Increasing Access to Medicines in Southern Africa

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Abstract

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 to the distributor translated down the value chain. On the other, we analyzed the costs of insourcing versus outsourcing of our partner's company distribution function, and the sales volumes at which the two alternatives are equivalent. We conducted a set of field interviews with local distributors and pharmacies; this combined with data gathered by a third party market research team and input from our partner company's South African business unit equipped us with the data required to address these questions. We realized how trust, information sharing and tailored incentive schemes played a pivotal role in the rollout of the price reduction scheme, making it relatively more successful for certain distributors, pharmacies, and product lines. Specifically, we were able to demonstrate how sales volume throughout the chain increased post subsidy implementation for two key distributors who passed on the largest price reductions as compared to the other distributors who were under review. 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. At the current sales volumes experienced by our partner company, the minimum order quantity was greater than the economic order quantity for 80% of the products, which resulted in a 25% increase in inventory holding costs.

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[1] HealthCo is the manufacturer with whom we collaborated on this project. The name was changed to maintain the anonymity of the organization, as were the names of all the distributors and pharmacies we worked with.

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1 Introduction

Access to medicines in Southern Africa, which we define as the following countries: Namibia, Botswana, Angola, Mozambique, Zimbabwe, Zambia, Malawi, Madagascar, Mauritius, and Seychelles, poses challenges for the private and public sectors due to economic instability and poor or lacking physical infrastructure. These two factors contribute to price inflation along the supply chain and can hinder distributors and pharmacies from providing high inventory service levels. Our research focuses on these two intertwined yet distinct research areas of the private sector, in partnership with a pharmaceutical company operating in Southern Africa. Throughout this thesis we analyze the following questions: 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 versus outsourcing at varying service levels, and what sales volumes are required to motivate the switch from outsourcing to insourcing?

1.1 Impact of the Logistics Fee on Price to Patient

During March of 2013, our sponsor company, HealthCo introduced a 10% subsidy to wholesalers in Zimbabwe. This was done in order to address the price inflation across the supply chain and attempt to increase sales volume and access to medicines. Wholesalers who chose to participate in this pilot had to agree to a markup ceiling of 115% on prices offered to pharmacies. Our research focused on determining what type of impact this pilot had on the sales volumes at a distributor level and the final price to the patient.

1.2 Outsourcing versus Insourcing in Southern Africa

Our research aims to answer the question of how increasing service levels impact the distribution costs in Southern Africa, and what sales volumes are needed to improve the attractiveness of insourcing versus outsourcing in the private sector. The data provided by our partner company allowed us to perform the analysis needed to answer these questions. In order to provide a clear context for the motivation of methodologies and analyses applied we will provide a brief background description of the relationship between our partner company and its third party logistics provider.

Currently, HealthCo outsources its distribution network in Southern Africa to the Wholesaler, the largest drug company in Africa. HealthCo is also the Wholesaler's fifth largest shareholder. HealthCo and the Wholesaler formed a contract that specifies that the Wholesaler will purchase and distribute medicines in Southern Africa for HealthCo based off of a forecast provided by HealthCo. The Wholesaler subcontracts to the Subcontractor, in Johannesburg, South Africa to warehouse and distribute medicines for HealthCo into Southern Africa. The agreement specifies that HealthCo is to pay the Wholesaler 5.3% of HealthCo's total sales (to distributors) in Southern Africa. This 5.3% represents a 1.5% reimbursement to the Wholesaler for working capital plus a 3.8% reimbursement to the Subcontractor for warehousing and distribution costs. As business is forecasted to grow in Southern Africa, HealthCo needs to determine if the current distribution model will: 1) Provide the necessary capacity required as sales grow in the future, 2) Provide the desired service levels of 95% for non-critical medicines and 99.5% for critical medicines, and 3) Continue to be the best financial option as sales volumes increases.

The collaboration with the Wholesaler was created due to the fact that HealthCo has a larger footprint in Africa than the Wholesaler, with the exception of South Africa. On the other hand, the Wholesaler has a distribution network and established reputation in South Africa, with a desire to expand into the rest of Africa. This collaboration led to HealthCo's decision to outsource to the Wholesaler. The decision to outsource in Africa is one that has been researched, with a focus on outsourcing for the public sector (USAID, 2010). What appears to be a lack of research in the private sector could be attributed to companies maintaining privacy in order to increase competitiveness.

High medicine prices can be attributed to high distribution and warehousing costs, which can make up a substantial portion of a country's medicine budget. Often times, funding for distribution in the public sector is scarce or poorly estimated, which results in higher required margins in order to recover the necessary funds (Babaley, Prashant, Tata, 2011). While the research conducted on the public sector is not directly translatable to the private sector, it gives us an indication of what to anticipate when simulating the warehousing and distribution costs of HealthCo if they are to discontinue the outsourcing of these supply chain functions to the Wholesaler.

The purpose of our research is to provide HealthCo with a tractable model that will estimate warehousing and distribution costs, and also to provide a clear methodology and process that can be utilized by both the private and public sectors in Southern Africa. This could aid the private and public sector in determining break-even prices for medicines, petitioning for accurate funding (for public sector), and performing root cause analysis on functions within the supply chain that may be contributing to high costs.

2 Literature Review

In order to address the first key research question, concerning the increase of efficiency across the supply chain in Zimbabwe that results in price reductions for the patient, we analyzed relevant research which we will discuss below. The relevant research includes: the economic and political landscape in Zimbabwe, the distribution and pricing strategies of generic vs. branded drugs, the approach NGO's have taken to increase access to medicine in developing countries, and the supply chain role that private companies may play in the public sector.

Many of the areas covered in addressing our first key research question were also helpful in addressing the second one, which is whether or not HealthCo should open a distribution center in Southern Africa. In addition, we conducted research into the business and operational challenges that the company would need to address if it decided to open its own distribution center. Relevant research claims that by aggregating demand, forecast accuracy and stock availability will improve. Our research aims to explain why this may be true and understand the costs associated with poor forecast accuracy and varying service levels.

2.1 Economic & Political Landscape of Zimbabwe

Zimbabwe's economy was recently characterized by hyperinflation, which brought HealthCo to leave the country in 2006 and re-enter it in 2010 (Bhatia, Johnson, 2013). According to the Federal Bank Reserve of Dallas, in July 2008 month-to-month inflation had reached 2,600% and in 2009, the country changed their currency to the US dollar (as cited in Bhatia, Johnson, 2013). Currently, businesses in Zimbabwe still have to deal with a high cost of borrowing money (18% to 24% during 2012) and, as a consequence, the payment terms granted by the different actors along the supply chain play a key role in determining those actors' relative profitability and the long-term sustainability of the overall chain. According to Business Monitor International (2013), Zimbabwe will remain one of the least-attractive pharmaceutical and healthcare markets regionally and globally, on account of the elevated political, economic and social risks, as well as the lack of finances for adequate healthcare provision and capacity utilization. In particular, the reimbursements due to the pharmacies registered with the major public medical insurance

provider were subject to delays in 2013 because of the poor state of the public finances, which negatively affected the flow of payments across the entire supply chain.

Within this grim economic context, the prospects of multinational drug companies operating in the country are more promising than those of local manufacturers, given that the government policies over the last few years have favored and encouraged imports, disadvantaging domestic drug-makers. In effect, Zimbabwean pharmaceutical companies have been paying duties on imported raw materials, while imported drugs have been exempted from duties and Value Added Tax (Business Monitor International, 2013).

2.2 Distribution and Pricing Strategies of Generic vs. Branded Drugs

One of the key short-term challenges faced by global pharmaceutical manufacturers is represented by the "patent cliff", which will occur in 2015, when many of their patents will expire, bringing their drugs in competition with those of generics manufacturers. This is expected to have particularly strong consequences in developing countries, due to the generally low income levels and high price sensitivity of the local populations. According to a report by PricewaterhouseCoopers issued in 2010, multinational drug manufacturers are poised to lose $118 billion in revenue across all their subsidiaries. The threat is pushing these firms to develop innovative business models and strategies for reaching new markets (Yap, 2013). In this sense, the development of innovative forms of collaboration between HealthCo and its distributors and pharmacies could provide the company with a strategic competitive advantage.

One of the key challenges in Zimbabwe is related to the distribution of drugs in rural markets and the marketing strategies adopted in those areas, where brand recognition is lower and plays a lesser role in purchasing decisions as compared to urban areas. In this sense, drug manufacturers and distributors may decide to invest in awareness programs and development projects, helping inhabitants of those areas develop a better understanding of the healthcare options available to them. In particular, as the costs for last-mile delivery are often very high, pharmaceutical companies may consider making infrastructure investments in this area with a view to gaining long-term market share.

Accurate demand forecasting is also a determining factor faced by HealthCo in developing countries, including Zimbabwe, due to the lack of infrastructure and communication channels (Yap, 2013). A more accurate forecasting process could help reduce safety stock levels along the chain, and the savings generated could be shared among the different actors.

2.3 High Margins in the Public and Private Sector

Distribution margins in the private sector tend to be high. The cause of these high margins has yet to be unmasked, and "the linkages among retail, wholesale, and manufacturer prices of essential drugs continue to be of considerable interest in the access-to-medicines debate" (Babaley *et al*, 2011). Research points to the lack of sufficient funding for supply chain functions in vertically funded programs as a main contributor to high margins. In order to fund such functions, prices of essential medicines are ultimately raised (Babaley *et al*, 2011). The first step towards reducing the price to the patient is understanding these linkages between the major players in the supply chain; our research will attempt this in order to determine where key cost cutting opportunities exist.

2.4 Role of Non-for-Profit Organizations

According to Yadav, the public sector is able to provide more affordable prices to consumers, its stock out rate is higher due to inefficiencies in distribution and/or lack of infrastructure in more remote areas. On the other hand, the private sector has a lower stock out rate and higher prices due to the fact that mark up on medicine is not regulated at the distributor or pharmacy level (as cited in Bhatia, Johnson, 2013). In the private sector the distributor markup can range from 10-30% and up to 50% at the pharmacy level (Bhatia, Johnson, 2013). Improving efficiency within the supply chain is key in attempts to reduce the cost of medicine to the end consumer while maintaining high product availability.

Supply Chain Management Systems (SCMS) is a non-profit organization with field offices spanning across Southeast Asia, Africa, and Latin America. It has successfully implemented increased availability of commodities at lower costs through various supply chain techniques (Nicholson, English, Guenther, and Claiborne, 2013, p. 80). According to Nicholson et al.

(2013), SCMS and CHAI-UNITAID (another non-profit collaboration) have shown that accurate forecasting and the ability to aggregate demand when placing orders are potential solutions to preventing stock outs and lowering the cost of medicine (p. 84). By aggregating the demand at a brand or country level, the minimum order quantities (MOQ) can be met, thereby reducing lead times and increasing availability. Furthermore, potential discounts could be offered by the manufacturer to the distributor if larger quantity orders are placed. Another strategy for increasing product availability depends on improving forecasting methods. Supplier reliability could be improved by providing an accurate forecast to be utilized in manufacturing planning (Nicholson et al., 2013, p. 102).

Another key component to SCMS's success is the Working Capital Fund. This fund allows distributors to place orders well in advance (to mitigate stock outs) and does not require the distributor to pay the supplier until the medicine is actually delivered. This aids in reducing the cash conversion cycle of distributors, which ranged from zero to 165 days for Zimbabwe distributors (Bhatia, Johnson, 2013, p. 42). This could in turn increase the number of distributors in the market. According to Bhatia and Johnson (2013), decreasing barriers to entry for distributors could potentially decrease the price of medicine to the end consumer (p. 88). In general, increasing the number of distributors increases capacity and could decrease stock outs if inventory is managed efficiently.

