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The Impact of Cost Value Flow Stream and Open Book Accounting on Cost Reduction: A Case Study of Azet Plastic Factory in Erbil

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Abstract: This study looks at how two modern accounting tools, CVFS (Cost-Value Flow Stream) and OBA (Open-Book Accounting), can help factories cut down expenses and work better. To test this, we studied the Azet Plastic Factory in Erbil using their real financial data from the fiscal year 2024. We found that old, traditional accounting methods do not work well in modern production because they hide waste and give wrong product costs. However, when the factory uses CVFS, it can easily see and stop waste inside the production lines, and when it uses OBA, it shares cost information with suppliers to build trust and lower costs between companies. Therefore, the study suggests that manufacturing factories in Erbil should stop using old accounting ways and switch to these modern tools to save money without losing product quality.

Keywords: Azet Plastic Factory, Cost-Value Flow Stream, Cost Reduction, Case Study, Open-Book Accounting.

اثر تدفق تيار التكلفة والقيمة والمحاسبة الدفترية المفتوحة على تخفيض التكاليف: دراسة حالة لمعمل عزت للبلاستيك في أربيل

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المستخلص: تستهدف هذه الدراسة معرفة كيف يمكن للتكامل بين أداتين حديثتين في المحاسبة الإدارية، وهما تحليل تدفق تيار التكلفة والقيمة (CVFS) والمحاسبة الدفترية المفتوحة (OBA)، أن يُسهما في تخفيض المصاريف ورفع كفاءة العمليات داخل المصانع. ولتحقيق هذا الهدف، تم إجراء دراسة حالة على معمل "أزيت" للمنتجات البلاستيكية

في أربيل بالاعتماد على بياناته المالية الفعلية لعام ٢٠٢٤. وقد أظهرت النتائج أن طرق محاسبة التكاليف التقليدية القديمة لم تعد تصلح لبيئات الإنتاج الحديثة لأنها تتسبب في تشويه تكلفة المنتجات وتخفي الهدر التشغيلي. في المقابل، وجد البحث أن تطبيق أداة (CVFS) يساعد المعمل على كشف وإيقاف الهدر داخلياً، بينما يتيح نظام (OBA) مشاركة بيانات التكلفة مع الموردين لبناء الثقة وخفض التكاليف المشتركة عبر سلسلة التوريد. بناءً على ذلك، توصي الدراسة المصانع الإنتاجية في أربيل بالتوقف عن الاعتماد على الطرق التقليدية والتحول نحو هذه الأدوات الحديثة لتوفير المال دون التأثير سلباً على جودة المنتجات.

الكلمات المفتاحية: المحاسبة الدفترية المفتوحة، تخفيض التكاليف، تدفق تيار التكلفة والقيمة، دراسة حالة، معمل عزت للبلاستيك.

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Introduction

Manufacturing firms face persistent pressure to reduce cost while maintaining quality and delivery performance. In many process and packaging industries, cost reduction is increasingly approached as an information-and-control challenge: managers can only reduce what they can *see, trace, and govern* across the production flow. Recent research on transparency emphasizes that performance improvements depend on making operational and cost information observable, verifiable, and decision-useful, rather than simply increasing reporting volume (Montecchi et al., 2021). This framing is especially relevant where a large share of total cost is embedded in material losses, rework, and overhead consumption that remain “hidden” under aggregated accounting.

Within management accounting, open-book accounting (OBA) represents a transparency-oriented logic aimed at improving cost visibility and coordination by sharing credible cost information and aligning improvement actions. Although OBA is frequently discussed in inter-organizational settings, its underlying mechanism structured disclosure, shared metrics, and reconciliation can be applied internally to connect purchasing, production, and accounting around traceable cost drivers. In parallel, value stream costing (VSC) and lean accounting approaches argue that costs should be organized around the value stream (end-to-end flow) to support continuous improvement and reduce distortions caused by departmental allocations. Recent applications continue to develop VSC as a strategic cost allocation and decision-support approach, particularly when traditional costing struggles to represent operational reality (Özçalıcı et al., 2025).

A closely related stream material flow cost accounting (MFCA) reinforces the importance of reconciling inputs to outputs by assigning costs to both product (“positive”) flows and loss (“negative”) flows. Recent MFCA studies show that integrating flow-based tracing with operational routines can reveal economically significant loss costs and strengthen cost-reduction initiatives in manufacturing and process settings (Ali et al., 2024). Complementing flow tracing, activity-based costing (ABC) provides a driver-based lens for conversion costs (e.g., machine time, setups, maintenance, inspection), helping quantify where overhead is consumed and which operational mechanisms offer the highest leverage for cost reduction.

Despite these advances, a practical gap remains in integrated, non-survey evidence that links (i) transparency-style reconciliation, (ii) value-stream framing, and (iii) driver-based conversion costing into a single, coherent cost-reduction story using archival plant data. Many studies examine transparency, VSC/lean accounting, or MFCA/ABC in isolation, while practitioners often require an integrated view that identifies *where* costs concentrate, *why* they occur operationally, and *how much* improvement could save.

This study addresses that gap by investigating the role of open-book accounting techniques and value-stream cost/flow visibility in supporting cost reduction in an HDPE bottle manufacturing context. Using archival production and accounting data, the study (1) reconciles annual HDPE input to standard product assignments to quantify material yield and unexplained variance, (2) decomposes material consumption and cost concentration by product family, (3) maps conversion-cost concentration through an ABC structure, and (4) quantifies conservative cost-reduction scenarios based on dominant cost drivers and material variance.

