 1 to entry: For the purposes of this document, a supply chain consists of at least two organizations, of which one organization purchases a material, a part or an intermediate product from a supplier or sells products to a customer.

[SOURCE: ISO 26000:2010, 2.22, modified — Original Note to entry has been deleted and new Note to entry has been added.]

4 Material and energy efficiency in a supply chain

4.1 Roles of an initiating organization in a supply chain

For the purposes of this document, an initiating organization will start the process of applying MFCA in its supply chain. This can be done by jointly analysing MFCA opportunities with suppliers, by discussing MFCA-related improvement opportunities with customers, or by simultaneously addressing MFCA-related improvement opportunities with one or several suppliers and/or one or several customers.

4.2 Generation of material losses from the viewpoint of a supply chain

The main objective of MFCA is to enhance material and energy efficiency. This can be achieved by reducing material and energy losses and by reducing the material use in products. In many cases, this can be achieved within an organization without reference to other organizations. In other cases, collaboration between two or more organizations in a supply chain can achieve even more reduction of total material losses throughout the supply chain. [Figure 1](#) illustrates material losses in the supply chain.

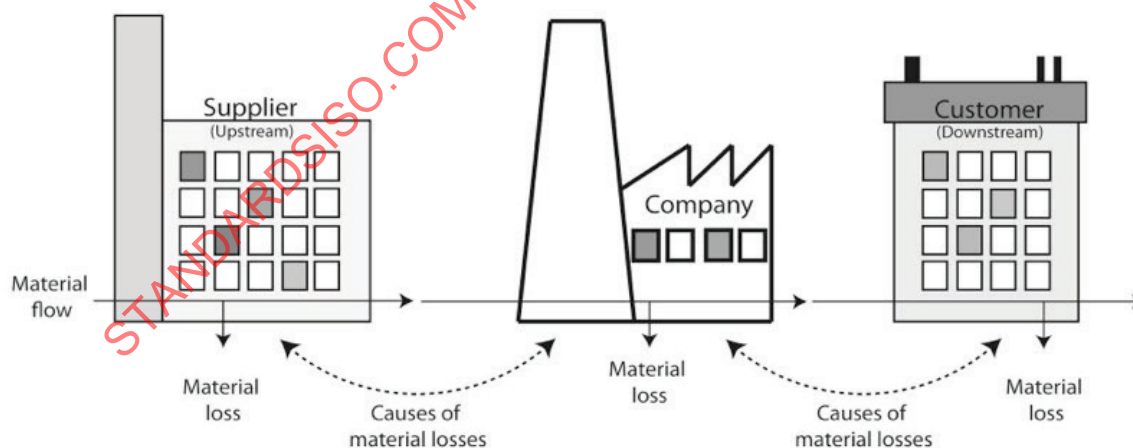


Figure 1 — Understanding material losses in the supply chain

In an upstream process in the supply chain, material losses may be due to various causes (e.g. dimensions or variations in quality of supplied materials). In a downstream process, an excessive degree of precision (design and specifications) or an excessive standard of quality required by the customer may also lead to material losses.

If upstream organizations know how their products are used in the downstream process, they may have an opportunity to propose collaborative projects to improve overall material efficiency.

If an organization understands the causes of material losses due to product specifications or other matters (e.g. processing condition) for materials or products delivered to downstream organizations, it becomes aware of potentially unnecessary material losses in the production of these materials or products. If it is found that excessive specifications result in additional material losses, a request for revision in specifications may lead to material and energy savings.

4.3 Cumulative material losses in a supply chain

In certain cases, the cumulative material losses caused by interlinked organizations in a supply chain may be significant. [Figure 2](#) illustrates an example of a simplified supply chain with a total material and energy loss of 70 % from the original inputs.

