RESEARCH JOURNAL

CLASS OF 2013

Summaries of select research projects by graduates of the MIT-Zaragoza Master of Engineering in Logistics and Supply Chain Management (ZLOG)

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Introduction

Welcome to the 2013 MIT Zaragoza Master in Logistics and Supply Chain Management (ZLOG) Research Journal!

The seven papers included in this journal were chosen from the ten theses submitted by the ZLOG class of 2013 at the Zaragoza Logistics Center. The articles are written as executive summaries and are intended for a business, rather than an academic, audience.

The purpose of the executive summaries is to give the reader a sense for the business problem being addressed, the methods used to analyze the problem, and the relevant results, conclusions and insights gained. The complete theses are, of course, much more detailed. We have also included a complete list of this year’s ZLOG theses with short descriptions at the end of this journal.

The articles in this publication cover a wide range of interests, approaches, and industries. The topics include: scenario planning, supply chain segmentation strategies, inventory management, cold chain, humanitarian demand-supply planning and reverse logistics. This variety of topics illustrates one of the hallmarks of the ZLOG program: the students’ ability to focus their course work and research on topics that most interest them.

The ZLOG program is designed for early to mid-career supply chain professionals who want a more in-depth and focused education in supply chain management, transportation and logistics.

The projects highlighted in this journal reflect the variety of ZLOG student interests. All projects are conducted in conjunction with the Zaragoza Academic Partner (ZAP) Program, an initiative to enhance applied research and closer industry-academia relationships in the field of supply chain management.

The ZAP Program gives ZLOG students the opportunity to work closely with industry professionals on actual supply chain problems, and gives companies an opportunity to interact with a student or student team along with a professor as expert thesis advisor who together bring new insights and approaches to a current supply chain project.

We hope you enjoy the articles. If you want to access the entire thesis of any of those appearing in this journal, just let us know and we can make it available to you. Also, if you wish to discuss any other aspect of the ZLOG program or wish to find out how your company can interact with ZLOG students, please do not hesitate to contact me directly.

Happy reading!

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Scenario Planning: A Tool to Prepare for the Future

By Mark Ismael Vital Boyonas and Luis Olavarria
Thesis Advisor: Professor María Jesús Sáenz, Ph.D.

Summary:
This thesis tackles the question of how organizations can prepare for the future in a world in which the only constant is change. This project is an attempt to take an alternative perspective in planning for the future. Applying the framework used in Scenario Planning, a structured approach is elaborated to describe a replicable methodology for sensing critical uncertainties in the external environment.

Introduction
The ability to strategically plan for the future is a key element in the success of Supply Chain Networks. Traditionally, forecasts have been used to guess how the future may be, but in the long run, forecasts tend to be wrong. Alternatively, key performance indicators (KPIs) have provided organizations with an opportunity to visualize a ‘rear-view’ picture of what has occurred in the past and is occurring in current operations. ‘Side-view’ visualization could also be done through complex analysis using deep dives into big-data made available through the use of advanced Enterprise Resource Planning (ERP) systems. This viewpoint can also be complemented by using traditional benchmarking comparative analysis within and across industries. These forms of indirect vantage points of the state of an organization and its immediate environment provide limited guidance that can be useful for correctly and accurately foreseeing what is coming ahead.

This research attempts to develop a framework that will explore the possibility of developing a new breed of indicators that will provide forward-looking guidance, which can help organizations strategize accordingly in response to the ever-changing scenarios within and outside the company, industry, and market environments. Through the careful analysis of how these indicators evolve, organizations can be guided on the appropriate management direction and strategy that should be employed in order to remain profitable and competitive in their environments.

An application of the Scenario Planning methodology was specifically demonstrated on the supply chain operations of the sponsoring company, a leading manufacturer of specialty chemical products catering to the business-to-business market.

Methodology for Scenario Planning
Scenario Planning is a long-range planning process that is based on understanding the nature and impact
of the most uncertain yet important Driving Forces affecting the world. Scenarios are described as “carefully constructed plots that make the significant elements of the world scene stand out boldly” (Schwartz, 1996). It is a group thinking process that encourages knowledge exchange and development of mutual deeper understanding of central issues important to the future of the business.

The steps for creating scenarios under the Intuitive Logics school’s methodology for scenario planning were first articulated in the book called “The Art of the Long View” (Schwartz, 1996).

There are eight steps outlined in this methodology, but the processes were only described without specifying how each step should be carried out to replicate the methodology. This rationale was based on the assumption that scenario creation is a developed skill and cannot be made from recipes.

**Scenario Development Process**

The research activities were limited on the application of the steps related to: (1) the exploration and prioritization of the Driving Forces and Local Factors, (2) scenario logics development, and finally (3) indicators development.

The scope of the scenario creation process was also determined to be the Asian Pacific region for a time horizon of ten years and with a specific focus on the sponsoring company’s supply chain strategy.

**Exploration and prioritization of the Driving Forces and Key Local Factors**

In order to develop scenarios, the first thing that needs to be done is an analysis of the organization’s competitive environment. This analysis needs to be from both the internal and external environments. First, key Local Factors need to be identified and prioritized. These Local Factors are closely related to the organization’s internal capabilities, which directly impact performance and can be influenced by executive decisions of managers. In the case of an organization’s supply chain, internal capabilities such as the level of talent of existing workforce will directly influence the failure or success of supply chain initiatives.

Driving Forces, on the other hand, are circumstances in the external environment that could have major impact on the business (specifically and directly on the internal Local Factors discussed above) but these forces are essentially outside the organization’s own control. In contrast to the Local Factors, the organization does not have direct influence to the future direction of these forces. The organization is just a passive recipient of the effects of these changes. Examples of these Driving Forces are changes in consumer needs/demand patterns and the formation of trading relationships between countries, among others.

These Driving Forces and Local Factors need to be identified by the organization so that they can be prioritized based on degree of impact to their business and the degree of their uncertainty in the future. In the case of this study, the identification was carried out through preliminary research on the industry that was the basis of a set of questionnaire used in a workshop among a group of internal supply chain experts in the sponsoring company. Finally, a prioritization of the aforementioned Driving Forces was done through a modified Delphi process that included inputs from a group of high level executives within the company.

**Scenario Logics development**

Once the Driving Forces and Local Factors were prioritized by impact and uncertainty, the three Driving Forces with the highest impact on the organization were used to form the axes along which different scenarios would diverge. In the case of this study, the identified Driving Forces were (1) the emergence of trading blocks, (2) the change in consumer needs, and (3) the availability of logistics infrastructure in the region. Based on these Driving Forces, three scenarios logics were created based on the two-win one-loss combination, where two of the Driving Forces took a high value and the third a low value.
**Indicator development**

Scenario monitoring can be facilitated by reading a set of leading indicators and signposts that may give insights regarding the actual direction of how the future is unfolding by comparing them to the contents of the developed scenarios. This can be done by using indicators that are directly and indirectly related to the identified **Driving Forces** that define the critical uncertainties of the created scenarios. Two types of leading indicators can be used for scenario monitoring.

The first type of indicators are more quantitative in nature and are directly related to the prioritized **Driving Forces**. In this study, the indicators developed were based on measuring (1) the number of free trade agreements signed in the region as a measure of emergence of trading blocks, (2) the per capita GDP as a measure of changing consumer needs, and (3) the combination of road, rail, and air infrastructure statistics as a measure of development in logistics infrastructure. Integrating these three indicator measures into a single Scenario Score, a scenario monitoring dashboard was proposed to detect the status of each of the three scenarios.

The second type of indicators developed are more qualitative in nature and are known as ‘weak-signals’. These indicators are based on news and information that are expected to potentially escalate a series of changes that will unhinge the **Driving Force**’s trajectory. Two examples of this type of indicators were elaborated: (1) the rise to power of Aung San Suu Kyi in Myanmar and (2) the Construction of the Thailand Canal.

**Managerial Implications**

This thesis project has been an initial attempt to introduce the Scenario Planning methodology to the sponsoring company as a tool that can help them navigate their supply chain through the uncertainty of today’s world.