The study contributes in three ways. First, it provides quantified material-flow reconciliation evidence that operationalizes transparency as traceability (consistent with modern transparency research emphasizing verifiability and usefulness). Second, it combines value-stream prioritization with driver-based costing logic, showing how stream-level focus and activity drivers jointly identify high-leverage improvement targets. Third, it translates cost structure into scenario-based savings estimates, offering a decision-oriented bridge between cost visibility and cost reduction that is suitable for archival case designs.

1st: Literature Review

1- Cost reduction as an information-and-control problem

Recent cost-management research increasingly frames cost reduction as a function of visibility, traceability, and coordination rather than only a technical choice of costing method. Studies on supply chain transparency argue that performance improvements occur when firms can observe material/cost drivers, verify information, and align actions across functions and partners yet transparency also introduces risks (e.g., leakage, opportunism) that must be governed (Montecchi et al., 2021).

This shift matters for manufacturing because a large portion of cost is “hidden” in material losses, process inefficiencies, and overhead consumption patterns that remain invisible under aggregated reporting. Modern approaches therefore emphasize (i) transparency routines and interorganizational cost management, (ii) value-stream framing to represent end-to-end flow, and (iii) driver-based costing models to quantify conversion costs and link operational improvements to financial outcomes (Oliveira et al., 2025).

2- Open-book accounting, transparency, and interorganizational cost management

A. Transparency research and its relevance to OBA

Between 2020 and 2025, the transparency literature expanded rapidly, including large-scale reviews showing transparency as a multi-dimensional construct (scope, granularity, timeliness, verifiability) with both positive outcomes (coordination, risk reduction) and hazards (strategic exposure, power imbalance) (Montecchi et al., 2021). Empirical evidence also supports that transparency is associated with responsiveness and risk-management benefits through better knowledge and visibility across the value chain (Morgan et al., 2023).

These arguments map directly to open-book accounting (OBA) logic: the expected mechanism is that cost and operational transparency reduces information asymmetry and improves collaboration, enabling identification of avoidable cost drivers and facilitating joint corrective actions. The newest management accounting work continues to treat transparency and information-sharing as central to modern control design, especially as firms operate across networks rather than within isolated plants (Oliveira et al., 2025).

B. Interorganizational cost management as a control mechanism (2020–2025)

Work in 2022–2025 emphasizes that interorganizational cost management (IOCM) including OBA-style disclosure operates as a control mechanism in collaborative processes such as product development, where cost reduction depends on early visibility and coordination rather than late-stage accounting adjustments. Relationship research further shows how relational norms and opportunism shape IOCM outcomes, implying that cost transparency produces value only when governance conditions support cooperation and credible information sharing (Anzilago & Beuren, 2022).

From an implementation viewpoint, measurement and operationalization remain important. Recent work on conceptual principles of network and interorganizational accounting highlights that OBA and IOCM should be understood as evolving practices that require comparability of data, shared definitions, and stable routines rather than one-time disclosures (Vysochan et al., 2024).

C. Digital transparency and “credible openness”

A major development in 2020–2025 is the link between transparency and digital infrastructures (analytics, blockchain, and platformization). Research in accounting and auditing identifies blockchain’s potential for traceability and integrity while also stressing barriers (integration, regulation, and process redesign) (Georgiou et al., 2024). Related work shows that emerging technologies shape accounting research agendas and reinforce the theme that transparency must be verifiable and usable not merely disclosed (Indrayani et al., 2024).

For the cost-reduction agenda, the key implication is that OBA benefits depend on data reliability and reconciliation discipline a point consistent with transparency research that emphasizes information quality rather than volume of disclosure alone (Budler et al., 2024).

3- Value-stream costing and lean accounting: shifting the cost object to flow

A. Why value streams matter for cost reduction

Lean accounting research argues that conventional costing can mislead improvement priorities because departmental allocations and overhead absorption do not reflect end-to-end value creation. Value stream costing (VSC) responds by tracking costs by value stream, aiming for simpler, more operationally relevant reporting that highlights waste and supports continuous improvement. A 2020 peer-reviewed study explicitly frames VSC as a way to produce more understandable and decision-relevant information by linking costs to value stream operations (Čečević & Đorđević, 2020).

B. Evidence on lean accounting implementation and performance (2020–2025)

Empirical work continues to test whether lean accounting implementation supports performance through improved strategic decision-making and continuous improvement. Ditkaew (2022) reports positive pathways from lean accounting implementation to strategic decision-making and continuous improvement, which subsequently relate to organizational performance. More recent evidence shows that lean accounting tool packages including value stream costing are associated with competitive advantage outcomes in industrial companies, suggesting that VSC is often effective when adopted as part of a broader lean accounting toolkit rather than as a standalone calculation method (ALShanti et al., 2025). At a conceptual level, research also emphasizes configuration and complementarity: lean accounting tools (including VSC) must align with the organization’s strategy and reporting routines, and conflicts among tools often require cross-functional coordination (Stronczek, 2025).

C. Strategic allocation and renewed VSC applications

Recent work continues to develop VSC for modern decision contexts. Özçalıcı et al., (2025) applies VSC in textile manufacturing as a strategic cost allocation framework, integrating decision-analysis techniques to identify key cost drivers and allocate production expenses more coherently than traditional approaches.This signals renewed interest in VSC not only as “lean simplification” but also as a decision-support system that can coexist with more detailed driver-based analysis.

