Supply Chain Strategy in Post-Earthquake Haiti

by

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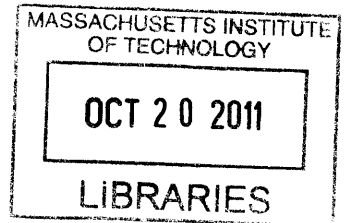
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Table of Contents

1. Introduction

Partners In Health (PIH) is an international, non-profit healthcare organization with operations in several countries on multiple continents. PIH focuses on providing healthcare treatment to people living in some of the poorest places in the world, and has been operating in Haiti since 1985. At that time, PIH established a small community clinic in the central Haiti village of Cange. Today that facility has grown to become an entire medical complex, featuring a 104-bed, full-service hospital with two operating rooms, adult and pediatric wards, and clinics treating a variety of diseases and issues, from women's health to infectious diseases.

In addition, Zanmi Lasante ("Partners In Health" in Haitian Creyeol) has also expanded its operations to 11 other sites across Haiti's Central Plateau and beyond (Figure 1). Today, ZL ranks as one of the largest nongovernmental health care providers in Haiti – serving a catchment area of 1.2 million across the Central Plateau and the Lower Artibonite. ZL employs over 4,000 people, almost all of them Haitians, including doctors, nurses and community health workers (Zanmi Lasante/ Haiti).

From its beginnings 25 years ago, PIH/ZL has grown tremendously, and recent years have been no exception. Since 2004, patient encounters have increased almost threefold, from 0.9 million to 2.6 million, and the number of clinical sites has almost doubled. This growth has corresponded to an increase in drugs and supplies. In 2006, approximately 1000 m^3 of drugs and supplies were moved through the system. Only two years later, in 2008, that number had more than doubled to 2200 m^3. This significant increase has greatly strained the underlying supply chain.

Figure (1): PIH Operations in Haiti

The January 2010 earthquake has increased the scale and variety of health needs in the region. Although still not completely quantified, the general expectation is for thousands of people to migrate from the hardest hit areas (in and around Port-au-Prince) to areas less directly affected by the earthquake, namely areas with permanent PIH clinics (the Central Plateau and Arbonite regions).

On top of this potential un-planned for increase in possible patient population for existing clinics, PIH has its own expansion plans. Specifically, PIH has opened a site, Verettes, within the past 6 months and plans to open a new hospital facility in Mirebalais within the next year.

The Mirebalais Hospital is planned to be a seven building complex, with over 180,000 ft^2. It will be a 320- bed facility, potentially serving a greater number of patients than the rest of the Partners in Health clinics combined. In addition, the Mirebalais hospital is will be a teaching hospital and a national referral facility, providing services (such as an Intensive Care Unit) that cannot be found at other hospitals in Haiti, meaning that patients outside of PIH's normal catchment will be sent for treatment to this site (PIH Breaks Ground on Teaching Hospital in Mirebalais, Haiti) The Mirebalais Hospital is expected to be a state of the art facility that will greatly increase the level and amount of care found in Haiti, but the supply chain organization and processes currently supporting PIH/ZL clinics in Haiti will

need to be adapted to such huge change. Before introducing methods for confronting these changes, it is best to understand how the supply chain of Partners In Health currently operates- specifically, current PIH policies regarding ordering, distribution, and warehouse locations/capabilities.

Partners In Health procures the majority of its drugs/products from one supplier, the International Dispensary Association Foundation (IDA), based in the Netherlands. By ordering from IDA, PIH is often able to obtain the drugs and supplies they need for their medical sites at lower prices than they could otherwise find if they went to the commercial marketplace. However, PIH currently acquires these supplies from IDA through an annual order, which IDA fulfills as it is able. This results in shipments arriving in Haiti in batches, some over the few months after the order is placed, some not arriving for up to eight months later.

Overall, this ordering process saves PIH money in terms of the cost of goods, but forces PIH to maintain a larger inventory and often make emergency purchases to deal with the arrival variability.