Above and beyond the understanding of how these dynamic forces interact to form a range of plausible futures, the value of Scenario Planning can also be seen on their implications on the strategic positioning of an organization. In this thesis project, how to evaluate these strategic implications was not covered in the original scope of the project and therefore was not elaborated in much detail. It is recommended that the sponsoring company devotes more time and resources to understand these implications and as a next step design a way to assess these implications as they are critical to the true potential of the methodology.

**Conclusions**

In today’s managerial world, companies struggle to find ways to prepare for the future, especially in the supply chain arena. In this thesis project, an alternative methodology to tackle this situation was demonstrated in the form of Scenario Planning. The choice of this approach is counter to the inward perspective of measuring performance in sensing the current state of the organization. Scenario Planning has offered a wider outward perspective in looking at where the company is in relation to its environment. This viewpoint offers a definite advantage in better positioning organizations for the future.

Three main contributions were seen in this research.

- First, how scenarios are efficiently created was demonstrated. In this thesis project, the main structures for creating vivid descriptions of three distinct plausible versions of the future were laid out in the form of scenario logics that can be used as the foundation for creating storylines that can be utilized for strategic and sensing purposes.

- Second, a straightforward framework to monitor scenario evolution was presented. For this, a simplified methodology to monitor scenario evolution was demonstrated through identifying and measuring key ‘ingredients’ that indicate the relative position of the present versus the developed scenarios. The Scenario Scores represented the measurement of how much of each scenario has already come to reality. In addition, ‘weak-signals’ also have to be monitored to ensure that immeasurable changes in the external environment are also taken into consideration.

- Third and most importantly, an elaboration on the whole Scenario Planning Process was developed; this is by far the most important contribution of the thesis project, not only to the sponsoring company, but also within Scenario Planning literature as a whole.

**Major Reference**

Introduction

A leading company for specialty chemicals has already adopted a model to segment its customers and products, and it now wants to determine if this segmentation is rational and how the supply chain can be tailored and differentiated for each segment. The overall goal of this project is to see how the supply chain can be coordinated in order to improve the service offered to its different classes of customers in such a way that its most important customer segments are better off from a service delivery standpoint.

The company understands that a one size fits all strategy (offering all customers same level of service and supply chain solutions) isn’t good enough to compete effectively. Attempting to give all clients equal service usually results in a decline of overall service, a dramatic increase in costs, and most importantly, allows for the possibility of a lower priority customer preempting a higher priority one (Byrnes 2010).

The chemical company has 11 broadly segmented business units segmented based on the different markets the products within these units serve. The scope of this project was to narrow down to one business unit serving consumer and industrial needs. Then it was further narrowed to two business lines dealing with paints and agricultural chemicals.

The company had specifically requested that the segmentation and differentiation strategies proposed in this project be practical and general enough to be
replicated across all business units. In adherence to this requirement, we focused on two differentiation strategies: (1) Prioritization of service delivery based on customer class, and, (2) Inventory rationalization as a tool for differentiated service. These two strategies are general enough to be adopted in any business unit and also prove to be very cost efficient, as they simply re-organize the service delivery process and inventory allocation method based on customer classification.

It’s important to mention at this point that “service” within the context of this thesis will be predominantly viewed from an order fulfillment point of view (the time that elapses between order entry and order delivery). The primary measurement of this service is ON TIME IN FULL (OTIF). This measurement checks if an order line was delivered to customers on time and that the full quantity requested by the customer was delivered.

**Literature Review**

Several works performed by other researchers in the field of segmentation and supply chain differentiation were reviewed. The segmentation of products and customers into ABC categories based on volume and variability of demand was researched by Vitasek et al (2003). A hybrid of this kind of segmentation was adopted by the chemical company, and production strategies like MTF, PTO and MTO are driven by this segmentation. Mentzer et al (2001) demonstrated that timeliness (i.e., the time that elapses between the dates an order is placed to when it is received) impacts perception of service; their prioritization of service level based on service time was selected as this project's model for supply chain differentiation.

**Methodology**

**Primary Research**

Surveys and interviews were performed with customers, customer service representatives, and functional business leaders in order to get an idea about current service performance and also understand which areas within the supply chain need to be improved. This project found that customers highly valued Quality and Reliability of delivery, as seen in Figure 1.

The differentiation model proposed in this project will help the chemical company provide more reliable delivery lead times to each customer segment. It was also observed that 67% of customers surveyed did not regularly measure service performance of the chemical company.

**Historical Data Analysis**

Two Year historical data on all orders fulfilled was analyzed to understand the calculated service performance of the company. OTIF is the main KPI for measuring service at the company. A key finding was that the chemical companies’ most important customer segments are experiencing the lowest OTIF performance, which clearly shows the impact of having non-differentiated service levels, as seen in Figure 2. In order to reverse this trend, we adopted service prioritization.
Differentiation Application

Two segmented based supply chain differentiation strategies were adopted: (1) Prioritization of service delivery based on customer class, and (2) Inventory rationalization as a tool for differentiated service. These two strategies were selected due to their broad applicability and cost effective qualities. These strategies also provide a clear bridge between the current product-based segmentation models already in place and the customer segmentation model.

In order to prioritize service time Queuing theory was used as a method to offer different service times to different customer segments based on their priority classes, A, B, and C. This project analyzed the current service times in the company (without any prioritization: can be seen as the horizontal lines in in the Figure 3 for each scenario. This line is reflects the W value) and compared the results with our proposed model (i.e. with prioritization: can also be seen in the Figure 3 as the vertical bar values Wi for each customer segment) under multiple scenarios in the both business lines. For the agricultural chemical business line, three scenarios were analyzed: (1) stable demand; (2) demand decrease by 30% to reflect off peak seasonality; and (3) demand increase by 30% to reflect peak season, as seen in Figure 3.

Inventory rationalization as a tool for differentiated service was the second differentiation strategy summarized. Deshpande & Cohen (2003) was the source for all insights presented, and all values, results and figures were obtained from their work.

Inventory rationalization is a process of allocating inventory to some customer classes while delaying fulfillment to other customer classes that have lower priority. This model assumes inventory is managed continuously using a \((Q, r, K)\) policy where \(K\) represents the threshold at which we stop serving all customer classes and only serve customers with highest priority. \(Q\) simply means the fixed quantity that will need to be ordered when inventory drops below \(r\), which is the re-order point. Figure 5 visualizes the model.

For the Paints business line, four scenarios were analyzed: (1) Equal percentage of orders from all customers, or 33% from A customers; 33% from B customers, and finally 33% from C Customers; (2) A scenario when the highest priority segment, A customers, have majority of the orders or 80% for A customers: 15% for B and 5% for C customers; (3) C customers with the majority of the orders, or 5% for A customers, 15% for B, 80% for C; in a fourth scenario, conditions were identical to the third scenario, but then we analyzed what happened when the normal prioritization rule of serving A customers first is changed. Figure 4 shows a summary of all four scenarios, and by comparing scenarios 3 and 4, the impact of changing the prioritization order can clearly be seen.

Figure 4: Summary of results with the Paint business line.

The case analyzed compared inventory rationalization models with two typical models that companies usually adopt: (1) Round up model,
meaning rounding up over all inventory levels to be able to meet the highest fill rate demanding customer, and (2) keeping separate pools of stock to meet each customers fill rate demands independently. Rationalization policies offer the most benefits when there is a significant difference in the cost of stocking out among customer classes and also when the fraction of demand from priority class customers is small when compared to the total.

Recommendations

- Standardization of the OTIF measurement needs to be done, because customers measure OTIF based on their request delivery dates while the company measure OTIF based on their first confirmed delivery date.

- The two suggested supply chain segmentation strategies should be adopted, and the opportunity to charge each customer segment for better service could be explored.

- Customer segmentations must be clearly communicated to all functional departments from customer service to operations. Any manual override of the prioritization driven by segments should be discouraged to ensure adherence.

- Since most customers indicated that they do not track OTIF performance regularly, the chemical company should make their own monthly OTIF metrics visible and transparent. This could be a value adding service.