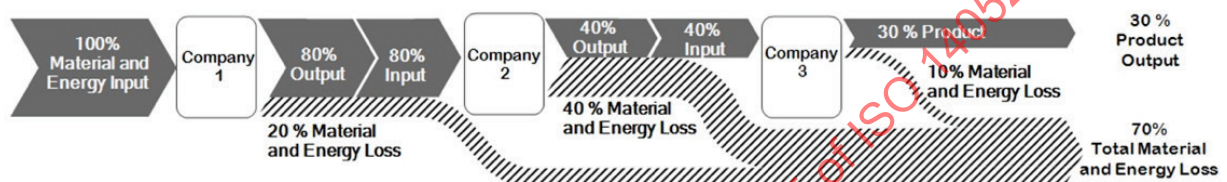


Figure 2 — Cumulative losses in the supply chain

In this example, 30 % of the inputs are included in the product. This reinforces that collaboration between organizations (companies 1, 2 and 3) has the potential to reduce overall material and energy losses to the benefit of multiple organizations.

5 Principles for successful application of MFCA in a supply chain

5.1 Commitment

The initiating organization is able to coordinate with other organizations involved in order to apply MFCA in a supply chain. Participating organizations are committed to improving material and energy efficiency in the supply chain.

5.2 Trust

The project is based on mutual trust between all organizations involved. When required, confidentiality of information is guaranteed among the involved organizations.

5.3 Collaboration

All participating organizations collaborate closely in implementing MFCA. In particular, for sharing and analysing the results, close collaboration is needed in order to reach solutions that provide benefit for all participating organizations.

5.4 Shared benefit

All participating organizations realize that the successful implementation of MFCA in the supply chain requires sharing of both efforts and benefits.

6 Information-sharing on MFCA analysis

6.1 General

Within the supply chain, information shared among organizations is often limited to specifications and price for products while fundamental MFCA implementation steps need different types of quantitative and other measurable information (e.g. amount and cost of material losses). It is important to clearly define the types of information shared for MFCA implementation in the supply chain. [Annex A](#) provides a case example of MFCA. [Annex B](#) provides an example of information-sharing activities.

6.2 Sharing of process-related information on material flow

Before the quantification of material flows, the material flow model within the defined boundary should be shared for review between the organizations. In particular, the establishment of the material flow model illustrates the overall flow of materials through the multiple organizations. This helps organizations to get an overview of the entire process and to identify the points where material losses may be present.

6.3 Sharing of physical information on material flow

Sharing of basic information on the physical quantities of material flows and energy use is the basis of information-sharing. When sharing such information in the supply chain, the organizations can maintain confidentiality on cost-based information such as production cost. Often, this already leads to discussions between the organizations to enhance material efficiency.

Summarized data of physical quantities will not readily allow the organizations in the supply chain to understand sufficiently the operating system in order to increase material and energy efficiency. Detailed information on the losses (e.g. composition, type of losses) is needed. The organizations can have in-depth discussions on quality requirements and specifications of components and products.

6.4 Sharing of quantified information on environmental impacts

Sharing of quantified information on environmental impacts related to material losses (e.g. CO₂ equivalent) helps organizations to focus on inefficiencies, which have potentially adverse effects on environment (e.g. emissions).

When sharing quantified information on environmental impacts, the information provider needs to be transparent in showing how the quantification of information on environmental impacts has been done (e.g. using ISO 14040, ISO 14044, ISO 14046 and ISO 14064).

6.5 Sharing of monetary information

Sharing of monetary information enables discussion on initiatives to reduce material, energy and system costs associated with the material losses. This type of information-sharing is recommended in order to identify the opportunities for enhancing material and energy efficiencies in the supply chain with the related monetary benefits.

7 Steps for the implementation of MFCA in a supply chain

7.1 General

[Figure 3](#) provides an outline of the MFCA implementation steps constructed in accordance with a Plan-Do-Check-Act (PDCA) cycle. Initial activities (see [7.2](#) to [7.8](#)) should be conducted before PDCA-based MFCA implementation (see [7.9](#) to [7.13](#)).