Whenever medicines and supplies arrive, PIH deploys them through a hub and spoke supply chain, stocking products until their final use at a clinic. Figure (2) shows a hub and spoke system for PIH in Haiti, with the Cange Depot serving as the Hub, sending out supplies to multiple clinic pharmacies through multiple spokes. Like the other sites on the Cange premises, the importance of the Cange warehouse can be traced to the initial establishment of PIH operations in Haiti at this location.
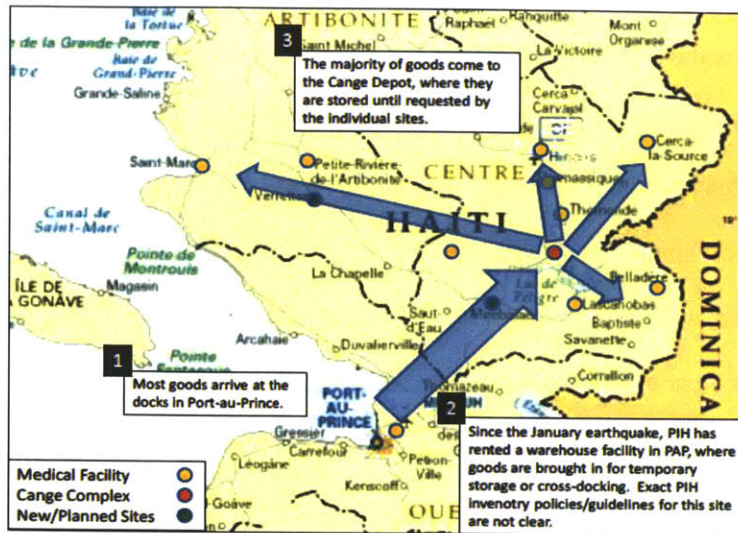
Figure (2): PIH Supply Chain Network

With operations of PIH continuing to grow and expand outside Cange PIH needed to re-evaluate the structure and policies of its supply chain. Rather than simply treating all of the products that move through PIH's supply chain in a similar manner- with most following a route of coming in through Port-au-Prince, then moving to storage at the Cange Depot, before finally moving to the actual clinic site for patient use- they were considering a segmented supply chain that could utilize new/expected storage facilities and different stocking policies.

The question of how to decide which products are kept where, and in what amounts, is best answered through the analysis of product characteristics. The variety of products can be grouped by similar characteristics (by factors to be described later) and then managed differently in the areas of inventory level, ordering policy, and network flow. Segmentation approaches are the focus of this research.

There are six sections explaining this approach to applying segmentation to PIH's supply chain, with the goal of improving operations now and in the future. First, the Literature Review discusses previous academic research in this area, especially work done in the areas of humanitarian logistics,

disaster Relief, and segmentation. The Methods section details the steps I took throughout the project, focusing on demand Forecasting, segmentation development, and segmentation application. The Data Analysis section describes the data sources and issues as well as the process for segmentation implementation in a Microsoft Access database. Finally the Results section shows the impact the segmentation process and analysis will have on determining new inventory and ordering policies as well as inventory location decisions.

2. Literature Review

The best starting point for my literature review is a thesis written by Hoover and Heberly (2010). This research work provides an excellent background for the problems facing Partners in Health in their supply chain operations. It focused on the inventory policies of the most important products within PIH's system. Using historical data, the authors began by forecasting future demand for this particular group of products and then evaluated the suitability of the existing warehouse capacity in Haiti. The authors focused on a slice of PIH ordering, not a comprehensive evaluation that the segmentation work required. While some of their conclusions are applicable to this research, overall their focus was different. Still, the data analysis they conducted regarding demand forecasting and warehouse capacity provided the basis for this work.

This literature focused on papers written under three headings: Logistics in Humanitarian Operations, The Role of Logistics in Disaster Response and Relief, and The Segmentation Process and Implementation.

2.1 Logistics in Humanitarian Operations

Being able to evaluate and analyze Partner In Health's operations in Haiti requires a basic understanding of how the supply chain operations of international, non-profit groups are typically organized. Oloruntoba and Gray (2006) provide a general overview of this process as they outline a model for the stages, challenges, and effects of supply chains on humanitarian operations. The authors provide a useful flow chart, detailing the flow of products through a typical humanitarian supply chain: Government donor – International Agency – International NGO (e.g. PIH) – Local NGO (e.g.Zanmi Lasante) – Community based organizations (e.g. clinics) – Consumers. The author's work provides an excellent starting point for evaluating PIH's operations, but does not provide methods for evaluating and/or improving those operations.

