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Using Data Analysis to Identify Operational Bottlenecks in Business Processes: A Consulting-Based Case Study

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ABSTRACT

This study examines how data analysis can be used to identify operational bottlenecks in business processes within a consulting context. Drawing on a real-world consulting case focused on pallet management, the research analyzes more than six million transactional records to detect inefficiencies in asset circulation, repair activities, and purchasing patterns. The findings reveal that high pallet replacement rates were primarily driven by limited traceability and insufficient process controls rather than asset shortages. By applying descriptive analytics and KPI-based diagnostics, the study demonstrates how data-driven approaches can improve asset utilization and reduce operational costs. The results contribute to the literature on analytics-enabled process improvement while offering practical insights for managers seeking to enhance operational efficiency.

1. Introduction

This study addresses this gap by examining the role of data analysis in identifying operational bottlenecks within consulting-driven process improvement initiatives. Specifically, the study seeks to answer the following research question: How can data analysis be used to identify operational bottlenecks in business processes during consulting projects?

The main objective of this research is to evaluate how data analysis enables the identification of bottlenecks in business processes, providing practical evidence applicable to operational efficiency consulting projects. To achieve this objective, the study pursues the following specific aims:

• An examination of the main stages involved in a process efficiency consulting project.
• The identification of key performance indicators (KPIs) with the greatest potential for cost reduction within the analyzed process.
• An evaluation of the impact of data-based diagnostics on overall process efficiency.

Using a consulting-based case study focused on pallet management, the article applies descriptive data analysis to a real business process and assesses the economic and operational implications of data-driven diagnostics. By adopting a structured and practice-oriented approach, this research contributes actionable insights for both academics and practitioners seeking to bridge the gap between business analytics theory and consulting practice.

2. Methodology

2.1 Research Design

This study adopts a qualitative case study approach supported by descriptive data analysis. The case study method was selected due to its suitability for examining a real-world consulting project where contextual factors, operational constraints, and managerial decision-making play a central role. This approach allows for an in-depth understanding of how data analysis is applied in practice to identify operational bottlenecks and support efficiency improvement initiatives within business processes.

The research is based on a consulting project focused on optimizing the management of reusable pallets used for merchandise transportation across the company's value chain. The organization and industry context are anonymized to ensure confidentiality, while preserving the operational characteristics relevant to the analysis.

2.2 Consulting Project Scope and Phases

The consulting project followed a structured process efficiency methodology composed of four main phases:

Initial diagnosis and problem definition: The project began with eight semi-structured interviews across supply chain, plant management, commercial, and data registration teams to understand current pallet management practices and define the project scope. The analysis identified excessive monthly pallet purchases (35,000 units) despite lower repair volumes (26,000 units) and additional repairable stock. The recovery rate averaged 85% in the previous year, with inefficiencies primarily driven by limited traceability and insufficient control across the value chain.

Data collection and process mapping: Operational data related to pallet movements, inventory levels, losses, repair activities, and associated costs were collected from internal records and operational reports. According to the company there is a stock of 174,700 that needs to be reorganized such as the stock awaiting repair, new purchases and the days of stock in every area. In order to align the inventory, the pallet flow needs to be mapped across key stages of the value chain, including storage, transportation, customer delivery, and return processes. This phase aimed to establish a clear link between process activities and available data sources.

Data analysis and bottleneck identification: Descriptive data analysis was applied to identify patterns, inconsistencies, and performance gaps within the pallet management process. This phase involves the elaboration of a flowchart, the situations identified based on the interviews and the charts made by the data provided. Subsequently, some hypotheses of what could be done better came up and key metrics were analyzed to detect bottlenecks and control gaps affecting pallet circulation and availability. The analysis focused on identifying stages where pallet losses were concentrated, repair decisions were suboptimal, or cycle times were excessive, contributing to unnecessary replacement costs.

Economic impact assessment and roadmap design: Based on the diagnostic results, the consulting team estimated the economic impact of the identified inefficiencies and evaluated the potential cost savings associated with proposed optimization initiatives. An implementation roadmap was then designed to support managerial decision-making and guide the gradual adoption of improved tracking, control mechanisms, and repair strategies.

2.3 Data Description

The analysis relied on historical operational data covering a defined observation period. The dataset included:

- Number of pallets in stock
- Average monthly pallet purchases
- Average monthly pallet repairs
- Number of pallets recovered from customers

The data were validated for consistency and completeness prior to analysis. Given the applied nature of the study, the focus was placed on data reliability and practical relevance rather than on large-scale or high-frequency datasets.

