Pallet drop-size optimisation and its effect on the supply chain using a cost-to-serve model

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Abstract. The study explores the critical role of transportation within the Supply Chain, emphasising efficient planning, implementation, and control of goods and information flow from suppliers to customers. Focused on optimising the number of pallets per shipment and occurrence of the shipments to decrease secondary transport costs and environmental impact. The study is conducted with a leading Fast Moving Consumer Goods (FMCG) company in the UK by deploying the methods; Define, Measure, Analyse, Improve, Control (DMAIC) for data collection and Cost-to-Serve (CTS) for data analysis. Initially, a new Cost-to-Serve tool is developed to visualise customer performance and identify opportunities for improvement. Subsequently, a secondary tool is created to monitor the performance of identified customers. An Excel simulator is constructed to extract key performance indicators for logistics performance. Results reveal significant cost savings, with £207K saved in the first five months of 2023 through shipment reduction of 9.09% compared to 2022. Even with inflation, the cost per pallet has remained steady, showing minimal variation from the average of 2022. This underlines the efficacy of the CTS tool in enhancing secondary transportation performance within the wider supply chain context.

1 Introduction

In logistics, pallets are vital for storing and moving goods efficiently. This project focuses on optimising pallet drop sizes using the CTS model to enhance supply chain efficiency. By analysing product characteristics, transportation modes, and distribution networks, the optimal number of pallets per shipment is determined to minimise costs and maximise efficiency. The CTS model evaluates total costs, including transportation, inventory holding, and handling, to identify the most efficient supply chain strategy. Optimising pallet drop sizes improves transportation efficiency by selecting the right number of pallets, optimising space, and reducing trips, fuel consumption, and overall costs.

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2 Background and literature review

2.1 Transportation of Fast Moving Consumer Goods (FMCG)

[1] noted the FMCG sector's significant share of global consumer spending among transportation-dependent industries, with retail essential for daily provision of goods, drawing attention from consumers and policymakers. [2] emphasised the FMCG supply chain's role in enhancing transportation efficiency, primarily through road transport. [3, 4] highlight retailers' challenges, including managing costs, improving customer service, and reducing ecological footprints amidst rising service demands, leading to more frequent deliveries with smaller shipments and fragmented flows.

2.2 Optimisation of the number of pallets per shipment (pallet drop-size)

Pallets are vital in logistics, and crucial for moving and storing goods efficiently. Their size and drop size significantly impact logistics efficiency and costs. [5] state that optimised stacked pallet load units cut transportation costs and boost logistics efficiency [6] stated that efforts to optimise product distribution from suppliers to hubs and manufacturers in cooperative warehouses and transportation networks should consider multiple associated constraints.

2.3 Reduction of transportation cost and carbon footprint

The Activity-Based Costing (ABC) model allocates costs based on activities required to provide goods and services linking expenditures to customers, services, products, and orders for a better understanding of operational processes and costs [7]. [8] mentioned the correlation between customer profitability and Cost-to-Serve (CTS) analysis through segmentation, offering a thorough evaluation beyond gross profit measurement.

CO2 reduction poses challenges for industries prioritising responsiveness and cost, notably in Fast-Moving Consumer Goods (FMCG), where sustainability may conflict with transportation cost and responsiveness [9]. [10] stress that optimising truckload utilisation cuts operational expenses, boosts revenue, reduces truck usage, and lessens congestion and pollution. Factors like loading volume, fuel consumption, and unused space significantly affect carbon emissions in truckload operations.

The studies collectively show a strong correlation between pallet drop size and various factors like truckload utilisation, shipment optimisation, congestion mitigation, resource allocation, transportation costs, and sustainability. Thus, optimising pallet drop size emerges as a strategic approach to enhance the efficiency, sustainability, and cost-effectiveness of logistics operations.

2.6 DMAIC

The DMAIC method in Six Sigma is often described as an approach for problem-solving [11], a continuous improvement technique used to identify and improve specific areas of a process [12] and a methodology which has been effectively implemented in many applications such as SCM performance [13]. [14] outlined the DMAIC phases: define (outlining project scope and expectations), measure (identifying factors for enhancement and evaluating current performance), analyse (identifying root causes and prioritising opportunities), improve (employing experimentation and statistical methods for enhancements), and control (implementing a systematic plan to sustain improvements).