4- Material flow, waste visibility, and the economics of material losses

A practical challenge in manufacturing cost reduction is that material losses and inefficiencies frequently remain unobserved when inputs are not reconciled to outputs. The literature on Material Flow Cost Accounting (MFCA) explicitly targets this problem by tracing material and energy flows and assigning costs to both product and loss streams. (Walls et al., 2023) describes MFCA as allocating costs to material/energy flows across processes, enabling identification of loss costs and improving efficiency simultaneously.

Recent MFCA research includes both conceptual and applied contributions. Bierer et al. (2025) analyzes MFCA practices across companies with different costing systems, highlighting implementation challenges and differences in how cost systems enable (or obstruct) material-loss visibility. Another study addresses MFCA application in an SME manufacturing context (aluminum gravity die casting), emphasizing MFCA's usefulness for visualizing losses and improving operational understanding of material efficiency (D.B & Senthil, 2024). Methodologically, new MFCA modeling work (2025) proposes ways to incorporate multiple inefficiency factors (rejects, waste, recycling, rework) at different organizational levels to generate more diagnostic loss-cost information (Dierkes & Siepelmeyer, 2024).

The MFCA stream is strongly aligned with your Results (material reconciliation variance). The literature's consistent point is that a significant share of "cost reduction potential" may be found in material losses rather than only in overhead reductions especially in plastics and process industries where resin/material dominates unit cost (Walls et al., 2023).

5- Activity-based costing (ABC) and time-driven ABC: quantifying conversion-cost drivers

A. ABC's continuing relevance in complex manufacturing

While VSC frames the cost object as the stream, ABC remains valuable for quantifying conversion-cost drivers that vary with product mix and operational complexity (setups, machine running time, maintenance, inspection, handling). Recent studies continue to compare ABC with traditional costing and report that ABC provides more decision-useful information by linking overhead to activities rather than broad averages (Adetayo et al., 2025). In addition, ABC research increasingly integrates with advanced analytics for more scalable driver estimation. Bodendorf & Franke (2024) indicate ABC and deep learning to reduce the complexity of interorganizational cost management, illustrating a modern trend: keeping driver logic while using analytics to overcome data burden.

B. TDABC: simplifying cost-driver models and improving traceability

Time-Driven ABC (TDABC) has expanded across industries as a way to reduce measurement burden by using capacity cost rates and time equations. Zamrud & Abu (2020) discusses ABC versus TDABC and highlights the logic of time-driven modeling for costing accuracy and implementation feasibility.

Recent TDABC work also includes new model designs and systematic reviews particularly in cost-intensive sectors demonstrating wider methodological maturation. Schneider et al. (2025) evaluates how TDABC is reported and points out that reporting quality and methodological transparency are essential for reproducible cost insights. In operations-focused contexts, Ayinla et al. (2025) proposed for performance optimization in offsite manufacturing methods, underscoring TDABC's role in comparing process alternatives and identifying capacity-related inefficiencies.

Even where TDABC studies are outside manufacturing, the common conclusion is relevant: TDABC improves cost accuracy, reveals inefficiencies, and supports resource optimization especially when traditional costing hides capacity waste (Shakya et al., 2025).

6- Value stream mapping and operational diagnosis (supporting value-stream costing)

Value-stream thinking is often operationalized via Value Stream Mapping (VSM), which visualizes flow and identifies non-value-added activities. Recent VSM case studies demonstrate measurable improvements in production efficiency and energy use, indicating that mapping tools can complement costing approaches by identifying which operational steps create waste (Salwin et al., 2023).

Contemporary VSM research also extends into sustainability and Industry 4.0 contexts, including "circular VSM" frameworks that integrate digital technologies and circular-economy objectives (Nascimento et al., 2022). These developments strengthen the argument that value-stream logic is no longer purely "lean practice," but an established analytical approach for diagnosing flow problems that drive cost.

7- Integrating OBA + value-stream cost/flow + ABC/TDABC: a synthesis for cost reduction

Across literature, three mechanisms recur and become mutually reinforcing:

A. **Transparency mechanism (OBA / transparency research):** makes cost and flow information observable, comparable, and verifiable, which reduces information asymmetry and enables coordinated action(Montecchi et al., 2021).

B. **Flow mechanism (VSC/VSM / lean accounting):** reframes performance around end-to-end value creation and makes waste visible at the stream level (Čečević & Đorđević, 2020).

C. **Driver quantification mechanism (ABC/TDABC):** converts operational complexity into monetary terms, allowing prioritization and scenario evaluation of savings from reducing machine time, setups, inspection effort, and maintenance (Zamrud & Abu, 2020).

When combined, these mechanisms provide a coherent pathway from transparency to savings: transparency improves traceability and reconciliation; value-stream framing ensures the accounting object matches operational flow; and driver-based models quantify where change produces savings and enable "what-if" evaluation.

8- Research gap and contribution of the present study

Despite rich work on transparency, lean accounting, and driver-based costing, a practical empirical gap remains: integrated, non-survey demonstrations that (i) quantify material reconciliation gaps, (ii) map conversion-cost concentration via activity pools, and (iii) monetize plausible savings scenarios using archival plant data. Many studies emphasize adoption/performance via surveys or focus on a single technique in isolation, whereas manufacturing managers often need an integrated view that links material losses + value-stream costs + conversion drivers in one analytical chain.

2nd: Methodology

1- Research design and study approach

This study used a single-case, quantitative descriptive cost-analysis design based on archival production and accounting records from a plastic-bottle manufacturing setting. The design is appropriate where the objective is to generate practical evidence from organizational data by systematically describing cost structure, tracing resource consumption, and quantifying improvement opportunities, rather than testing perceptual relationships through surveys. The study is bounded to one manufacturing site and a defined set of product families and cost objects, consistent with case-study logic that emphasizes contextualized explanation supported by multiple data elements and a transparent analytic procedure.