Providing a more quantitative approach, Van Der Laan and Brito (2006) present the concept of having a performance measurement system in place to evaluate the effectiveness of humanitarian operations. The authors combine previous research and their evaluation of humanitarian responses to both the Asian tsunami and Hurricane Katrina as the basis for developing performance metrics by which humanitarian groups could/should be evaluated. For a specific example, they apply their ideas to evaluating a Dutch healthcare NGO that is somewhat similar to Partners in Health. Their conclusions for areas of improvement, including procurement processes, forecast accuracy, and network development, have a large degree of overlap with some of the focus areas of this research. While their work has a larger scale and focuses more on short-term responses, instead of on-going operations like PIH, the author's approach to develop methods of evaluation is particularly relevant.

2.2 The Role of Logistics in Disaster Response and Relief

The general study of humanitarian logistics is a growing field, yet much of the focus is in the area of disaster relief. While on the surface such work may not have a direct correlation a longer-term, more established healthcare operation- PIH must maintain the ability to respond to crises. The supply chain in Haiti should be prepared to respond to events similar to the 2010 earthquake or the cholera outbreak later in the year.

Bleckin (2010) discusses the rise in the study of logistics in the context of humanitarian work, especially as it applies to disaster preparation and response, using the January 2010 earthquake in Haiti as an example. It provides a good introduction to this field, but does not provide specific, quantitative-based methods or models that. This was mainly a paper on the effects of supply chains on humanitarian response, not on the evaluation/improvement of those supply chains.

For more specific examples, Beamon and Kotelba (2006) provide a more empirically-based article that introduces topics such as inventory control and highly variable. For inventory control, the authors develop a model that attempts to optimize order quantities and time cycles- both factors examined in this research. Beamon and Kotelba look at these problems in the context of emergency response, not

more permanent operations. Still, they provide several ideas for NGO inventory policies that are applicable to this research.

Also looking at disaster relief, Balcik and Beamon (2008) focuses on facility location. The authors develop a model to determine the ideal number and location of distribution centers for a humanitarian organization as well as the inventory to be kept at each. The authors then conducted multiple computational experiments to evaluate their model with regards to disaster response and the implications of managing such a system. The results of their work were some very interesting performance metrics and methods for monitoring/evaluating a humanitarian system, but again, they focused on responsiveness to a disaster or emergency, not normal operations. This research will draw on their conclusions to consider how PIH could both carry on day-to-day operations and be ready to respond to an emergency.

2.3 The Segmentation Process and Implementation

Segmentation analysis typically has not applied to humanitarian operations. Working with a limited budget and not focused ?profits like many typical companies, non-profit international healthcare organizations such as PIH have traditionally not conducted analysis common in the commercial arena. However, Partners in Health has realized that segmentation could be useful as it needs to adapt its supply chain to its changing scope and scale of services. This research focuses on examining the ways in which segmentation could be applied in PIH operations in Haiti.

Successful best practices in the area of segmentation are the focus of the article by Constastine, Ruwandi, and Wine (2009). The authors do not consider humanitarian work at all in their writing, but the article describes the process of segmentation within a supply chain, as well as the advantages of doing so. Specifically, the authors point out the effectiveness of segmentation in helping create a supply chain that has a higher level of service, without an increase in cost. The top 50% of companies (as rated by the authors) were found to employ some type of segmentation in their companies' supply chains in order to serve different customer groups with unique products. These results serve as a starting point for the

process of implementing segmentation on PIH's supply chain, where there previously had been none. This article is not empirically based, but provides an excellent foundation for evaluating the best practices of the field of supply chain management.

Applying segmentation to humanitarian logistics is the focus of an article from USAID (Allain, Goentzel, Bates, Durgavich, 2010). Here, the authors develop a generalized framework applying and implementing segmentation within a public health supply chain. The article details the advantages of segmentation, provides steps to segmenting the products, and an overall process for an organization to follow. Lastly, the article provides a hypothetical case study as an example to follow.

Most useful to my work was the segmentation factors, specifically those pertaining to public health products. public health supply chain. Applying several of the factors suggested by this paper to PIH operations was a large part of this research.

The concept of density allowed me to combine some of these factors, following the suggestions from Lovell, Saw, and Stimson (2004). Looking at the application of segmentation in a commercial supply chain setting, the authors developed a method by which segmenting could be done by a factor they named Product Value Density (PVD). This PVD concept is useful to this research because it provides an example of combining multiple product characteristics (in this case, cost, size, and weight) into a single segmentation factor. In working with the PIH supply chain, this practice becomes useful as multiple, seemingly un-related factors are combined to produce larger, coherent segmentation groups.