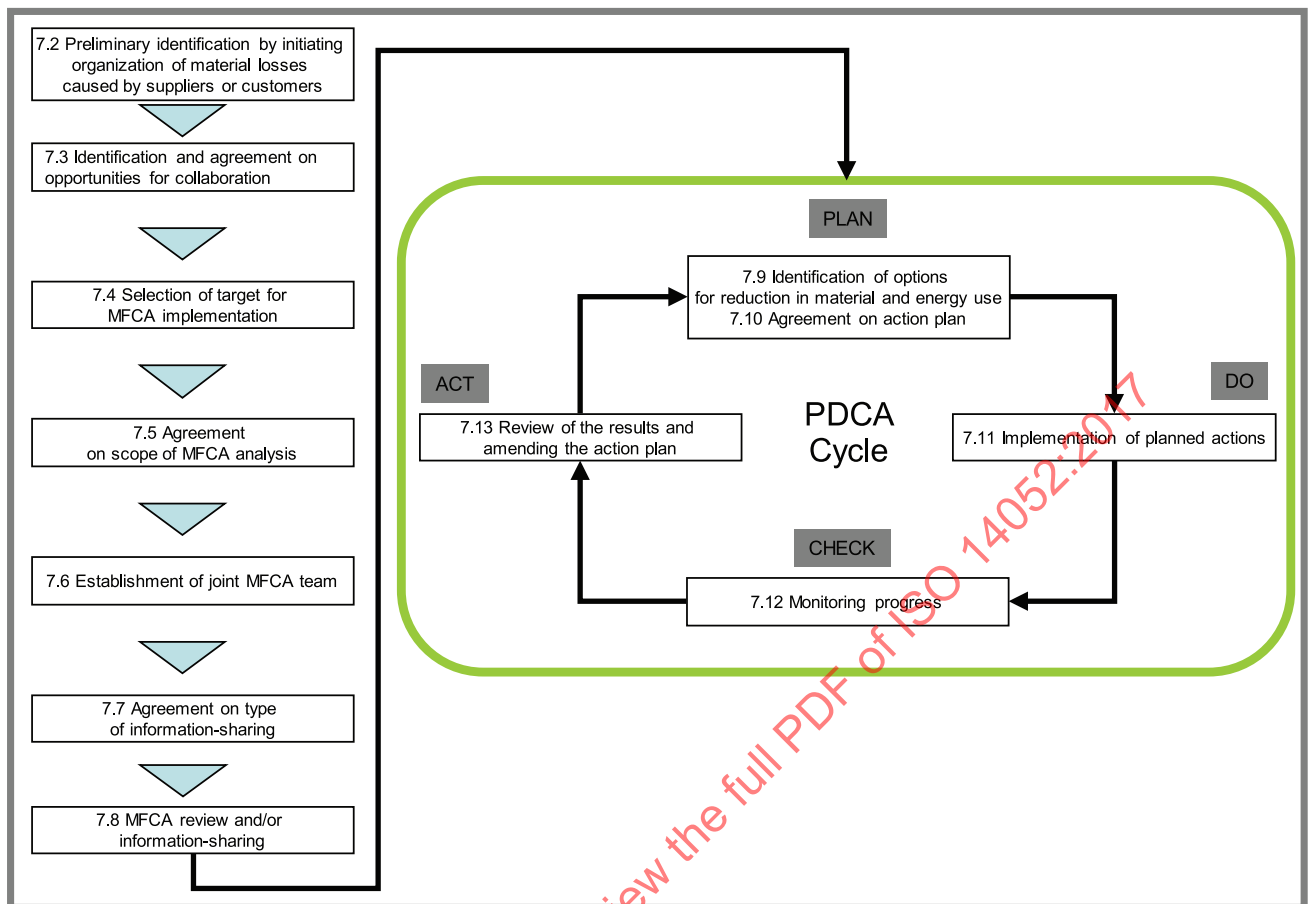


Figure 3 — PDCA-Cycle for implementing MFCA in the supply chain

7.2 Preliminary identification by the initiating organization of material losses caused by suppliers or customers

The initiating organization should start the process by an internal MFCA review. During the course of the review process, the initiating organization identifies material losses potentially caused by suppliers or customers. Based on the results of the review, the initiating organization will identify potential opportunities for the application of MFCA in its supply chain and approach the relevant supplier(s) and/or customer(s).

