Increasing Access to Medicines in Southern Africa

By: Chelsey Graham and Ricardo Ghersa
Thesis Advisor: Dr. Jarrod Goentzel

Summary: Economic instability and poor or lacking physical infrastructure are some of the factors that contribute to price inflation along the supply chain in Zimbabwe. Our research, in partnership with one of the Big Pharma companies, addressed two intertwined yet distinct research areas. On one hand, we evaluated how price reductions (i.e. subsidy) offered by our partner company distributors in Zimbabwe translated down the value chain. On the other, we analyzed the costs of insourcing versus outsourcing of our partner’s company distribution function in Southern Africa, and the sales volumes at which the two alternatives are equivalent. We realized how trust and information sharing played a pivotal role in the rollout of the price reduction scheme, making it relatively more successful for certain distributors, pharmacies, and product lines. In addition, through the application of inventory policies, such as economic order quantities and the power of two policy, and Monte Carlo simulation we were able to determine the impact that forecasting error, minimum order quantities, and sales volumes can have on the decision to outsource.

Chelsey Graham holds three years of work experience as a process engineer within the supply chain retail division. Prior to the SCM program, she received a B.S. in Industrial Management/Industrial Engineering from Purdue University.

Ricardo Ghersa received a B.S. in Economics in Milan and a Masters in Finance in Reims. Prior to the SCM Program, he worked as an International Operational Auditor for Nestle and Hutchison Whampoa, conducting reviews at HOs and factories across the business units of these two companies.

KEY INSIGHTS

1. The logistics fee contributed to lowering prices across distributors and narrowing the gap between prices charged by the different distributors.

2. Pharmacies passed the savings to the final consumers and the prices charged for certain product lines became very close to their generic alternatives.

3. Minimum order quantities (MOQ) can have a large impact on inventory holding costs, and in the case of our partner company, affect the decision to outsource. Due to large MOQ’s, the MOQ was ordered for 50% of the SKUs over the EOQ in our model. This resulted in a 25% increase in inventory holding costs.

The Problem

Our research focuses on two research areas involving the distribution of medicines of the private sector, in partnership with a pharmaceutical company operating in Southern Africa. 1) Will price reductions at the distributor level in Zimbabwe translate to the consumer, and if so, how does this impact over sales volume? 2) What is the cost of insourcing the distribution function vs. outsourcing at varying service levels, and what sales volumes are required to motivate the switch from outsourcing to insourcing?

Methodology

1. Logistics Fee Implementation

The key data source used for evaluating how the logistics fee was implemented by the different actors across the supply chain came from semi-structured
interviews we conducted with distributors and pharmacists during a visit to Zimbabwe in December 2013.

The Questionnaire
In order to effectively conduct our interviews, we compiled a questionnaire to be used as a guide and aimed at gathering specific data on sale volumes and prices, as well as gaining visibility on the key operations and challenges faced by both distributors and pharmacists, so as to be better placed to correctly interpret the data collected.

The Sample Selection
Next, we selected a stratified sample of pharmacies by classifying them according to two criteria: population density and level of income. By so doing, we captured the purchasing trends of the main categories of the population living in and around the capital city of Zimbabwe. As for distributors, we were able to meet with all five that distribute our partner company’s medicines.

Value Chain Analysis & Sales Volume Review
The data collected were then used for three purposes:
1) To quantify the mark-ups applied by the different players along the value chain for medicines sold in Zimbabwe, from the original manufacturing sites all the way through until to the final consumer.
2) To determine how sales volumes at the wholesaler and the distributor level where affected by the implementation of the logistics fee.
3) To determine the profitability of the pharmacies visited and discuss how they would be impacted by a new change in prices.

2. Warehouse and Distribution Model

EOQ vs. MOQ
To aid our partner company in the decision of whether or not to continue to outsource the warehousing and distribution functions, we developed a model that calculates the inventory holding costs (based on cycle stock, safety stock, and in-transit stock), warehousing costs, and transportation costs from the manufacturer to Lusaka, Zambia – the potential warehouse location. Using historical sales data for products that made up 80% of total Southern African sales, we applied the economic order quantity policy to determine the optimal order quantity. We then compared this to the MOQ required by the manufacturer to determine the impact that MOQ’s have on inventory holding costs.

Sensitivity Analysis
We used the forecast for these same products to determine the forecast error in order to calculate required safety stock. We varied the service levels (90, 95, and 99.5%), k factor, to determine the impact on total costs and the actual service level being provided by the current third party logistics provider (3PL).

Optimal Mode of Transportation
In order to determine the cheapest mode of transportation by supplier site (ocean vs. air), we calculated the average fixed and variable rates by mode for each supplier site based on historical data. We then calculated the optimal interval between orders (\( T^* \)), and applied the power of two policy by supplier (\( T_{\text{practical}} \)). This allowed us to determine the weighted average of the number of orders by supplier site, while remaining within 6% of the optimal cost. This was then used to calculate fixed transport costs (per shipment).

\[
T^* = \frac{Q^*}{D}
\]

\[
T_{\text{practical}} = \frac{\ln\left(\frac{T^*}{\sqrt{2}}\right)}{2 \ln(2)}
\]

Logic within the model chose the cheapest mode of transportation by supplier site. We were then able to compare the total costs using this method to the total costs of using “all air” or “all ocean” modes of transportation.