3 Methods

The methods section describes the data and formulas that were used to perform the analysis needed to answer both questions stated previously, with the aim that these models can be replicated to aid others with similar goals of improving the supply chain in order to increase access to medicines in critical countries.

3.1 Logistics Fee Implementation and Impact on the Value Chain

In March 2013, HealthCo initiated a pilot project in Zimbabwe to reduce the price to the patient by compensating one of the distributors (Distributor B) with a "logistics fee" that was not included in the mark-up price to their customer. In practice, this was a reimbursement on the part of HealthCo to the distributor, which effectively lowered the price the distributor was charged for by 10% across all product ranges. This mechanism was then extended to the all the other distributors. As a result of the implementation of this fee, HealthCo established a lower suggested price to the final consumer and forecasted a correlated increase in sale volumes.

This section is structured in three parts. In the first one, we describe the type of data that we collected, and the approach we adopted to collect them. In the second part, we briefly discuss the limitations on the data collected that should be taken into account when interpreting the results of our research. Finally, we outline the methodology followed to analyze the data collected in order to quantify the impact that the logistics fee has had on the prices charged by the Wholesaler, the distributors and the pharmacies, as well as on their margins and sales volumes.

3.1.1 The Sources Used for Data Collection

The data collection relied upon three different sources. The first source is the semi-structured interviews with distributors and pharmacists we performed during a visit to Zimbabwe in December 2013. The second source of data comes from market research and a set of related mystery shopping visits that our partner company had commissioned in order to collect information on the prices charged to final consumers for certain medicines; as well as to assess the overall effectiveness of the distribution model in Zimbabwe. The third source is the

company's logistics and sales departments, which shared with us historical data on prices, volumes and sales by distributor.

Source One - Interviews with Distributors and Pharmacists

The questionnaire

In order to effectively carry out a series of interviews with distributors and pharmacists during the course of our stay in Zimbabwe, we compiled a questionnaire to be used as a guide during our in-person interviews. In order to compile this questionnaire, we drew inspiration from a set of questions that had been used for a market research carried out in another developing country for similar reasons to ours and tailored these questions to our specific needs (Yadav, Smith, Alphs, 2012).

In particular, we structured our questioning around two key areas:

- The effectiveness of the logistics fee implementation and whether there were any relevant differences in its implementation between pharmacies owned and managed by distributors as compared to independent pharmacies.
- The stock management procedures adopted by distributors and by pharmacies. Gaining an understanding over whether stock was managed effectively at pharmacy and distributor level was relevant in order for us to assess whether cost saving opportunities or improvements in terms of the availability of medicines existed in this area, which could have led to a further reduction in prices to the final consumer.

Exclusively for our interview with pharmacies, our set of questions covered three additional topics:

- General business information (i.e. challenges faced by the business, access to capital, etc.). Assessing the business settings of the different pharmacies was necessary in order to gauge whether or not they operated in line with the local standards, and to evaluate whether the data collected should have accounted for special business circumstances.
- The credit and payment terms, with a view to assessing whether the current terms ensured smooth operations for the pharmacy, and whether a potential change in the terms could have brought any potential benefits.

- The revenue and cost structure: Revenues and margins of pharmacies were collected so that we could determine how changes in medicine prices and sale volumes would impact the pharmacy's profitability.

In summary, in addition to gathering specific data on sale volumes and prices, we tried to gain 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

The next step was to select a stratified sample of distributors and pharmacies to capture various aspects of their businesses. The approach we adopted was to classify them in four categories based upon two criteria: population density and level of income. We then visited pharmacies belonging to all four segments (i.e. low density/ low income level areas, low density/ high income level, high density/ low income and high density/ high income). We believe that this approach allowed us to capture the purchasing trends of the main categories of the population living in and around the capital city of Zimbabwe, Harare. A total of 17 pharmacies were visited either by us or by an employee of our partner company. Note that, with regard to the distributors, we were able to arrange interviews with all the distributors for HealthCo (i.e. Distributor B, Distributor A, Distributor D, Distributor C and Distributor E).

Source Two - The Market Research

The objective of the data collection carried out by our partner company was similar yet narrower than ours. Their interest mainly laid in assessing whether prices had changed before and after the implementation of the logistics fee, and whether this measure had resulted in an increase to their medicines' competitiveness relative to the generics available on the market.

The company collected data related to prices for the four top selling product lines in Zimbabwe, i.e. MED1, MED2, MED3 and MED4. These four product categories were selected - other than for the fact of being top-sellers and for having a high strategic relevance within the company's product range - due to the fact that they were distributed to most pharmacies within the country.

Source Three - Data provided by the Logistics and Sales Departments

The logistics and sales departments in South Africa provided us with sales volumes and values over 2012 and 2013, split by distributors and by product.

3.1.2 Data Limitations

It is important that we mention the data limitations that we faced in the performance of our analyses. The results from our research are to be reviewed and interpreted by taking these limitations into account.

In-market Sales Data

- Two out of the five distributors visited (Distributor A and Distributor B) shared their price lists as well as their in-market sales (i.e. sales to pharmacies), whereas it was not possible to collect this information from the other distributors.
- This gap was partially filled by data that our partner company itself provided us with, i.e. in-market sales were obtained for 2013 but not for 2012, limiting our ability to draw comparisons between different years.

Sales from Pharmacy to Final Consumer

- In terms of how volumes changed before and after the implementation of the logistics fee, only limited data related to a handful of products and a limited time period could be collected.
- In terms of prices charged by pharmacies before and after the implementation of the logistics fee, we often had to rely on the pharmacist's word and were not able to double check the figures in the system. Also, this data could not be collected in all pharmacies visited.

3.1.3 The Analyses Performed

Value Chain Analysis

First, we defined and quantified 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.

In our analyses, we relied on data that provided us with sales data to the final consumer (Distributor A and Distributor B, accounting for 42% of sales performed by the Wholesaler in Zimbabwe in 2013). In particular, we performed a "value chain analysis", i.e. we tracked the mark-ups applied by the different actors) on their top-five selling SKUs.

The Supply Chain for Medicines

The distribution of medicines into Zimbabwe in relation to our partner company works as follows: all the medicines sold in Zimbabwe are first imported into South Africa - either from the port of Durban or from Cape Town - from sixteen different supplier locations they are shipped to Imperial Health Services, which, as described in section 1.2, is used by the Wholesaler to store and to distribute medicines into the Southern Africa region. The Wholesaler then sells the medicines to the distributors of the Southern African countries. The Zimbabwean distributors sell, in turn, to pharmacies, which then provide consumers with the final product.

In order to quantify the mark-ups and margins that are pocketed along the chain by the different actors, we compared the following prices for the above-mentioned top-selling SKUs:

- Ex-works price (i.e. the cost of production and of distribution for the medicine), which, will refer to as P_{EW}.
- Price charged by the Wholesaler to the distributors, which we defined as price wholesaler P_W.
- Price charged by the distributors to the pharmacies, which we define as price distributor P_D.
- Prices charged by pharmacies to the final consumers, which we define as price pharmacy P_F.

We derived the mark-up that HealthCo applies to the ex-works price by comparing the price P_w with P_{EW}. Note that HealthCo receives this mark-up in full since the Wholesaler purchases and sells medicines at price P_W to the distributors. Both the Wholesaler's and the Subcontractor's only income is a combined 5.3% commission on sales to distributors in Southern Africa. Similarly, we derived the mark-up that the distributors add by comparing P_D with P_w. Finally, we derived the mark-up and margins for pharmacies by comparing P_F with P_D.

This set of price comparisons was performed for two periods: before the implementation of the logistics fee (from January 2012 to March 2013) and after (from March to December 2013).

Sales Volume Review

Second, we determined how sales volumes at the Wholesaler and the distributor level where affected by the implementation of the logistics fee. In order to gain the most insight, we performed different types of reviews:

- Sale volumes per month by product, for the top-selling SKUs over a two-year period.
- Sale volumes per month by distributor.
- Sale volumes per month by distributor and by SKU, for the top selling SKUs.

Pharmacies Profit & Loss Review

Finally, we looked at the sales and profitability related to pharmacies we visited, and discussed how they would be impacted by a new change in prices and volumes.

3.2 Development of the Insourcing Decision Model

In order to determine if a shift in the distribution model for HealthCo from outsourcing to insourcing proves feasible, we developed an Excel-based model that allowed us to simulate inventory, transportation, and warehousing costs. This model assumes an economic order quantity (EOQ) for the A-SKUs in Southern Africa (defined as the top 20% of SKUs that make up 80% of the total sales in Southern Africa), order quantity (MOQ) required by the manufacturer as needed. The following methodology was applied to 71 A-SKUs in total. These SKUs were chosen to model due to the fact that a forecast is created for these products by HealthCo, which allowed us to calculate safety stock using more sophisticated methods described below.

The model uses Monte Carlo simulation via @Risk software to understand how these costs would change if sales volume were to continue to grow. The simulation software allows us to apply a lognormal distribution to the demand of the A-SKUs, which best represents the demand distribution of these 71 SKUs. In order to simulate future volume per A-SKU, we applied a percentage of the total future, simulated demand to each SKU based on the historical percent to

total demand. The objective function used in the simulation was the difference between the projected insourcing distribution costs and the current costs of utilizing the Wholesaler as a third party distributor. Therefore, should the objective function be less than zero, it is more favorable to insource the distribution function.

The assumptions, data, and methods described below were applied to create a model that would closely represent inventory levels and warehouse costs of a distribution center located in Lusaka, Zambia, since this is the most likely location of the distribution center by HealthCo if the shift to insourcing is made.

3.2.1 Data Descriptions and Assumptions

The data used for the model were provided by HealthCo and the Subcontractor. All sales data and SKU information pertain to Southern Africa. Sales data from January through September 2013 was used to determine an average annual demand per SKU. All formulas discussed below will reference the annual demand as *D*.

Forecast data for 2013 per SKU was used to determine forecast accuracy and excess inventory holding costs that would be accrued due to over forecasting. The HealthCo-the Wholesaler contract states that if HealthCo presents the Wholesaler with an inflated forecast, additional charges may be applied; however, HealthCo states that this has not happened in the past.

Air and ocean rates from all manufacturing supplier sites were used to determine an average rate by logistics service provider by mode of transportation for each supplier site. This file included multiple rates/invoices for each supplier site. The data were cleaned to exclude any irrelevant information. A variable and fixed rate was calculated for each supplier site. The variable rate consists of a base rate, an accessorial variable charge, and a fuel factor mechanism charge (all per container for ocean freight and kilogram for air freight). Only the standard rates were averaged for each mode type (i.e., excluded direct or express rates) and only rates for 40-foot containers for ocean freight were used since this is historically the container size that HealthCo uses. Tables 1 and 2 below represent the final data after it was cleaned and the steps outlined above were performed. UK rates were applied to SKUs with no supplier site information. The

road rates from Durban, Capetown, and Johannesburg to Lusaka were then added to the rates with Durban or Capetown destination ports. Lead times by supplier site to Johannesburg were also provided and used to determine safety stock and pipeline inventory levels per SKU. The Subcontractor provided us with air, ocean, and road rates and lead times from Asia and Europe to Lusaka, Zambia.

In addition to the above data, unit costs (a.k.a. ex-works price), prices (sell price to the Wholesaler), product dimensions and weight, number of units per pallet, and minimum order quantity per SKU were also provided.