7.3 Identification and agreement on opportunities for collaboration

The initiating organization and relevant supplier(s) and/or customer(s) in the supply chain will identify and agree on opportunities for collaboration to implement MFCA. The use of an impartial party could assist in ensuring commitment from and collaboration between participating organizations, especially at the early stages of the project.

The initial agreement should address how benefits of the project will be shared between the organizations. The following opportunities can be considered among others:

- the customer shares relevant MFCA data with the supplier and assists the supplier in improving the material delivered in such a way that the costs to the customer will decrease;
- the supplier encourages the customer to use a different material or the same material in a different specification and proves that the substitute will reduce the costs to the customer;

- the supplier and the customer decide on an open discussion on potential improvements in order to identify synergies.

7.4 Selection of target for MFCA implementation

For the purposes of MFCA implementation in the supply chain, it is important to set a target that potentially has opportunities for improvements. For example, during its internal MFCA review, the initiating organization may find some crucial material losses in respect of volume, cost reduction and environmental impact and critical raw materials. Subsequently, the initiating organization should investigate the cause of these critical material losses.

Some causes of these losses could be associated with suppliers and/or customers. In the next step, the initiating organization should identify possibilities to start collaboration with supplier(s) and/or customer(s). After prioritizing the possible areas for collaboration, the initiating organization should contact selected organization(s), based on the principles (see [Clause 5](#)). Finally, the initiating organization should enter into an agreement with supplier(s) and/or customer(s) to start a collaborative MFCA project.

In addition, the initiating organization should find out if some suppliers or customers have any plans to make a new investment in the production process and/or in developing new product or model changes. This would become a good opportunity for the initiating organization to collaboratively implement MFCA in the supply chain.

7.5 Agreement on scope of MFCA analysis

The organizations involved should agree on the scope of the MFCA analysis that will be covered by the collaborative project.

7.6 Establishment of joint MFCA team

Expertise necessary for the establishment of a supply chain wide MFCA team should be based on the guidance in ISO 14051. In addition, expertise for technical sales and procurement functions can also be beneficial in the supply chain wide implementation of MFCA.

7.7 Agreement on type of information-sharing

See [Clause 6](#) for details.

7.8 MFCA review and/or information-sharing

MFCA review of the selected target products or processes should be conducted in accordance with ISO 14051. More importantly, information-sharing should be implemented as agreed among the organizations involved.

7.9 Identification of options for reduction in material and energy use

Based on the results of the MFCA analysis, each organization selects the data on material and energy losses to be shared with the other organizations. After sharing the selected information on material losses, all organizations should consider and identify possible ways to reduce material losses.

7.10 Agreement on action plan

Based on the results of the previous step, the options to be improved should be selected and agreed upon. Subsequently, organizations should agree on specific targets and a schedule for implementation of the action plan.

7.11 Implementation of planned actions

All the organizations involved should implement the agreed actions.

If the reduction of material and energy losses are part of companies' goals or if the expected improvements are part of a contract between a supplier and a customer, it is convenient to set individual indicators which need to be monitored (e.g. the waste reduced/year, percentage of re-work reduced). Companies are encouraged to develop and use representative indicators of reduction of material losses and economic benefits shared in the supply chain.

7.12 Monitoring progress

Once the planned actions have been implemented throughout the supply chain, it is important to monitor progress of the project. This includes regular meetings to assess reduction of material losses in all organizations in the supply chain as a result of the implemented actions. This should include an analysis of the type and source of material losses, and proposals of appropriate actions among the organizations for further improvement in reducing material losses. Monitoring based on the set indicator(s) is an option to systematically understand progress of the MFCA application in the supply chain.

7.13 Review of the results and amending the action plan

Based on evaluation of the results of the MFCA project amendment of the action plan should be considered and changes made, if needed, to lead to even further improvements in the next management cycle.

