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*Material Flow Cost Accounting (MFCA) as a Tool for
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Haider Atta ZABIN

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Material Flow Cost Accounting (MFCA) as a Tool for Identifying Hidden Costs and Rationalizing Resource Use Compared to Traditional Cost Accounting

By: Haider Atta Zabin ¹

Abstract

Cost accounting is traditionally used to allocate all costs associated with production loss to good products, which does not enable management to independently measure the resources that are being wasted in terms of materials, energy, and manufacturing processes. Material flow cost accounting, which was developed according to ISO 14051:2011, solves this problem by measuring the flow of each unit of material entering the manufacturing process in physical and monetary terms, classifying outputs into "positive" and "negative" products." This study applies MFCA to the audited 2025 financial statements of Baghdad Soft Drinks Company, an Iraqi PepsiCo franchisee, reclassifying total operating cost of IQD 763.59 billion into MFCA's four cost centers and estimating the value of the negative product under three literature-informed loss-ratio scenarios (5%, 8%, 10%). The results show that MFCA reveals a negative-product cost of IQD 38.18–76.36 billion — 36 to 73 times larger than the IQD 1.05 billion the traditional system discloses as scrap-sale revenue — and equal to 20–41% of net profit before tax. The findings confirm that a material "hidden cost" exists in the company's accounts and offer a replicable procedural model for other Iraqi industrial companies constrained to published secondary data.

Keywords: *Material Flow Cost Accounting; Traditional Cost Accounting; hidden costs; environmental management accounting; ISO 14051; Iraq; food and beverage industry.*

1. INTRODUCTION

Cost accounting and management accounting occupy a pivotal position within the information system of industrial enterprises, serving as the primary source from which management derives the data needed for pricing, performance control, and rationalizing decisions related to the use of scarce economic resources. For decades, industrial enterprises have relied on Traditional Cost Accounting (TCA) systems to determine product cost; these systems are grounded in aggregating the three cost elements (direct materials, direct labor, and indirect manufacturing overhead) and charging them in full to good finished-production units, without explicitly distinguishing the resources consumed in materials, energy, and processes that ultimately end up as production loss, waste, or scrap (Nishimura et al., 2021). As a result, the cost of loss is implicitly absorbed into the cost of good output and does not appear to management as an independent, measurable, controllable line item subject to decision-making — a phenomenon referred to in the environmental management accounting literature as "Hidden Costs" (Usul & Olgun, 2025).

¹ Department of Accounting, College of Administration and Economics, University of Wasit, Email: hzbyen@uowasit.edu.iq

One of the most significant tools in environmental management accounting, which was developed to compensate for this methodology deficiency in traditional systems, is Material Flow Cost Accounting (MFCA), which was incorporated into ISO 14051:2011 in the International Organization for Standardization. MFCA philosophy is based on the following principle that differs from the principles of TCA considerably: each unit of material used in the manufacturing process needs to be accounted for quantitatively and financially irrespective of its ultimate destination. Production outputs are classified into a “Positive Product,” representing good, saleable units, and a “Negative Product,” representing what was lost in the form of material, energy, or operational effort as waste, loss, or scrap (Dekamin et al., 2026). Accordingly, MFCA’s four cost elements — Material Cost (MC), Energy Cost (EC), System Cost (SC), and Waste Management Cost (WMC) — are allocated between the positive and negative products according to each one’s actual share, thereby revealing the true monetary value of wasted resources and providing management with an objective basis for rationalizing resource use, reducing cost, and improving both environmental and economic performance simultaneously (Aranda-Usón et al., 2024; Li et al., 2026).

Numerous applied studies have employed MFCA across diverse industrial and agricultural sectors — including food and agricultural industries (Dekamin et al., 2025, 2026; Bux & Amicarelli, 2022), industrial wastewater treatment and manufacturing (Nishimura et al., 2021; Ho et al., 2021; Sahu et al., 2021), and recycling and the circular economy (Aranda-Usón et al., 2024; Li et al., 2026; Nishitani et al., 2022) — and have largely concluded that traditional cost systems conceal material values of loss that ordinary financial statements fail to disclose, and that adopting MFCA leads to more rational resource-allocation decisions. However, a systematic review by Tran and Herzig (2020) found that practical applications of MFCA remain heavily concentrated in Japan, Germany, and a handful of middle-income Asian economies, while developing-country evidence — particularly from the Middle East — stays scarce; practical applications of MFCA to Iraqi industrial companies remain almost entirely absent, despite the fact that Iraq’s food-processing manufacturing sector, led by the soft-drink industry with its intensive use of water, energy, and packaging materials, constitutes a fertile environment for applying this approach and uncovering whatever hidden costs it may carry.