Warehousing Costs
The one-time setup cost of opening a warehouse was estimated using Warehouse-in-a-Box™, a Supply Chain Management System (SCMS) solution. The size of the warehouse required was calculated by converting average inventory on-hand to pallets using dimensional data provided by our partner company. Labor costs were provided as a percentage to sales by an external party currently subcontracted by our partner company.

Simulation
We used @Risk Monte Carlo simulation to determine how the total warehousing and distribution costs changed as a function of sales volume, ranging from 4 to 13 million, increasing in increments of 1 million for each simulation.
Results

Logistics Fee
1. Overall, the logistics fee succeeded in better aligning the price structures of distributors. An analysis on two of the distributors showed that the distributor who originally charged lower prices did not need to pass on the full price decrease received from the wholesaler to the pharmacies in order to continue to provide lower prices than the competitor. See table below for price changes before and after the logistics fee implementation.

<table>
<thead>
<tr>
<th>Distributor</th>
<th>Pre Post (%)</th>
<th>MED2 Pre Post (%)</th>
<th>MED3 Pre Post (%)</th>
<th>MED4 Pre Post (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>40.7 29.6 -27%</td>
<td>22.0 15.8 -36%</td>
<td>8.7 9.3 7%</td>
<td>8.0 6.0 -25%</td>
</tr>
<tr>
<td>A</td>
<td>47.5 28.8 -38%</td>
<td>28.5 17.0 -40%</td>
<td>8.0 9.0 13%</td>
<td>7.5 5.0 -33%</td>
</tr>
<tr>
<td>E</td>
<td>40.0 31.5 -21%</td>
<td>26.0 19.3 -31%</td>
<td>11.0 8.1 25%</td>
<td>8.5 4.9 -43%</td>
</tr>
<tr>
<td>D</td>
<td>41.3 31.8 -25%</td>
<td>22.0 19.8 -10%</td>
<td>11.8 9.8 -17%</td>
<td>7.8 5.8 -26%</td>
</tr>
<tr>
<td>B</td>
<td>50.0 35.3 -29%</td>
<td>27.0 24.0 -11%</td>
<td>10.0 8.5 -15%</td>
<td>8.0 6.5 -19%</td>
</tr>
</tbody>
</table>

*Prices are expressed in USD

2. Pharmacies passed the full price reduction to the final consumer. In particular, the retail price reduction applied by the pharmacies was a reflection of the pricing applied by the distributor.

3. The gap in prices of the branded versus the generic alternatives became decreased for two out of the company’s four top-selling product lines.

4. A clear increase in volume sales was detected for two out of the five distributors. The graph below displays how volumes reacted for one distributor post implementation.

Comparative Warehouse Cost Analysis
Our model and simulations allowed us to determine that the current costs of outsourcing is 67% cheaper than the option to insource at the current sales volume (at a 99.5% service level). At four times the current volume, the cost of outsourcing will be more expensive than insourcing 95% of the time. Inventory holding costs make up 60% of the total costs, which is in part attributed to high levels of safety stock due to large forecast error. Large MOQ’s required by the manufacturer are another cause for high inventory holding costs. The MOQ was 77% higher on average than the EOQ, causing a 25% increase in the total inventory holding costs (for all simulations). This explains why such high sales volumes are needed before insourcing becomes the more financially attractive option.

Varying Service Levels
We compared the cost of outsourcing vs. insourcing at varied service levels, and determined that at a 90% service level (excluding one-time cost of opening a warehouse), the total cost of outsourcing is 30% less than insourcing at current sales volumes. This remaining gap could be attributed to the following differences between our partner company and the 3PL: forecasting capabilities, safety stock policies, and capital and non-capital costs. This small gap leads us to conclude that the service level being provided by the 3PL is no greater than 90%. The graph below compares the cost of insourcing by mode to 80% of the total cost of outsourcing. The cost of the 3PL is 5.3% of total sales; 80% of this was taken in order to compare against the model outputs, which are based on the top products that make up 80% of total sales.

Conclusion
We noticed how the different distributors implemented the logistics fee with varying levels of effectiveness, depending on their original price structures, and that the fee contributed to lower prices across all distributors. A review of the sales volume (at the distributor level) confirmed the insight
that the fee was particularly successful in increasing volume with certain distributors and product lines. Similarly, at a pharmacy level, the application of the price reduction to the final consumer varied substantially depending on the specific pharmacy and products. In effect, the retail price reduction applied by the pharmacies was a reflection of the pricing applied by the distributor.

As far as the results of the insourcing decision are concerned, we verified that large MOQ’s and forecast accuracy greatly impact inventory holding costs. In general, larger sales volumes are needed in order for the insourcing of logistics functions to make sense financially (four times the current volume in the case of our partner company). Forecasting accuracy will also improve with higher, more stable volume levels and the EOQ has less of a chance of being overridden by large MOQ’s, ensuring that a balance between transactions costs and excess inventory costs is maintained. However, outsourcing may also mean sacrificing service levels for lower costs. The model established that at a 90% service level the cost of insourcing is 550,000 GBP greater than the current cost of outsourcing (sans the one-time cost of opening a warehouse). This gap may be attributed to poor forecast accuracy and high MOQ’s, but also raises the question of whether a service level less than 90% is being provided by the 3PL.