2.4 Analytical Approach

A descriptive analytical approach was used to evaluate pallet management performance and identify operational bottlenecks. The analysis included:

- Comparison of pallet inflows and outflows across process stages.
- Identification of days of inventory in the major process stages.
- Assessment of repair versus replacement patterns.
- Evaluation of technology support for monitoring pallet movements

The analytical approach was intentionally kept simple and transparent to reflect common consulting practices and ensure that the results could be easily interpreted and replicated by practitioners.

3. Results

Table 1: Baseline and target performance indicators in pallet management

Indicators of each area	Baseline	Goal
Supply area indicators		
Stock awaiting repair	38.6K	0.4K
New and/or repaired stock	29.5K	21.0K
Days of stock in supplies	35 days	11 days
Purchases (average of last 6 months)	35.9K	16.5K
Recoveries (average of last 6 months)	34.6K	34.6K
Use of repaired pallets	-	39.3K
Sorting, repair, and resealing (average of last 6 months)	26.8K	39.3K
Production area indicators		
Production stock	11.2K	3.6K
Reserves (average of last 6 months)	61.0K	58.6K
Days of stock	6 days	2 days
Monthly consumption (transfers to APT)	58.6K	58.6K
Dispatch area indicators		
Dispatch stock	95.4K	95.4K
Percentage of reconciliation with m2 / pieces	ND	100%
Dispatch to customer (average of last 6 months)	52.0K	52.0K
Total stock	174.7K	120.4K

Source: PwC, 2021.

3.1 Results of the identification of bottlenecks in business process

In line with the general objective of this study—to demonstrate how data analysis can be used to identify operational bottlenecks in business processes within a consulting context—the results provide quantitative evidence derived from the large-scale analysis of operational data. The empirical assessment was based on a Kardex system containing more than 6 million pallet movement records, where each record corresponded to a single inflow or outflow transaction registered across multiple operational areas.

The consolidation and analysis of this dataset revealed that total pallet stock reached approximately 174,700 units at the time of analysis. Despite this level of asset availability, average monthly pallet purchases remained high, at approximately 35,900 units, while average monthly pallet recoveries were approximately 34,600 units. In parallel, pallets pending repair accumulated to approximately 38,600 units, indicating that a substantial portion of existing assets was not being effectively reintegrated into circulation. These quantitative patterns demonstrate that the identified bottlenecks were primarily related to process inefficiencies in pallet circulation and control rather than to insufficient asset capacity.

3.2 Results of the most meaningful KPIs

3.2.1 Inventory days of pallets

The calculation of days of inventory across process stages revealed marked differences in pallet retention times. At baseline, supply-related stages exhibited approximately 35 days of stock, while production stages averaged approximately 6 days, and downstream transfer points operated with inventories equivalent to approximately 2 days of stock.

The target state defined for post-implementation operations aimed to reduce supply-stage inventory levels to approximately 11 days of stock , while maintaining production inventories at a maximum of 2 days of stock . These targets reflected a rebalancing of pallet circulation intended to reduce extended well times in non-production stages and improve overall flow velocity across the value chain.

3.2.2 Repairs and purchases of pallets

The assessment of repair and replacement activities revealed a persistent imbalance between repair volumes and new pallet acquisitions. The repaired pallets were approximately 26,800 units , while average monthly pallet purchases reached approximately 35,900 units. In parallel, pallets pending repair accumulated to levels exceeding 38,000 units, indicating a misalignment between repair capacity and recoverable pallet availability.

Under the target operating model defined during the engagement, repair and recovery volumes were expected to increase to approximately 39,300 units per month, allowing monthly pallet purchases to decrease to approximately 16,500 units. This shift reflected a target prioritization of repaired and recovered pallets as the primary source of supply for ongoing operations.

3.3 Technology Support for Pallet Movement Monitoring

The review of technology support for pallet movement monitoring showed that pallet tracking relied predominantly on transactional inventory records supported by manual data entry, particularly in interactions involving external stakeholders. Although virtual inventory locations were available, the validation of pallet movements lacked automated controls, limiting real-time visibility and increasing exposure to data inconsistencies.

The target post-implementation state incorporated automated validation of pallet returns and movements, with system-generated transaction posting replacing manual registration at key handover points. This target configuration aimed to achieve full system-based traceability of pallet flows and to enable reconciliation between physical movements and system records on a continuous basis.

3.4 Estimated Economic Impact of Identified Inefficiencies

Based on baseline purchasing volumes, repair activities, and inventory levels, pallet-related expenditures represented a recurring operational cost driver. Scenario-based estimates indicated that reducing monthly pallet purchases from approximately 35,900 units to 19,000 units or fewer could materially affect total pallet-related costs.