Cited Sources


Conclusions

This thesis was born out of the desire of the chemical company to move away from the current one size-fits-all, first-come, first-serve supply chain model and move towards a differentiated supply chain that services customer segments in a differentiated way. This was achieved by first mapping requirements, and then, analyzing historical OTIF performance on various segmentation criteria. Two major differentiation strategies were proposed: 1) Prioritization of service delivery based on customer class, and 2) Inventory rationalization as a tool for differentiated service. These two strategies were proposed due to their practical nature and cost effective qualities. Priority queuing theory was applied to order fulfillment process and resulted in very significant service improvements for high priority customers when compared to the current general first-come first-serve model. This priority queuing model, if applied to the order confirmation process, ensures better reliability of delivery dates, which primary research shows was highly valued by customers and also enables customer segmented order confirmations to be possible.
KEY INSIGHTS

1. Improved inventory control can increase access to medical supplies, bring down the costs, and ensure those supplies are available when needed.

2. Standard methodologies for inventory control as well clear channels of communication can improve data collection to inform inventory replenishment decisions.

3. Aggregating replenishment of diverse products with a single supplier while maintaining local suppliers can provide cost savings while still allowing for flexibility in responding to demanding variability.

INTRODUCTION

The World Health Organization (WHO) estimates that 30-50% of the population in Sub-Saharan Africa lacks reliable access to essential health products [1]. Consistent provision of health products and related support materials (e.g., clinic equipment like generators), combined with appropriate services, could massively reduce the impact of disease in Sub-Saharan Africa [2]. MedOrg, a humanitarian organization that provides medical assistance to vulnerable populations, aims to mitigate the factors that impair consistent access to the health services and products. It runs its humanitarian operations through multiple Mission Centers (MCs) based throughout Europe. Within each MC, there is a Logistics Department that supports logistics and supply operations of country-level projects. The head offices in each country (the "missions") are responsible for coordinating the medical and logistical needs of the projects around the country. All of the missions are served by one of three MedOrg supply centers, including MedOrg-Logistics, which serves Ethiopia, the mission that is the focus of this paper.

This thesis evaluates how country-level supply and logistics staff in MedOrg can manage stock keeping and product re-ordering to better match supply with demand during times of non-emergency conditions. Specifically, it evaluates (1) communication barriers that contribute to inefficient ordering processes, and (2) potential inventory control models that could provide a simple, easy-to-use method for ordering products. The objective is to support MedOrg in affordably ensuring access to core products in its field operations.

To do this, both qualitative and quantitative methods were used. Stakeholder interviews and a review of MedOrg’s primary documents were conducted to evaluate possible areas of improvement in MedOrg’s supply chain policies, procedures, and strategy. Analytic modeling of variations on the economic order quantity (EOQ), joint-replenishment (JRP), and order-up-to models was used to compare different approaches to improving MedOrg’s inventory replenishment system. Input data for the model was derived from an analysis of MedOrg’s procurement and logistics system. A literature review was conducted to gain comparative references for inventory control practices and replenishment models.
QUALITATIVE ANALYSIS – PROCESSES AND PEOPLE

Interviews
The interviews with the 11 MedOrg stakeholders, which included both logisticians and non-logisticians, revealed several obstacles to improving communication to achieve more consistent supply of products; these obstacles center around strategy, policy, and practice.

- At both the international and local level, supply chain does not have a strategic place in the decision-making process;
- There is lacking a formal system of communication or reporting between different departments and levels within MedOrg. While there is an online procurement and logistics system, it is used inconsistently, leading to distrust of system reports;
- Rather than following a formal reordering policy, current orders are based on the order quantities of previous order requests, adjusted for stock on hand, lead time (if the source had changed), and remaining budget.

Recommendations
Based on the literature review and interview results, several recommendations were made:

- Logistics staff can participate in project development by writing a Procurement and Supply Management (PSM) plan to complement each project plan. A PSM plan thoroughly details how each goal within a project plan will be practically implemented.
- Once a project is underway, a steering committee made up of medical, finance, supply chain, and other relevant personnel, can be responsible for both yearly planning and monthly evaluation of plans using common reports and communication channels;
- MedOrg can create a global policy document that provides standardized methodology for supply chain processes to help people better understand and adopt related policies.
- Policies should be followed by habitual trainings, as well as how-to guides that help staff conduct the data entry, communication, and reporting task for which they are responsible.
- Supply chain improvements should be measured by using appropriate KPIs and performance appraisal goals for all levels of staff.

QUANTITATIVE ANALYSIS – INVENTORY CONTROL MODEL

Model Selection
A combination of JRP and periodic review models were analyzed:

Model One: International (MedOrg – Logistics) Orders Only. In this model, the set policy is to use the JRP’s indirect grouping strategy (IGS) [3] to order all products from MedOrg-Logistics, eliminating all local procurement. The first variation of the model (1a) assumes that ordering from MedOrg can be done following an optimal time interval following the IGS [3]. The second variation (1b) enforces MedOrg’s current policy of limiting international procurements to every six months. Once the order interval is set, MedOrg-Ethiopia uses the order-up-to model to set the maximum inventory position allowed. It then procures enough products to cover the difference between that level and the inventory position [4]. In all three models, the OUL accounts for demand and lead-time variability, as well as the use of periodic review [5].

Model Two: Two-tier ordering system from MedOrg-Logistics and local suppliers. In this model, the ordering policy is to procure enough products to meet average lead time demand from MedOrg-Logistics. Then MedOrg-Ethiopia orders from local suppliers the difference between the OUL and the inventory position (including the MedOrg-Logistics shipment) as time period for placing local orders. The time for placing orders with local suppliers based on the local lead time. Like in Model One, the ordering pattern is analyzed using both the optimal order interval (2a) and the policy of a 6 month order interval (2b).

Model Three: Local Orders Only. In this model, the ordering policy is to order all products locally, eliminating all procurement from MedOrg-Logistics. Joint replenishment is not employed because it is assumed that no one local supplier can provide all products. Instead, products are procured independently, sourced by the appropriate local supplier. The review period is 30 days, which MedOrg already uses due to the limited staff resources.

The following table visually summarizes at what interval each model would employ the different order types:

<table>
<thead>
<tr>
<th>Order Policies by Model</th>
<th>Order Type</th>
<th>Reorder Point</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MedOrg Logistics</td>
<td>Optimal T*</td>
<td>1a</td>
</tr>
<tr>
<td></td>
<td>183 Days</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Local</td>
<td>Described in models</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Data Collection
The P&L system was used to identify core products to evaluate: demand patterns; lead time variability; establish average unit prices; and look for patterns in preferences for local versus international procurement by product type. Order and holding costs were set after consulting key supply staff and referencing relevant literature. Through the process of data cleaning, a key result became clear: 23% of the data were invalid. Moreover, consumption data for most items was insufficient so
procurement volumes were used as a substitute. This underlines the importance of implementing effective procedures and trainings for data entry for all staff using the system.

MODEL RESULTS

Parameter Values
Applying the input data to the unconstrained JRP models (1a and 2a) resulted in a basic order cycle of 268 days. The cycles between two successive replenishments of items ranged from 1 to 4. The longer review period required a larger safety stock, though by dividing the procurements between MedOrg-Logistics and local suppliers, the second model reduces the amount of stock necessary to have on hand. See below for an example using therapeutic food moving from Model 1a to 2a.

The magnitude of stock reduction is larger as the order cycle is increased, but the initial investment in stock is greater as well. The OUL for an order cycle of 283 days was 15% higher on average than the 183 day lead time across the included products. The safety stock was very high for both models because all uncertainty in the system is captured in the safety stock level. The third alternative, ordering entirely locally, reduced the OUL significantly given the elimination of the long international lead time.

Costs
Material Costs. The unit price for the items under analysis was generally 145% higher locally rather than internationally. Thus, material costs were most expensive in Model Three. Model 2a also had high material costs because of the proportion of system stock procured locally given the long review period. The cost difference between 1b and 2b was negligible given the small time gap between the review period and the lead time.

Holding Costs. Holding costs can be reduced either by decreasing the order interval, or by introducing a secondary, faster replenishment option which allows a delay in ordering and holding stock. In Model One, reducing the order cycle (Model 1a to 1b) achieved a 5,500€ savings. When flexibility was introduced (Model 1a to 2a) there was an average total holding cost reduction of 3,800€. Accordingly, Model Three had the lowest holding costs.