Problem Statement: The research problem stems from the fact that the traditional cost accounting system applied in Iraqi industrial companies — as is the case with Baghdad Soft Drinks Company, the subject of this study — deals with production loss merely by recording the proceeds of its sale as incidental revenue (“returns from sale of production scrap”), without disclosing the true cost (materials, energy, and system) consumed in generating this loss before it became scrap. Accordingly, the main research question can be formulated as follows: To what extent can the application of Material Flow Cost Accounting (MFCA) reveal material hidden costs in Baghdad Soft Drinks Company that the traditional cost accounting system fails to disclose? Two sub-questions follow from this main question: (1) What is the magnitude of the gap between the value of production loss recognized by the traditional system and the value revealed by material flow cost accounting? (2) How are MFCA’s four cost elements distributed between the positive and negative products in the company’s operations?

Significance of the Study: The significance of this research stems from its provision of a practical application — rather than a survey-based or statistical one — of a modern management accounting tool to actual, audited financial data of an Iraqi industrial joint-stock company, thereby filling an applied gap in the Iraqi accounting environment identified by Tran and Herzig (2020) and providing management with a replicable procedural model for other industrial companies seeking to rationalize costs and improve resource-allocation decisions.

Objectives: The study aims to: (a) present the theoretical framework of Material Flow Cost Accounting (MFCA) and compare it with Traditional Cost Accounting (TCA); (b) reclassify the operating-activity cost elements of Baghdad Soft Drinks Company for 2025 according to MFCA’s four cost centers; (c) estimate the monetary value of loss (the negative product) and compare it with what the traditional system discloses; (d) offer practical recommendations to management regarding resource-use rationalization.

Scope of Research: The application of the research was limited to the audited financial statements of Baghdad Soft Drinks Company (a privately-owned joint stock company), which is an industrial manufacturer of beverages like soft drinks, mineral water, and juices through a franchise with PepsiCo, for the fiscal year ending 31 December 2025.

Research Methodology & Structure: The research followed a descriptive and analytical method of case study wherein the financial statements of the firm were analyzed and re-classified using the methodology of MFCA. This research is structured into five broad sections, where Section Two is dedicated to the theoretical background and the literature review, Section Three details the methodology and implementation process of the research, Section Four shows the data analysis and findings, while Section Five highlights the conclusions and recommendations of the study.

2. LITERATURE REVIEW

2.1 Traditional Cost Accounting (TCA): Definition and Methodological Flaws

Traditionally cost accounting is regarded as the accounting system dealing with the aggregation of the costs of products (direct material, direct labor, and manufacturing overhead) and allocation of those to completed production units to determine unit cost, cost of inventory, and for decision-making purposes. According to international accounting standards like inventory (IAS 2), this cost accounting system treats abnormal losses as losses in the income statement more than normal losses, whereas normal losses (ordinary losses) are absorbed in the cost of good units without being separately recognized in terms of amount and reasons for its occurrence.

In this regard, the environmental management accounting literature has criticized the TCA approach quite strongly, foremost for the reason that it involves the hidden inclusion of loss, which does not enable management to determine the exact economic effect of the inefficiency of resources used in production because this method is based on the pure economic approach of calculating cost without any relationship between the cost of production and the actual movement of materials (Nishimura et al., 2021). In their research, Usul & Olgun (2025) have shown that firms using any type of TCA method, either actual or standard costing, do not provide cost of loss in a separate line item irrespective of the specific TCA method used. This fact shows that the failure of TCA is embedded in its conceptual design rather than in its operational use. Similar to this, Stanescu et al. (2021) have also claimed that traditional managerial accounting information systems were not designed for capturing environmental impact, and therefore, even good cost systems need the accounting layer to make physical waste visible to management through monetary signals.

2.2 Material Flow Cost Accounting (MFCA): Origin, Philosophy and General Framework

Material flow cost accounting was developed in Japan and Germany in the beginning of 1990s as a result of need for practical solution to combine performance related to environmental issues and economy of industrial enterprises, then officially accepted as standard by the International Organization for Standardization under ISO 14051:2011 and establishing the general framework for various industries (Kitada et al., 2022). The philosophy of material flow cost accounting is based on the idea of mass balance, according to which any material unit entering the quantity center of the production process must be accounted both physically and financially until its exit from that center either as part of the “Positive Product,” or “good saleable units,” and as part of the “Negative Product”

Figure 1 summarizes this logic schematically.