8 Further use of MFCA information in a supply chain

The primary purpose of MFCA is twofold:

- to reduce adverse environmental impacts;
- to reduce costs by improving material and energy efficiency.

However, information generated during the implementation of MFCA in a supply chain can also be used for other related purposes. Information on the environmental impacts of the materials used could form the basis for considering substitute materials with less harmful substances.

In addition, the information can help to monitor the discharge of waste to air, water or soil. MFCA information in a supply chain can be used as a basis for monitoring environmental indicators, e.g. carbon footprint and water footprint by applying ISO/TS 14067 and ISO 14046. Indicators on emissions, water, waste and material/energy efficiency can be derived from the MFCA data at all stages of the supply chain. The MFCA information can also help in identifying and mitigating risks in the supply chain.

Annex A

(informative)

Case example: Supply-chain MFCA project related to the production of compressor piston parts for automobile air conditioners

A.1 Background

Company A is an initiating organization for this case example. Company A manufactures a component of automobile air conditioners through a forging process, and supplies it to Company B which further processes the component.

Company A implements MFCA to reduce its material losses. During the course of implementing MFCA, Company A realizes that reduction of several types of material losses requires collaboration with Company B. Consequently, Company A communicates with Company B to implement a collaborative MFCA project.

After an agreement between Companies A and B is reached, Company A supports Company B for the implementation of MFCA. Based on the agreement, the information shared between Company A and Company B is process-related information on material flows, physical information on material flows, quantified information on environmental impacts and monetary information.

A.2 Material flow model of targeted product

Companies A and B decide to develop a material flow model to identify material losses generated in their supply chain. Through analysis of the material flow model and the related production processes, material losses are identified in both companies, as shown in [Figure A.1](#).

