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Reverse Logistics Model
for a Remanufacturing Business
in the European Region

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Summary:

This thesis focuses on the development of an effective reverse logistics model for a remanufacturing business of an Original Equipment Manufacturer (OEM) within Continental EU and Russia. We make use of the Define-Measure-Analyze-Improve-Control (DMAIC) methodology to build current models and recommend future-state transportation standards for the finished goods and the engine/part return with the objective of decreasing the overall logistics spend for the company.

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KEY INSIGHTS

1. A well-defined reverse logistics model decreases the variability and uncertainty of the used engine or part returns within OEMs remanufacturing supply chains.

2. Milk runs lead to overall transportation cost reduction across a route, although not necessarily for a specific location within the route.

3. Truck utilization for a specific milk run can be increased not only by increasing sales but also by consolidating volume with other suppliers and customers who transport across the same route.

Introduction

The sponsor company of this thesis is a global OEM that designs, manufactures, distributes, and services engines and related technologies. The company employs roughly 50,000 people worldwide and serves customers in almost 200 countries and territories through a network of more than 500 company-owned and independent distributor locations and approximately 5,500 dealer locations. The company sold roughly $20 billion in 2011 with a net margin of 10%. The main focus of this thesis is on engines and related spare parts sold by the remanufacturing division within Continental EU and Russia.

There is a growing need to produce eco-friendly products due to stringent legislation, as well as incentives to retain customers beyond the lifecycle of the original products by providing price-based discounts on remanufactured parts. Given the need to focus on long term profitability and asset recovery, the OEM has faced severe constraints in attaining the expected profitability within the remanufacturing business in Europe. Poor quality and lack of sufficient volume of used engines/parts has posed a major challenge and is a bottleneck to the European remanufacturing supply chain. Lack of a well-

defined reverse logistics model increases the variability and uncertainty of the supply in the overall supply chain for remanufactured engines.

This thesis addresses some of these key issues and recommends alternative reverse logistics models. It also analyzes the logistics costs associated with the current and proposed transportation models and concludes with recommendations related to implementable models to reduce transportation cost as a percentage of sales.

Methodology

We depict current models and recommend future-state transportation standards for the finished goods and the engine/part return within Continental European Union by using the DMAIC process (Define – Measure – Analyze – Improve – Control). In the Define phase, we revisited and refined the problem statement, identified and understood the targeted business process, confirmed geographical scope and critical outputs, and recommended a finalized project charter. In the Measure phase, we collected and consolidated the various data elements that were used to calculate current and future transportation costs. During Analyze phase we made use of the data elements from the measure phase and obtained a baseline analysis as a starting point to comprehend the current transportation costs and the related transportation cost as a percentage of sales. In the Improve phase, we built the future-state models and computed the appropriate cost savings and benefits, if applicable. A sensitivity analysis was performed as a part of this phase to understand when future state models can become beneficial if they are not implementable immediately. We also went one step further by estimating the opportunity cost of not implementing the recommended models and hence the lost revenue by not attaining the expected engine returns. Finally, we provided recommendations and next steps for implementing the future – state models.

## Remanufacturing at the OEM - AS-IS process

The following figure outlines the remanufacturing process currently employed by the OEM. The process involves two loops: (1) a forward flow in which engines or parts are
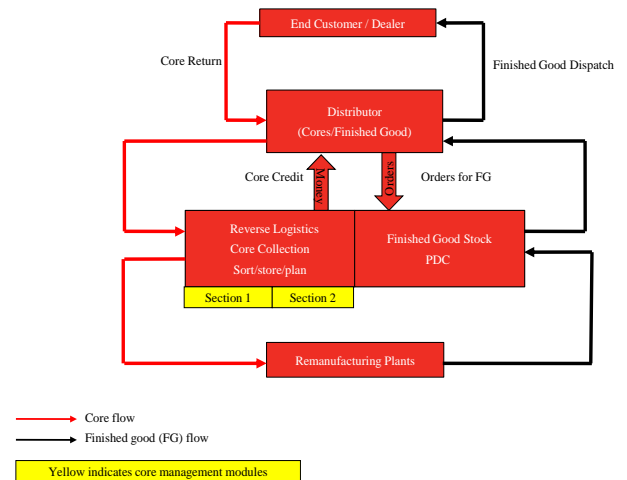
manufactured and sold to the end customer through distributors or dealers, and (2) a reverse flow where engines or parts are returned to the master distribution center and possibly the remanufacturing plants for further processing.