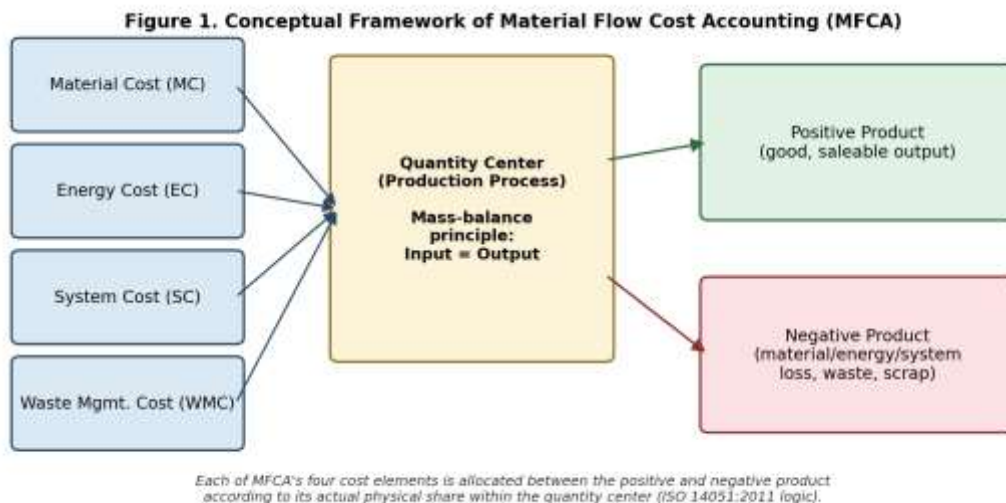


Figure 1. Conceptual Framework of Material Flow Cost Accounting (MFCA)

Four cost elements under the MFCA concept are categorized into four major centers, namely: (1) Material Cost (MC) that covers the cost of both primary and secondary raw materials along with packing material; (2) Energy Cost (EC) that involves electricity, fuel, and water usage; (3) System Cost (SC) that includes salaries, depreciation, and any other service costs that are needed for operating the manufacturing process; and (4) Waste Management Cost (WMC) which is the direct cost incurred for handling loss. These four cost centers are allocated between positive and negative products based on the actual share (in weight or volume) of each quantity center.

Most studies have found that the primary benefit from the implementation of MFCA is making loss "visible" in quantitative terms and monetary units, thus providing management with an objective justification for rationalizing resources rather than using only financial metrics that do not show the influence of operational inefficiency (Aranda-Usón et al., 2024). Nishitani et al. (2022) have conducted large-scale empirical research of manufacturing companies in Japan, proving the practicality of the visibility effect and showing that companies implementing MFCA demonstrate a triadic development in MFCA maturity, environmental performance, and economic performance. Thus, the authors justify MFCA as a tool that allows connecting ecological and financial objectives rather than substituting one for another. Higashida (2021) has broadened the concept by showing that MFCA can be applied at the level of the whole company, as it makes the incentives for reducing losses clear for suppliers when cost information is revealed.

2.3 Prior Studies

Prior studies applying material flow cost accounting can be classified into five principal thematic strands.

(a) Food and Agricultural Industries: This strand has grown rapidly since 2020 and forms the closest comparator group for the present study, given its shared concern with material- and packaging-intensive processing. Dekamin et al. (2026) applied the MFCA methodology in comparison with TCA to kiwifruit and citrus production, concluding that the traditional system overlooks a considerable proportion of input cost converted into field loss that goes unrecorded in accounting terms. The same research group extended MFCA to a wide range of crops in quick succession: soybean (Dekamin & Barmaki, 2019), coriander seed (Dekamin, Kheiralipour, & Afshar, 2022), viticulture (Dekamin, Norooz-Valashedi, & Toranjian, 2024), the major greenhouse crops (Dekamin, Sadeghimofrad, & Ahmadloo, 2024), tea (Dekamin et al., 2025), watermelon (Dekamin, Rezaei, & Nabavi-Pelesaraei, 2025), hazelnut (Rezaei, Dekamin, & Nabavi-Pelesaraei, 2025), and a comparison of furrow and sprinkler irrigation systems in potato production (Dekamin et al., 2026). Corn production under conventional versus conservation tillage was likewise assessed by Afshar and Dekamin (2022). Together these studies show that precisely tracking the flow of inputs (water, fertilizer, and energy) enables the identification of waste sources that traditional accounting methods conceal, and that irrigation choice in particular — a recurring theme also

documented for onion (Boru et al., 2024) and framed by the agronomic literature on water stress in tuber crops (Wagg et al., 2021; King et al., 2020; Singh et al., 2020) and on fertilizer-driven water pollution (Craswell, 2021) — is a major, quantifiable source of hidden cost. In the non-agricultural sector, MFCA has been used by Bux and Amicarelli (2022) for analyzing meat production processes to identify environmental entrepreneurship prospects; however, Mirmoradi et al. (2025) and Falcone et al. (2024) have utilized energy and life cycle assessment approaches for analyzing resource losses in cotton, canola, and citrus value chains.