Various studies confirm DMAIC's effectiveness across diverse contexts. [15] demonstrated how a tooling manufacturer reduced costs and improved quality using DMAIC. [16] enhanced warehouse efficiency, significantly increasing process cycle efficiency. [17] successfully reduced risk factors in the coffee manufacturing industry through DMAIC interventions. [18] achieved cost reduction and quality improvement in a small and medium-sized enterprise with DMAIC.

2.7 Cost-to-Serve Model in Supply Chain

The CTS model in SCM is crucial for grasping the real cost of delivering products or services to customers. [19] proposed a conceptual framework for analysing information in supply chain collaboration, identifying key factors influencing cost-to-serve. This comprehensive view fosters collaboration with supply chain partners. [20] explored applying CTS analysis to humanitarian supply chains, optimising resource allocation and improving aid delivery efficiency.

3 Research methodology

3.1 Adopting the DMAIC principle

The project applies the DMAIC principle to address the identified problem, encompassing defining, measuring, analysing, implementing improvements, and controlling benefits (Fig. 1). This methodology, proven effective across industries, applies to the current case. The case study utilises DMAIC to lay the groundwork for mapping activities, streamline the development of a new CTS Tool #1 (Fig. 2), and identify optimisation opportunities.

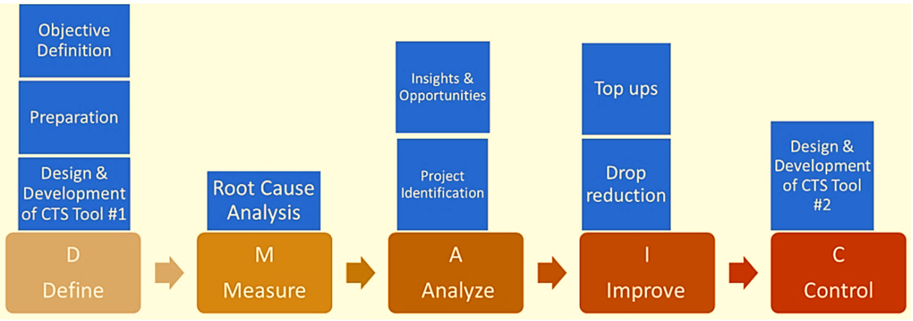

Fig. 1. DMAIC Framework of the Project

3.2 Data model creation and feeding into Snowflake Software

A three-step method (loading data, cost allocation, and data model creation) was employed to build the data model and subsequent visualisations. Cost allocations for secondary transportation transactions were conducted using the ABC method. The resulting data was exported as a comma-separated value (CSV) file for use in Snowflake software.

3.4 Produce Visualisations through Power Business Intelligence

The outcomes of the Cost to Serve project were categorised into two main areas: (1) Key Logistics Performance Indicators and (2) Financial gains through Cost Savings (Fig. 3). Microsoft Power BI offers a range of visual options that can be customised and combined within the Power BI Dashboard to effectively communicate insights and facilitate data-driven decision-making which has been deployed here.

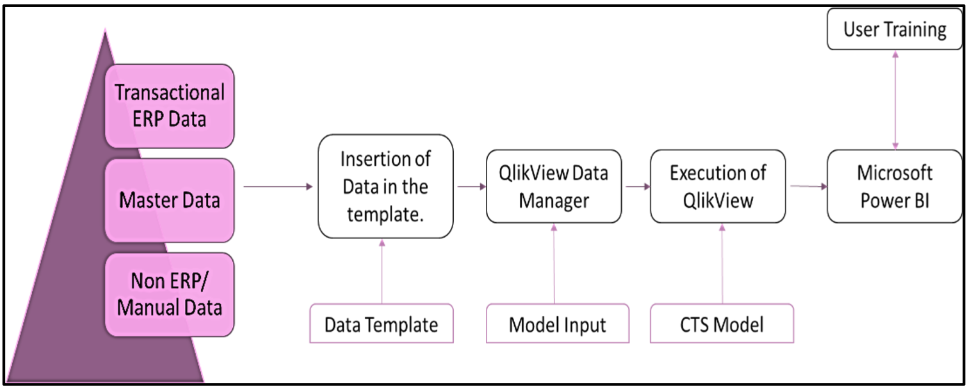

Fig. 2. Process of CTS Tool #1

4 Results and analysis

CTS Tool #1 played a crucial role in identifying opportunities with multiple benefits, revealing three significant types: (1) Top-ups, (2) Suppressions, and (3) Customer Service Optimisation and (4) tailored solutions for specific customers. Through CTS Tool #1 analysis, five customers were identified, resulting in £1.1m savings with an 11.5% shipment reduction. These five customers constituted over 80% of the total opportunity identified.