Ordering Costs. Allowing for flexibility did increase ordering costs because it introduced the additional procurement opportunity to order locally thereby increasing the number of orders in the system. Local ordering costs were less, on average, for Model 2a than 2b because not every product needed to be procured every cycle.
Total Costs. Model 1a was the most cost-effective model in this analysis. However, it is important for MedOrg to consider the benefits of the fast turnaround times provided by local suppliers. While it is slightly more expensive than relying solely on MedOrg-Logistics, it provides a realistic operational solution that balances the need for flexibility with the benefits of joint replenishment.

Average Total Cost by Model

<table>
<thead>
<tr>
<th>Model</th>
<th>Average Total Cost (€)</th>
</tr>
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<tbody>
<tr>
<td>1a</td>
<td>390,000.00</td>
</tr>
<tr>
<td>1b</td>
<td>380,000.00</td>
</tr>
<tr>
<td>2a</td>
<td>370,000.00</td>
</tr>
<tr>
<td>2b</td>
<td>360,000.00</td>
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<tr>
<td>3</td>
<td>350,000.00</td>
</tr>
</tbody>
</table>

CONCLUSION

Through the qualitative analysis, three main areas of improvement were clarified.

1. Establishing a more strategic communication structure across departments could help to align each department’s yearly goals and ongoing operations.

2. Improving the Supply and Logistics Department’s strategic role at both the MC and mission level could help to ensure the implementation of education and monitoring and evaluation schemes for supply chain improvement.

3. Creating clear policies and procedures that focus on standard inventory control methodology across platforms should help to establish benchmarks for operations improvement; facilitate cross-platform peer-to-peer education, and design appropriate curricula and how-to guides to assist staff in contributing to a more efficient system.

The model results:

1. Support more reliance on MedOrg-Logistics, as well as the establishment of a flexible inventory control policy;

2. Highlight the need for better data collection and further analysis of additional constraints encourage additional research on product segmentation and the role of MedOrg-Logistics in inventory replenishment. This research can help MedOrg to more accurately define its inventory policies and understand the benefits of a coordinated inventory strategy.

The relationship between the qualitative and quantitative findings is important to highlight. Without implementing recommendations like those outlined in this paper, as well as by the MedOrg’s pilot team, it will be much more difficult for MedOrg to have adequate data to accurately manage inventory. Improved inventory control can increase access to medical supplies, bring down the costs of providing life-saving supplies to target populations, and ensure those supplies are available when needed. Thus, investment in inventory management improvements is core to MedOrg’s mission to deliver aid to people affected by armed conflict, epidemics, natural or man-made disasters, or exclusion from health care.

CITATIONS

**KEY INSIGHTS**

1. A risk index can be developed for cold chain shipments based on the key drivers of shipment quality (Origin-Destination, Carrier, Packaging type).

2. A prototype tool developed to evaluate alternate shipment strategies, demonstrated that overall shipment risk could potentially be reduced as well as offering new options for sales people to propose to customers.

3. For both the risk index and tool it is imperative that appropriate data be collected in an integrated process to support future decision making.

**Introduction**

Most temperature-controlled distribution channels operate efficiently; however incidents like the deaths of 128 children in India prompted agencies throughout the world to reexamine pharmaceutical good distribution practices [1]. It is estimated that 40% or more of the vaccines in the Sub-Saharan Africa have completely lost their effectiveness due to the inability to keep the product at a stable temperature, usually between 2°C and 8°C [2]. This is due to the lack of appropriate cold chain infrastructures in the region. In 2011, UNICEF procured around 2.5 billion doses of vaccines at a cost of $1,030 million [3]. Assuming 40% of the procured vaccines are sent to Sub-Saharan Africa and the percentage of ineffective vaccines handled by UNICEF is the market average, the cost of the lost vaccines would be around $165 million. Therefore, keeping a product within the required temperature range is one of the pre-eminent challenges in the Life Sciences and Healthcare [LSH] distribution channels.

Cold Chain in the LSH industry refers to the supply chain for a product that has to be maintained at a predetermined temperature range in order to preserve its potency and effectiveness [4]. Key challenges are controlling the proper temperature and humidity through the whole shipment, complying with the regulations established by different governments and agencies and the ongoing monitoring over the lifespan of the product while minimizing the overall cost.

Cost reduction is starting to become critical as over the last few years, patents of top selling
pharmaceutical drugs have expired [5], thereby allowing generics to enter the market and reducing the branded pharmaceutical margins.

**Problem statement and thesis scope**

The main research objective of the thesis was to analyze shipment data in order to identify possible patterns and provide a risk mitigation strategy. This was done focusing on answering the following research questions:

1. Can we establish a process for Risk Mitigation in XYZ’s approach to new cold chain opportunities with Life Sciences & Healthcare companies?

2. What are the most efficient means to build a tool that provides analytics to existing customers?

Therefore, the thesis analyzed historical shipment data and explained the patterns through the analysis of the shipment claim activity. Based on the analysis results, patterns obtained led us to define the main drivers that affect shipments’ quality and analyze the various dimensions affected.

We provided a general framework to design a tool that will mitigate the shipment-associated risks. Furthermore, it will allow optimizing the current temperature management service portfolio, improve service levels through data analytics and make suggestions to shippers on alternative trade-routes or different types of packaging.

Additionally, we explored data integration methods to mitigate the risk of product damage and enhance the service level and quality offered to the customers by potentially including all the sources into one single risk factor. The risk index can help identify profitable trade-lanes where to strategically position and differentiate from competition.

**Identified patterns**

The study analyzed over 30,000 shipments done between 2007 and 2013 and identified those that have registered a case with a final impact on the customer:

- **Temperature Excursion** cases are registered when a shipment has a reading above or below the temperature range specified in the Standard Operating Procedure [SOP].

- **Delay** cases are registered when a shipment departure is delayed two hours from its original schedule or if during the shipment the delay affects the next step in the SOP.

- **Physical Damage** cases are registered when the packaging is damaged to the point that it can no longer maintain a stable temperature or when the product integrity is affected.

- **Administration issues** are registered whenever a shipment does not follow the instructions and guidelines established in the SOP.

Based on the customer impact, analysis was done under the four major categories, trying to define the main drivers that affect to each of them.

<table>
<thead>
<tr>
<th>% of Exports</th>
<th>Export Region</th>
<th>Case Rate Import Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1%</td>
<td>AMLA</td>
<td>67%</td>
</tr>
<tr>
<td>61.5%</td>
<td>AMNO</td>
<td>2%</td>
</tr>
<tr>
<td>5.1%</td>
<td>ASPA</td>
<td>10%</td>
</tr>
<tr>
<td>1.0%</td>
<td>EMA</td>
<td>6%</td>
</tr>
<tr>
<td>30.3%</td>
<td>EURO</td>
<td>15%</td>
</tr>
<tr>
<td>Grand Total</td>
<td></td>
<td>7%</td>
</tr>
<tr>
<td>Total IMPORTS</td>
<td></td>
<td>21.4%</td>
</tr>
</tbody>
</table>

*Table 1. Case rate per export/import region*

**Figure 1. Customer impact rates**
Risk assessment tool and analysis

The risk assessment tool was designed to help the sales and field teams make better decisions about which airports, carriers and type of packaging are best suited for their client. It gives various alternatives for locations and carriers that have an overall low risk index than the current status quo.

Combining the indexes for origin, destination, carrier and packaging, the tool will provide a consolidated risk index for each optimized alternative. The algorithm follows the following relation, where risk indexes for the main issues are considered.

\[
Risk\ score = \sum_{i=1}^{4} W_i \cdot I_i
\]

\[
Impact\ Index = \sum_{j=1}^{4} R_{ij} \cdot [CR_{ij} + EX_{ij}]
\]

Since numbers can only tell half the story, the tool is intended to complement the existing knowledge and experience of the teams with historical shipments data analytics. The algorithm searches for alternatives to the current trade lane and optimizes the routes available.