Table 1: Average Air Rates by Supplier Site

*Rates in GBP		JOHANNESBURG		CAPE TOWN		Durban			
Country	MODE	Avg Variable	Avg Fixed	Avg Variable	Avg Fixed	Avg Variable	Avg Fixed	Variable UOM	Fixed UOM
Australia	AIR	2.48	39.78	2.13	43.89	0.00	0.00	kg	Shipment
Belgium	AIR	1.91	10.38	1.87	17.02	0.00	0.00	kg	Shipment
Canada	AIR	2.18	14.78	0.00	0.00	0.00	0.00	kg	Shipment
China	AIR	3.48	28.77	3.40	30.90	0.00	0.00	kg	Shipment
France	AIR	1.94	29.05	2.12	35.79	0.00	0.00	kg	Shipment
Germany	AIR	2.07	10.89	2.04	15.62	0.00	0.00	kg	Shipment
Ireland	AIR	1.70	20.75	1.73	31.08	0.00	0.00	kg	Shipment
Italy	AIR	3.18	37.67	3.05	42.33	0.00	0.00	kg	Shipment
Philippines	AIR	1.46	12.20	2.64	57.95	0.00	0.00	kg	Shipment
Poland	AIR	2.46	33.20	2.39	74.53	0.00	0.00	kg	Shipment
Singapore	AIR	3.05	16.66	3.29	18.49	0.00	0.00	kg	Shipment
Spain	AIR	1.93	52.43	0.00	0.00	0.00	0.00	kg	Shipment
Switzerland	AIR	2.90	17.28	2.41	64.35	0.00	0.00	kg	Shipment
UK	AIR	1.51	6.50	1.38	6.07	0.00	0.00	kg	Shipment

Table 2: Average Ocean Rates by Supplier Site

*Rates in GBP		JOHANNESBURG		CAPE TOWN		Durban			
Country	MODE	Avg Variable	Avg Fixed	Avg Variable	Avg Fixed	Avg Variable	Avg Fixed	Variable UOM	Fixed UOM
Belgium	OCEAN FCL	0.00	0.00	2648.64	54.76	0.00	0.00	Container	Shipment
Canada	OCEAN FCL	0.00	0.00	4411.89	46.06	0.00	0.00	Container	Shipment
China	OCEAN FCL	0.00	0.00	2378.51	54.60	0.00	0.00	Container	Shipment
Netherlands	OCEAN FCL	2465.39	53.95	0.00	0.00	0.00	0.00	Container	Shipment
France	OCEAN FCL	0.00	0.00	3146.31	82.72	3161.39	81.15	Container	Shipment
Germany	OCEAN FCL	0.00	0.00	2712.34	18.68	2859.83	0.00	Container	Shipment
Ireland	OCEAN FCL	0.00	0.00	2739.29	49.80	2493.13	78.26	Container	Shipment
Italy	OCEAN FCL	0.00	0.00	3667.34	120.35	3862.14	100.70	Container	Shipment
Singapore	OCEAN FCL	0.00	0.00	0.00	0.00	2456.96	77.19	Container	Shipment
Spain	OCEAN FCL	0.00	0.00	0.00	0.00	2214.01	91.30	Container	Shipment
Switzerland	OCEAN FCL	4203.41	73.04	0.00	0.00	2960.65	70.60	Container	Shipment
UK	OCEAN FCL	2338.68	30.00	2432.57	37.50	2522.22	35.00	Container	Shipment

3.2.2 Economic Order Quantity, Inventory, and Transportation Cost Formulation

This section explains the formulations and assumptions that were used to create the distribution cost model and simulation.

The following assumptions were established through discussions with our partner company and were used when creating the model:

- No charges applied from third party distributor to HealthCo for inflated forecasts
- Current charges from third party distributor are equal to 5.3% of total HealthCo sales of Southern Africa
- No penalties or charges applied for under forecasting (i.e., potential lost sales, expedited shipping charges, etc.)
- Annual Holding Cost equals 20% (WACC + Non-Capital Costs = 7% + 13%)

3.2.3 Applied Inventory Policies

Equation 1 was applied to determine the optimal ordering quantity per SKU for all A-SKUs. This policy is appropriate when demand is deterministic or highly stable. The SKUs classified as A-SKUs are high velocity medicines with a stable demand pattern, which makes them candidates for applying EOQ to determine the optimal ordering quantity. The A-SKUs collectively have an average coefficient of variation equal to one, based on monthly sales during 2013.

$$\text{EOQ (optimal order quantity) or } Q^* = \sqrt{\frac{2 * Ct * D}{Ce}} \qquad (1)$$

Where C_t = transaction cost (cost/order or shipment), C_e = excess inventory cost (Annual Holding Cost*C, where C = unit cost per SKU or ex-works price), and D = annual demand. For our model, C_t was estimated by taking the average salary of an employee within the Subcontractor's Export Department, of 30,000 ZAR, multiplied by three; the estimated number of employees needed to manage the ordering process. This total was then divided by 3,180; the total number of orders currently processes by the Wholesaler for HealthCo in 2013.

The model calculates the total transportation costs and then chooses the cheapest available mode of transportation by supplier site. In order to calculate transportation costs, we applied the "Power of Two" policy to aggregate SKUs into multiple orders per supplier site. This policy guarantees that the costs will still be within 6% of the optimal, minimized cost determined by the EOQ. Equation 2 and 3 were calculated for each SKU respectively, and SKUs with the same $T_{practical}$ (Caplice, 2013) were grouped together when placing orders by supplier site. For

simplification purposes, we used the weighted average of $T_{practical}$ by supplier site based on annual demand as a percentage of the total demand.

$$T^* = Q^*/D \tag{2}$$

$$T_{practical} = 2^{\frac{\ln\left(\frac{T^*}{\sqrt{2}}\right)}{\ln(2)}} \tag{3}$$

3.2.4 Inventory Holding Costs and Warehousing Costs

Other formulations and costs considered in the model include the inventory holding costs and warehousing costs.

Inventory Holding Costs

$$\text{Inventory Holding Cost/SKU } (HC_i) = \text{Average Inventory} * C_e \tag{4}$$

$$\text{Average Inventory} = \text{Average Cycle Stock} + \text{In-transit inventory} + \text{Safety Stock} \tag{5}$$

$$\text{Average Cycle Stock} = Q^*/2 \tag{6}$$

$$\text{Safety Stock} = \text{RMSE (monthly)} * \sqrt{12} * k \tag{7}$$

Where k refers to the normal inverse of the desired service level. For SKUs that were not forecasted (28 out of the 71 A-SKUs), a safety stock equivalent to one month's worth of demand was applied. The root-mean-square error (RMSE) represents the standard deviation of the forecasted demand to the actual demand.

$$\text{RMSE} = \frac{\sqrt{\sum_{i=1}^{12} monthly\ forecast\ error}}{n} \tag{8}$$

$$\text{In-transit inventory/SKU} = \text{Average monthly demand} * \text{Lead time} \tag{9}$$

$$\text{Inventory Holding Costs} = \sum_{i=1}^{n} HC_i \text{, where } i \text{ represents each individual SKU } \{1, n\} \quad (10)$$

Warehousing Costs

The warehousing costs include labor and the cost of Warehouse-in-a-Box™, which is a warehousing solution provided the Subcontractor in conjunction with SCMS. The Warehouse-in-a-Box™ solution for a 500 m^2 warehouse is $900,000, which includes the following one-time costs (SCMS, n.d.):

- 1 x 500 m^2 warehouse with 77 m^2 offices and ablution facilities
- Inclusive: civil preparation, electrics, plumbing, erecting and installation of all equipment
- such as:
- Air conditioners for offices and warehouse
- Racking – approximately 650 pallets
- CCTV and digital recording equipment
- Generator suitable for the size of the facility
- Firefighting equipment
- Material handling equipment consisting of a 4.5m forklift, manual pallet jacks and dock leveler.
- Office furniture
- 3 weeks training in Warehouse practices and procedures.

Variable costs were allocated to activities via a cost matrix provided by the Subcontractor. The inputs stated below were used to determine variable costs by activity as a percent of sales.

Inputs:

- Orders per month = 265
- Weighted average of units per pallet (to total order quantities) = 2750
- Weighted average of months of demand on hand = 3-4 months

Outputs:

Table3: Breakdown of Warehousing Costs by Activity

Activity:	**Low**	**High**
Order processing and management	0.28%	0.34%
Receiving stock onto the ERP system and put away	0.46%	0.55%
Pick, pack dispatch and transport management	0.64%	0.77%

The high estimate percentages were used to calculate warehousing costs in the model in order to establish a "worst case scenario" baseline.

Once the model was created and all of the above calculations were performed, @Risk was used to vary the sales volume in order to determine how the volume impacts the total distribution costs. Current costs of outsourcing are equivalent to 5.3% of total Sales in Southern Africa. These costs were then compared to the total distribution costs of insourcing at different sales volumes.

4 Results

Section 4.1 focuses on the price inflation throughout the supply chain and how the logistics fee implementation impacted sales volumes. Section 4.2 focuses on the cost differences between insourcing and outsourcing medicine distribution, and the level of sales that causes insourcing to become a more attractive option.

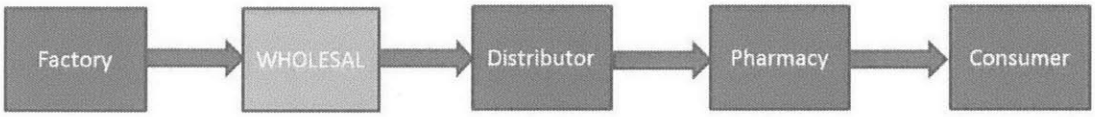
4.1 Logistics Fee Implementation

In this section we focused on providing answers to three major questions:

1. How have prices and margins changed for the different players along the value chain following the implementation of the logistics fee?

4.1.1 The Wholesaler Mark-up Pre and Post Logistics Fee Implementation

This section focuses on the mark-up applied by the Wholesaler to the different distributors.



For the sake of comparison, all the costs/ prices were translated in US dollars, the currency currently in use in Zimbabwe. For the sake of illustration purposes and simplicity, we focused on the sales performed by the Wholesaler to a particular distributor, accounting for 15% of total sales by the Wholesaler in 2013, given that the prices applied by the Wholesaler to all the distributors are the same. In particular, we looked at the costs and prices related to the five top-selling SKUs for this distributor.

The two tables below display the margins deriving from the difference between P_w (selling price from the Wholesaler to the distributors) and P_{EW} (ex-works price) before and after the implementation of the logistics fee.

Table 4: The Wholesaler Mark-up

Top-5 Sellers (over '12 and '13) - Wholesaler Mark-Up - Before March 2013					
Item Num	Item	Factories to Wholes.	Wholesaler to Distr.A		
		P_{EW}	P_w	Margin	Mark-Up
11	MED1-SKU1	3.7	8.7	57%	135%
12	MED1-SKU2	2.3	4.7	52%	110%
31	MED3-SKU1	2.7	2.7	1%	1%
13	MED1-SKU3	2.4	11.3	79%	370%
21	MED2-SKU1	1.4	6.5	78%	356%

**Prices are expressed in USD*

Top-5 Sellers (over '12 and '13) - Wholesaler Mark-Up - Apr to Dec 2013					
Item Num	Item	Factories to Wholes.	Wholesaler to Distr.A		
		P_{EW}	P_w	Margin	Mark-Up
11	MED1-SKU1	3.7	7.8	53%	111%
12	MED1-SKU2	2.3	4.2	47%	87%
31	MED3-SKU1	2.7	2.4	-10%	-9%
13	MED1-SKU3	2.4	10.2	76%	323%
21	MED2-SKU1	1.4	5.8	75%	307%

**Prices are expressed in USD*

We can observe the following:

1. Margins (and mark-ups) differ greatly from SKU to SKU.
   MED3-SKU1 represents an exception in that it appears that no mark-up is applied to its P_{EW}.
2. Average mark-ups (excluding MED3-SKU1) before the logistics fee were in the order of 243%; after the logistics fee, they decreased to 207%. To be noted that this is a straight average (i.e. not weighted for the sales of each product during the year).