Methods

Segmentation to PIH's supply chain in Haiti involved three steps:

1. Segmentation Factor Development

2. Segmentation Grouping

3. Policy Assignment

Each of these steps are described in the sections below.

3.1 Segmentation Factor Development

A segmentation factor is a product characteristic or quality that can be used to describe or distinguish individual products as well as groups of products. They can describe the product itself, transportation requirements of the product, demand considerations of the product, or a variety of other options.

As mentioned in the Literature Review, Several articles mentioned in the Literature Review described different segmentation factors. Borrowing from both the USAID paper (Allain et. all 2010) and the Product Value Density article (Lovell, Saw, & Stimson 2004), Table 1 shows a combined listing of the various factors one could use to segment a supply chain (humanitarian or otherwise):

Table (1): Segmentation Criteria	
Group	Factor
Product	Life Cycle
	Handling Characteristics
	Shelf Life
	Size & Weight
	Value
	Product Value Density
Market	Demand location/level/variability
	Service Expectations
	Seasonality
Source	Limitations of raw materials

	Economies of scale Production flexibility Lead-time
Other	Geographic infrastructure Transport mode(s) available Customs/duties/trade agreements Legislation Cold/cool chain requirements

(Allain et. al 2010) & (Lovell, Saw, & Stimson)

However, for the purposes of this thesis project, considering the constraints of PIH's operations in Haiti, evaluating the supply chain for over a dozen different factors is not suitable. Partners In Health does not want to own or operate a large number of distribution centers throughout the country of Haiti, nor are they seeking to establish a vast network requiring a tremendous increase in transportation costs and complexity. Considering that the current structure of the system is based heavily on one central site and a couple newer facilities with as-yet-un-defined roles, segmenting the supply chain into groups that allowed for better service, increased efficiency, but without a corresponding increase in complexity seemed to be the best approach.

As such, I examined the list above and, with input from members of PIH, focused my segmentation mainly on the following areas:

- Daily Report

- Usage Rate

- Usage Variability

- Replenishment Rate

- Sourcing

- Distribution

- Cold Chain

- Shelf-Life

- Crisis

These are factors for which PIH had information and PIH personnel thought were most important to the supply chain and the service required at their Haitian sites. In the following sections, these factors are described in more detail, and then, later in this thesis, the analysis of their segmentation is used to develop improvements to PIH's supply chain operations. This paper details exactly what went into each of the factors listed, describing each of these factors, regardless of whether they were mathematical calculations or survey responses. The exact breakdown of the results, and their implications, are discussed in the Data Analysis and Results sections.

Daily Report

The first factor comes from PIH clinical personnel input. The Daily Report is generated by each PIH site to monitor those drugs/medical products for which inventory levels are of the utmost importance to patients in Haiti. The Daily Report segmentation serves as the initial breakdown for products that absolutely must be in stock at all times, for a variety of reasons. It may include drugs that are not used very often, but are necessary to save lives when they are needed. There was no mathematical approach to this segmentation, but rather this factor relies on input and experience from PIH physicians, both Haitian and ex-patriot.

Usage Rate

This category deals with the demand of each of the products. The demand data are the reported consumption from 2010, as stored in the EMR website mentioned previously. The factor is combined for all the sites to show the overall demand in the system that the PIH supply chain must serve. To make this factor even simpler, the resulting data are evaluated to define categories about how often the drug is used. Descriptions of the Usage rate categories are provided in the Analysis section.

Usage Variability

Closely related to the previous factor is Usage Variability, which takes the historical demand and describes the changes in that demand period. Using PIH data, the results are best calculated using monthly time buckets, as this is how the information is stored in the EMR site. The standard deviation along is not useful here to describe this variability since the standard deviation for demand in products that exceeds 10,000 per year cannot be compared with that of demand for products that is less than 500 per year. Instead, Coefficient of Variation is used. The Coefficient of variation (CV) is defined as:

$$CV_i = {standard\ deviation(i)} / {mean\ (i)}$$

For some product (i).

Normalizing the standard deviation provides a factor that is usable for comparison amongst data with large differences in their respective amounts. As with Usage rate, the CV is used to define a few categories for easier management.

Replenishment Rate

This factor seems to be very similar to Usage rate, but it is perfectly correlated with usage. The source of data is again the EMR website but this seeks to describe and compare how often the clinics are requesting more supplies of a particular product. While the Usage Rate describes how quickly the products are consumed on site at all of the clinics; Replenishment Rate describes the frequency of shipments from the central Cange Depot to the clinics.

