

Implementation of Material Flow Cost Accounting in the Wiring Harness Industry (Case Study of PT X in Jepara)

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Abstract: - This study aims to determine how the application of Material Flow Cost Accounting (MFCA) can be applied to the wiring harness industry so as to improve its operational performance efficiently and effectively. The method used in this research is qualitative descriptive analysis. This research was specifically conducted at PT X wiring harness industry in Jepara. The findings show that the implementation of MFCA at PT X Jepara has material loss costs consisting of energy costs, system costs and material costs. The author can use this information to manage the material cost of losses incurred by PT X Jepara by creating new products that are useful and have added value selling value.

Key-Words: - Material Flow Cost Accounting; Cost Accounting; Cost Analysis; Business continuity; Business sustainability.

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1 Introduction

Quality control and regulation are essential aspects for any industry to ensure consistent product quality within a manufacturing setting (Azlaila et al., 2022). According to Loen (2018), quality control must be implemented from the very beginning of the production process up to the distribution stage. This is vital to build customer trust, ensure product safety, reduce the number of defective items, and prevent cost inefficiencies due to potential losses.

PT X Jepara is a privately owned manufacturing company in Indonesia and part of the Bansu Group, operating under PT Bansu Electric Indonesia. This company specializes in the production of wiring harnesses, an essential component commonly used in the manufacturing and assembly of vehicles. A wiring harness is a structured network of cables or an electrical circuit system that serves as the main electrical pathway for a vehicle's body. On a daily basis, PT X Jepara produces a substantial number of wiring harnesses that must be manufactured in accurate quantities and within precise timeframes. Accurate production planning is critical for sustaining future production

growth and ensuring timely and correct deliveries to customers, whose monthly order quantities may vary.

The wiring harness, also known as a body cable, plays a crucial role in vehicles, especially motorcycles and four-wheeled vehicles. It functions to transmit electrical power and data signals between various parts of a vehicle. As noted by Baene et al. (2025), this component is integral not only to power distribution but also to information flow in mechanically powered vehicles. Generally, a wiring harness is understood as a bundled system of cables used in vehicles and heavy equipment to manage electrical systems. Its purpose is to direct electrical power appropriately based on the operational needs of the vehicle's electrical devices. As described by Eder et al. (2021), wiring harnesses consist of various materials, each with distinct purposes, and are interconnected in series to deliver electrical power and communication signals.

The production quantity of wiring harnesses at PT X Jepara is determined monthly based on customer orders. The company fulfills these orders through daily shipments that must cumulatively meet the total requested quantity within the agreed delivery period (Taufik & Saadah, 2024). Currently, production planning involves communicating directly with customers to estimate preorder volumes for the following month. However, customers often cannot provide accurate estimates, requiring PT X Jepara to make its own forecasts. This process frequently results in discrepancies between production volumes and actual demand. PT X Jepara must accurately forecast production quantities to procure materials, ensure on-time deliveries, and align production outputs with varying monthly customer demands. Accurate forecasting and production planning are therefore crucial to synchronize manufacturing activities with internal policy decisions and customer requirements.

The production process itself involves integrating various manufacturing components into a cohesive whole to produce profitable products that meet customer needs. According to Muttaqin & Prasetyo (2022), production activities not only focus on product-based services but also consider service-oriented elements that can be offered to customers. Meanwhile, Salu et al. (2018) state that production processes involve numerous raw materials and can take different forms depending on the nature of the product or service. Feigenbaum, as cited by Supriyadi (2022), defines quality control as the evaluation of a product's performance by comparing it to established standards and specifications, followed by corrective actions in the event of deviations. Ariani, as cited by Widiensyah (2019), explains that quality control tools can be categorized into those using quantitative data (e.g., check sheets, Pareto charts, histograms, scatter plots, control charts, and run charts) and those using qualitative data (e.g., flowcharts, brainstorming, fishbone diagrams, affinity diagrams, and decision trees).