(b) Manufacturing and Processing Industries: Nishimura et al. (2021) used a hybrid model integrating technical knowledge with MFCA to reduce energy consumption in industrial wastewater-treatment plants, a direction Ho et al. (2021) advanced further by embedding MFCA logic directly into the synthesis and design of a wastewater-treatment plant so as to minimize waste-generation cost from the outset rather than measuring it after the fact. Usul and Olgun (2025) examined how MFCA is applied in companies adopting different traditional costing systems, showing that the gap between what traditional systems recognize and what MFCA reveals recurs regardless of the underlying costing system applied. Dechampai et al. (2021) combined MFCA with a two-dimensional cutting-stock optimization model in a Thai lingerie manufacturer, demonstrating that pattern-cutting waste — a category of loss structurally similar to packaging trim in beverage bottling — can be substantially reduced once its true cost is made visible. Dunuwila et al. (2020) applied MFCA to concentrated latex manufacture to improve simultaneously the financial and environmental sustainability of the process, Huyen (2020) used it to analyze the cost of the steel-production process at a Vietnamese steel corporation, and Sahu et al. (2021) documented improved financial and environmental performance through MFCA in a small and medium-sized manufacturing enterprise. Magrini and Jagodzińska (2022), in turn, combined life-cycle assessment with material flow cost accounting to evaluate the feasibility of recovering rare-earth elements from used magnets.

(c) Circular Economy and Waste Management: Aranda-Usón et al. (2024) discussed the dynamic capabilities required to build a “circular accounting” system that integrates material flows within a firm’s circular-economy strategy, building on earlier evidence that dynamic accounting capabilities (Scarpellini et al., 2020) and broader eco-innovation capacity (Cainelli et al., 2020)

are preconditions for circular-economy adoption at firm level. Li et al. (2026) modeled material flows and the economic feasibility of sorting PLA packaging waste at material recovery facilities, while Demuytere et al. (2024) applied a prospective material-flow analysis to the end-of-life decommissioning of a North Sea offshore wind farm, and Rostek et al. (2023) modeled the future availability of zinc from recycling versus primary mining — both illustrating that MFCA-adjacent material-flow methods extend well beyond conventional manufacturing into infrastructure and critical-materials planning. Di Vaio et al. (2023) provides a systematic literature review confirming that accounting and accountability models for the circular economy, MFCA included, remain fragmented and call for more firm-level applied case studies of exactly the kind undertaken here. Chari et al. (2022) further show that Industry 4.0-enabled dynamic capabilities strengthen the resilience of circular manufacturing supply chains, Costa et al. (2023) extend circular-economy accounting to a forest-based collective-ownership setting, and Scarpellini (2022) documents the social, not only environmental and economic, impacts that a firm's circular business model can generate once reported transparently. In the livestock sector, Linh et al. (2026) applied material flow cost accounting to improve waste recycling in intensive pig farms moving toward a zero-emission model.

(d) MFCA in Service and Non-Manufacturing Settings: Although MFCA was conceived for physical production lines, recent studies have tested its applicability where the “material” flow is less obvious. Arieftiara et al. (2021) implemented MFCA as an eco-efficiency analysis tool in the health-service industry, showing that resource-loss visibility can be achieved even in largely intangible-service settings, while Higashida (2021), as noted above, demonstrated its coordination role across supply-chain partners rather than within a single plant.

(e) Research on the Practice and Sustainability of MFCA: A significant contribution to the topic has been made by Kitada et al. (2022), who studied reasons for discontinuation of MFCA in Japanese firms who have employed the approach. The authors showed that successful employment of MFCA depends on the extent to which information on physical quantity can be sustained in accounting rather than a one-time use of the technique. Another important insight related to the sustainability and implementation of MFCA was provided by Walz and Günther (2021) through their multi-case study, which indicated that the economic and environmental impacts of MFCA

can be very diverse and dependent on how sustainable the use of the tool is in management control compared to its use as an annual reporting tool.

2.4 Research Gap and the Position of the Current Study

As can be seen from the above review, the majority of practical studies related to MFCA have been performed in Japan, Germany and also in a number of Asian industrial and agriculture enterprises and have mainly used accurate internal quantitative information (actual production volumes and consumption of inputs) that cannot be obtained by outside researchers. The systematic literature review of Tran and Herzig (2020) on MFCA application in developing countries provides additional evidence of this trend, noting limited number of applied studies and the need for further country-level studies beyond the traditional Japan-Germany-Asia core. However, the studies of application of the MFCA technique to Arab or Iraqi industrial companies using published annual financial statements (as alternative data source in case when actual cost information is unavailable) have been rather limited in spite of large number of industrial joint-stock companies, which must publish annual financial statements according to law. The present research aims at filling the gap in practical studies of application of the MFCA technique using published financial statements of Baghdad Soft Drinks Company as a sample case in Iraq.