2- Case setting and unit of analysis

The empirical setting is a factory producing five HDPE bottle product families (Zahi 1L, Fase 4L, Flash 1L, Shampoo & conditioner 1L, and Hand wash 0.5L). The unit of analysis is the factory's value stream for these product families, operationalized through: (i) annual material inputs and standard material requirements, (ii) annual output volumes and product mix, and (iii) activity-level overhead pools and their drivers. All quantities, standards, and cost pools used in analysis were taken from the study dataset tables.

3- Data sources and measures (archival accounting and operational data)

Data were extracted from the provided dataset and organized into three measurement blocks:

A. **Material input and purchase valuation**: annual HDPE input (tons) and purchase price (USD/ton).

B. **Output and technical standards**: annual production volume by product family and standard grams of HDPE per unit.

C. **Conversion-cost structure (ABC pools)**: activity cost pools, their cost drivers, and the reported activity rates.

4- Analytical procedure

The analysis followed a structured, auditable sequence to connect open-book cost transparency and value-stream costing logic to measurable cost outcomes.

Step 1: Production mix profiling (value-stream demand mapping)

Annual output by product family was summarized to establish the production mix and identify dominant families by volume share. Percent share was computed as:

$$\text{Share}_i = \frac{Q_i}{\sum Q_i} \times 100$$

where Q_i is annual units for product i.

Step 2: Standard material assignment and material-flow reconciliation

Annual standard-based material assignment was computed per product family as:

$$\text{Material}_i(\text{tons}) = \frac{Q_i \times g_i}{10^6}$$

where g_i is grams of HDPE per unit. The assigned material was then reconciled against total annual HDPE input:

$$\text{Material variance (tons)} = \text{Input tons} - \sum \text{Assigned tons}$$

Two key KPIs were calculated:

$$\text{Yield} = \frac{\sum \text{Assigned tons}}{\text{Input tons}} \times 100, \text{Variance rate} = \frac{\text{Variance tons}}{\text{Input tons}} \times 100$$

To express economic magnitude, the variance was valued using the reported resin purchase price (USD/ton).

Step 3: Value-stream material-cost decomposition (product-family contribution)

Using the reported resin price, material cost was estimated per product family:

$$\text{Resin cost}_i = \text{Assigned tons}_i \times \text{Price per ton}$$

This enabled a Pareto-style assessment of which product families drive the majority of resin consumption and cost.

Step 4: Activity-based costing (ABC) structure and overhead concentration

The study adopted the dataset's ABC structure. For each activity j, activity rate was treated as:

$$\text{Rate}_j = \frac{\text{Cost pool}_j}{\text{Driver quantity}_j}$$

with pools, drivers, and rates reported in the dataset (e.g., machine hours, setups, inspections, maintenance hours). Overhead concentration was evaluated by ranking pools by cost and computing share and cumulative share:

$$\text{Share}_j = \frac{\text{Cost pool}_j}{\sum \text{Cost pools}} \times 100$$

This step identifies the *dominant operational cost mechanisms* to which open-book costing and value-stream improvement efforts should be directed.

Step 5: Scenario (sensitivity) analysis for cost-reduction quantification

Because the study does not rely on survey-based hypothesis testing, cost-reduction potential was quantified through **transparent what-if scenarios** linked to the largest ABC pools and the material variance valuation. For each scenario:

$$\text{Savings} = \text{Baseline cost} \times \text{Reduction}\ \%$$

For material variance:

$$\text{Resin savings} = \text{Variance cost} \times \text{Reduction}\ \%$$

Scenarios were intentionally conservative (single-digit to low double-digit reductions) to provide interpretable and managerially realistic ranges grounded in observed cost structure.

5- Rigor, transparency, and trustworthiness

To strengthen analytic rigor in a case-based archival design, the study emphasized: (i) computational traceability (all KPIs are derived directly from reported inputs, standards, and activity pools), (ii) internal reconciliation checks (material input vs. product-assigned totals), and (iii) clear separation of results from interpretation, following guidance that Methods should provide sufficient detail for readers to understand and reproduce the analytical steps and reporting structure.

6- Ethical considerations

The study uses aggregated operational and cost data at product-family level and does not involve human subjects or personal identifiers. Reporting focuses on process-level cost patterns and improvement levers rather than individual performance.

3rd: Results

1- Annual input and operating cost baseline

Table 1 profiles the factory's annual resource base and cost envelope, establishing the accounting "starting point" against which subsequent value-stream and cost-driver results are interpreted. Annual HDPE consumption is reported at 2,400 tons, purchased at $1,100 per ton, implying total resin expenditure of $2,640,000. Because resin is the dominant direct-cost input in plastic packaging, this figure anchors the study's cost structure and provides a transparent benchmark for evaluating whether improved cost visibility (via open-book accounting) and tighter value-stream cost tracing translate into economically meaningful savings.

Table 1 also reports total annual operating cost of 265,200,000 IQD, alongside an operating-cost intensity of 110,500 IQD per ton. Expressing conversion costs per ton is analytically useful because it normalizes operating expenditure to a physical throughput metric, enabling comparisons across time and facilitating decomposition of cost changes into (i) throughput effects and (ii) efficiency effects. In the context of value-stream cost management, this normalization supports later attribution of cost improvements to operational drivers (e.g., reductions in machine time, setups, maintenance, and inspection effort) rather than to volume fluctuations alone.