To contribute to waste reduction and resource optimization, **Material Flow Cost Accounting (MFCA)** is introduced as a management accounting method that helps track material losses in both monetary and non-monetary terms. As noted by Fakoya (2014), MFCA assists managers in making decisions to reduce material consumption and waste. Hyršlová et al. (2011) further explain that MFCA integrates material, energy, and information management to handle resource flows efficiently and achieve organizational objectives. This study aims to explore the implementation of MFCA at PT X Jepara, particularly in its wiring harness production processes. The goal is to improve operational efficiency and effectiveness. The findings are expected to benefit not only PT X Jepara but also other manufacturers, both large and small, by promoting efficient use of

resources and providing insights into environmentally responsible practices. Furthermore, this research highlights the practical application of MFCA in managing material losses. It supports PT X Jepara in making data-driven decisions when investing in new products by using the information derived from MFCA as a benchmark. Ultimately, MFCA can become a valuable tool for improving sustainability, reducing costs, and enhancing production efficiency.

2 Theoretical Framework

2.1. Material Flow Cost Accounting (MFCA)

According to ISO 14051, as cited by Christ & Burritt (2016) in the *Material Flow Cost Accounting Manual*, MFCA is a management tool developed to optimize the use of basic resources while minimizing emissions, non-products, and waste. Technically, MFCA serves as an instrument to enhance material efficiency. ISO 14051 encourages the adoption of MFCA to improve transparency in material flow and resource consumption, supporting data-driven decision-making across industries. Furthermore, MFCA functions as a platform that addresses both regional challenges and profitability concerns. Through MFCA practices, companies are better equipped to identify where useful material is generated or wasted during the production process. This allows industries to reduce waste and enhance material productivity, creating a link between economic and environmental management. According to Jasch (2008), MFCA also aims to identify visible physical and monetary losses as well as the costs associated with the transformation of materials into waste (i.e., zero-value emissions).

2.2 Key Components of MFCA

The primary objective of MFCA is to facilitate transparency in material flow and related costs. The process involves several key components:

1. Materials

Materials play a central role in MFCA since the core goal is to utilize them efficiently. In this context, "materials" refer to all direct inputs used in the production process. Any part of these inputs that fails to become a final product is classified as material loss. Such losses can occur at various stages, including energy dissipation during production.

2. Material Flow

MFCA requires detailed information about the movement of materials throughout the production process—both in physical and monetary terms. It tracks all material inputs and identifies outputs that result in waste or inefficiency within the system.

3. Cost Accounting

MFCA integrates cost distribution systems to provide a comprehensive understanding of monetary implications. This involves calculating the financial value of raw material inputs transformed into products and quantifying material losses. This analysis is based on physical data such as mass and load characteristics.

2.3 Implementation Stages of MFCA

1. Stage 1: Management Engagement and Role Definition

The implementation begins with strong managerial support, followed by a bottom-up approach at the operational level. Full organizational commitment is necessary to ensure

successful MFCA execution. Cross-functional cooperation is vital, as information from various departments is needed for comprehensive analysis. Required competencies include:

- Technical knowledge of material inputs and energy usage
- Familiarity with material processes (e.g., combustion, chemical reactions)
- Quality control expertise
- Environmental impact awareness
- Cost accounting proficiency

2. Stage 2: Defining Process Scope and Material Flow Boundaries

The next step involves defining the scope and boundaries of the MFCA process. These boundaries may apply to a single process, multiple processes, or an entire supply chain. Determining these limits is crucial for identifying significant economic and environmental impacts. Once defined, logistics records and technical data are used to classify items into quantity centers for analysis. Past studies suggest a one-year timeframe for initial MFCA implementation. However, it lacks the capacity to assess the duration needed for data integration or the effects of systemic changes, such as seasonal fluctuations. ISO 14051 emphasizes the importance of understanding process boundaries and locating points of material loss within them.

3. Stage 3: Cost Allocation

MFCA categorizes costs into several types:

- Raw material costs: Value of all materials consumed in production.
- Energy costs: Expenditures on electricity, fuel, steam, etc.
- System costs: Include transportation, depreciation, maintenance, and personnel.
- Waste management costs: Expenses related to handling waste generated during production.