Under the defined target state, the organization aimed to eliminate the need for approximately 19,000 pallet purchases per month , equivalent to more than 50% of recent average monthly acquisitions . Depending on the pace of implementation, the estimated financial impact associated with achieving these targets ranged from mid to high six-figure monthly savings, with full stabilization expected within a three- to six-month horizon. Based on average unit acquisition costs, the reduction of approximately 16,500 pallet purchases is associated with an estimated savings of USD 218,000

4. Discussion

In line with the main objective of this study, the findings demonstrate how data analysis enables the identification of operational bottlenecks in business processes and provides practical evidence for operational efficiency consulting projects. By analyzing large-scale transactional data extracted from a Kardex system containing more than six million pallet movement records, the study illustrates how descriptive analytics can uncover inefficiencies that remain hidden under traditional aggregate reporting. This supports the growing body of literature emphasizing the role of data analytics as a foundational capability for evidence-based process improvement in contemporary organizations (Wamba et al., 2017).

Addressing the first specific objective, the results highlight the importance of identifying key performance indicators (KPIs) that drive the greatest cost savings. The analysis shows that indicators such as pallet recovery rates, repair throughput, days of inventory by process stage, and the ratio of repaired versus newly purchased pallets were particularly effective in revealing cost-intensive inefficiencies. Rather than focusing solely on output volumes or procurement metrics, these KPIs provided a system-level view of asset utilization and flow efficiency. This finding aligns with process management research suggesting that performance measurement systems focused on flow-based and asset-centric indicators are more effective in identifying structural bottlenecks than traditional siloed metrics (Dumas et al., 2018). At the same time, it contrasts with studies that caution against over-reliance on quantitative KPIs without sufficient contextual interpretation, particularly in complex operational environments (Mikalef et al., 2020).

With respect to the second specific objective, the study demonstrates how minimizing human error through automated controls across the value chain can significantly enhance process transparency and data reliability. Although virtual inventory structures were available in the enterprise system, the heavy dependence on manual transaction inputs limited their effectiveness. The proposed automation of pallet return registration through weight-based validation represents a shift from human-dependent data entry toward system-generated operational data. Prior research in process analytics and digital operations supports this approach, highlighting automation as a key mechanism for reducing variability, improving data accuracy, and strengthening internal controls (van der Aalst, 2016; Rai et al., 2019). However, alternative perspectives in the literature emphasize that automation alone does not guarantee improved outcomes unless accompanied by appropriate governance structures and user adoption mechanisms (Sarker et al., 2019), a consideration that remains relevant for future implementations.

Regarding the third specific objective, the findings provide empirical evidence of the monetary impact of data-based diagnostics on process efficiency. By quantifying purchasing volumes, repair activity, inventory levels, and recovery flows, the analysis enabled scenario-based estimates of potential cost reductions associated with improved pallet utilization. The identification of avoidable monthly pallet purchases and the associated cost impact illustrates how data analytics can translate operational diagnostics into financially relevant insights for managerial decision-making. This supports prior research arguing that the value of analytics lies not only in descriptive insight but in its ability to inform economically meaningful actions (Grover et al., 2018). At the same time, some scholars argue that financial benefits from analytics initiatives may be contingent on organizational maturity and change management capabilities (Côrte-Real et al., 2017), suggesting that realized outcomes may vary across contexts.

Overall, this study contributes to applied business research by demonstrating how data analysis can be operationalized within a real consulting engagement to identify bottlenecks, prioritize efficiency initiatives, and estimate their economic relevance. By explicitly linking analytical techniques to consulting objectives—namely KPI identification, automation of controls, and monetary impact assessment—the case bridges academic research on process optimization with the practical demands of operational efficiency consulting. The findings reinforce the relevance of data-driven approaches in managing complex asset flows, while also acknowledging the organizational and governance conditions that influence their effectiveness.

5. Managerial Implications

The results of this study offer several managerial implications for organizations seeking to improve operational efficiency through data-driven diagnostics, particularly in asset-intensive support processes. First, the case demonstrates the importance of selecting and monitoring key performance indicators (KPIs) that reflect asset flow efficiency rather than isolated functional performance. Indicators such as pallet recovery rates, repair throughput, days of inventory by process stage, and the ratio of repaired to newly purchased assets proved critical in identifying cost-intensive bottlenecks. For managers, this suggests that focusing on flow-based and asset-utilization KPIs can reveal savings opportunities that remain hidden when performance is assessed primarily through procurement or production metrics.

Second, the findings highlight the managerial value of minimizing human error through the introduction of automated controls across the value chain. Although digital inventory structures were in place, the reliance on manual transaction recording limited data reliability and process transparency. The proposed automation of pallet return registration through weight-based validation illustrates how operational data can be generated directly from physical flows, reducing dependence on human input. From a managerial perspective, this implies that relatively targeted automation initiatives—when applied at critical handover points—can significantly enhance data accuracy, strengthen internal controls, and improve decision-making without requiring full-scale system replacements.