3. METHODOLOGY

3.1 Research Method

The study adopted a descriptive-analytical, applied case-study approach, as the most suitable method for achieving the research objectives, which requires a direct practical application of material flow cost accounting (MFCA) to actual data, rather than reliance on a field survey or a multi-sample statistical analysis. This choice is consistent with the methodology adopted by most of the prior studies reviewed in Section Two (Dekamin et al., 2026; Nishimura et al., 2021; Sahu et al., 2021), which applied MFCA in depth to a single unit of analysis (a firm or a crop) rather than breadth across a wide sample.

3.2 Study Population, Sample, and Rationale for Selection

The research sample was Baghdad Soft Drinks Company (a private joint-stock company), an Iraqi industrial manufacturing company established in 1989 and headquartered in Baghdad/Zaafaraniya,

which produces soft drinks, mineral water, juices, and packaged dairy products under a franchise from PepsiCo, with paid-up capital of approximately IQD 204.3 billion distributed among the government, mixed, and private sectors. The choice of this company was based on two primary factors: first, being an industrial manufacturing firm with a production line (materials → production & packaging → finished goods), which is essentially the basic requirement in order to be able to apply the principles of MFCA; and second, the presence of an explicit measure of production losses in the form of “returns from sale of production scrap,” as shown in the production account – unlike other firms chosen during the initial stages of sample selection process (readymade garments firm, real estate investment firm and a commercial bank).

3.3 Data Sources

Secondary data, in the form of the audited accounting statements of Baghdad Soft Drinks Company during the fiscal year ending 31 December 2025, were used as the source of data in this study, which have been approved by the licensed independent auditor (Ali Ghalib & Co.) and the Federal Board of Supreme Audit, and include: general balance sheet (statement A); production, trading, profit and loss, and distribution account (statement B); profit and loss account (statement C); statement of cash flows (statement D); besides, twenty detailed supporting statements (inventory; wages and salaries; goods supplies; service supplies; contracting and services; interest and land rental; operating-activity revenues; among others). The accuracy of the figures employed was confirmed through matching the subtotals with the corresponding totals of each statement several times (e.g., matching total goods supplies with the summation of its various detailed accounts).

3.4 Steps for Applying Material Flow Cost Accounting (MFCA)

The application of material flow cost accounting was done to the company's data through five consecutive procedural steps, which are depicted in Figure 2.

Figure 2. Five-Step Procedure for Applying MFCA to Published Financial Statements

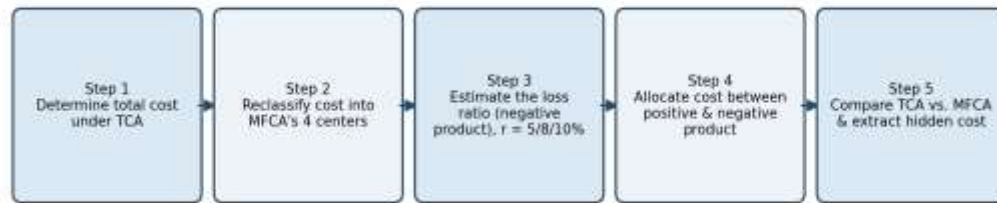


Figure 2. Five-Step Procedure for Applying MFCA to Published Financial Statements

Step One - Calculation of Total Cost using the Conventional Approach: All the components of operating-activity costs were determined as per the audited income statement (Statement C) for the current year 2025, amounting to IQD 763,585,494,357, which will act as the benchmark to compare against the results from MFCA approach.

Step Two - Classification using the Four Cost Centers under MFCA: All the cost components that have been calculated above remained unchanged in total cost; however, they were classified into four cost centers of MFCA, i.e., Material, Energy, System, and Waste Management based on the schedule attached to the financial statements as per the matrix in Table 1.

Step Three — Estimating the Loss Ratio (Negative Product): The inability of the financial statements to report the actual physical amounts of production losses is the main limitation encountered in methodology within the context of this research, a limitation that is common to other secondary-data studies that have been conducted (Usul & Olgun, 2025; Olgun, 2023). For this reason, the reported figure “returns from sale of production scrap” (IQD 1,051,358,775 for 2025) was used as an indicator of the existence of actual production losses rather than as an estimation of their total amount; this figure accounts only for the monetary gains resulting from the sale of scrap but does not take into account the total consumption of resources (material, energy, and system costs) involved in creating the scrap. Three loss ratios, therefore, were selected (5%, 8%, and 10%), which represent the range of values identified in the literature review in Section Two for similar food and manufacturing industries in terms of material and packaging

intensity (Bux & Amicarelli, 2022; Dechampai et al., 2021; Sahu et al., 2021), and the medium (8%) scenario was chosen as a baseline.