The allocation of these costs is based on the ratio of input materials to lost materials. Following ISO 14051, material costs for a given period are calculated by multiplying the physical quantity of each material flow by its unit cost. This allows the differentiation of costs associated with positive (product) and negative (waste) outputs. Example cost ratios:

- Positive output percentage of raw material: Value associated with usable output.
- Negative output percentage of raw material: Value associated with waste.

Notably, 100% of waste management costs are attributed to material losses.

4. Stage 4: Interpreting and Communicating MFCA Results

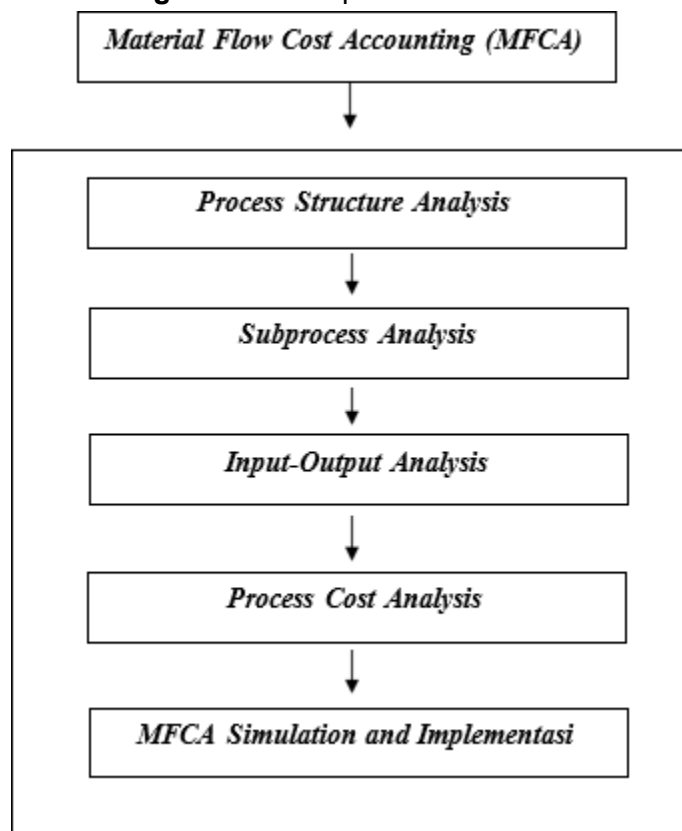
MFCA yields insights into monetary losses, unutilized input materials, labor, and system costs associated with inefficiencies. These results enhance industrial process transparency and help management evaluate material use efficiency. The MFCA framework exposes hidden costs and inefficiencies that traditional accounting methods may overlook. The outcomes may be organized in tabular form for further analysis, correlating physical quantities with financial data. This facilitates the identification of production stages contributing most to environmental and financial losses. Findings should be disseminated to relevant stakeholders to support operational improvements and strategic decision-making (Drury, 2013). MFCA results empower managers with data-driven insights for boosting economic and environmental performance. Training employees to understand MFCA can foster a culture of continuous improvement and innovation.

5. Stage 5: Recommendations Based on MFCA Outcomes

MFCA results can be used to evaluate whether material usage across production lines is efficient or prone to waste. The data may also uncover opportunities to improve both environmental sustainability and financial performance by converting waste into valuable new products. Strategic recommendations may include an analysis of potential costs and benefits of introducing new products made from material waste. Key considerations include:

- Availability of discarded materials suitable for transformation
- Required skills and processes to minimize damage during conversion
- Investment in machinery capable of repurposing waste
- Adequate energy resources to support reprocessing
- Market analysis for launching new recycled-material products.

Figure 1. Conceptual framework



3 Research Method

This research adopts a qualitative approach, focusing on a single case study subject. According to Jaya (2020), statistical or quantitative measurement alone is insufficient to capture the complete results of qualitative research. The purpose of this study is to develop a concept or design framework for implementing Material Flow Cost Accounting (MFCA) at PT X Jepara, a company engaged in the production of wiring harnesses. Creswell (2007) stated that case study research aims to understand an issue through a specific case, which later serves as the basis for corrective recommendations.