The table below summarizes how prices, margins and mark-ups changed following the implementation of the logistics fee.

Table 5: The Wholesaler - Percentage Changes to Prices & Margins

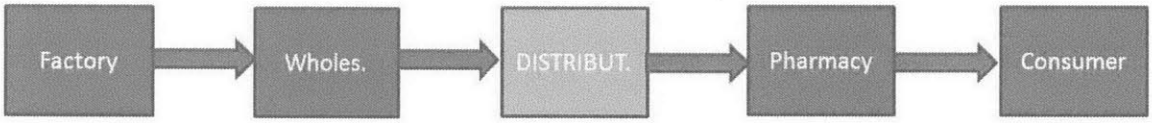
Top-5 Sellers (over '12 and '13) - Percentage Changes to Prices & Margins					
Item Num	Item	Wholesaler to Distr.A			
		(P_W-P_{EW})		Margin	Mark-Up
11	MED1-SKU1	-0.9	-10%	-5%	-24%
12	MED1-SKU2	-0.5	-11%	-6%	-23%
31	MED3-SKU1	-0.3	-10%	-11%	-10%
13	MED1-SKU3	-1.1	-10%	-2%	-47%
21	MED2-SKU1	-0.7	-11%	-3%	-48%

**Prices are expressed in USD*

In line with our prior observation, we can calculate that the average mark-up decreased by approximately 30%. We can also observe that prices decreased by approximately 10%, which is a confirmation that the logistics fee was correctly implemented.

4.1.2 Distributor Mark-up Pre and Post Logistics Fee Implementation

This section focuses on the mark-up applied by the distributors to the pharmacies.



For this part of analysis we focused on two different distributors: Distributor A (accounting for 15% of total sales in 2013) and Distributor B (accounting for 27% of total the Wholesaler sales in 2013), and on their top-5 selling SKUs.

Distributor B

The two tables below display prices, margins and mark-up related to sales from Distributor B to pharmacies for its top-five selling SKUs. Note that only four of the five SKUs are the same as those used to illustrate the mark-up added by the Wholesaler. These calculations are derived from the difference between P_D and P_W.

Table 6: Distributor B Mark-up

Top-5 Sellers (over '12 and '13) - Distributor B Mark-Up - Before March 2013					
Item Num	Item	Wholesaler to Distr.B	Distr.B to Pharmacies		
		P_W	P_F	Margin	Mark-Up
11	MED1-SKU1	8.7	14.0	38%	61%
12	MED1-SKU2	4.7	7.3	35%	54%
41	MED4-SKU1	1.5	2.9	49%	97%
13	MED1-SKU3	11.3	17.5	35%	55%
21	MED2-SKU1	6.5	13.0	50%	101%

**Prices are expressed in USD*

Top-5 Sellers (over '12 and '13) - Distributor B Mark-Up - Apr to Dec 2013					
Item Num	Item	Wholesaler to Distr.B	Distr.B to Pharmacies		
		P_W	P_F	Margin	Mark-up
11	MED1-SKU1	7.9	13.5	42%	72%
12	MED1-SKU2	4.2	7.2	41%	70%
41	MED4-SKU1	1.4	2.9	53%	111%
13	MED1-SKU3	10.2	17	40%	67%
21	MED2-SKU1	5.8	10.5	45%	81%

**Prices are expressed in USD*

We can notice that margins and mark-ups, with the exception of MED2-SKU1, slightly increased for Distributor B after the implementation of the logistics fee. This shows that Distributor B lowered its prices to pharmacies relatively less than what the Wholesaler did, which is apparent if we look at the table below, which summarizes how prices, margins and mark-ups changed following the implementation of the logistics fee.

Table 7: Distributor B - Percentage Changes to Prices & Margins

Top-5 Sellers (over '12 and '13) - Percentage Changes to Prices & Margins					
Item Num	Item	Distributor B to Pharmacies			
		(P_F - P_W)		Margin	Mark-up
11	MED1-SKU1	-0.5	-4%	4%	11%
12	MED1-SKU2	-0.05	-1%	6%	16%
41	MED4-SKU1	0	0%	3%	14%
13	MED1-SKU3	-0.5	-3%	5%	12%
21	MED2-SKU1	-2.5	-19%	-6%	-21%

**Prices are expressed in USD*

Distributor A

The same information concerning prices, margins and mark-ups from Distributor A to pharmacies is displayed below:

Table 8: Distributor A Mark-up

Top-5 Sellers (over '12 and '13) - Distributor A Mark-Up - Before March 2013					
Item Num	Item	Wholesaler to Distr.A	Distr.A to Pharmacies		
		P_W	P_F	Margin	Mark-Up
11	MED1-SKU1	8.7	18.0	52%	106%
12	MED1-SKU2	4.7	9.8	52%	108%
31	MED3-SKU1	2.7	5.7	52%	108%
13	MED1-SKU3	11.3	22.0	49%	94%
21	MED2-SKU1	6.5	14.5	55%	124%

**Prices are expressed in USD*

Top-5 Sellers (over '12 and '13) - Distributor A Mark-Up - Apr to Dec 2013					
Item Num	Item	Wholesaler to Distr.A	Distr.A to Pharmacies		
		P_W	P_F	Margin	Mark-Up
11	MED1-SKU1	7.8	13.91	44%	78%
12	MED1-SKU2	4.2	7.52	44%	79%
31	MED3-SKU1	2.4	4.49	46%	84%
13	MED1-SKU3	10.2	17.96	43%	77%
21	MED2-SKU1	5.8	10.32	44%	79%

**Prices are expressed in USD*

We notice that margins and mark-ups decreased across the board. In particular, margins went down from an average 52% to an average 44%, and mark-ups went down from an average 108% to an average 79%. This can also be seen from the following table.

Table 9: Distributor A - Percentage Changes to Prices & Margins

Top-5 Sellers (over '12 and '13) - Percentage Changes to Prices & Margins					
Item Num	Item	Distributor A to Pharmacies			
		(P_F - P_W)		Margin	Mark-Up
11	MED1-SKU1	-0.9	-10%	-5%	-24%
12	MED1-SKU2	-0.5	-11%	-6%	-23%
31	MED3-SKU1	-0.3	-10%	-11%	-10%
13	MED1-SKU3	-1.1	-10%	-2%	-47%
21	MED2-SKU1	-0.7	-11%	-3%	-48%

**Prices are expressed in USD*

Logistics Fee Implementation - Comparison between Distributor A and Distributor B

The analysis of these two distributors can be generalized by saying that distributors did not decrease prices by the same percentages following the implementation of the logistics fee. Whereas Distributor A seems to have reduced prices by the same percentage amount as the logistics fee (i.e. approximately 10%), the price decreases implemented by Distributor B averaged 5%. It is important to underline that Distributor B's prices before the implementation of the logistics fee were lower than those charged by Distributor A, and that after the implementation they are still slightly lower (as it can be seen by comparing the tables in the Distributor B section with those in the Distributor A section). Given the initial lower prices, Distributor B did not need to pass the full price decrease received from the Wholesaler to the pharmacies in order to continue charging prices which are in line with those charged by the competitors (slightly lower).

Overall, the logistics fee succeeded in better aligning the price structures of these two distributors.

4.1.3 Pharmacy Mark-up Pre and Post Logistics Fee Implementation

This section analyzes the margins and mark-up applied by pharmacies, and the extent to which they have lowered the prices for the final consumer following the implementation of the logistics fee.

We went about quantifying this impact in two ways.

Pharmacy Margins

First we focused on how margins (and mark-ups) changed at pharmacy level following the implementation of the logistics fee. In order to do this, we compared the cost to pharmacies of the five top sellers for Distributor A with the price that pharmacies charged to the final consumers for three of the SKUs.

In reviewing the results of this analysis, we have to account for the following limitations:

1. Each distributor used to charge slightly different prices for the same SKU before the logistics fee, and each distributor implemented the logistics fee to a different extent (as we have just seen with the example of Distributor A and Distributor B).
2. The prices charged by pharmacies for these SKUs are an average of the prices observed out of a sample of seventeen pharmacies.

Thus, using Distributor A to derive the cost that pharmacies used to pay (before the fee) and have been paying (after the fee) is only a generalization for a collection of different situations, but indeed helps us gain a high-level understanding of how prices and margins have been changing at a pharmacy level. Also, Distributor A passed on the 10% decrease in prices to pharmacies, and so is representative of an ideal situation whereby the distributor fully implemented the logistics fee.

Table 10: Pharmacy Mark-up

Top-5 Sellers (over '12 and '13) - Pharmacy Mark-Up - Before March 2013					
Item Num	Item	Distr.A to Pharmacy	Pharmacy to Consumer		
		P_D	P_F	Margin	Mark-Up
31	MED3-SKU1	5.7	10.4	45%	83%
13	MED1-SKU3	22.0	42.6	48%	94%
21	MED2-SKU1	14.5	24.9	42%	72%

**Prices are expressed in USD*

Top-5 Sellers (over '12 and '13) -Pharmacy Mark-Up - Apr to Dec 2013					
Item Num	Item	Distr.A to Pharmacy	Pharmacy to Consumer		
		P_D	P_F	Margin	Mark-Up
31	MED3-SKU1	4.5	8.9	50%	98%
13	MED1-SKU3	18.0	31.1	42%	73%
21	MED2-SKU1	10.3	18.2	43%	76%

**Prices are expressed in USD*

The following table summarizes how prices, margins and mark-ups changed at a pharmacy level following the implementation of the logistics fee.

Table 11: Pharmacy - Percentage Changes to Prices & Margins

Top-5 Sellers (over '12 and '13) - Percentage Changes to Prices & Margins					
Item Num	Item	Pharmacy to Consumer			
		(P_F-P_D)		Margin	Mark-Up
31	MED3-SKU1	-1.5	-14%	15%	4%
13	MED1-SKU3	-11.5	-27%	-21%	-6%
21	MED2-SKU1	-6.7	-27%	4%	1%

**Prices are expressed in USD*

We notice that pharmacies lowered the prices more than 10%, thus passing the full price reduction to the final consumers. Margins and mark-ups slightly increased for two out of the three SKUs, but this can be explained by the fact that pharmacies usually round-off prices to the nearest dollar). In general, pharmacies maintained margins of about 50%.

Pharmacy Prices

The second type of analysis that we performed looks at how prices for the four top-selling product lines in Zimbabwe (i.e. MED1, MED2, MED3 and MED4) changed across a set of

seventeen pharmacies. The current prices for the corresponding generic products were also collected.

The results are summarized in the following table.

Table 12: Pharmacy - Average Prices Pre & Post Logistics Fee

Average Prices Pre and Post Logistics Fee Across Four Top-Selling Product Lines															
MED1				MED2				MED3				MED4			
Pre	Post	(%)	Gen	Pre	Post	(%)	Gen	Pre	Post	(%)	Gen	Pre	Post	(%)	Gen
42.6	31.1	**-27%**	n/a	24.9	18.2	**-27%**	13.0	10.4	8.9	**-15%**	8.7	8.0	5.5	**-32%**	5.6

**Prices are expressed in USD*

The key observation here is that, whereas for MED2 the price differential with the generic alternative is still relevant, for MED3 and MED4, the prices of the branded versus the generic alternatives became very close to one another after the implementation of the logistics fee.

Price Changes by Main Distributor

Finally, we looked at how pharmacies purchasing most of their supplies from a specific distributor lowered the prices more or less relative to pharmacies performing most of their purchases from a different distributor each time they place an order. We could perform this analysis thanks to the fact that each of the pharmacy visited indicated the "main distributor" they were trading with.