Third, the case underscores the role of data-based diagnostics in supporting economically grounded decision-making. By leveraging large-scale transactional data from the Kardex system, managers were able to quantify the monetary impact associated with inefficiencies in pallet recovery, repair, and purchasing activities. The ability to translate operational patterns into estimated cost impacts enabled a more informed prioritization of improvement initiatives and supported alignment between operational teams and financial stakeholders. This reinforces the managerial importance of integrating analytics capabilities into routine performance management processes.

Fourth, the study highlights the need for cross-functional governance in managing reusable assets. Inefficiencies observed in the case were not confined to a single department but spanned supply, logistics, production, and commercial interfaces. For managers, this suggests that effective bottleneck management requires coordinated ownership of asset flows and clearly defined accountability across organizational boundaries, supported by shared performance indicators and standardized data definitions.

Overall, the managerial implications of this study indicate that data analytics can serve as a practical enabler of operational efficiency when combined with appropriate KPI selection, automation of critical controls, and cross-functional governance structures. Organizations facing similar challenges can leverage these insights to improve asset utilization, reduce avoidable costs, and enhance the robustness of their operational processes.

6. Limitations and Future Research

Despite the contributions of this study, several limitations should be acknowledged. First, the research is based on a single consulting case conducted within one large manufacturing organization. While the use of large-scale transactional data strengthens the internal validity of the analysis, the findings may not be directly generalizable to organizations operating in different industries, with alternative asset structures, or under distinct regulatory and operational conditions. Future research could address this limitation by applying similar data-driven diagnostic approaches across multiple organizations or sectors to assess the robustness and transferability of the identified patterns.

Also, the study was conducted in the context of a consulting engagement in which the research team acted as an external advisory party. As a result, the scope of the project was limited to diagnostic analysis and the formulation of improvement recommendations, without direct involvement in the implementation or post-implementation monitoring of the proposed solutions. Consequently, the study does not assess the realized operational or financial outcomes of the recommended interventions. Future research could address this limitation by examining implementation-phase data or by conducting longitudinal studies that evaluate the effectiveness and sustainability of data-driven recommendations over time.

Finally, the monetary impact of data-based diagnostics was estimated using scenario-based calculations derived from observed operational patterns and average cost assumptions. Although these estimates provide a meaningful indication of economic relevance, actual realized benefits may vary depending on implementation quality, external market conditions, and managerial decision-making. Longitudinal analyses incorporating post-implementation performance data would enable a more precise assessment of realized financial benefits and the durability of efficiency gains.

7. Conclusion

This study examined how data analysis can be leveraged to identify operational bottlenecks in business processes, providing applied evidence from a consulting-based case within a large manufacturing organization. By analyzing more than six million transactional records related to pallet movements, the research demonstrated how large-scale operational data can be transformed into actionable insights that support efficiency improvement initiatives in asset-intensive support processes.

The findings confirm that operational bottlenecks are often structural rather than transactional in nature, arising from misalignments between process design, control mechanisms, and information systems. Through the systematic use of key performance indicators—such as inventory days, recovery rates, repair versus replacement ratios, and inventory adjustment frequencies—the study showed how data-based diagnostics enable the identification of high-impact inefficiencies and the prioritization of targeted interventions. In doing so, the research addressed the main objective of demonstrating the role of data analysis in uncovering bottlenecks relevant to operational efficiency consulting projects.

In line with the specific objectives, the study highlighted the importance of selecting KPIs that are directly linked to cost drivers and asset utilization, illustrating how even non-core processes can generate significant financial impacts when inefficiencies persist over time. Furthermore, the proposed automation of pallet return registration illustrates how data-driven controls can minimize human error and enhance process transparency across the value chain. Although the implementation of these solutions was outside the scope of the consulting engagement, the quantified improvement potential provides a robust basis for managerial decision-making and investment prioritization.

From an academic perspective, this research contributes to the growing body of literature on analytics-enabled process improvement by bridging theoretical insights with real-world consulting practice. It demonstrates how descriptive analytics applied to high-volume operational data can support evidence-based recommendations without requiring advanced predictive models, reinforcing the practical relevance of data analytics in organizational contexts with varying levels of digital maturity.

Overall, the study underscores the strategic value of data analysis as a diagnostic tool for identifying and addressing operational bottlenecks. By aligning analytical insights with process governance and control design, organizations can improve asset utilization, reduce unnecessary costs, and enhance operational resilience. The findings reaffirm the relevance of data-driven approaches for both researchers and practitioners seeking to improve business process performance in increasingly complex operational environments.

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