This allows us to take into account the small storage spaces and ordering preferences at each site. As mentioned in the Introduction, clinics tend to have a small inventory space- the exact conditions and/or size of each space are highly variable. Capturing the frequency of replenishment is an attempt to capture this effect on the supply chain as a whole. For example, a larger volume (m³) product that is used

fairly often could potentially require more frequent shipments from Cange than a smaller, more frequently used one.

Sourcing

Sourcing is included to help with inventory policy development. Depending on where a product is sourced, the resulting cost and lead time can vary greatly. This factor attempts to distinguish cost and lead time by identifying where a product comes from. While most of the products in PIH's inventory come from the IDA Foundation, the organization described in the introduction, there a number of products can be either acquired locally in Haiti and/or are sourced from other areas, such as different humanitarian groups. Also, the extent to which PIH can affect these sources (and can be affected by them) varies by product. Depending on the sourcing for each product, different inventory and service levels can be utilized.

Distribution

This factor describes the extent of sites at which a product is stocked in PIH's system. While the Usage Rate and other factors may affect the inventory policy more, this segmentation factor will affect both the inventory policy as well as the decision(s) for where to keep this inventory. A product that is only used at a handful of sites can be identified with this factor; the resulting inventory should be kept at a location that serves those limited sites best.

Cold Chain

This factor is the result of a clear characteristic: whether the product needs to be stored in a refrigerated environment before use or can transported and stored at ambient temperatures. This category needs to be so that a refrigerated item is not assigned to an inventory location without cold-chain capabilities. This relies on PIH personnel input and product information from the supplier.

Crisis

This factor was added after personnel from PIH identified certain drugs that, regardless of the factors mentioned already, need to be stockpiled, with different inventory policies due to the nature of their use. These products are ones that may require surplus inventory to meet events that cannot be anticipated. Examples of these products are those that were needed to treat the 2010 cholera outbreak as well as those medicines requested immediately following the January 2010 earthquake. By identifying these products separately through this factor, it is easy to dictate separate policies for them as needed.

3.2 Segmentation Grouping

All of these factors can be combined in literally several thousands of ways. The actual approach used to breakdown and then re-group these products depends on intent and supply chain objectives that one hopes to accomplish through segmentation. In the next chapter, I describe a couple of different variations with regards to the actual segmentation grouping.

3.3 Segmentation Policy Assignment

When the above factors are combined to form actual segmentation groups the resulting classifications are most useful when they are used to set distinct policies/guidelines for supply chain operations.

Segmentation Policy Assignment seeks to do just that: use the general objectives of each group to implement supply chain policies. In this step, the policies will incorporate the following parameters:

1. K value: This value is tied to the service level. For certain products, a stock-out could have tragic results for the well-being of a patient. The K value is used to set different levels of safety stock to cover demand fluctuations. There is no way to know absolutely what the

demand in the future for a product or group of products will be, so the K value helps create a buffer. Products that have a greater "stock-out cost" will have a higher K value to compensate.

2. Safety Stock (SS) = $k * \sigma_{(L+R)}$

   This value is equal to the average level of inventory just before replenishment arrives. A larger safety stock provides a buffer against a higher-than-expected demand during the lead time. In this case, the lead time refers to the review period combined with the replenishment lead time.

3. Re-Order Point (s) = $X_L + k*\sigma_{(L+R)}$

   This accounts for the Safety Stock (#2) as well as X_L, the expected demand during the lead time. This is used as a guideline for when replenishment order needs to be placed. If demand is exactly as forecasted, the Safety Stock will not be utilized based on ordering at a point (s) where the Safety Stock and Demand over the lead time are combined. The re-order point allows for the product to be re-supplied only while X_L inventory is used, with a buffer equal to the Safety Stock remaining for uncertainty Lead Time: The amount of time necessary for another company/organization to supply a product.

   In this case, for PIH, the lead times of their products vary mainly based on whether the product is locally available or must be brought into the country. For this research, the assumption was made that lead time was fixed- the time necessary for products to be supplied to PIH was treated as a constant, regardless of its amount. In reality, as discussed in the introduction, the lead times vary by order to order and product to product. At this time, there needs to be further research done into including a variable lead time into a segmentation analysis. For simplicity, all lead times assigned are constants.