System integration

Adding the proposed risk tool as a subsystem alongside other external databases to complement XYZ’s existing database can potentially deliver an overarching functionality. Ultimately what would be expected from it would be to gather the information from all different databases available.

One way would be to integrate the information on existing storage facilities in the main airports utilized. This can help in many ways: first, potential patterns between cases and the absence of appropriate facilities can be evaluated; second, it can improve sales people’s visibility to have real-time information about the existing facilities at each potential way-point.

Integrating a flight database with the tool would provide the real time data of the carriers available, the type of aircraft used for the flight, and the actual cost charged by the carrier for each shipment. This information can be valuable when there are disruptions such as long delays or grounding flights because the system will readily provide alternatives for the given criteria.

Real-time weather updates can avoid problems such as temperature excursions that could have been caused by forecasting errors. It could provide better insight to which packaging or insulation type from the different customers performs best under the different weather conditions. Moreover, having a real time weather report can help XYZ actively manage the shipments to the point where if gel packs or dry ice are needed at any point due to sudden changes in climate conditions, XYZ can act responsibly.

Data integration can provide in-depth analysis and an overview of the root cause is with the integration of the data provided by the temperature sensors and the actual shipment temperature forecast data. Should there be an excursion on a certain shipment, it would be possible to pinpoint the exact location where the excursion took place. In addition the resilience of the packaging can also be analyzed by comparing the change in the internal temperature of the package as a result of the variation in external temperature.

Data gathering improvement

Optimizing the available data for key measurements could give a company a competitive advantage in the cold chain airfreight and service providers market.

Based on the validity time, creating categories to consolidate passive packaging types across different customers will allow comparison between the different technological solutions used. The best performing solutions can be identified and proposed to other clients for each category. It can also provide feedback to the customers on packaging behavior and stability. For active containers categories, it could be useful to differentiate between dry ice and cooling fan solutions. Similar clusters should be done for the available passive packaging solutions.

![Figure 4. Proposed Packaging categories](image)
Furthermore, analytics should consider the root cause behind each issue registered, following a systematic procedure and performing analysis and correlation between the cases registered and the root cause. Linking the root cause with the final impact to the customer, will allow targeting improvements on the solutions that have the greatest impact.

Moreover, both fields should be sufficient to give insightful information to the customers regarding the main causes affecting their shipments. It will also allow the sales force team to define best practices, and the quality team to be aware of the weaknesses of the chain and focus on those to provide a better service.

Conclusions

Designing a one-size-fits-all supply chain strategy for normal cargo can be worthwhile and can benefit from lowering costs through economies of scale. However this is not the case with cold chain as handling shipments tend be less flexible, and limited in the number of qualified carriers and lanes that can be used. Additionally, customers look for speed and reliability; rendering cost as a secondary factor.

By finding common denominators between different customers and integrating or adopting what a best performer might be doing can help minimize the risk for other clients. The data gathering improvement and system integration recommendations seek this improvement by identifying the main gaps in the data and highlighting the key measurements to be considered in the future.

Linking the information between the SOPs and the shipment database will allow the tool to analyze the information directly from the source, while the database will be checking for consistencies in data entry and avoid errors in the SOP documents.

Once the tool considers all variables, the service provider should be able to provide customers with solutions for alternative trade routes, and packaging options that have the least amount of risk associated.

Conducting a tradeoff analysis between having a flexible SOP and the cost of that service is necessary. On one hand, Embarking onto long term agreements with a specific carrier to ensure a minimum quota on a certain route is definitively a way reduce shipping costs, but can also limit the flexibility for XYZ to select the best carrier for each shipment and provide the service level needed.

The stability profile for each product is significantly different and therefore some products have higher tolerance for temperature excursions and delays than others. This has been considered when developing the tool, giving a certain weight to each customer impact, depending on the customer’s input when establishing a new SOP.

Data is a core element in all operations. The ability to collect data that specifically addresses questions to improve service level is never an easy task. The most significant challenge is not gathering the data, but developing an integrated strategy that virtually allows everyone involved in supply chain processes to use the data for improved decision-making and improving the bottom line.

Bringing this together, the data collection, analysis, system integration and the risk tool are all part of achieving a strategic fit across the supply chain.

Cited Sources


Developing a Supply Base Rationalization Tool for a Global Organization

By Siddharth Sharma & Richard Swapp
Thesis Advisor: Dr. Alejandro Serrano

Summary:
This thesis analyzes the supplier base for a leading oil and gas service provider. We create a scalable tool to guide procurement decisions in the presence of an inflated supply base while making recommendations for a rational supplier base and delivering a tool to dynamically assess risks and costs.

Introduction
As companies begin to recognize significant benefits associated with efficient operational processes, weaknesses within the supply chain become more evident than previously realized. However, when the weakest link resides outside the firm, it may lead to significant problems. This is true with regard to a company's supply base. It is critical for a company to monitor and manage its supply base to ensure smooth operations and profitable results. The issue of managing suppliers becomes a major challenge when the company has global operations, billions of dollars in purchases, and a history of mergers and acquisitions. The problem becomes more challenging when an imbalance exists between the revenue and the number of suppliers within a given region. As operations shift from one geographic location to another, the supply base must respond dynamically by expanding in areas of growth and contracting in areas of decline.

The problems of a supply base with such magnitude are many. First, a strong buyer-supplier relationship, which is fundamental to the success of the business, is negatively impacted. Second, the supplier relationship managers are over-burdened, which affects staff productivity. Third, and more importantly, the company incurs an opportunity cost from not being able to take full advantage of economies of scale. In addition, by nature of the Oil and Gas industry, operations are located in risky areas around the globe. As such, geographic and operational risks must be accounted for in procurement decisions.

A spend analysis is the first step towards supply base reduction (Aberdeen Group, 2004). Once the spending habits of the company have been assessed it is possible to identify elimination criteria. Ogden et
al (2003) indicate three plausible approaches to elimination including systematic elimination, standardization, and tier-formation. However, in many cases the supply base is actually too small to support operations. This is particularly true in high-growth regions. As such, Duffy (2005) suggests segmenting suppliers based on volume and value. Creating a quartile graph allows category level strategies to be developed. However, the company of interest (“The Company”) also has to operate in risky regions. In this thesis, we combined risk scores from the United Nations and The Economist Intelligence unit and plotted these against the ratio of number of non-critical suppliers to critical suppliers. This plot, shown on page 3, clusters supplier sub-categories and allows for analysis to indicate when a specific commodity should be diversified or consolidated.

Using this framework, we evaluated each supplier category and every region where The Company has operations. Through this process we were able to identify suppliers to be eliminated and regions where suppliers are needed to sustain operations.

Analysis and Strategy

As defined by The Company, a critical supplier, among other criteria, is one that accounts for 70% of spend within a category. As such, spending was expected to be concentrated with critical suppliers. This was verified in the spend analysis. However, it was found that 97% of all suppliers are non-critical.

![Number of Suppliers and Supplier Spend](image)

The figure above shows that only 3%, roughly 3,000 suppliers, are listed as critical to operations of The Company. This suggests there is significant potential for supplier reduction, as spend with non-critical suppliers does not represent a majority of total spend within any given category. Consolidation can help The Company develop stronger relationships with fewer suppliers and negotiate better contracts.

The spend analysis found that 86% of total spend is managed by local managers. Based on this finding, an analysis was conducted to understand how well different management models managed their supplier portfolio. The Supplier Management Progress (SMP) is a pre-defined process in The Company that, at a very high level, can be used to describe the strength of relationship The Company has with a particular supplier. The table below shows that local managers have the lowest overall percentage of the SMP complete in both non-critical and critical supplier categories.