The table below shows how prices have decreased with pharmacies classified based on their main distributor.

Table 13: Pharmacy - Average Prices Pre and Post Logistics Fee by Distributor

Pharmacy - Average Prices Pre and Post Logistics Fee By Main Distributor												
Distributor	MED1			MED2			MED3			MED4		
	Pre	Post	(%)	Pre	Post	(%)	Pre	Post	(%)	Pre	Post	(%)
C	40.7	29.6	-27%	22.0	15.8	-28%	8.7	9.3	7%	8.0	6.0	-25%
A	47.5	28.8	-39%	28.5	17.0	-40%	8.0	9.0	13%	7.5	5.0	-33%
E	40.0	31.5	-21%	28.0	19.3	-31%	11.0	8.1	-26%	8.5	4.9	-43%
D	41.3	31.8	-23%	22.0	19.8	-10%	11.8	9.8	-17%	7.8	5.8	-26%
B	50.0	35.5	-29%	27.0	24.0	-11%	10.0	8.5	-15%	8.0	6.5	-19%

**Prices are expressed in USD*

Pharmacies with Distributor A as their main supplier lowered the prices the most for MED1 and MED2, whereas pharmacies having Distributor E as their main supplier decreased prices the

most for MED3 and MED4. We can thus conclude that the retail price reduction applied by the pharmacies was a reflection of the pricing applied by the distributor.

The limitations related to this data to note: information on prices pre and post the implementation of the logistic fee could not be obtained for all pharmacies, providing us with a limited data sample. Nonetheless, the trends we pointed out should be held as valid.

2. How have volumes changed along the value chain following the implementation of the logistics fee?

As outlined in the methodology section, the approach that we followed to quantify the change in volumes has been twofold. We first reviewed sales from the Wholesaler to the different distributors, and we then reviewed sales from the distributors to the pharmacies.

4.1.4 Sales from the Wholesaler to the Distributors

A review of how aggregate volumes for all the five distributors changed before and after March 2013 did not provide any meaningful insight. The below graph summarizes the monthly sales which have been performed by the Wholesaler from January 2012 to December 2013. No specific trend can be easily detected. It is important to point out that towards the end of 2013 a number of distributors had their accounts placed on hold because of delays in reimbursement by the major medical aid provider to pharmacies. In particular, Distributor A had their account on hold from November 2013 to March 2014, Distributor B from December 2013 to February 2014, and Distributor E had their account on hold for brief periods intermittently. This in turn caused a delay in payments owed by the pharmacies to distributors and by the distributors to the Wholesaler. These account holds impacted the sales volume seen below.

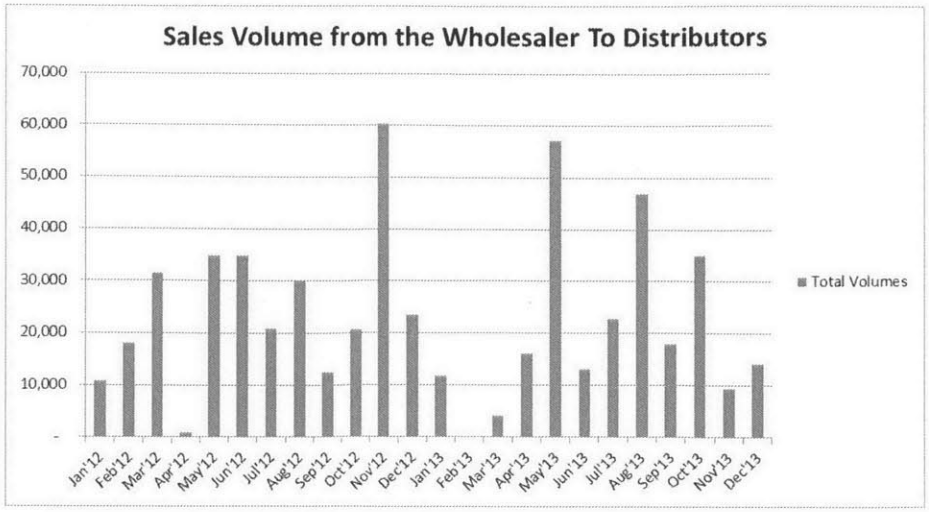
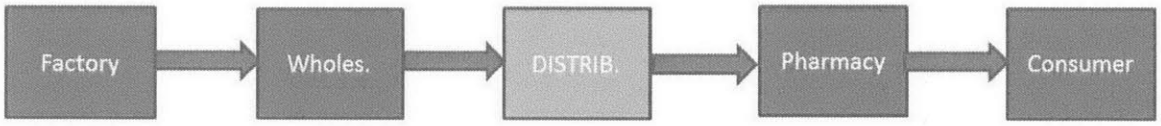


Figure 1: Sales Volume from the Wholesaler to Distributor

Review by product - A more detailed review for the trend of monthly sales volume across 2012 and 2013 for the top five sellers did not make any specific trend apparent either.

4.1.5 Distributors Purchases from the Wholesaler and Sales to Pharmacies

Next, we performed an analysis by distributor. In particular, we looked at how volume purchases varied across 2012 and 2013 for the top-four distributors (Distributor B, Distributor A, Distributor C and Distributor D).



The only two distributors for which a clear pattern was detectable were Distributor B and Distributor D, whereas for Distributor A and Distributor C the data did not show any specific trend. Note that, for all of the distributors, we were not able to obtain data related to distributors' sales to pharmacies for 2012.

Distributor B

From the graph below, we notice that a clear increase in purchases (to the Wholesaler) took place from March 2013 as compared to the same period on the same year. Sales-wise, an increase can be observed in the month immediately following March 2013.

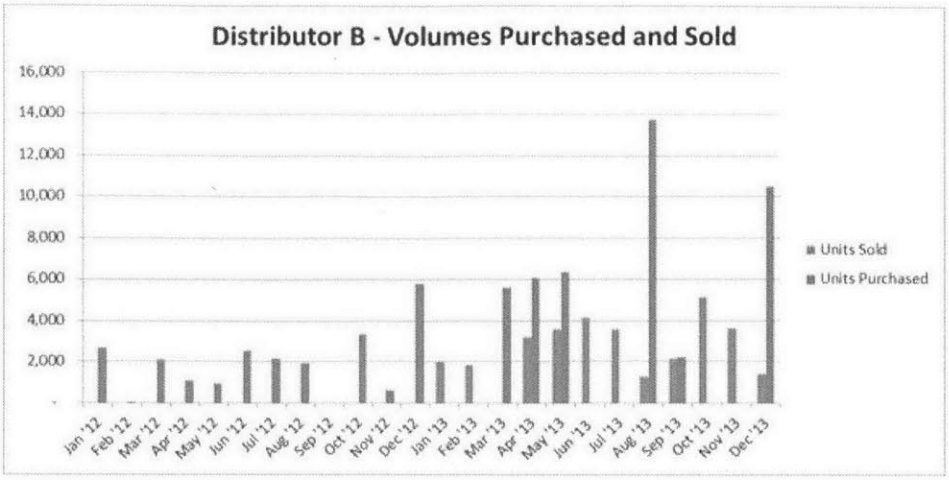


Figure 2: Distributor B - Volume Purchased vs. Sold

Distributor D

From the graph below, we notice that a clear increase in purchases (to the Wholesaler) took place from March 2013. From a sales perspective, it would appear as if volume sold increased after March 2013.

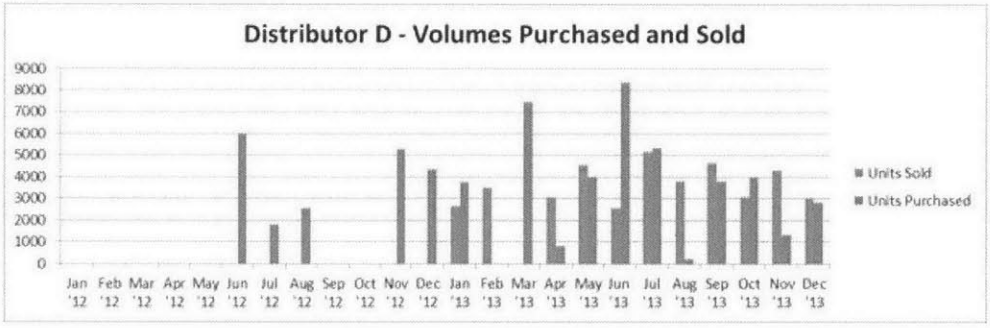


Figure 3: Distributor D - Volume Purchased vs. Sold

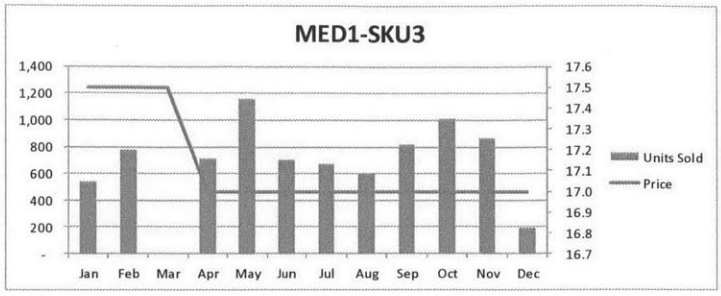
4.1.6 Distributors' Sales to Pharmacies for Top Three Selling SKUs

As a last step, we looked into details at the sales volume for the five top selling SKUs of two distributors (Distributor B and Distributor A). This analysis was performed for 2013 only, due to the limited sales data available prior to the price change.

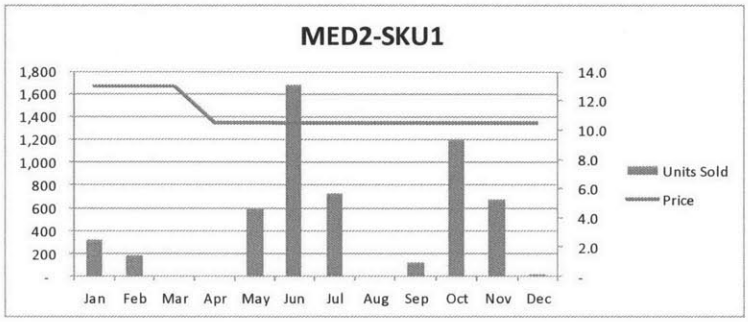
Distributor B

The below graphs display volume sales trend to pharmacies and match then with the decrease in price occurred in March 2013.

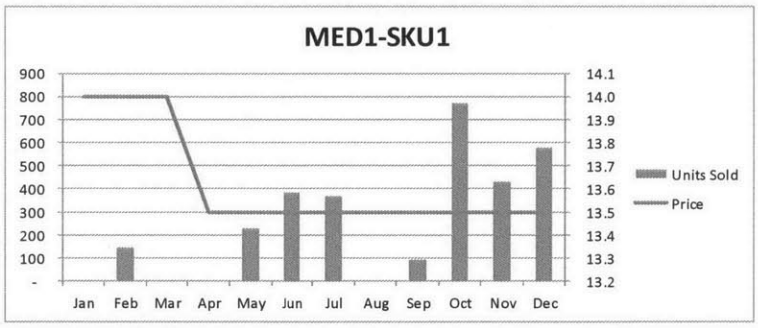
1. Top-selling SKU: MED1-SKU3 - 8,042 units sold in 2013



2. MED2-SKU1 - 5,516 units sold in 2013



3. MED3-SKU1 - 5,000 units sold in 2013

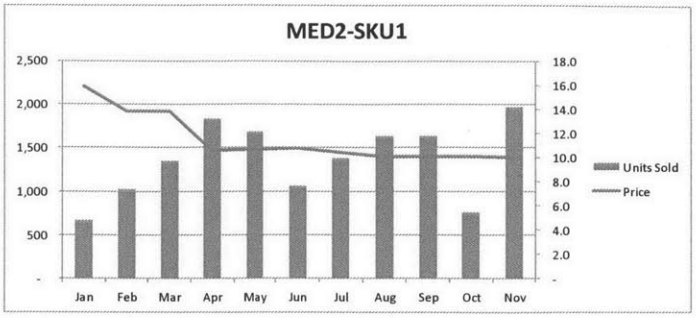


It may be argued that, for all three products, an increasing trend in volume sales is detectable and that, the top three sellers for Distributor B thus confirm the trend we already observed at an aggregate level.