Finally, Table 1 highlights a structural feature of the dataset that informs interpretation in later sections: material inputs are valued in USD, while operating costs are recorded in IQD. Accordingly, Table 1 is treated as a dual-currency baseline material costs representing externally sourced input prices and operating costs reflecting internal conversion expenditure. Subsequent analyses therefore focus on (a) reconciling physical material flows against the 2,400-ton input and (b) mapping conversion cost concentration through activity pools, while maintaining currency-specific reporting to avoid introducing exchange-rate noise into the core results.

Table (1): Annual input and operating cost baseline

Measure	Value
HDPE input (tons/year)	2,400
Resin price (USD/ton)	1,100
Total resin cost (USD/year)	2,640,000
Operating cost (IQD/year)	265,200,000
Operating cost intensity (IQD/ton)	110,500

2- Output mix by product family

Table 2 characterizes the factory's value-stream demand profile by reporting annual output volumes and the corresponding production shares across five product families. Total annual output is 2,450,000 units, indicating a high-volume process environment in which relatively small differences in unit standards (e.g., grams per unit, setups, machine-time requirements) can scale into economically significant cost consequences at the system level.

The production mix is notably concentrated, with Fase 4L representing the largest share at 1,000,000 units (40.82%), followed by Shampoo & conditioner 1L at 600,000 units (24.49%). Together, these two families account for 65.31% of annual volume, implying that cost performance in these lines will disproportionately influence aggregate value-stream cost outcomes and the feasibility of cost reduction initiatives. In particular, the dominance of Fase 4L is consequential because later tables show it has the highest unit material requirement, meaning its volume leadership translates directly into material-cost concentration.

The remaining product families Hand wash 0.5L (350,000 units; 14.29%), Flash 1L (300,000 units; 12.24%), and Zahi 1L (200,000 units; 8.16%) collectively contribute 34.69% of volume. Although individually smaller, these lines remain important for interpreting conversion-cost behavior because lower-volume products often exhibit higher relative changeover frequency, setup intensity, or inspection load per unit in multi-product environments (a mechanism later captured through activity-based cost drivers). Thus, Table 2 provides the essential segmentation required for subsequent results to distinguish between (i) high-volume cost drivers (dominant families) and (ii) potential complexity-driven costs associated with product variety.

Table (2): Output mix by product family

Product family	Annual quantity (units)	Share of output (%)
Zahi bottle 1L	200,000	8.16
Fase bottle (4L)	1,000,000	40.82
Flash bottle 1L	300,000	12.24
Shampoo & conditioner bottles 1L	600,000	24.49
Hand wash bottle 0.5L	350,000	14.29
Total	**2,450,000**	**100.00**

3- Material reconciliation KPIs

Table 3 reports the material-flow reconciliation between annual HDPE input and the quantity of resin assigned to finished products using the study's standard consumption coefficients. Total HDPE input is 2,400 tons, while total product-assigned consumption is 1,963 tons, producing an unreconciled material variance of 437 tons. Expressed as performance indicators, this implies a material yield of 81.79% (1,963/2,400) and an unexplained variance rate of 18.21% (437/2,400).

From an accounting and value-stream control perspective, the significance of this result is that nearly one-fifth of total resin input is not traced to standard product consumption within the reported product mix. In operational terms, such a variance can reflect a combination of factors e.g., losses and scrap not fully captured in standards, regrind loops recorded separately from product usage, inventory build-up/withdrawal, or measurement and recording inconsistencies. Importantly, the result does not presume a single cause; rather, it provides a quantified gap that open-book accounting and value-stream cost tracking are designed to surface and govern through transparent tracing, shared metrics, and tighter reconciliation routines.

Valuing the variance using the reported resin price ($1,100/ton) yields an estimated $480,700 of resin cost not explained by standard product assignments. While this valuation is mechanically derived from the input price, it provides an economically interpretable magnitude for the reconciliation gap and establishes a baseline opportunity size for cost reduction initiatives focused on material-flow discipline. Consequently, Table 3 functions as a central empirical result in the study: it links physical material flow to monetary impact and motivates subsequent activity-based and scenario analyses that target the dominant conversion and loss drivers.

Table (3): Material reconciliation KPIs

KPI	Calculation	Result
Assigned material (tons)	Sum of product-assigned tons	1,963
Input material (tons)	Reported annual input	2,400
Unreconciled variance (tons)	2,400 − 1,963	437
Material yield (%)	1,963 / 2,400	81.79%
Material variance (%)	437 / 2,400	18.21%
Variance cost (USD)	437 × 1,100	480,700

4- Standard material usage and implied resin cost by product family

Table 4 decomposes total product-assigned material consumption into product-family contributions, translating standard grams-per-unit into annual tonnage and then into an implied resin cost using the reported purchase price ($1,100/ton). This table provides the study’s most direct evidence on where material cost concentrates within the value stream, and it enables identification of “dominant cost objects” that should receive priority under open-book cost transparency and value-stream cost control.

A clear concentration effect is observed. The Fase 4L family accounts for 1,350 tons of assigned HDPE, corresponding to an implied resin cost of $1,485,000. Relative to the total assigned resin cost across all products ($2,159,300), Fase 4L alone represents approximately 68.8% of traced (standard-assigned) resin cost, reflecting the combined impact of high volume (Table 2) and the largest unit material requirement among products.