4.1 Pallet Floor Size (PFS) and shipments per shipment

The analysis of PFS per shipment showed a maximum drop size of 26 pallets for a Full Truck Load (FTL). Across projects, the average drop size neared FTL, yet having space to accommodate 3-4 pallets more per shipment. There was a slight improvement from 2022, indicating a positive impact from implemented solutions and a promising trend for the remainder of 2023 (Fig. 3).

Examining shipments to customers per month, the analysis considered total pallets sold or volume ordered. Customer-1 (CS1) showed an effective reduction in drop frequency. CS2 exhibited a high initial volume with fewer shipments, continuing into the second month. CS3 initially less reflective, gradually showed suppression effects, notably in months 4 and 5. CS4 demonstrated strong performance, with higher volumes and fewer shipments, indicating successful suppressions.

4.2 Cost per pallet and shipment

The cost per pallet metric, influenced by volume, PFS per shipment, and shipment number, offered insights into cost dynamics. A deeper analysis showed higher PFS per shipment lowered cost per pallet, as seen in CS1's warehouse-A versus warehouse-B. Inflation significantly impacted cost per pallet across all customers, with variations noted in CS2, CS3, and CS4.

In 2023, shipments decreased by 9.09% to 2,499 from 2,749 in 2022, with an average secondary shipment cost of £900. This reduction trend, which cut 250 shipments in the first five months of 2023, is expected to continue, leading to substantial cost savings.

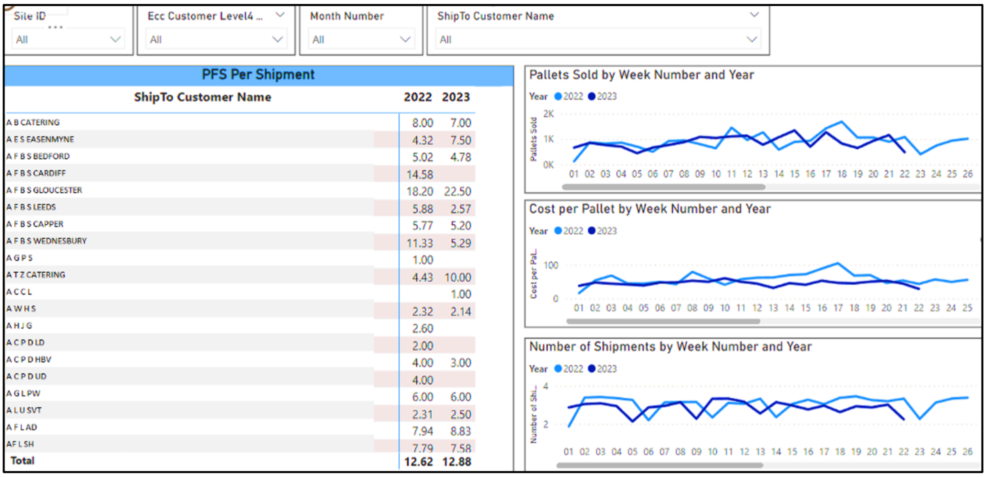

Fig. 3. KPI Metrics Performance Monitoring

4.3 Financial gain through cost savings

Cost savings, directly tied to the decreased number of shipments, were substantial. Identified opportunities for customers in 2023 totalled £263K, with £207K saved in the initial five months, reaching 86% of the opportunities. Monthly targets were consistently met, with savings surpassing targets in all months except month 4. Successful solution implementation notably reduced shipments on the road, contributing to the achieved savings.

5 Conclusions

Pallet Drop Optimisation, supported by a cost-to-serve model, cut costs, enhanced service levels, and promoted sustainability in the case company's supply chain. The study saved £207K in the first five months of 2023, maintained customer satisfaction, and increased pallet sales. It determined 26 pallets per shipment as optimal, leading to a performance improvement plan focusing on transport cost reduction and environmental impact. Optimisation reduced shipments through improved pallet top-up and order consolidation, revealing inefficiencies in warehouse operations and yielding significant cost savings. While the study was limited to one company and product portfolio, it highlighted the need for continuous analysis and inter-departmental collaboration. Extending the cost-to-serve tool to procurement, marketing, sales, finance, and customer experience could further improve organisational performance. Future research should assess the model's applicability across diverse companies and product portfolios.

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