The object of this research is PT X Jepara, located in Central Java, which was established in 2015 by Mr. Budi. This company specializes in producing wiring harnesses. The presence of material waste generated by PT X Jepara during the production process makes this case particularly compelling. The study aims to develop an MFCA system tailored to the company, using both structured and planned approaches to support the research objectives.

Data collection in this research relies on primary data sources. Tyoso (2016) defines primary data as information collected directly from the source. In this case, data was gathered through interviews with the Operations Director and Head of Production. Additionally, direct observation of the production site was conducted to support and enrich the findings.

The data analysis method follows five stages aligned with the MFCA implementation framework. Based on these stages, a proposed MFCA concept for the production process will be developed. The analysis includes categorizing production outputs into positive and negative outputs. The final step involves identifying potential MFCA solutions to address material losses and mitigate the negative environmental impacts resulting from the company's production activities (Putra, 2021).

4 Results and Discussions

4.1. Design of Material Flow Cost Accounting (MFCA) Implementation

Stage One: Engaging Management and Defining Roles and Responsibilities

The initial stage focuses on determining roles and responsibilities within all departments to ensure the production process runs efficiently and aligns with each unit's capacity. According to ISO 14051 (2014), clear role designation is a foundational step in implementing Material Flow Cost Accounting (MFCA).

However, in the case of PT X Jepara, the role allocation does not yet comply with ISO 14051 standards. Each production process is currently overseen solely by the owner, due to a shortage of human resources. The company lacks individuals with the required capabilities to lead each production section, highlighting a critical barrier in the application of MFCA.

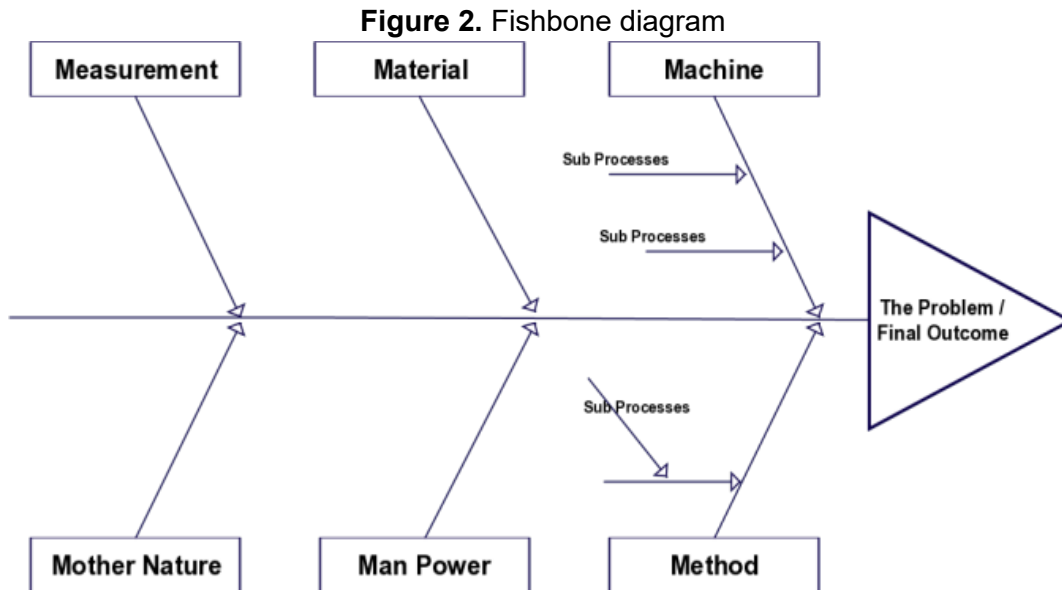
Table 1. Roles and Job Descriptions in the MFCA Implementation Team

No	Position	Quantity	Job Description
1	Head of Operations	1	Monitors the production process and reviews the usage of raw materials and available energy resources.
2	Head of Technical	1	Monitors machine usage and evaluates the suitability of operating hours throughout the production process.
3	Head of Quality Control	1	Oversees product quality assurance and reviews the number of defects in products during the production process.
4	Head of Environmental Affairs	1	Monitors waste generated from the production process and the methods used for waste management.
5	Head of Cost Accounting	1	Allocates production costs incurred at each stage of the production process that results in waste.