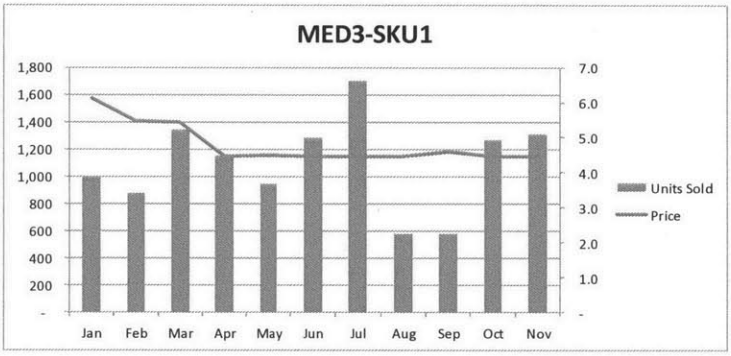
Distributor A

We performed the same review for Distributor A, with the following results.

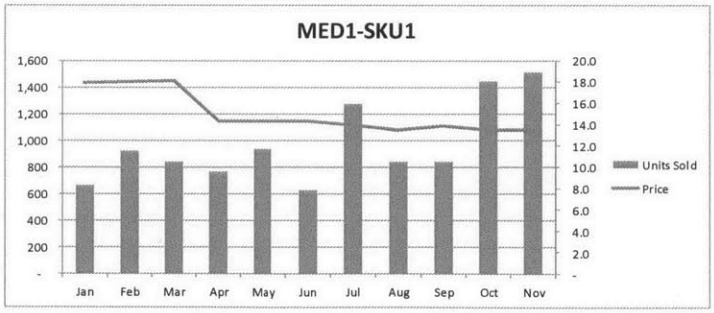
1. Top-selling SKU - MED2-SKU1 - 14,990 units sold in 2013.



2. MED3-SKU1 - 12,041 units sold in 2013.



3. MED1-SKU1 - 10,677 units sold in 2013.



It may be argued that a slight increase in sales took place after the implementation of the logistics fee. Note that, as already mentioned above at an aggregate level no specific trend could be detected.

3. How would pharmacies be impacted by a further decrease in prices?

In order to have a clear cut answer to this question, a sensitivity analysis at product and possibly pharmacy level would need to be performed, in order to determine how much a decrease in prices impacts volume. Such an analysis was outside the scope of our research due to data unavailability.

Nonetheless, a first step towards gaining a better understanding of the impact that a further decrease in prices could have on distributors and pharmacies was to gather information related to their revenues and costs, which we were able to do during our field visits.

We collected details related to the revenue and cost structure at ten of the pharmacies we visited. The graph below shows the revenue, gross income and operating income for each one. (Refer also to Appendix 5 for all the profit & loss values of the individual pharmacies).

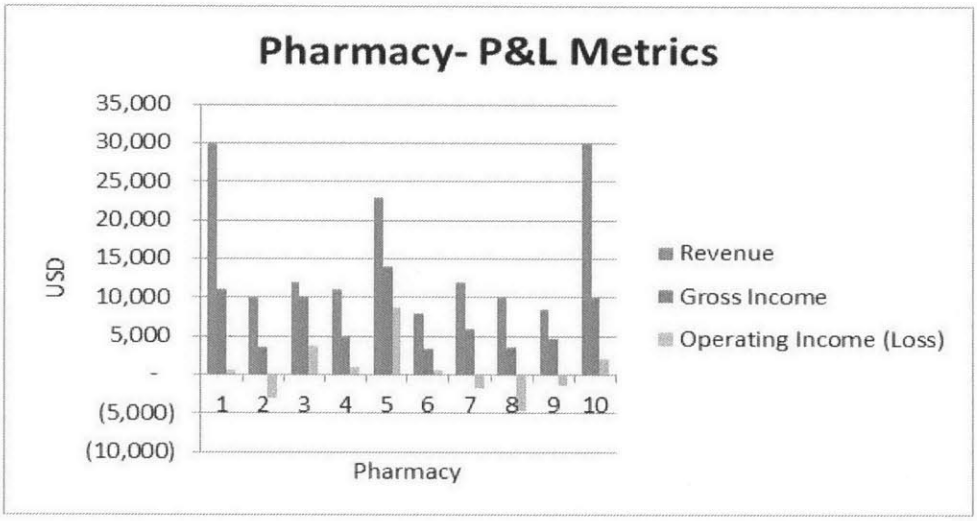


Figure 4: Pharmacy - P&L Metric Comparisons

This allowed us to compile a profit & loss statement based on the average of each line item that we collected from the different pharmacies. The standard deviation and Coefficient of Variation (C.V.) as defined by the ratio between the mean and the standard deviation were also calculated. Please refer to the below table.

Table 14: Pharmacy - P&L Statistics

Pharmacies Visited - P&L Statistics				
Item	Average		Standard Deviation	C.V.
	(USD)	%	(USD)	
Revenue	**15,460**	**100%**	**8,730**	**0.56**
Procurement Cost	8,330	67%	6,157	0.74
In-bound Transp.	5	0%	10	2.00
Gross Income	**7,128**	**33%**	**3,842**	**0.54**
Rent/Lease	1,015	4%	548	0.54
Utilities	103	0%	113	1.10
Licenses	355	1%	589	1.66
Salaries	4,760	20%	2,121	0.45
Communications	153	1%	90	0.59
Other Expenses	161	1%	107	0.66
Operating Income	**622**	**7%**	**3,810**	**6.13**

We should mention that the coefficient of variation for revenues and gross income was fairly low, at 0.56 and 0.54 respectively, whereas that related to operating income was much higher at6.13. The graph below displays this by showing the relationship between the average and the standard deviation for revenue, gross income and operating income.

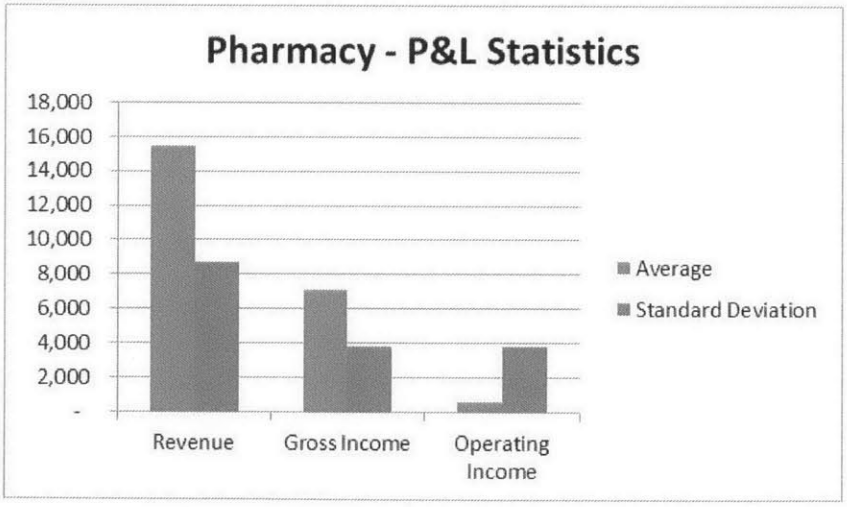


Figure 5: Pharmacy - P&L Statistics

The key insight is that behind this average profit & loss account encapsulates the results of pharmacies that are fairly profitable (six) and unprofitable (four). Any new change in prices should first and foremost focus on how that would impact the overall sales and profitability of this set of pharmacies.

4.2 Comparative Warehouse Cost Analysis

In this section we analyze the current costs of outsourcing to the Wholesaler and the potential costs to HealthCo of opening a distribution center. The costs were first compared as is, using the total annual HealthCo Southern Africa sales from 2013. Then, sales were varied using @Risk's Monte Carlo Simulation, in order to analyze how the fixed and variable costs change as sales volume increase. Fixed costs of the insourced distribution model include the one-time setup costs of opening a warehouse. Variable costs include all inventory related costs, transportation, warehouse-related labor, and the cost of outsourcing to the Wholesaler (included in model for comparison purposes only). On average, the MOQ was ordered 50% of the time for the 71 A-SKUs; this was due to a mix of low EOQ's or extremely high MOQ's.

4.2.1 Cost Comparisons of Service Level Sensitivity Analysis

This section outlines the results of the model output and breaks apart the costs for A-SKUs only into the following buckets (see Figure 4):

- Inventory costs; includes Safety Stock Value, In-transit Stock Value, Cycle Stock Value, and Inventory Holding Costs
- Transportation Costs (by mode)
- Warehousing Costs (fixed and variable)

The current costs of outsourcing to the Wholesaler was divided into the following buckets:

- Inventory Holding Costs (1.5% of Annual HealthCo Sales in Southern Africa)
- Warehousing Costs (3.8% of Annual HealthCo Sales in Southern Africa)

Table 15: Comparative Warehouse Cost Breakdown - 90% Service Level

	otal Sa ety Stoc Value	otal Cycle Stoc Value	otal In ransit Stoc Value	Inventory olding Costs	otal arehousing I S Estimates	otal rans	otal Costs Invt olding arehousing
Mixed	GBP 4,160,523	GBP 1,373,209	GBP 140,771	GBP 1,051,324	GBP 584,904	GBP 199,147	GBP 1,835,375
All Ocean	GBP 4,287,406	GBP 1,373,209	GBP 177,669	GBP 1,063,844	GBP 584,904	GBP 206,970	GBP 1,855,718
All Air	GBP 3,758,042	GBP 1,373,209	GBP 120,229	GBP 966,546	GBP 584,904	GBP 285,498	GBP 1,836,948
Aspen	N/A	N/A	N/A	GBP 167,904	GBP 425,357	N/A	GBP 593,261

In order to create a cost comparison of the current distribution model to the potential (insourced) distribution model only the inventory holding costs and warehousing costs from the model

output were measured against the costs of utilizing the Wholesaler as a third party distributor. Purchasing costs were omitted because they exist within each option. HealthCo would purchase the medicines at the ex-works price and pay for the transport from the supplier site to Southern Africa; these two costs in combination is equivalent to the transfer price. the Wholesaler purchases medicines at a higher "delivered" price, which includes transportation costs.

Inventory service levels impact the amount of safety stock one must hold; in order to display the cost impact of higher service levels we calculated the inventory holding costs, transportation costs, and warehousing costs at 90%, 95%, and a combination of 95% and 99.5% service levels for non-critical and critical medicines respectively. For each service level we calculated the aforementioned costs for each of the following modes of transportation:

1. Mixed Mode: This scenario calculates both the ocean and air costs by supplier site and chooses the mode that is the cheapest.
2. All Ocean: This scenario calculates the cost of using all water transportation from the supplier sites.
3. All Air: This scenario calculates the cost of using all air transportation from the supplier sites.