4. Review Period: For the purposes of this project, PIH utilizes a periodic review policy. Since PIH's inventory is maintained through manual inputs into the online EMR system as well as

actual physical counts, a periodic review policy best reflects this. This time period is set by those monitoring the supply chain system and inventory. This is time period, usually in terms of months or weeks, where the above policies will be evaluated. Typically, orders for more products occur after a review is done, to ensure a correct and useful order.

Taking these factors into consideration, and exploring the impacts of each, is the focus of the next section, Data Analysis. It focuses on actually conducting the breakdowns mentioned above, and provides insight into how each factor affects the data.

4. Data Analysis

This section will first discuss the data sources used for this project and then describe the segmentation process detailed above. Lastly, I will describe the steps taken to apply policies to segmentation groups in PIH's supply chain.

4.1 Data: Sources and Issues

The data used in this project came from several sources at Partners In Health. The main source of data was PIH's Electronic Medical Records (EMR) system. This is an online management system utilized by both personnel on-site in Haiti as well as in the Boston office of PIH. This system is used to record several different pieces of information pertinent to this project; the system contains the inventory and consumption data for the multiple sites in Haiti. Ideally, this allows for the personnel on-site in Haiti- the ones actually physically dealing with inventory moving through PIH's supply chain- to be the ones to maintain the records, with oversight provided by the Boston office.

For this thesis, I utilized the consumption data from January 2007 through January 2011, as reported on the EMR website. The website had the capability to export the data straight to Microsoft Excel, which was sufficient for the initial data analysis. This process, however, had several caveats.

First, the accuracy and/or completeness of the data are dependent on a variety of uncontrollable factors, such as: internet connectively at remote sites in Haiti or more urgent issues such as the earthquake response effort. When the various clinics throughout Haiti have connectivity issues, the completeness of the data is affected. Looking at consumption data for a specific product, one can see consistent, positive values with occasional periods of zero consumption. It confirms that it is difficult to go back and re-populate data that was not entered at the time. The impact of this is shown in Figure (3). This chart shows the overall demand, by month, from January 2007 – January 2011 as reported on the EMR site.
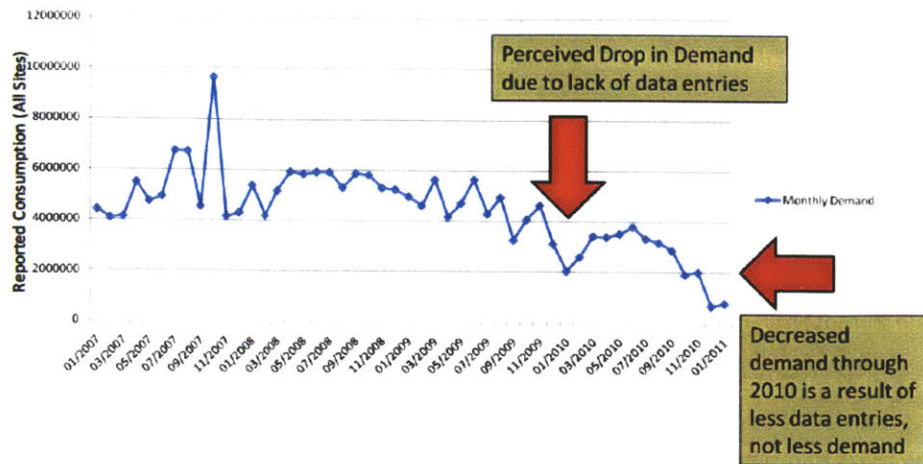
Figure (3) PIH Monthly Demand 2007-2010

The chart indicates a drop in demand after the earthquake. However, it stands to reason that there was a tremendous amount of medical supplies needed during this time, but because of the overwhelming workload on the Haitian staff, and the scope of the earthquake response, the inputs were not completed at many sites for many products. Still, this was the best source of consumption data for this project, and many of the segmentation factors (especially Usage factor) rely on this information.

Using older information (such as 2009, before the earthquake) may seem to be an option, but each year new products are added to PIH's supply chain and using older data would leave many products without any information. Thus, the analysis in this project is based on the consumption data of 2010, realizing this data was most likely underestimated. However, since the under-reporting most likely affected all products more or less equally, this approach seems most appropriate.