Stage Two: Defining Process Scope and Mapping Material Flow

This stage involves determining the scope of the MFCA application by identifying quantity centers, where all input and output data are measured physically. These measurements help in analyzing the transformation of raw materials into finished goods or waste. A complete production cycle is reflected through these flow measurements. To visualize this, a Fishbone Diagram (also known as the Ishikawa Diagram) was used to depict the material flow in wiring harness production. This diagram, introduced by Dr. Kaoru Ishikawa in the 1960s, helps identify root causes of problems through six main factors: materials, machines, manpower, methods, measurements, and environment. The steps involved in building the diagram include:

- Identifying the core problem
- Listing major contributing factors
- Brainstorming potential causes
- Reviewing each key issue
- Reaching consensus on the most likely root causes



Stage Three: Cost Allocation

At this point, cost elements are distributed into positive outputs (finished goods) and negative outputs (waste or material losses) within the wiring harness production operations. The cost allocation is based on labor, material, and system-related expenditures. This allocation is essential for evaluating the efficiency of material usage and system cost structure. The analysis also includes categorizing outputs to assess whether resources are being optimized or wasted.

Table 2. Operational Wiring Harness Allocation Cost, Positive Output, Negative Output

Stage	Power Used	Power Needed	Unit	Unit Price	Allocation Cost	% Positive Output	Positive Output Cost	% Negative Output	Negative Output Cost
Production									

Stage	Power Used	Power Needed	Unit	Unit Price	Allocation Cost	% Positive Output	Positive Output Cost	% Negative Output	Negative Output Cost
Cutting	Electricity	4.4	kWh	Rp 1,467.28	Rp 6,456	90%	Rp 5,810	10%	Rp 646
Taping	Electricity	15.84	kWh	Rp 1,467.28	Rp 23,242	98%	Rp 22,777	2%	Rp 465
Grommet	Electricity	4	kWh	Rp 1,467.28	Rp 5,869	100%	Rp 5,869	0%	Rp -
Shiage	Electricity	4	kWh	Rp 1,467.28	Rp 5,869	100%	Rp 5,869	0%	Rp -
Visual	Electricity	2	kWh	Rp 1,467.28	Rp 2,935	100%	Rp 2,935	0%	Rp -
Finishing	-	-	-			100%	-		
Total					Rp 44,371	97.50%	Rp 43,260	2.50%	Rp 1,111

Table 3. Allocation Cost, Positive Output, Negative Output for Wiring Harness Production

Raw Material	Allocation Cost	Positive Output Allocation Cost	Negative Output Allocation Cost
Copper	Rp 9,625,000	Rp 8,575,000	Rp 1,050,000
Rubber	Rp 360,000	Rp 360,000	-
Seal	Rp 216,000	Rp 216,000	-
Total		89.70%	10.30%

Table 4. Production Stages - Labor, Costs, and Output

Production Stage	Number of Workers	Needs (dozen)	Wage/dozen	Allocation Cost	Positive Output Percentage	Positive Output Cost	Negative Output Percentage	Negative Output Cost
Cutting	2	25	Rp 5,000	Rp	90%	Rp	10%	Rp

Production Stage	Number of Workers	Needs (dozen)	Wage/dozen	Allocation Cost	Positive Output Percentage	Positive Output Cost	Negative Output Percentage	Negative Output Cost
				250,000		225,000		25,000
Taping	5	10	Rp 25,000	Rp 1,250,000	98%	Rp 1,225,000	2%	Rp 25,000
Gromet	2	25	Rp 3,000	Rp 150,000	100%	Rp 150,000	0%	-
Shiage	2	25	Rp 5,000	Rp 250,000	100%	Rp 150,000	0%	-
Visual	1	50	Rp 3,000	Rp 150,000	100%	Rp 150,000	0%	-
Finishing	2	25	Rp 3,000	Rp 150,000	100%	Rp 150,000	0%	-
				Rp 2,200,000	97.7%	Rp 2,150,000	2.3%	Rp 50,000

Stage Four: Interpreting and Communicating MFCRA Results

Following the cost allocation process, the next step is to interpret the MFCRA results using a cost flow matrix. The matrix classifies costs into product costs and material loss costs, based on raw materials, labor, and system costs. It reveals that approximately 8.8% of materials are lost during the production process. Despite this relatively high percentage, the data shows that material losses occur at every stage of production. These insights present a valuable opportunity to improve efficiency and reduce production costs. The matrix helps visualize the flow of costs and identify areas for improvement.