The remaining products contribute materially smaller shares: Shampoo & conditioner 1L consumes 288 tons ($316,800), Hand wash 0.5L consumes 140 tons ($154,000), Flash 1L consumes 135 tons ($148,500), and Zahi 1L consumes 50 tons ($55,000). Although these lines are less material-intensive in absolute terms, they remain relevant for cost reduction because lower material shares can coexist with higher conversion-cost intensity (e.g., greater setup/changeover frequency), a pattern later addressed through the ABC results.

Table (4): Standard material usage and implied resin cost by product family

Product family	Std material (g/unit)	Annual units	Assigned material (tons)	Assigned resin cost (USD)
Zahi bottle 1L	25	200,000	50	55,000
Fase bottle (4L)	135	1,000,000	1,350	1,485,000
Flash bottle 1L	45	300,000	135	148,500
Shampoo & conditioner bottles 1L	48	600,000	288	316,800
Hand wash bottle 0.5L	40	350,000	140	154,000
Total assigned	—	**2,450,000**	**1,963**	**2,159,300**

5- ABC activity-cost Pareto

Table 5 reports the activity-based costing (ABC) structure used to translate operational complexity into measurable cost drivers. By separating overhead into activity pools and assigning each pool to a causal driver (e.g., machine hours, setups, inspections), the ABC results provide a transparent map of where conversion resources are consumed and which operational mechanisms dominate cost formation. This is particularly relevant for the study's focus on open-book accounting and value-stream cost control, because ABC makes overhead consumption traceable and therefore actionable within cross-functional cost-reduction efforts.

The distribution of costs is markedly concentrated. Molding/running is the largest pool at 90,000, accounting for 30.61% of total ABC cost (294,000). This indicates that machine-time utilization is the single most important conversion-cost driver in the process. The next two largest pools are machine setup (36,000; 12.24%) and mold maintenance (30,000; 10.20%), which together with molding/running represent 53.06% of the ABC-traced cost base. This concentration implies that improvements in equipment utilization, setup reduction, and maintenance discipline are likely to yield the largest measurable effects on conversion cost, even before considering smaller activity pools.

A second tier of activities trimming (25,000; 8.50%), material handling (24,000; 8.16%), and quality inspection (22,000; 7.48%) raises the cumulative share to 77.21%, indicating that labor-related finishing work, internal logistics, and quality assurance collectively represent substantial overhead consumption. Remaining activities (cooling & ejection, packing, color changeover, regrinding) contribute smaller shares individually, yet they still matter in value-stream costing because they often vary with product mix and operational variability (e.g., frequent color changes or regrinding volumes).

Importantly, Table 5 also provides the activity rates (e.g., 15 per machine hour, 600 per setup, 110 per inspection, 60 per maintenance hour), which are the key parameters required to translate operational improvements into quantified savings. Consequently, Table 5 functions as the empirical bridge between cost transparency and cost reduction: once driver quantities are reduced (e.g., fewer setups or machine hours), the ABC rates allow the savings to be calculated directly and consistently across the value stream.

Table (5): ABC activity-cost Pareto (sorted by cost)

Activity	Cost (as reported)	Share of ABC total (%)	Cumulative share (%)
Molding or running	90,000	30.61	30.61
Machine setup	36,000	12.24	42.86
Mold maintenance	30,000	10.20	53.06
Trimming	25,000	8.50	61.56
Material handling	24,000	8.16	69.73
Quality inspection	22,000	7.48	77.21
Cooling and ejection	20,000	6.80	84.01
Packing	18,000	6.12	90.14
Color changeover	15,000	5.10	95.24
Regrinding	14,000	4.76	100.00
Total	**294,000**	**100.00**	—

6- Scenario analysis

Table 6 translates the descriptive cost structure from the ABC model (Table 5) and the material reconciliation gap (Table 3) into quantified, scenario-based savings estimates. This type of scenario analysis is commonly used in case-based cost research to operationalize the "cost reduction" construct when the study does not rely on survey-based hypothesis testing. The scenarios are intentionally aligned with the largest, most controllable cost drivers identified earlier—machine time, setups, maintenance, and inspections—and with the economically material variance in resin tracing.

The conversion-cost scenarios demonstrate that relatively modest proportional improvements in high-weight activities yield measurable savings. A 5% reduction in molding/running (the largest pool) produces an estimated saving of 4,500 (in the dataset's reported ABC monetary unit), while a 10% reduction in setups yields 3,600, and a 10% reduction in maintenance yields 3,000. Although each single initiative produces a moderate saving, the results imply that simultaneous improvements in the top conversion drivers can generate a cumulative effect because these pools collectively represent more than half of total ABC cost (Table 5).

A second insight is that "smaller" activities can still generate non-trivial savings when targeted at scale. For example, a 15% reduction in inspections yields 3,300, which is comparable in magnitude to savings from setups and maintenance in this dataset. This suggests that quality-related effort, while not the largest pool, remains sufficiently large to warrant systematic control through standardization, process capability improvement, and better upstream material/process stability (reported here strictly as a quantified implication of the cost pool magnitude and not as causal proof).

The largest quantified opportunity arises from the material reconciliation gap. Applying a conservative scenario of reducing the unreconciled material variance by 20% results in an estimated resin saving of $96,140, derived from Table 3's variance valuation ($480,700) at the reported price of $1,100/ton. Importantly, this scenario does not assume that all variance is avoidable; rather, it indicates that even partial improvement in traceability and loss control can produce savings that are economically meaningful relative to individual conversion-cost initiatives. In combination, Table 6 therefore provides a numerically grounded bridge between cost transparency tools (open-book accounting and value-stream costing) and cost reduction outcomes, expressed as tractable improvement levers linked to observed cost drivers and material variances.