In Figure 5 below we can see that for the 95/99.5% service level combination, the mode of transportation that provides the lowest total costs is "All Air". This is due to the fact that as the service level increases so does the amount of safety stock required; using air as the mode of transportation allows for less safety stock due to shorter lead times. The cost of employing the Wholesaler is 67% lower than the total cost of the "All Air" mode option; however, the Wholesaler is only providing HealthCo with approximately a 90% service level (HealthCo Personnel, 2013). Therefore, the most accurate cost comparisons are at a 90% service level. It should be noted that 80% of the total cost of the Wholesaler option was taken to accurately compare the costs calculated in the model, which is the cost of warehousing A-SKUs only. The total cost of the Wholesaler is 60% lower on average of each of the mode options at a 90% service level.

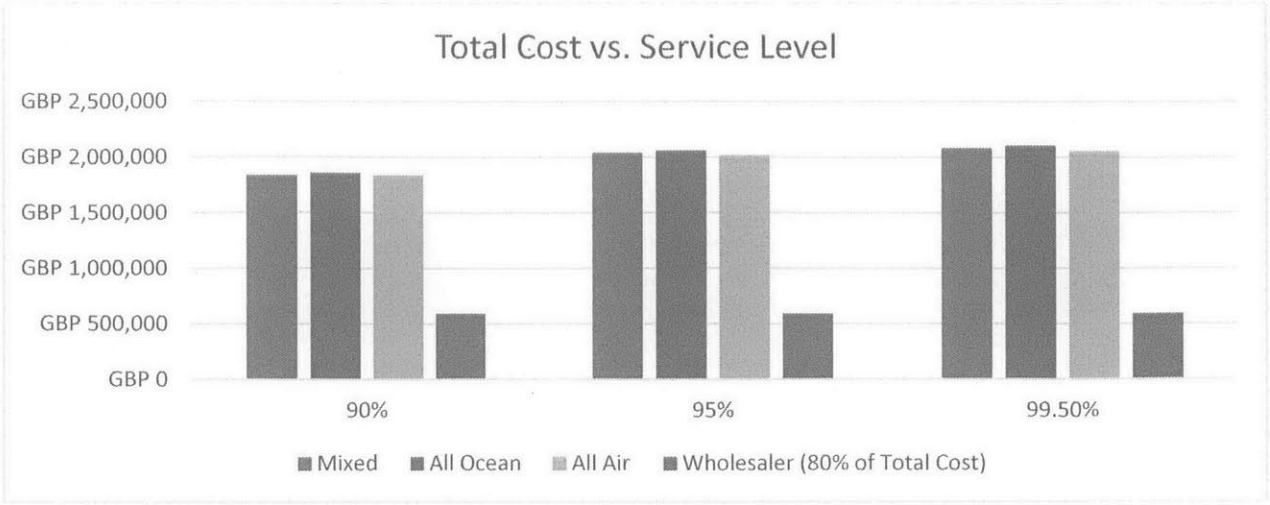


Figure 6: Current Distribution Costs vs. Insourced Distribution Costs

4.2.2 Simulating Warehousing Costs at Varying Sales Volumes

This section reviews the results of the total costs of insourcing versus outsourcing at varying sales volumes to determine at which level, if any, is it more favorable to choose to insource. For the simulation, the mixed mode of transportation option was used to calculate inventory holding costs and transportation costs. Also, as in the above analysis, costs were calculated for A-SKUs only.

Sales volumes for HealthCo in 2013 were approximately 3 million. We simulated sales volumes by using a lognormal demand distribution beginning at 4 million and ranging to 13 million, increasing the volume by 1 million for each subsequent simulation (all with a standard deviation of 1 million). When sales volumes had a mean of 13 million, the objective function was less than zero 95% of the time, meaning that we can be 95% confident that with this annual demand the cost of insourcing has a greater economic viability.

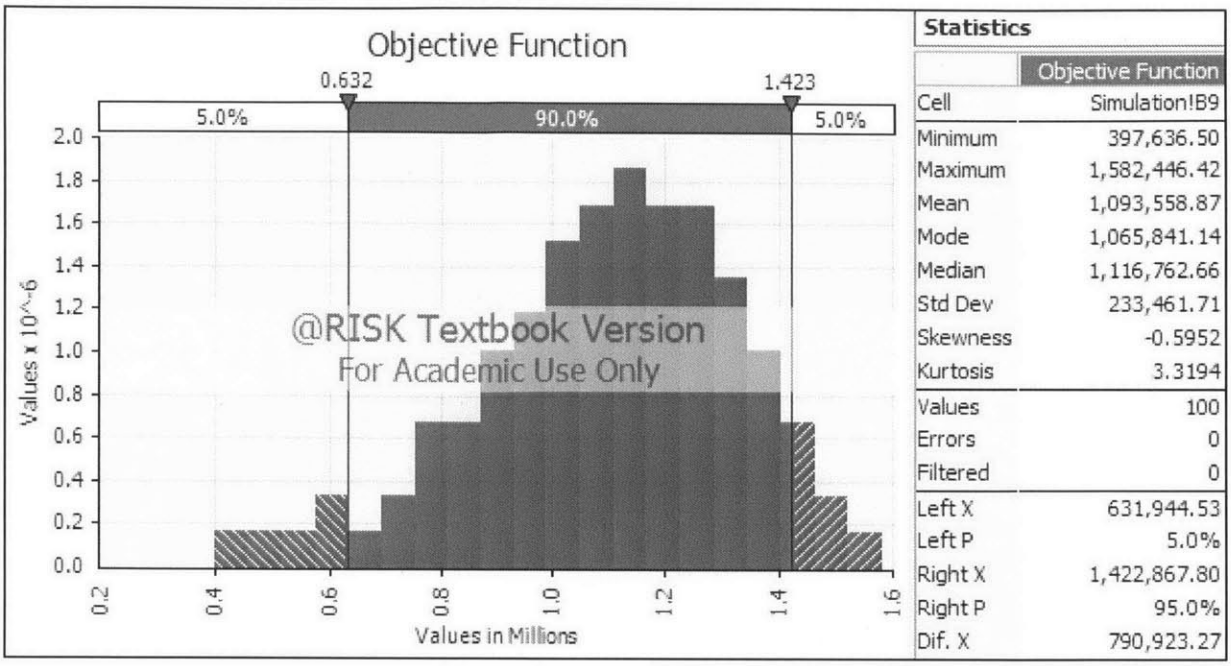


Figure 7: Objective Function with Demand Distribution of Ln(4 mil, 1 mil)

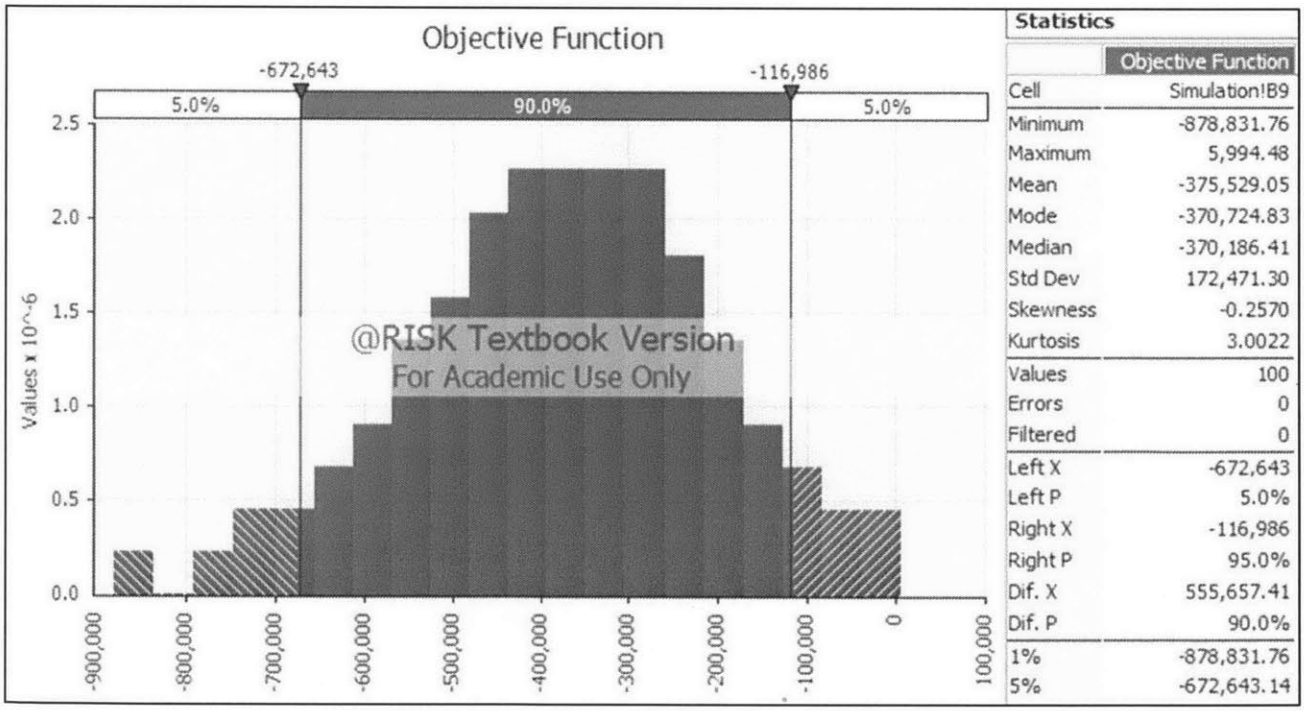


Figure 8: Objective Function with Demand Distribution of Ln(13 mil, 1 mil)

5 Discussion

This section provides a detailed interpretation of the results section and presents key insights that were discovered through performing the analyses that were previously described. In general, we verified that effectiveness of the logistics fee implementation were highly dependent on the distributor. Also, the costs associated with insourcing the distribution function are highly dependent on forecast accuracy as this increases the safety stock required to maintain a given service level. Also, by performing a sensitivity analysis on distribution costs it is clear that the service level being provided by the Wholesaler is no greater than 90%.

5.1 Impact of the Logistics Fee on Prices and Volumes

The key aim of our research was to determine whether the implementation of the logistics fee was successful. In order to determine this, we looked at the impact that the logistics fee had on the prices, margins and sales volumes for the different actors across the supply chain.
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 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. Finally, at a product level, we noticed how the logistics fee contributed to bring the prices of two product lines (MED3 and MED4) very close to those of their generic alternatives.

The challenge for the implementation of a future price reduction scheme is to have them applied uniformly across the board, so that the costs and benefits of lower prices be equally shared and no "free-rider" behavior takes place. In our analysis, we did not focus our attention on sales volume changes at a pharmacy level, due to the difficulty in collecting data from a relevant sample of pharmacies and for a sufficient timeframe. We suggest that future research focuses in this area. In particular, an understanding of the consumer behavior and their sensitivity to price

decreases related to the main types of medicines would be the starting point for thoroughly assessing the benefits of additional price decreases.

Another area which we only marginally touched upon during our research has been the inventory policies adopted by distributors and pharmacies. A stronger cooperation among the value chain partners concerning the forecasting and inventory management processes could potentially hold the promise of cost savings that could be passed on to the final consumer.

5.2 Impact of Service Level on Distribution Costs

At HealthCo's current volume levels, it costs more to insource warehousing and distribution functions than it does to outsource to the Wholesaler; however, high service levels are sacrificed as can be seen in Figure 3. According to HealthCo, the Wholesaler is providing approximately a 90% service level, which equates to a total cost of 750,000 GBP. When excluding the one-time cost of opening a warehouse, the cost of insourcing is still 550,000 GBP greater than the current cost of outsourcing. A few potential explanations may explain this discrepancy: 1) the Wholesaler is providing less than a 90% service level that is believed to be currently provided, 2) These lower costs may partially be attributed to economies of scale that the Wholesaler is able to produce simply because HealthCo is a subset of their overall distribution network, and 3) the Wholesaler may be using a more accurate forecast based on historical data, which will be further discussed in section 5.3. Even though costs would increase to 2 million GBP should HealthCo open its own warehouse; HealthCo would be able to provide its distributors with a 99.5% service level for critical drugs and a 95% service level for non-critical drugs.