4.2 Segmentation Factor Development

For simplicity, I will describe data analysis for each segmentation factor utilized in this thesis through Microsoft Excel charts and graphs. In the Results section, I will incorporate Microsoft Access, as the segmentation groups are best combined using more advance features than Excel can provide. However, at this point, the data are best described and trends are best explained through the more straight-forward application of Microsoft Excel.

Daily Report

This factor is a binary indicator set by PIH management: those products that are deemed vital enough to be included on the Daily Report ("Yes") and those that are not ("No"). Out of the 571 products looked at for this thesis, only 71 of them were classified as "Yes."

Usage Rate

As mentioned previously, this factor depends on the consumption data as reported by all the sites in Haiti on the EMR website in 2010. This value was divided into four categories for simplicity of grouping following these steps:

1. I applied the equation: $Total\ 2010\ Demand/365 \geq 1$. If this was true for a product, it was classified as "Daily."

2. If that equation equaled less than one, I applied the equation: $Total\ 2010\ Demand/52$. If this gave an answer greater than one, then the product was classified as "Weekly."

3. Products that were not fit as either "Daily" or "Weekly" were classified as "Infrequently." This was defined as being used less than once a week.

4. This resulted in a large number of products being classified as "Daily." Since the majority of the Haitian clinics are open for 10 hours a day, I examined the "Daily" group for answers to #1 that were greater than 10. These were re-classified as "Hourly."

This results in a breakdown as shown in Figure (4):
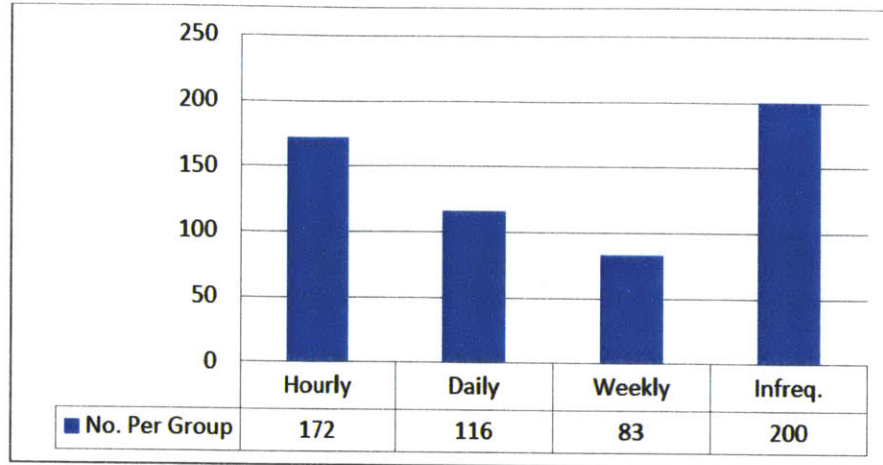
Figure (4): "Usage" Segmentation

Usage Variability

As described in the Methods section, this category relies on the Coefficient of Variation of the consumption data for each product in 2010. In order to translate these numbers into categories that each product could be segmented into, groupings of "High"($CV > 1$), "Medium" ($0.5 \leq CV \leq 1$), and "Low" ($CV < .5$) were applied. The parameters for each are shown in Figure (5):

Figure (5): "Usage CV" Segmentation

Replenishment Rate

For this factor, I examined the number of requests from each clinic as reported on the EMR website through 2010. This data has its own entry on the PIH website, and is thus simple to export to Excel and analyze the information.
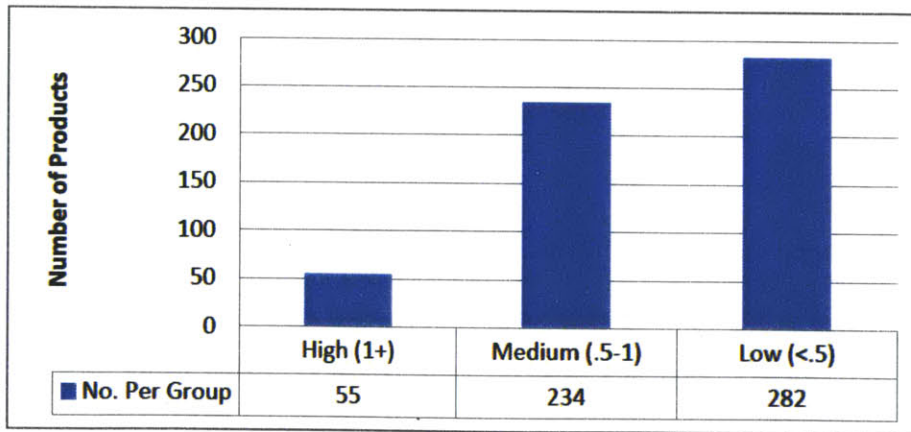
However, on its own, these data points were not useful for segmentation purposes. Instead, I used this data to calculate not the amounts requested, but rather the frequency of those requests. For reasons described in the Methods section, this allowed me to look at multiple supply chain issues through a single variable. To calculate this frequency, I noted in the above chart how often the product was requested and divided this number into groups of "Monthly" (12 or more requests per year), "Quarterly" ($4 \leq$ Requests < 12), and "Annually" (Less than 4 requests per year). This is shown in Figure (6):