<table>
<thead>
<tr>
<th>Mgt. Models</th>
<th>No. of Suppliers</th>
<th>Avg. SMP (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Critical</td>
<td>85,081</td>
<td>5%</td>
</tr>
<tr>
<td>Center-Led</td>
<td>302</td>
<td>70%</td>
</tr>
<tr>
<td>Centralized</td>
<td>403</td>
<td>42%</td>
</tr>
<tr>
<td>Coordinated</td>
<td>10,349</td>
<td>11%</td>
</tr>
<tr>
<td>Local</td>
<td>74,027</td>
<td>4%</td>
</tr>
<tr>
<td>Critical</td>
<td>2,651</td>
<td>41%</td>
</tr>
<tr>
<td>Center-Led</td>
<td>191</td>
<td>52%</td>
</tr>
<tr>
<td>Centralized</td>
<td>352</td>
<td>75%</td>
</tr>
<tr>
<td>Coordinated</td>
<td>951</td>
<td>39%</td>
</tr>
<tr>
<td>Local</td>
<td>1,157</td>
<td>30%</td>
</tr>
</tbody>
</table>

The percentage SMP is used to calculate managed-spend, which is a KPI for procurement managers at The Company, measured by multiplying spend with the percentage SMP. The figure below illustrates the issue with SMP at The Company. Over 79,000 suppliers have completed less than 10% SMP, yet these suppliers account over $3b in annual spend.

Revenue data was gathered from The Company’s 2012 Annual Report to compare the percentage of suppliers and the percentage of revenue per geographic region. It was found that suppliers in North America represent 42% of all suppliers; however, only 32% of revenue is generated within North America. The figure below illustrates the imbalance of this relationship across all geographies.
Supplier rationalization will require The Company to evaluate the effectiveness of the procurement team. Questions arise such as how many suppliers each manager oversees and how much spend can each manager efficiently handle. The figure below shows that currently 80% of total spend is managed by 23% (123 managers). This means 411 managers handle 20% of total spend. Currently, managers are achieving an average SMP of 25% and only 811 suppliers have an audit date listed. This suggests that the system could be made more efficient through restructuring or redistributing the workload.

Segmentation

Following the strategy outlined by Duffy (2005), supplier categories are segmented using a quartile graph as shown in the figure below.

<table>
<thead>
<tr>
<th>Logistics</th>
<th>Chemicals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logistics</td>
<td>Manufactured Equipment</td>
</tr>
<tr>
<td>Logistics</td>
<td>Oilfield Equipment &amp; Services</td>
</tr>
<tr>
<td>Facilities</td>
<td>Travel</td>
</tr>
<tr>
<td>HR Services</td>
<td>IT</td>
</tr>
<tr>
<td>Inst. Services</td>
<td>Blank</td>
</tr>
<tr>
<td>Indirect</td>
<td>Direct</td>
</tr>
</tbody>
</table>

For The Company, Volume was based on spend within a specific category and Value was determined based on indirect (low value) or direct (high value) segmentation. The Company segments supplier categories based on direct and indirect spend; these segments were readily transferred to our model. After clustering supplier categories based on volume, spend per category was determined. Categories with spend greater than the company average were identified as high volume and categories with spend less than the average were identified as low volume.

Risk

To incorporate the idea of risk into the model, two numerical risk scores were incorporated. The first came from The Economist, which ranks countries from 0 to 100 (100 = most risky) based on security, political stability, government effectiveness, legal and regulatory, macroeconomic, foreign and payments, financial, tax policy, infrastructure, and labor market (The Economist, 2011). These are risks associated with operating a business within a particular country. The second risk score was obtained from United Nations World Risk Report, which quantifies a country’s vulnerability to a natural disaster and the country’s ability to respond (United Nations University, 2011). These scores were combined using the following equation.

\[
\text{Combined Risk Score} = EIU \times (1 - UN)
\]

Where,

- EIU = Risk Score obtained from The Economist Intelligence Unit
- UN = Risk Score obtained from the United Nations University

The UN risk score is measured in percentage and has a maximum value of 32%. So that the combined risk score is not reduced to an insignificant numerical value, EIU is multiplied by the residual UN score (1 - UN). The combined risk score allows the risk of a disruption to be quantified.

The figure above shows the quartile graph with risk on the y-axis and the ratio of non-critical suppliers to critical suppliers on the x-axis. The horizontal line dividing the graph to upper and lower sections is the average risk score for category across all geographies. This represents an internal benchmark. The vertical line dividing the graph should be 1.00 meaning sub-categories with more non-critical suppliers than critical suppliers are diversified.

Tool Development

The objective of developing the procurement tool was to provide clear and concise information, via a simple-to-use graphical user interface, that would
empower the procurement team to make both strategic and operational decisions that reduce costs and increase efficiency.

The key inputs were identified as the supplier country and the product category. In order to provide a macro vs. micro-level assessment of the spend dynamics a “select all” option was included for both inputs. Additionally, provision was made to allow the sourcing managers to evaluate the Key Performance Indicators at the GeoMarket level.

The tool is designed to combine industry best practices, The Company’s procurement strategy, and the current state of key performance metrics in terms of providing outputs to the sourcing managers.

Findings and Recommendations

Nearly 51% of suppliers for The Company realized zero revenue during the first three quarter of 2012. These suppliers should be immediately marked for elimination. Further, for indirect categories such as Travel and HR services, more than 30% of the suppliers had no associated spend during the period under study. Procurement in indirect categories should be consolidated to take advantage of economies of scale. While many categories represent an opportunity to reduce the supplier base, some, such as chemicals, have a relatively low number of suppliers (1% of total) and are already well consolidated.

In general, for The Company, nearly every supplier category suffers from having dormant suppliers resulting in a diversified supply base. Opportunities exist to eliminate non-critical suppliers in low-risk regions. This will enable The Company to consolidate spending and negotiate better contracts with the remaining suppliers. While evaluation of suppliers as well as volume allocation will be left to the individual procurement manager, this work will guide managers to categories and countries where this type of rationalization is deemed necessary. A tool assessing how to allocate volume under a dual sourcing scenario could serve as an extension of this research. Rothkopf & Pibernik (2012) document this problem very well.

The Company, by the nature of its business, operates in locations with high geopolitical risk. However, there are ways to reduce risk and by segmenting suppliers, The Company should develop a strategy to reduce the risk of disruptions by looking for more stable suppliers in risky countries and by sourcing from less risky neighboring countries.

Initially, the procurement tool will call for aggressive cuts to the supply base in most regions. This will provide for a reallocation of volume to the remaining suppliers and position The Company to leverage lower prices and more standardized service. Further, with fewer suppliers, The Company will face a tradeoff between (1) Maintaining the same number of managers and attempting to increase supplier performance monitoring and (2) reducing the number of managers and maintaining current performance monitoring standards.

Cited Sources


Reverse Logistics Model for a Remanufacturing Business in the European Region

By Sudha Srinivasan and Athanasios A. Venetos
Thesis Advisor: Professor Alejandro Serrano

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.

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.

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.

<table>
<thead>
<tr>
<th>Milk run No.</th>
<th>Milk run route</th>
<th>Expected reduction in transportation cost</th>
<th>Expected cost savings (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rumst – Mechelen - Groß-Gerau – München – Rumst</td>
<td>83%</td>
<td>€ 720,176</td>
</tr>
<tr>
<td>2</td>
<td>Rumst - Groß-Gerau – München – Rumst</td>
<td>80%</td>
<td>€ 580,454</td>
</tr>
<tr>
<td>3</td>
<td>Rumst – Lyon - Gross-Gerau - Mechelen – Rumst</td>
<td>65%</td>
<td>€ 640,769</td>
</tr>
<tr>
<td>4</td>
<td>Rumst – Mechelen - Groß-Gerau – München – Krakau</td>
<td>60%</td>
<td>€ 790,003</td>
</tr>
<tr>
<td>5</td>
<td>Rumst – Mechelen - Groß-Gerau – München – Lyon – Madrid – Rumst</td>
<td>45%</td>
<td>€ 423,475</td>
</tr>
<tr>
<td>6</td>
<td>Rumst – Mechelen – München – Lyon – Rumst</td>
<td>35%</td>
<td>€ 120,364</td>
</tr>
<tr>
<td>7</td>
<td>Rumst – Dordrecht – Lubin – Gdansk – Krakau – Rumst</td>
<td>14%</td>
<td>€ 65,403</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Milk run No.</th>
<th>Milk run route</th>
<th>Expected loss (€)</th>
<th>Expected increase in overall sales to break even</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Rumst – München – Madrid – Rumst</td>
<td>€ 61,019</td>
<td>15%</td>
</tr>
<tr>
<td>9</td>
<td>Rumst – München – Lyon – Madrid – Rumst</td>
<td>€ 212,909</td>
<td>75%</td>
</tr>
<tr>
<td>10</td>
<td>Rumst – Madrid – Rumst</td>
<td>€ 316,322</td>
<td>507%</td>
</tr>
<tr>
<td>11</td>
<td>Rumst – Lyon – Madrid – Rumst</td>
<td>€ 343,684</td>
<td>342%</td>
</tr>
</tbody>
</table>

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.