Step Four — Allocating Cost between the Positive and Negative Products: The assumed loss ratio (r) was applied uniformly across the three allocable cost centers (Material, Energy, and System), according to the following two equations: Negative-product cost per center = Total cost of the center $\times r$; Positive-product cost per center = Total cost of the center $\times (1 - r)$. Assuming a uniform loss ratio across the three centers is a necessary methodological simplification in the absence of actual quantity data for each center individually — a point explicitly discussed among the study’s limitations below.

Step Five — Comparison and Extraction of the Hidden Cost: The value recognized by the traditional system for production loss (scrap sale proceeds only) was compared with the total value of the negative-product cost as revealed by MFCA under each loss-ratio scenario, and the difference between the two was treated as the “hidden cost” that the traditional system fails to disclose.

Table 1: Reclassification Matrix of Traditional Cost Elements under MFCA's Four Cost Centers

MFCA Cost Center	Items Included from the Financial Statements	Data Source (Schedule No.)
Material Cost (MC)	Main and auxiliary raw materials + consumed packaging materials	Schedule (12) Goods Supplies
Energy Cost (EC)	Fuel + gas + oils and lubricants + water + electricity	Schedule (12) Goods Supplies
System Cost (SC)	Wages and salaries + spare tools, supplies, stationery, clothing, food and medical materials + service supplies + contracting and services + interest and land rental + depreciation and amortization + taxes and fees	Schedules (11, 12, 13, 14, 15, 16)
Waste Management Cost (WMC)	Not disclosed as an independent item in the published statements; disclosure is limited to “returns from sale of production scrap” within revenue	Schedule (17) Operating-Activity Revenue

3.5 Methodological Limitations

The study acknowledges that its most significant methodological limitation lies in its reliance on published secondary financial data rather than actual physical quantity data on production loss — internal data not ordinarily published. This limitation was addressed methodologically through the approach detailed above (using literature-supported indicative loss ratios rather than arbitrarily assumed ones), with a recommendation — within Section Five — for future studies to use actual quantity data from the company’s internal records to enhance the accuracy of the results.

4. DATA ANALYSIS AND DISCUSSION

4.1 Traditional Classification of Operating-Activity Cost (TCA) for 2025

Table 2 presents the classification offered by the traditional accounting system (TCA) for the elements of operating-activity cost of Baghdad Soft Drinks Company for fiscal year 2025, as shown in the audited profit and loss account (Statement C). Note that this classification presents cost distributed by accounting nature (wages, supplies, depreciation, etc.) without any indication of the quantity or value that ended up as production loss; the only effect related to loss is confined to the “returns from sale of production scrap” item, amounting to IQD 1,051,358,775, which appears as an addition to revenue rather than as an independent cost item.

Table 2: Classification of Operating-Activity Cost Elements under the Traditional System (TCA) — IQD

Item	Value (IQD)	% of Total
Wages and Salaries	36,393,221,497	4.77%
Goods Supplies	639,977,390,431	83.81%
Service Supplies	31,819,738,193	4.17%
Contracting and Services	158,400,000	0.02%
Interest and Land Rental	81,600,000	0.01%
Depreciation and Amortization	52,448,166,945	6.87%

Item	Value (IQD)	% of Total
Taxes and Fees	2,706,977,291	0.35%
Total Operating Expenses	763,585,494,357	100.00%

4.2 Reclassification under MFCA's Four Cost Centers

Applying the second methodological step (the classification matrix in Table 1), the same total cost (IQD 763,585,494,357) was redistributed across MFCA's four cost centers, as shown in Table 3 and Figure 3. Material cost alone is seen to account for 78.72% of total cost — led by consumed packaging materials, which alone totaled IQD 372.5 billion — a proportion expected in a material-intensive industry such as soft-drink manufacturing, and consistent with Bux and Amicarelli's (2022) finding that material cost dominates the MFCA cost structure of food-processing firms, confirming that even a modest loss ratio would represent a substantial monetary value. The Waste Management Cost (WMC) center, meanwhile, could not be separated as an independent cost item because the published statements do not explicitly disclose it — a point discussed among the study's limitations.

Table 3: Reclassification of the Same Total Cost under MFCA's Cost Centers — IQD

Cost Center	Value (IQD)	% of Total
Material Cost (MC)	601,103,840,253	78.72%
Energy Cost (EC)	24,392,453,124	3.19%
System Cost (SC)	138,089,200,980	18.08%
Total	763,585,494,357	100.00%

Figure 3. Reclassification of Total Operating Cost under MFCA's Four Cost Centers, Baghdad Soft Drinks Company, FY2025