European Remanufacturing Supply Chain Network

The network includes complex interactions between suppliers, a Master Parts Distribution Center (PDC), Dealers, Customers, and Salvage yards. These nodes in the network must be brought together into a cohesive process to achieve the objectives of the OEM.
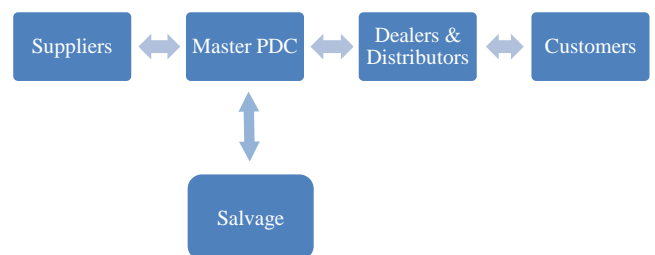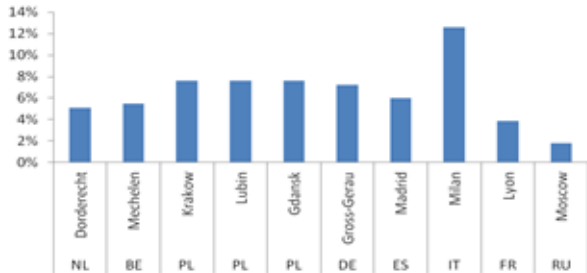

Baseline Analysis

After understanding the current As-Is process and consolidating the required data elements, a baseline analysis is performed to estimate the current transportation costs as a percentage of sales. Transportation cost as a percentage of sales is calculated for both forward and reverse models and is used as the main Key Performance Indicator (KPI) to compare current
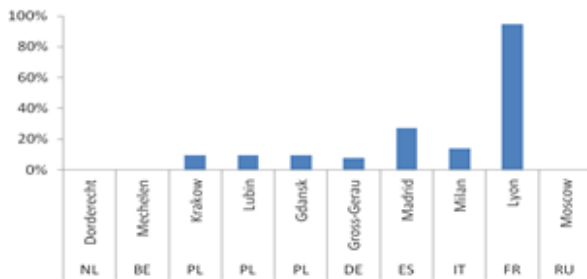
and future-state models within the European Region. The target for the KPI is 2.5%.

The charts below show the outcome of the baseline analysis for the forward and reverse transportation operations.

Transportation Cost as a Percentage of Sales (Forward)

Transportation Cost as a Percentage of Sales (Reverse)

The baseline analysis of the current transportation cost confirms that the transportation cost as a percentage of sales in most countries is greater than 2.5%, for both legs

Future-state Model Analysis

In the Future-state analysis three potential transportation models were evaluated: milk run model, hybrid model (milk run and standalone models), and consolidation center model.

A milk run is a round trip that has the same starting and ending point, during which both forward (distribution) and reverse (collection) flows are facilitated by the same truck. In this model, full utilization of truck is assumed. The transportation cost is calculated based on the fuel cost per mile, surcharge, and loading / unloading cost.

To perform the analysis, an open source vehicle routing software (VRP) named LOGVRP was used to generate the optimal routes based on the distances and contractually agreed delivery schedules. All cost calculations were performed by transferring the routes from the VRP to Excel. The analysis resulted in three milk run categories. Category 1 & 2 had significant cost savings with a potential to reach a 2.5% of transportation cost as a percentage of sales target but Category 3 would incur losses if implemented today.

Below are the results for Category 1 & 2 milk runs that included seven different scenarios.

Milk run No.	Milk run route	Expected reduction in transportation	Expected cost savings
1	Rumst – Mechelen - Groß-Gerau – Milan – Rumst	83%	€ 720,176
2	Rumst - Groß-Gerau – Milan – Rumst	80%	€ 568,454
3	Rumst – Lyon - Gross-Gerau – Mechelen - Rumst	67%	€ 448,769
4	Rumst – Mechelen - Groß-Gerau – Milan – Krakow – Gdansk – Lubin – Dordrecht – Rumst	60%	€ 799,003
5	Rumst – Mechelen - Groß-Gerau – Milan – Lyon – Madrid – Rumst	45%	€ 423,475
6	Rumst – Mechelen – Milan – Lyon – Rumst	31%	€ 120,364
7	Rumst – Dordrecht – Lubin – Gdansk – Krakow – Rumst	14%	€ 65,403

It can be seen that milk run 1 results in the highest reduction in transportation cost (83%) and significant cost savings (€720,176). Although milk run 4 has higher cost savings (€799,003), it has much lower reduction in transportation costs (60%) in comparison with current transportation costs. Also the number of locations involved in Route 4 is higher compared to the milk run 1.