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.
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.

**References**


KEY INSIGHTS

1. The benefits of centralizing some aspects of planning while leaving others decentralized can be combined in a single planning process.

2. An MRP process can provide the flexibility to overcome operational risks, such as escalation of conflict and port/road/border closures.

3. Inventory theory applied in industry, such as the (R, Q) order policy, can be effectively applied to ongoing operations in a humanitarian context.

Introduction

AidOrg operates 135 refugee camps in 79 countries worldwide. The running of these camps depends on the timely delivery of a range of eleven items essential to refugees’ lives, such as tents and blankets, collectively referred to as core relief items (CRIs). Demand for CRIs is highly unpredictable and driven by a myriad of factors that affect arrival rates of refugees at existing camps, from the evolution of conflict to rainy seasons and border closures. As the environments in which AidOrg operates include some of the world’s least developed regions, supply is exposed to a range of uncertainties that include security issues, long customs clearance times, and a lack of transportation infrastructure and capacity. Currently, demand-supply planning for long-term operations is highly decentralized to the country office and sub-office levels and performed on an ad hoc basis, raising the question of how it can be improved.

AidOrg operates separate supply chains to supply each of its two major types of operation. The first, its emergency response supply chain, relies on air freight to provide fast response to humanitarian disasters, such as earthquakes or the outbreak of civil war, anywhere in the world. The second, its supply chain for ongoing operations, is focused on supplying CRIs for new arrivals and replacement of worn out items to long-term refugee camps and, in order to reduce costs, relies primarily on surface transportation.

This research develops a demand-supply planning process for AidOrg’s supply chain for ongoing operations. The planning process aims to reduce AidOrg’s costs and increase availability, while at the same time standardizing planning functions at the country and sub-office levels and centralizing
aspects that can be improved through a global view of the supply network to the supply management head office. This research resulted in the writing of a new standard operating procedure (SOP) for planning, which AidOrg intends to implement in the summer of 2013.

Methodology

At the beginning of this research, a conceptual framework was drawn up, describing the operational context, the challenges that were anticipated, and the elements that were expected to be required to create a centralized planning system. Due to the complexity of the environments in which AidOrg operates and the fact that participants in any planning process implemented are located in different regions across the globe, an action research approach was taken to the case study (Akkermans, Bogerd, & Doremalen, 2004). Through this approach it was possible to spend three weeks visiting a number of the locations in which AidOrg operates, including the supply management head office in Budapest and field operations in three countries, and witness the challenges faced by AidOrg personnel on a day-to-day basis. This research also draws heavily on supply chain literature related to humanitarian logistics and inventory modeling, as well as benchmarking exercises with UNICEF and IKEA, to provide insight into the management of supply chains in other humanitarian organizations and best practice in industry.

A series of five hypotheses related to the value of a centralized demand-supply planning process were constructed, ready for validation by the case studies. For example, a potential issue identified with the planning process was the predictability vs. responsiveness dilemma (Ptak & Smith, 2011), as illustrated in the following diagram:

**Predictability vs. Responsiveness:**

**The Planning Dilemma**

It was hypothesized that, through a combination of advance planning and close monitoring and adjustment to the situation on the ground, the planning process could effectively deal with this tradeoff and provide both predictability and responsiveness. By validating the hypotheses through case studies demonstrating their accuracy, it was expected that conclusions could be drawn as to the value of a centralized planning process to AidOrg and generalized to other humanitarian organizations.

The Planning Process

Based on the original conceptual framework and the research performed, six distinct planning modules, each focusing on a different aspect of the overall planning process, were developed, as illustrated in the following diagram:

The planning process is performed over two years – the year prior to that being planned, during which supply and demand are analyzed and strategic decisions are taken, and the planned year itself, during which the strategy is adjusted as the year proceeds. Each of the six modules and their usages are described below.

**Needs Assessment:** At AidOrg, forecasting demand for CRIs is carried out by Programs officers and is beyond the scope of this research. However, the process developed by this research standardizes the format in which demand forecasts are passed to Supply officers and requires that forecasts for both the likely scenario and an alternative scenario (for example, the occurrence of a natural disaster) are provided.

**Network Design Strategy:** A series of simple rules were developed to determine where inventory should be stored in each country and in which locations, either in-country or in other warehouses in the region, safety stocks should be pooled for possible alternative scenarios indentified in the needs assessment process. This facilitates inventory pooling of safety stock, reducing holding and working capital costs, while maintaining availability.

**The Response Curve:** Each location produces a list of potential suppliers, their lead times, and
associated costs. This list is maintained and used as a reference if a stock out occurs and allows the supply officer to see all available supply options at a glance.

**Sourcing Strategy:** Locations that pool inventory or have high demand for CRIs are supplied directly from suppliers, which may be global or local suppliers, or other sources of CRIs, such as donations. For each location, a preferred primary source of CRIs, such as a low-cost supplier in Asia with long lead times, and a preferred secondary source, such as a nearby regional stockpile that can top-up inventory in the event that long lead times or other factors prevent the primary supplier from meeting demand, are selected. This multi-supplier strategy was adapted from techniques employed at IKEA.

**Inventory and Safety Stock Policy:** As all countries and locations are unique, a one-size-fits-all approach to inventory policy is not appropriate. Therefore, the planning process provides a menu of different inventory policies and the supply officer selects the most appropriate one for the situation. For example, in a location with high demand, the (R, Q) policy may be selected as it allows transportation costs to be minimized by shipping in full container loads. Safety stocks and required warehouse capacities are also calculated at this stage. The following graph illustrates the maximum stock level in a worst-case scenario at an AidOrg warehouse, and the different types of inventory held:

The diagram illustrates that inventory is highest just before a rainy season, when large quantities have been prepositioned, and, in this case, a distribution is about to be performed. To reduce capacity requirements, the process recommends that inventory for the replacement distribution be shipped to the location on the day of distribution, negating the need for it to be stored in the warehouse.

**MRP Process:** Benchmarking with IKEA demonstrated the value of computer software in allowing an organization to adapt quickly to demand fluctuations. As such, once the planned year has begun, MRP (or DRP) software is used to plan material requirements in each location on a monthly basis and to ensure that orders are placed in time to meet demand. The software dramatically increases responsiveness, as, whenever inputs, such as lead times or demand forecasts, change, it can instantly recalculate inventories and orders.

**Case Studies**

The countries selected for the case studies were South Sudan and Ethiopia. These countries were chosen for two reasons. Firstly, based on an analysis of population trends and budget spend, AidOrg has identified them, together with Kenya, Chad and the Democratic Republic of the Congo, as being two of the five countries that could benefit most from improved planning. Secondly, operations in the two countries face very different sets of challenges, demonstrating the flexibility of the planning process and its adaptability to different operational contexts.

South Sudan is one of the most challenging countries in which AidOrg operates, due to a range of factors such as rainy seasons that effectively isolate the camps with the highest new arrival rates for half the year, long customs clearance times that average approximately two months, and a chronic lack of transportation infrastructure. The following map of South Sudan depicts AidOrg warehouses and the transportation routes between them:
Applying the demand-supply planning process to South Sudan showed that very high levels of safety stock were required to be held in-country, as, due to the long customs clearance times, fast replenishment in the event of a sudden influx of refugees was not possible. In addition, while inventory could be pooled at Juba for camps in the south, high levels of inventory had to be prepositioned at camps in Upper Nile and Unity in the north in preparation for the rainy season, during which replenishment by road, even from Juba, is not possible. In the case of a stock out, the only back-up supply option with a short lead time is air freight from AidOrg’s regional stockpiles in Nairobi and Dubai, for which customs clearance procedures can be waived. However, as air freight is extremely expensive, maintaining high quantities of safety stock is cheaper than keeping lower quantities and risking stocking out.