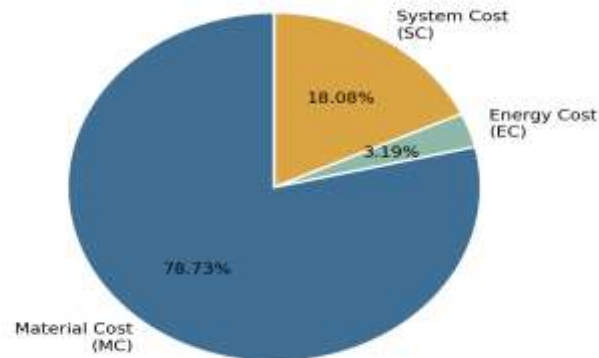


Figure 3. Reclassification of Total Operating Cost under MFCA's Four Cost Centers, FY2025

4.3 Allocating Cost between the Positive and Negative Products (Base-Case Scenario: 8% Loss Ratio)

Steps Four and Five of the methodology were applied by distributing the three allocable cost centers (Material, Energy, and System) between the positive and negative products under the base-case scenario (8% loss ratio), as shown in Table 4. The results reveal that the total value of negative-product (loss) cost under this scenario amounts to IQD 61,086,839,549 — equivalent to 6.42% of total operating-activity revenue and 32.56% of the company's net profit before tax for 2025 — a proportion that cannot be considered marginal by any managerial standard.

Table 4: Allocation of the Three Cost Centers between the Positive and Negative Products at $r = 8\%$ — IQD

Cost Center	Positive Product (92%)	Negative Product / Loss (8%)
Material Cost (MC)	553,015,533,033	48,088,307,220
Energy Cost (EC)	22,441,056,874	1,951,396,250
System Cost (SC)	127,042,064,902	11,047,136,078
Total	702,498,654,808	61,086,839,549

4.4 Sensitivity Analysis and Revealing the Hidden Cost: MFCA versus TCA

Table 5 and Figure 4 present the sensitivity-analysis results across the three adopted loss-ratio scenarios (5%, 8%, and 10%), comparing the total value of negative-product cost revealed by MFCA against the single value recognized by the traditional system (scrap sale proceeds of IQD 1,051,358,775). Even under the most conservative estimate (5%), the actual worth of the resources used in producing the loss is over 36 times the amount revealed by the traditional system; the difference becomes larger, reaching about 58 times in the case of the median loss ratio, and almost 73 times in the case of the upper limit scenario. In other words, what the company records as "incidental revenue from scrap sales" is merely a small percentage (under 3%) of the actual costs involved in producing the loss in terms of materials, energy, and processes.

Table 5: Comparison of the Value Revealed by TCA and Negative Product Value under MFCA for Three Different Loss Ratio Scenarios

Assumed Loss Ratio (r)	Value Disclosed under TCA (IQD)	Negative-Product Value under MFCA (IQD)	Gap / Hidden Cost (IQD)	MFCA-to-TCA Ratio	% of Net Profit
5%	1,051,358,775	38,179,274,718	37,127,915,943	36.3x	20.35%
8% (base)	1,051,358,775	61,086,839,549	60,035,480,774	58.1x	32.56%
10%	1,051,358,775	76,358,549,436	75,307,190,661	72.6x	40.69%

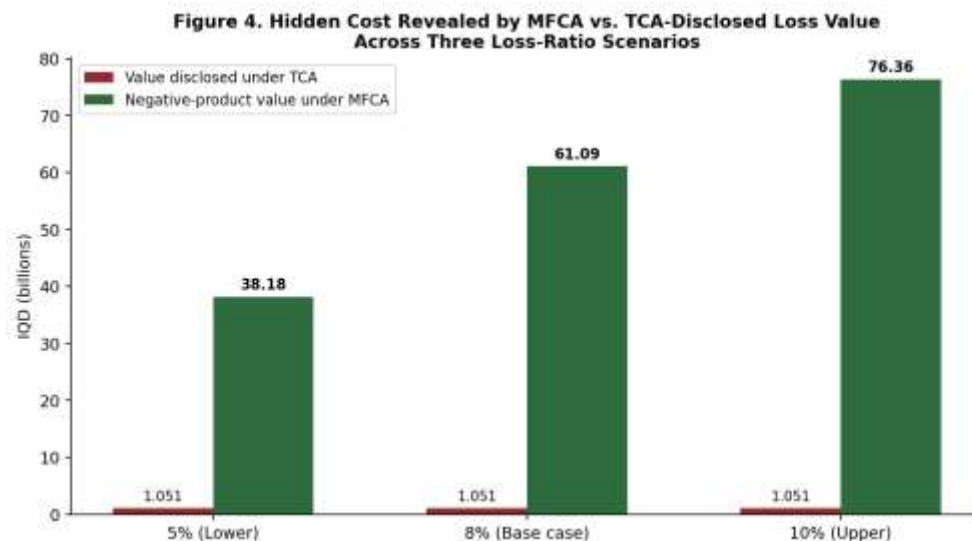


Figure 4. Hidden Cost Revealed by MFCA vs. TCA-Disclosed Loss Value Across Three Loss-Ratio Scenarios