Table 5. Cost Breakdown

Component	Raw Material or Direct Material Cost	Energy Cost	System or Direct Labor Cost	Waste Management Cost	Total
Product	Rp 9,151,000	Rp 43,260	Rp 2,150,000	-	Rp 11,344,260
	89.7%	97.5%	97.7%	-	91.2%
Material Loss	Rp 1,050,000	Rp 1,111	Rp 50,000	-	Rp 1,101,111
	10.3%	2.5%	2.3%	-	8.8%
Total	Rp 10,201,000	Rp	Rp 2,200,000	-	Rp

Component	Raw Material or Direct Material Cost	Energy Cost	System or Direct Labor Cost	Waste Management Cost	Total
		44,371			12,445,371
	100%	100%	100%	-	100%

Stage Five: Applying MFCA Results

In the final stage, results are discussed and coordinated with PT X Jepara to provide suggestions and recommendations based on MFCA findings. The main recommendation is to reuse discarded wiring cables to produce smaller wiring harnesses—specifically for electric bicycles. This initiative not only supports environmental sustainability but also offers potential cost savings.

Table 6. Material Loss

No.	Material Loss	Qty	Price	Total
1	Synthetic Rubber	42 Meter	Rp 25,000	Rp 1,050,000
	Total			Rp 1,050,000

From the material loss above, it can be processed into smaller wiring harnesses so that they can be resold with the following detailed costs incurred:

Table 7. Raw Material Costs

No.	Raw Material Cost	Qty	Price	Total
1	3mm Elastic Rubber	80 Meter	Rp 800	Rp 64,000
2	Rubber	10 Kilo	Rp 5,000	Rp 5,000
3	Crimping	1 Doz	Rp 13,500	Rp 13,500
4	Raw Copper	80 Meter	Rp 48,000	Rp 48,000
	Total			Rp 130,500

Table 8. Overhead Costs

No.	Overhead Cost	Qty	Unit	Total
1	Electricity (Processing Machine)	4.4 Kwh	Rp 1,467	Rp 6,456
	Total			Rp 6,456

Table 9. Direct Labor Costs

No.	Direct Labor Cost	Qty	Unit Price	Total
1	Staff Cost	2 people	Rp 90,000	Rp 180,000
	Total			Rp 180,000

A preliminary cost-benefit analysis was conducted to evaluate the feasibility of repurposing material losses into new products. The analysis suggests that this initiative is both environmentally beneficial and financially viable, assuming appropriate processes and equipment are available.

5 Conclusions

The implementation of Material Flow Cost Accounting (MFCA) is highly valuable for industries, particularly for small and medium-sized enterprises (SMEs), as it provides clear visibility into the production process through the design of material flow systems. By applying MFCA, business operators can assess the efficiency of material usage by quantifying the amount of waste generated during each stage of production.

MFCA also enables businesses to accurately allocate costs related to raw materials, energy, and labor, crucial information for making informed, efficient, and profitable decisions.

At PT X Jepara, it was observed that material loss (negative output) from the cutting process reaches approximately 10%, with no follow-up action currently in place to manage this waste. As a result, unused cable scraps continue to accumulate. Furthermore, the lack of personnel assigned to specific roles and responsibilities has led to these cable wastes being left unmanaged.

To address this issue, we propose a business enhancement strategy at PT X Jepara, reprocessing discarded cable waste into smaller, functional wiring harnesses. This approach not only helps reduce waste but also transforms it into a value-added product, aligning with both environmental sustainability and economic gain.

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