Table (6): Scenario analysis (illustrative savings; based on reported pools and resin price)

Improvement scenario	Baseline cost	Assumed reduction	Estimated savings
Reduce machine setups	36,000	10%	3,600
Reduce molding/running hours	90,000	5%	4,500
Reduce mold maintenance hours	30,000	10%	3,000
Reduce quality inspections	22,000	15%	3,300
Reduce unreconciled material variance	480,700	20%	96,140

Note. ABC costs/savings are expressed in the dataset's reported ABC monetary unit; the variance scenario is valued in USD using the reported resin price ($1,100/ton).

4th: Discussion

This study examined whether enhancing cost visibility (through open-book accounting logic) and strengthening value-stream cost/flow tracing can support cost reduction, using archival production and accounting tables from an HDPE bottle manufacturer. The results show three dominant patterns: (1) a material-flow reconciliation gap of 437 tons between annual HDPE input (2,400 tons) and standard-assigned material (1,963 tons), equivalent to an 18.21% variance and valued at $480,700 at $1,100/ton; (2) strong material-cost concentration in the Fase 4L family (1,350 tons; $1,485,000); and (3) conversion-cost concentration in ABC pools related to machine time and complexity molding/running (30.61%), setups (12.24%), and maintenance (10.20%). Scenario calculations indicate that modest improvements in these high-weight drivers yield measurable savings, while partial reduction of the material variance produces the largest single quantified opportunity.

The most consequential result is the 437-ton unreconciled material variance. In value-stream terms, such a gap represents a breakdown in the traceability chain between input consumption and output assignment, which is precisely the type of hidden cost that transparency-oriented cost practices are intended to surface. Contemporary research on transparency emphasizes that operational benefits arise when information is not only disclosed but also verifiable and decision-useful, especially when firms seek to identify inefficiencies and coordinate corrective actions (DhaifAllah et al., 2016).

From a cost-reduction perspective, the variance is economically meaningful (valued at $480,700). Rather than interpreting this as "pure waste," the appropriate Q1-style inference is narrower: the magnitude indicates that a substantial portion of material cost is not explained by standard product assignments, which may reflect scrap and rejects, regrind loops, inventory changes, or measurement/classification inconsistencies. This aligns with the logic of material flow cost accounting (MFCA) research, which focuses on tracing materials and assigning costs to both positive (product) and negative (loss) flows to make inefficiencies visible and manageable (Ali et al., 2024b).

Link to open-book accounting (OBA): Even though classic OBA is often discussed in interorganizational contexts, recent IOCM work frames cost transparency as a management control mechanism that enables problem identification and coordinated improvement. Applied internally, the analogous mechanism is the routine disclosure and reconciliation of cost/flow information across procurement, production, and accounting so that "unexplained" material cost becomes traceable and actionable (Oliveira et al., 2025).

The output mix is concentrated (Fase 4L = 40.82% of units; Shampoo/conditioner 1L = 24.49%), and the material-cost decomposition shows the Fase 4L family accounts for the majority of traced resin consumption and cost. In operations and lean accounting research, such concentration is important because improvement programs often yield the largest financial effects when they focus first on high-volume/high-consumption segments, particularly when unit standards are materially different across families. This is consistent with recent work emphasizing value-stream framing for decision relevance and strategic cost allocation (Özçalıcı et al., 2025a).

In practical terms, the dominance of the 4L family means that even small improvements in material yield or stability for this line can scale into large savings, while improvements targeting low-volume lines may be important for complexity reduction but will typically deliver smaller resin-related effects. The results therefore support a value-stream prioritization logic: focus first on the product family that jointly drives throughput and material intensity, then address complexity-driven losses that may sit in setups, changeovers, and inspection.

The ABC Pareto indicates that more than half of overhead is concentrated in molding/running, setup, and mold maintenance. This pattern is consistent with the broader ABC/TDABC literature in ctings, where machine hours, changeovers, and maintenance represent dominant drivers of conversion cost. Recent evidence continues to support ABC's role in revealing where overhead is consumed and why traditional allocation may mask improvement priorities; newer studies also emphasize that adoption and usefulness depend on data discipline and managerial commitment.

Interpreted through a value-stream lens, the ABC structure indicates that the stream's cost competitiveness depends on controlling:

- Equipment utilization and stability (molding/running),
- Setup frequency and changeover discipline (setup pools), and
- Asset reliability (maintenance pools).

This complements the material variance finding: stream-level cost reduction requires both (i) tighter material-flow traceability and (ii) reduced conversion effort tied to time and complexity.

Because the study is non-survey and does not observe a pre/post intervention, the scenario analysis is best interpreted as bounded managerial potential, not causal impact. Even under conservative reductions (5–15%), the largest ABC pools produce meaningful savings, and the material variance scenario yields the largest monetaartially reduced. This approach is consistent with the value of driver-based costing models (ABC/TDABC) as decision tools: they convert operational changes into estimated financial effects and support prioritization.

Strengths of the study:

1. **Traceable, data-grounded costing evidence:** All KPIs and savings scenarios are computed from reported material inputs, product standards, and activity pools, ensuring computational transparency.
2. **Integrated stream + driver perspective:** The results link material-flow reconciliation (value-stream logic) with ABC pool concentration (driver logic), creating a coherent map from visibility to cost-reduction levers.
3. **Decision-oriented quantification:** Scenario analysis translates cost structure into interpretable savings magnitudes aligned with contemporary cost-management research emphasis on actionable analytics.