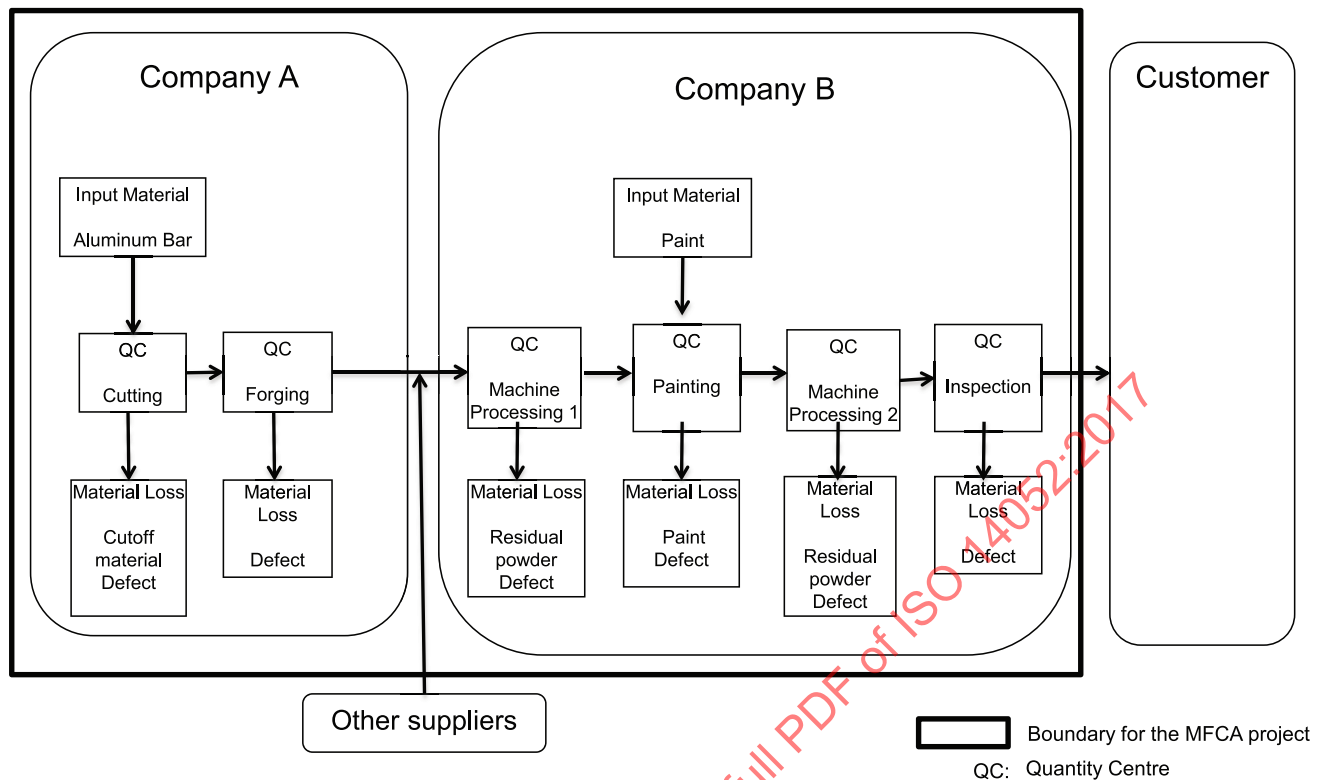


Figure A.1 — Material flow model of Company A and Company B

A.3 MFCA review and identified material losses

As shown in [Figure A.1](#), the following material losses are identified in the supply chain:

- a) Company A:
 - cut-off material and defects in the cutting process;
 - defects in the forging process;
- b) Company B:
 - residual powder and defects in the machine processing 1;
 - paint and defects in the painting process;
 - residual powder and defects in the machine processing 2;
 - defects in the inspection process.

A.4 Identification of options for reduction of material use

Companies A and B categorize their material losses into either those to be improved internally or those to be improved collaboratively. [Table A.1](#) summarizes the detail on the MFCA analysis.

Table A.1 — Improvement items and approach

No.	Target process	Improvement approach	Company		
			A	B	A and B
1	1-1	Improving internal diameter processing of forged parts		✓	✓
	1-2	Improving convex portion of forged parts	✓		✓
	1-3	Improving convex portion at bottom of forged parts		✓	✓
	1-4	Less standard surface of forged parts			✓
	1-5	Reduce the joint defect rate		✓	
	1-6	Improve taper shaving			✓
2	2-1	Shot-blasting of even unpainted portions			✓
	2-2	Appropriateness of range of painting of cylindrical portion		✓	
	2-3	Appropriateness of paint thickness of cylindrical portion		✓	
3	3-1	Appropriateness of surface processing accuracy of piston end			✓
	3-2	Appropriateness of processing accuracy of piston bottom		✓	✓
	3-3	Excessive facing margin	✓		
	3-4	Appropriateness of ## department processing accuracy		✓	✓
	3-5	Reduce the defect rate after ## processing		✓	

A.5 Agreement on action plan/improvements

To start with, items 1-1 and 1-3 are implemented. Company B shares the material loss information with Company A and proposes to Company A that the design and processing of products provided to Company B be changed, as Company A is responsible for the product design and processing in Company B.

After Company A accepts Company B's proposal, Company B improves the production process of the products to reduce the material losses generated in Company B.

Companies A and B agree on taking the following actions.

- a) Each company implements improvement measures that can be done within each company, including those related to adjustment of existing equipment or review of procedures.
- b) Companies A and B work together to take the following actions:
 - to implement improvement measures that involve other departments, suppliers, and customers;
 - to resolve constraining factors such as design review, upgrade of equipment and relevant investment (the activity will be discussed between Companies A and B for implementation at each company);
 - to explore the possibility for innovation to overcome existing constraints (the activity will be discussed by Companies A and B for implementation at each company).

A.6 Project results

Companies A and B review their material flows in the supply chain. Subsequently, they examine material losses generated in each company. The material losses are analysed and it is found that some of the material losses generated in Company A are due to Company B and vice versa. Based on the agreement between Companies A and B, multiple improvement measures are taken to reduce material losses. These measures result in the reduction of material losses (roughly 14 t/year and 5 000 000 JPY/year). From the case example, it is understood that application of MFCA in the supply chain provides more