Below are the results for Category 3 milk runs, which included four different scenarios.

Milk run No.	Milk run route	Expected loss	Expected increase in overall sales to break even
8	Rumst – Milan – Madrid – Rumst	€ 61,019	15%
9	Rumst – Milan – Lyon – Madrid - Rumst	€ 212,909	75%
10	Rumst – Madrid – Rumst	€ 316,322	567%
11	Rumst – Lyon – Madrid – Rumst	€ 343,684	342%

For milk runs in category 2 & 3, a sensitivity analysis was performed, utilizing Excel Solver where needed, in order to estimate by how much sales should increase so that one is indifferent between current and proposed scenarios. Below are the results of the sensitivity analysis.

Milk run No.	Milk run route	Expected increase in overall sales
7	Rumst – Dordrecht – Lubin – Gdansk – Krakow – Rumst	45%
8	Rumst – Milan – Madrid – Rumst	15%
9	Rumst – Milan – Lyon – Madrid - Rumst	75%
10	Rumst – Madrid – Rumst	567%
11	Rumst – Lyon – Madrid – Rumst	342%

A significant increase in sales is required to reach a target 2.5% of transportation cost as a percentage of sales.

Due to lack of data, a high level analysis was performed for Russia. Due to the complexity and unique process that exists today in Russia, combined with high custom/duty charges, a consolidation center model at Moscow was recommended.

Opportunity Cost Analysis

An opportunity cost analysis was conducted for each of the recommended milk-runs within category 1 in order to estimate the lost revenue that the OEM incurs by not implementing the proposed milk run and hence not achieving the desired 90% core (used engines) return ratio (90% core return ratio is the current expected target for all Continental European Union countries and Russia).
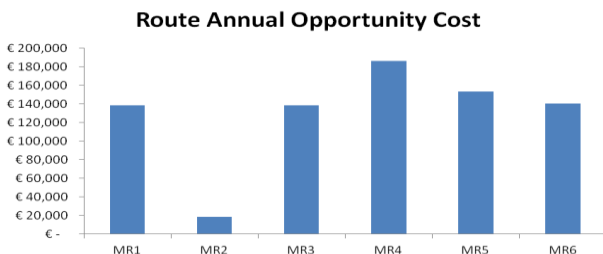
As it can be observed from the analysis results, the highest lost annual revenue of €186,465 is incurred for MR4 (Rumst – Mechelen – GroB-Gerau – Milan – Krakow – Gdansk – Lubin – Dordrecht – Rumst). If this milk run were implemented today, there would be a significant opportunity to increase the return revenues by increasing the core return ratios along the route to 90%. This will also increase the truck utilization, and hence reduce cost/kg.

Recommendations

Based on the current analysis, milk run 1 (Rumst – Mechelen – GroB-Gerau – Milan – Rumst) is currently recommended for a pilot

implementation considering the cost savings of €720,175 and an overall transportation cost reduction of 83%. There is also a significant core return opportunity cost of €138,861 in this route annually, provided the core return for these locations is increased to 90% due to newly implemented milk run. Thus, the overall estimated savings is approximately €859, 000.

Next steps

The next step for the OEM involves taking the findings of our study and performing a pilot program. This should involve the following steps: 1) a detailed stake holder analysis to understand which country organizations should be involved; 2) an analysis of the type of transportation contracts that exist today, if any, and the changes needed; 3) consolidation of third party logistics providers when possible or at least a coordinated milk run plan across different third party logistics providers used today, and 4) working with the distributors to understand today's constraints and how this process can be implemented to make it both profitable for the OEM and its distributors.

Also, a detailed change management plan must be created to understand the change impacts and how the SOP's (Standard Operating Procedures) need to be updated to accommodate the new processes and the new or realigned roles.

Overall there is a significant opportunity to decrease the transportation cost, if the proposed models are considered and implemented in an organized manner.

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