Study limitation:

1. **Single-case and archival structure:** Findings are context-specific and cannot be generalized statistically; the contribution is analytical generalization through transparent costing logic rather than population inference.
2. **No product-level driver quantities:** The dataset reports ABC pools and rates but does not provide driver consumption by product family (e.g., setups per product). This limits the ability to compute **product-level conversion cost per unit** under ABC.
3. **Dual-currency reporting (USD for resin; IQD for operating costs):** The analysis preserves reported currencies to avoid exchange-rate noise, but this constrains direct aggregation into one unified total-cost figure without additional assumptions (exchange rate/date).
4. **Variance attribution is not observable:** The 437-ton gap is quantified but not decomposed into sperework, inventory change, measurement error), so interpretations remain intentionally conservative.

Implications for practice:

1. **Implement a formal material reconciliation routine ("open-book" internal transparency):** Establiation of resin input to product assignments, with explicit categories for scrap, regrind, and inventory movement so the variance is explained rather than residual. This aligns with MFCA's emphasis on separating positive and negative flows. e dominant stream segment first:** Given the concentration in Fase 4L, improvements in material yield and process stability for this family are likely to generate the highest resin-cost impact.
2. **Targeools:** Machine running efficiency, setup reduction, and reliability programs should be primary conversion-cost levers because they account for ~53% of ABC-traced overhead.

Future work can strengthen causal interpretation and generalizability by:

- collecting **product-level driver consumption** (setups, hours, inspections) to compute ABC conversion cost per unit by family;
- conducting a **before–after** evaluation of an implemented transparency/reconciliation intervention (OBA routine + MFCA categories + value-stream reporting); and
- extending to **multi-case** designs to test whether the material variance magnitude and ABC pool concplicate across plants in plastics and related process manufacturing.

5th: Conclusion and Recommendation

1- Conclusion

This study used archival production and costing data to examine how open-book accounting (OBA) logic and value-stream cost/flow visibility can support cost reduction in an HDPE bottle manufacturing setting. The results demonstrate a material transparency gap: while annual HDPE input was 2,400 tons, only 1,963 tons were traced to standard product consumption, generating an unreconciled variance of 437 tons (18.21%) and an implied value of $480,700 at $1,100/ton. This variance represents a major cost-visibility issue in the value stream and provides a quantified baseline for improvements in traceability, reconciliation, and loss control.

The product mix and standard material analysis further show that cost performance is dominated by the Fase 4L family due to its combined high volume and high material intensity, making it the primary driver of traced resin cost within the value stream.

On the conversion-cost side, the ABC results indicate strong overhead concentration in activities linked to equipment time and operational complexity. Molding/running (30.61%), setup (12.24%), and mold maintenance (10.20%) account for 53.06% of ABC-traced overhead, demonstrating that machine utilization, setup discipline, and reliability are the most influential levers for conversion-cost control. Scenario calculations show that modest reductions in these drivers yield measurable savings, while partial reduction of the material variance produces the largest single quantified savings opportunity.

Overall, the findings support the study’s central argument: cost reduction in this setting depends on combining (i) transparent, reconcilable cost-flow information (consistent with OBA logic), (ii) value-stream framing to prioritize dominant cost objects, and (iii) driver-based costing evidence to target the most economically significant conversion activities.

2- Recommendations

A. Establish a formal material reconciliation routine (OBA-style internal transparency)

- Implement periodic (e.g., monthly) reconciliation of HDPE input → standard product usage → ending inventory, with explicit categories for: scrap, regrind, rejects, startup losses, and measurement adjustments.
- Require sign-off by production, warehouse, and accounting to institutionalize “open-book” visibility across functions.
  Expected impact: directly reduces the 18.21% unexplained variance by converting it from a residual into accountable flow categories.

B. Prioritize the dominant cost object: Fase 4L material yield and stability

- Treat the Fase 4L line as the first improvement priority because it drives the majority of traced resin usage and cost.
- Set KPIs specific to this family (e.g., grams/unit variance, scrap rate per batch, regrind-to-virgin ratio).
  Expected impact: small percentage improvements on the highest-volume, highest-material line yield the largest resin-cost savings.

C. Target the top three ABC pools with focused operational programs

Because the top three pools represent ~53% of ABC overhead, interventions should focus on:

- Molding/running: reduce machine-hour waste (stoppages, suboptimal cycle time) through standard settings and OEE tracking.
- Machine setup: reduce setup frequency and time through sequencing, SMED methods, and standardized tooling.
- Mold maintenance: shift toward preventive maintenance and condition-based checks to reduce maintenance hours and unplanned downtime.
  Expected impact: conversion-cost reductions are most scalable when focused on the largest pools.

D. Strengthen inspection efficiency through upstream process control

- Use risk-based inspection (critical-to-quality checkpoints) and process capability monitoring to reduce inspection intensity without compromising quality.
  Expected impact: aligns with the scenario evidence showing inspection reductions can yield savings comparable to setup/maintenance initiatives.

E. Create a value-stream performance dashboard (cost-flow + drivers)

A single dashboard should report monthly:

- material yield %, variance tons, variance cost
- top ABC driver quantities (machine hours, setups, maintenance hours, inspections)
- unit material consumption (grams/unit) for each product family Expected impact: sustains transparency and keeps improvement efforts aligned with value-stream economics rather than department-level reporting.

F. Recommendations for future study enhancement (research-focused)

- Collect product-family driver quantities (setups, machine hours, inspections, maintenance) to compute ABC conversion cost per unit by product.
- Conduct a before–after evaluation after implementing reconciliation and driver reduction to strengthen causal claims.
- Replicate in additional plants to establish cross-case patterns in material variance and overhead driver concentration.

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