Ethiopia is a very different country, with 10 day customs clearance times, well-maintained roads that negate the impact of rainy seasons and multiple potential locations for pooling safety stock and emergency replenishment, including the central warehouse in Addis Ababa and the Nairobi regional stockpile. Ethiopia’s supply network topology is shown on the following map:

Conclusions

In this work, a complete demand-supply planning solution has been developed for AidOrg using an action research methodology, facilitated by case studies. Due to the incorporation of general rules and menus of options, flexibility is provided to overcome the myriad of factors that influence supply and demand in the complex, fast-changing environments in which humanitarian organizations operate. In addition, the planning process centralizes aspects of planning that benefit from a view of the entire supply network while leaving aspects, such as needs assessment, that benefit from local knowledge, decentralized.

By using case studies to validate a series of hypotheses, the potential benefits of implementing centralized demand-supply planning in ongoing humanitarian operations are analyzed and the results of the work generalized. In particular, the case studies demonstrate that a combination of advance planning and an MRP process, used to create responsiveness, can reduce costs while maintaining availability, thus mitigating the planning dilemma presented in Ptak & Smith, 2011. The application of techniques learnt through benchmarking with IKEA, such as multi-supplier strategies, and from supply chain literature, such as the (R, Q) order policy, illustrate the relevance of these techniques to the humanitarian sector. These insights provide a basis for planning in ongoing humanitarian operations, an area in which very little research currently exists, as most literature on humanitarian supply chains focuses exclusively on emergency response.

**Primary References**


Branded Drugs vs. Generics: Different Approaches to Supply Chain

By Samuel Ohene Amoah and Bruna Correa de Faria

This thesis investigates different approaches to in-market distribution and logistics with emphasis on an off-patent blockbuster drug in the Spanish pharmaceutical market. It delves into some triggers that allow the successful generic companies to shrink their margins and win in the market place and explores strategies to contend with the extremely competitive market.

The Impact of Distribution Center Bypass in the Luxury Fashion Industry

By Saman Askari and Ali Mahdavi Nader

This study analyzes the effects of eliminating a layer of regional distribution centers in the distribution of a large global fashion retailer’s luxury products and instead distributing the products from a central warehouse in Italy directly to retail or wholesale outlets around the globe. Based on the devised cost model and the assumptions made, it is determined that centralization is most effective for high-priced products with high uncertain demand, and least effective for low-priced products with high predictable demand.

Improving Supply Chain Sustainability: A Purchasing Model Based on a Company Pioneering Sustainability

By Okan Balaban and Arieti Ríos Manrique

This thesis studies the improvement in sustainability practices related to the indirect footprint of a company by providing a purchasing model and recommendations to decrease it. It also incorporates the use of a Factor or Matrix of unique Factors (named Differentiating Factor) calculated using qualitative and quantitative data to achieve precision on the prioritization of this data.

Scenario Planning: A Tool to Prepare for the Future

By Mark Ismael Vital Boyonas and Luis Olavarria

This thesis tackles the question of how organizations can prepare for the future in a world in which the only constant is change. This project is an attempt to take an alternative perspective in planning for the future. Applying the framework used in Scenario Planning, a structured approach is elaborated to describe a replicable methodology for sensing critical uncertainties in the external environment.

Segmentation Strategies in Supply Chain

By Zoltan Ejiofoh and Ana Novillo

This thesis focuses on the various segmentation strategies that could be adopted by companies and develops a model that demonstrates how the supply chain could be tailored to offer differentiated service to different customer and product segments. The proposed differentiation model is one that is cost effective and could be easily implemented across all business units.
Improving Inventory Management in Non-Emergency Humanitarian Aid Operations

By Sarah Robbins-Penniman

This thesis examines the relationship between improving data collection and accurately setting an inventory control policy within a humanitarian aid organization. Interviews and analytical modeling are used to evaluate how one aid organization can more cost-effectively ensure a high service level of essential aid items.

Risk Mitigation in Time and Temperature Sensitive Shipments in the Life Sciences and Healthcare Industry

By Samer Sharaiha and Luis Pastor

This thesis analyzes the effective utilization of the data generated from Life Science and Healthcare shipments managed by a major airfreight provider. It defines patterns and provides a risk mitigation strategy, identifying potential business applications, and optimizing the current temperature management service portfolio to be offered to customers.

Developing a Supply Base Rationalization Tool for a Global Organization

By Siddharth Sharma & Richard Swapp

This thesis analyzes the supplier base for a leading oil and gas service provider. We create a scalable tool to guide procurement decisions in the presence of an inflated supply base while making recommendations for a rational supplier base and delivering a tool to dynamically assess risks and costs.

Reverse Logistics Model for a Remanufacturing Business in the European Region

By Sudha Srinivasan and Athanasios A. Venetos

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.

Centralized Demand-Supply Planning for Global Humanitarian Operations

By Rowan Veale

This thesis builds on academic literature and industry best practice and uses action research to develop a new, more centralized demand-supply planning process for ongoing operations at AidOrg’s refugee camps, based on case studies of operations in South Sudan and Ethiopia. Case study results are evaluated against a set of predefined hypotheses to investigate how the proposed planning process creates value and its generalizability to other humanitarian organizations. The new process balances predictability with responsiveness and is customizable to suit the diverse environments in which AidOrg operates.
ZARAGOZA LOGISTICS CENTER

Zaragoza Logistics Center (ZLC) is a research institute established by the Government of Aragon in Spain in partnership with the Massachusetts Institute of Technology (MIT) and the University of Zaragoza. Founded in 2003, the ZLC campus is located in the heart of PLAZA, the largest logistics park in Europe that serves as a working laboratory to transfer new knowledge and working practices. ZLC has rapidly become recognized as an international center of excellence for education and research in logistics and supply chain management focusing on:

- enhancing economic growth and competitiveness through innovation
- engaging with both industry and the public sector in the development and dissemination of knowledge

To accomplish its mission ZLC partnered with the MIT Center for Transportation and Logistics to form the MIT-Zaragoza International Logistics Program, a unique model of collaboration between industry, government and academia. This successful partnership led to the creation of the MIT Global SCALE Network that now spans four continents. In addition, Zaragoza Logistics Center participates in several national and international research and educational initiatives.

In 2008 the Spanish Ministry of Education and Science officially recognized ZLC as a Knowledge Transfer Office (KTO) after previously being designated the National Center of Excellence for research in the area of logistics and supply chain management, CNC LOGISTICA, in 2006. This latest recognition puts ZLC in the leading role to define and coordinate research, development and innovation initiatives across Spain in logistics and supply chain management.

ZLC has the continued support of local saving banks Ibercaja and CAI and the European Social Fund in its activities.

MIT ZARAGOZA INTERNATIONAL LOGISTICS PROGRAM

The MIT Zaragoza Program encompasses a masters degree, a doctorate degree, and executive education courses leading to certificates in various logistics-related disciplines.

The MIT Zaragoza Master in Logistics & Supply Chain Management Program (ZLOG) has been ranked as the #1 Logistics Master in Spain and it is based upon the curriculum of Massachusetts Institute of Technology (MIT) which is ranked as #1 in the US. Our alumni base includes over 500 supply chain professionals in more than 50 different countries. On average 95% of students are hired within 3 months of graduation. The average salary increase for the ZLOG Class of 2011 has been 72%.

The research program uses the logistics park as a working laboratory to experiment with new logistics processes, concepts and technologies, in active collaboration with leading academic institutions and companies from around the world.

MIT-Zaragoza actively engages with companies from around the world to exchange ideas and collaborate on leading-edge research. If your organization would like to collaborate with our faculty, students, and other industry and public sector partners on constantly evolving research projects, there are several outreach opportunities available including Research Groups, Supply Chain Education Partners Program, Symposia, and the Supply Chain Summit.
MIT-ZARAGOZA
International Logistics Program

www.zlc.edu.es/zlog