4.5 Discussion of Findings

These results corroborate Dekamin et al.'s (2026) assertion that the traditional system neglects a significant portion of input costs that result in losses and Usul and Olgun's (2025) discovery that the discrepancy is repeated irrespective of the traditional costing system used. The results are also in agreement with the SME case study by Sahu et al. (2021), in which MFCA identified a significant amount of loss that was included in the normal operations cost in the cost report. This is also in line with the finding of Bux and Amicarelli (2022) that manufacturing companies in the food sector have hidden costs due to high packaging and material costs, something that this research repeats for packaging materials in Baghdad Soft Drinks Company.

The results also confirm, from a practical standpoint, the importance of Kitada et al.'s (2022) observation that MFCA's real value is only realized when supported by an internal system for tracking actual loss quantities, a conclusion reinforced by Walz and Günther's (2021) multi-case evidence that the magnitude of MFCA's reported benefits depends on how deeply the tool is embedded in ongoing management control rather than applied as a one-off exercise. Reliance on indicative ratios — as this study was compelled to do given the nature of the published secondary data, a constraint documented more broadly by Tran and Herzig's (2020) systematic review of MFCA in developing countries — while sufficient to demonstrate the existence of the gap and its approximate magnitude, does not substitute for a precise internal measurement system that would enable management to target specific sources of loss (such as a particular filling line or packaging-material type) and take corrective decisions accordingly. Economically, the fact that estimated loss cost equals between one-fifth and over two-thirds of annual net profit (depending on the scenario) gives management a clear financial incentive to adopt an internal quantity-tracking system that would enable MFCA to be applied with full precision rather than relying on estimated ratios.

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusions

1. The real-world practice showed that in the case of TCA system used by Baghdad Soft Drinks Company, the accounting for production losses includes only the proceeds from the sale of scrap (IQD 1,051,358,775 for 2025) as accidental income without any disclosure of the true cost (materials, energy, and system cost) incurred to incur this loss.

2. In using MFCA, it can be seen that the true value of negative-product (loss) cost varies between IQD 38.18 and 76.36 billion, depending on the scenario of loss ratio (5% to 10%), i.e., between 36 and 73 times the value reported by the traditional system, thus proving the core assumption of the study about the existence of material "hidden cost" in traditional financial statements.

3. Material cost alone constitutes 78.72% of total cost of operating activity with packaging material (IQD 372.5 billion) being the leading one. This item is particularly important for any future cost reduction and loss reduction program, a pattern that is consistent with the results found by Bux and Amicarelli (2022) for the food sector.

4. The estimated negative product cost amounts to 20.35% to 40.69% of the pre-tax net profit of the business for 2025 (depending on the scenario) – a substantial percentage with economic implications that provide a good reason economically to invest in the development of such a measurement system.

5. The study demonstrated the feasibility of adapting MFCA methodology to operate within the constraints of published secondary financial data (rather than internal quantity data) by adopting literature-supported indicative loss ratios, thereby offering a replicable procedural model for other Iraqi industrial companies facing the same data constraint — directly responding to the gap Tran and Herzig (2020) identified for developing-country MFCA research.

5.2 Recommendations

A. Recommendations to Company Management:

1. Establish an internal system for measuring the actual (weight/volume) quantities of production loss at each production line (soft drinks, mineral water, juices), rather than merely recording scrap sale proceeds, as a prelude to applying MFCA with full precision without the need for estimated ratios.

2. Direct cost-rationalization priorities specifically toward the packaging-materials item, being the largest component of material cost (78.72% of the total), and study the feasibility of reducing spoilage rates therein or substituting some of its inputs with less wasteful materials.

3. Integrate MFCA outputs into the periodic management reporting system (rather than confining them to annual financial statements), so that positive- and negative-product cost is regularly presented to executive management in support of real-time operational-control decisions,

consistent with Walz and Günther's (2021) finding that embedding MFCA in ongoing management control — not one-off reporting — is what drives its benefits.

B. Recommendations for Future Research:

4. Conduct future studies using actual quantity data from the company's internal records (rather than the indicative ratios adopted in this study) to enhance the accuracy of loss-cost estimation.
5. Expand the scope of application to a sample of several Iraqi industrial joint-stock companies (rather than a single company), enabling sectoral comparisons and verification of the generalizability of the findings, thereby helping close the developing-country research gap documented by Tran and Herzig (2020).
6. Examine the extent to which MFCA's administrative application persists after initial adoption, considering Kitada et al.'s (2022) and Walz and Günther's (2021) findings regarding the risk of companies discontinuing its application, or applying it superficially, if not supported by integrated resource-planning systems.

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