5.3 Impact of Forecast Accuracy and MOQ's on Overall Costs

Safety stock value of the A-SKUs was 73% of the total average inventory (in-transit, cycle stock, and safety stock), and is highly dependent upon the forecast error (see Equation 7 and 8). The average mean absolute percent error (MAPE) for the A-SKUs was approximately 7,000%. This error is most likely attributed to the fact that HealthCo recently implemented the forecasting process for Southern Africa, which is a top-down forecast that doesn't include algorithms. This may also explain the gap of 1.1 million GPB between the cost of outsourcing to the Wholesaler

versus the cost of insourcing at a 90% service level, seeing as the Wholesaler utilizes "Just Enough" forecasting software. Public Tenders, medicines bought by the Ministry of Health, may provide another explanation for the large forecast error. Tenders are bid on by HealthCo and the demand is difficult to predict until the bid is actually awarded. Improving the forecast would decrease the overall costs by decreasing the amount of safety stock required to account for the uncertainty in demand. Another option may be to apply different safety stock policies to SKUs where the majority of the sales volumes comes from Tenders.

Another notable finding from running the simulation was that the total inventory holding costs did not vary much even as sales volumes increased. This is due to the fact that the MOQ was still 77% higher on average than the EOQ for 39 of the 71 A-SKUs even with a simulated total demand of 13 million (sales volume of 3.25 million for A-SKUs). This means that unnecessary excess inventory must be ordered due to manufacturing lot sizes, which resulted in a 25% increase in inventory holding costs. Supply chain coordination from the manufacturer all the way downstream to the distributor is important when attempting to cut costs out of the chain. The potential to reduce the MOQ is greater in instances where the manufacturer and distributor are vertically integrated, as is the case with our partner company; attempts to do so would provide the ability to lower prices to pharmacies (and potentially the patient) and increase overall access to medicines.

6 Conclusion

Our research focused on analyzing two intertwined business problems - i.e. the effectiveness of price decreases along the medicines value chain and the cost of insourcing versus outsourcing - from a financial and mathematical perspective. Our field visit in Zimbabwe allowed us to gain a better grasp of the business and social context in which such decisions must be made, which brought us to realize that our results cannot be interpreted without a deep understanding of the history, social structure and current economic and political situation of Zimbabwe and of the whole South African region. Despite the fact that the Zimbabwean economy is undergoing a long recovery process in the aftermath of a recent hyperinflation crisis, we still witnessed a proactive business attitude during our visits to distributors and pharmacies. In particular, one of the distributors visited was striving to create robust forecasting and monitoring processes and an internal culture centered on the idea of continuous improvement. At a pharmacy level, we met with pharmacists who were willing, in principle, to experiment with new pricing strategies.

Within this context, the success of the logistics fee could be proved for two of the distributors; on their side, pharmacies passed the reduction in prices on to the consumer with varying levels of effectiveness, dependent mainly on the pricing applied by the main distributor they were dealing with. This brings us to believe that further attempts at reducing prices to the final consumer should put a strong focus on communicating the scheme and align the players' incentives in such a way that the changes be applied in a uniform and coordinated manner in order to realize the full impact of the price reductions.

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), which 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 Wholesaler. The model that we created is scalable and can be used to aid other organizations, including the public sector, in determining costs associated with the warehousing and distribution of medicines.

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Appendix

Appendix 1: Breakdown of Inventory Costs by Type per Mode Selection

	Min. of Trans Costs (Mixed)				
	Total Invt Holding Cost	**Total Invt Holding Cost (w/o In Transit)**	**Safety Stock**	**In Transit Stock**	**Cycle Stock**
Total Costs	GBP 1,051,324.41	GBP 1,052,488.58	GBP 4,160,522.63	GBP 140,771.10	GBP 1,373,208.80
	All Ocean				
	Total Invt Holding Cost	**Total Invt Holding Cost (w/o In Transit)**	**Safety Stock**	**In Transit Stock**	**Cycle Stock**
Total Costs	GBP 1,065,008.44	GBP 1,042,715.13	GBP 4,287,405.81	GBP 177,669.33	GBP 1,373,208.80
	All Air				
	Total Invt Holding Cost	**Total Invt Holding Cost (w/o In Transit)**	**Safety Stock**	**In Transit Stock**	**Cycle Stock**
Total Costs	GBP 967,710.35	GBP 952,259.58	GBP 3,758,041.58	GBP 120,228.71	GBP 1,373,208.80

Appendix 2: Breakdown of Inventory Costs per Mode Selection at a 95% Service Level

	Min. of Trans Costs (Mixed)				
Item	**Total Invt Holding Cost**	**Total Invt Holding Cost (w/o In Transit)**	**Safety Stock**	**In Transit Stock**	**Cycle Stock**
Total Costs	GBP 1,255,297	GBP 1,235,595	GBP 5,180,387	GBP 140,771	GBP 1,373,209
	All Ocean				
	Total Invt Holding Cost	**Total Invt Holding Cost (w/o In Transit)**	**Safety Stock**	**In Transit Stock**	**Cycle Stock**
Total Costs	GBP 1,268,274	GBP 1,245,980	GBP 5,309,554	GBP 177,669	GBP 1,373,209
	All Air				
	Total Invt Holding Cost	**Total Invt Holding Cost (w/o In Transit)**	**Safety Stock**	**In Transit Stock**	**Cycle Stock**
Total Costs	GBP 1,147,686	GBP 1,132,235	GBP 4,663,742	GBP 120,229	GBP 1,373,209

Appendix 3: Breakdown of Inventory Costs per Mode Selection at a 90% Service Level

	Min. of Trans Costs (Mixed)				
Item	**Total Invt Holding Cost**	**Total Invt Holding Cost (w/o In Transit)**	**Safety Stock**	**In Transit Stock**	**Cycle Stock**
Total Costs	GBP 1,051,324	GBP 1,031,622	GBP 4,160,523	GBP 140,771	GBP 1,373,209
	All Ocean				
	Total Invt Holding Cost	**Total Invt Holding Cost (w/o In Transit)**	**Safety Stock**	**In Transit Stock**	**Cycle Stock**
Total Costs	GBP 1,063,844	GBP 1,041,551	GBP 4,287,406	GBP 177,669	GBP 1,373,209
	All Air				
	Total Invt Holding Cost	**Total Invt Holding Cost (w/o In Transit)**	**Safety Stock**	**In Transit Stock**	**Cycle Stock**
Total Costs	GBP 966,546	GBP 951,095	GBP 3,758,042	GBP 120,229	GBP 1,373,209

Appendix 4: Pharmacy Cost Structure Questionnaire

TOPIC	NUM	QUESTION	ANSWERS
General Business Information	1	What are the days of operations of this pharmacy?	1.□ Monday
			2. □ Tuesday
			3. □ Wednesday
			4. □ Thursday
			5. □ Friday
			6. □ Saturday
			7. □ Sunday
	2	What are the hours of operation of this pharmacy?	1. _____
			2. □ Don't know
	3	How many employees do you have? Please specify your position in the checkbox.	Number of employees:
			1. □ Owner _____
			2. □ Medicine seller _____
			3. □ Shop manager _____
			4. □ Shop attendant _____
			5. □ Other (specify)_____
			6. □ Refused
	4	What are the challenges you face operating your business (select all that apply)?	1. □ Not enough money
			2. □ Not enough customers
			3. □ Heavy taxes
			4. □ Regulatory challenges (with NDA, etc)
			5. □ Difficult to find trained staff (i.e. drug sellers)
			6. □ Other_____
			7. □ Refused/ Don't know
Payment & Credit Terms	5	If you had USD 10,000 to use for your pharmacy without interest, how would you spend it? (select all that apply)	1. □ Buy more of the same medicines I usually stock
			2. □ Stock medicines that I do not currently stock
			3. □ Pay rent
			4. □ Pay employee salaries
			5. □ Give myself a bonus
			6. □ Pay my suppliers
			7. □ Renovate my shop
			8. □ Save it
			9. □ Other (specify)_____
	6	Do you have enough access to money to operate your business as you would like to?	1. □ YES
			2. □ NO
			3. □ Refused/ Don't know
	7	What months of the year are you most capital constrained	1. □ Month_____
			2. □ Refused/ Don't know

		(select all that apply)?	
	8	Do you offer credit to any of your customers?	1. □ YES
			a. If YES, please describe the percent of customers and the terms
			2. □ NO
			3. □ Refused/ Don't know
	9	Please answer the following questions regarding your suppliers' payment terms, credit offered, outstanding payments to suppliers, and any other special credit conditions (e.g. promotional items, etc.).	1. Distributor A_____
			a. Terms (repayment period, day of month, no credit offered)_____
			b. Current balance outstanding_____
			c. Special conditions_____
			2. Distributor B_____
			a. Terms (repayment period, day of month, no credit offered)_____
			b. Current balance outstanding_____
			c. Special conditions_____
	10	Does the pharmacy have any lines of credit from places like banks, microfinance institutions and/or relationships with vendors & businesses where your pharmacy incurs expenses? Please list the source of financing and credit limit.	1. □ Source_____, Limit_____
			2. □ Source_____, Limit_____
			3. □ Source_____, Limit_____
			4. □ Other (specify)_____ (write "N/A" if none)
			5. □ Refused/ Don't know
Inventory	11	How often does the person responsible for ordering medicines place orders for your pharmacy?	1. □ More than once a week
			2. □ Once a week
			3. □ Once every 2 weeks
			4. □ Once per month
			5. □ Once every 2 months
			6. □ Other (specify)_____
			7. □ Refused/ Don't know
	12	Which of your suppliers deliver medicines directly to your store?	1. □ (specify)_____
			3. □ Refused/ Don't know
	13	How do you decide what quantities of the products to order/buy?	1. □ Order same quantities as last month
			2. □ Look at sales of the products in previous month and forecast my needs for the period I'm buying for
			3. □ Purchase based on money available

			4. □ Other_____
			5. □ Refused/ Don't know
	14	When the pharmacy needs more medicines which one of the following do you do most often:	1. □ Someone from the shop goes to the supplier
			2. □ Place order by phone, and supplier delivers product directly to the shop
			3. □ Place order by phone, supplier sends product to another location where we go pick it up
			4. □ Other (specify)_____
			5. □ Refused/ Don't know
	15	How frequently do you go to the supplier to pick up the supplies of medicines?	1. □ Once per week
			2. □ Once every 2 weeks
			3. □ Once per month
			4. □ Other (specify)_____
			5. □ Never pick-up
			6. □ Refused/ Don't know
	16	If using Dispensware (or other software) can we download volumes sold by product for the previous 1-2 months and related inventory levels.	1. □ YES
			2. □ NO
			If cannot get the data for all drugs, focus on the 4 above-mentioned drugs
			3. □ Refused

Appendix 5: Pharmacy - P&L Metrics

Pharmacies - P&L Metrics										
Pharmacy	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Revenue	**30,000**	**10,000**	**12,000**	**11,000**	**23,000**	**8,000**	**12,000**	**10,000**	**8,600**	**30,000**
Gross Income	**11,100**	**3,500**	**10,200**	**5,000**	**13,980**	**3,400**	**6,000**	**3,500**	**4,600**	**10,000**
Rent/Lease	500	800	1,000	900	750	1,000	2,500	800	800	1,100
Salaries	9,500	5,000	4,800	2,500	4,000	1,500	4,800	5,000	4,500	6,000
Operating Income	**598**	**(3,039)**	**3,851**	**1,068**	**8,778**	**648**	**(1,699)**	**(4,730)**	**(1,353)**	**2,098**