	Monthly	Quarterly	Annually
■ No. Per Group	116	254	201
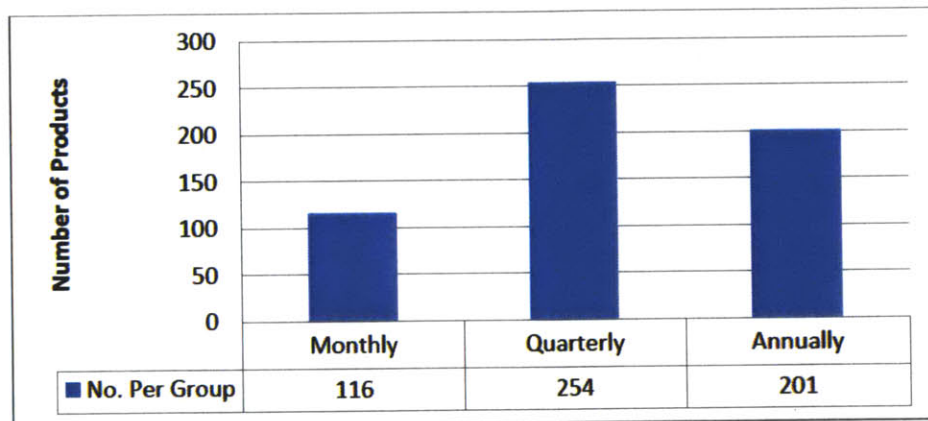
Figure (6): "Replenishment Rate" Segmentation

Distribution

To show the distribution requirements, this factor describes how many sites carry a certain product. Like in the other factors already described, these numerical results were converted to three distinct categories. The purpose of utilizing this segmentation factor is to distinguish which products have a more general application (and thus will be used at all sites) and those with a more specialized purpose. Those products not used routinely at all of PIH's Haitian clinics can then be identified as either "Specialized," which includes uses such as Women's Health and Pediatrics, and "Surgical," which includes those drugs and items needed for more complicated surgical procedures. Figure (7) shows the specific breakdown.
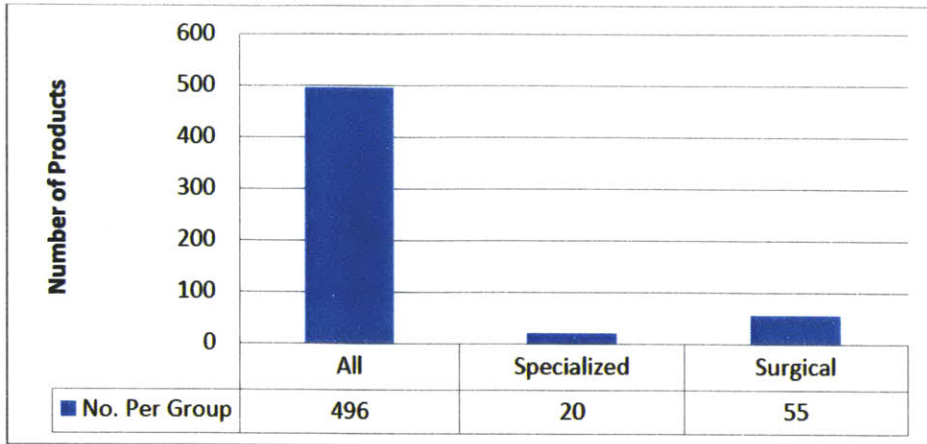
Figure (7): "Distribution" Segmentation

Sourcing

For simplicity in this factor, I limited the inputs to four different categories: "IDA," "Haitian Vendor," "PEPFAR/Global Fund," and "Other." The "Other" category is a catch-all meant to identify those drugs not from IDA, Haitian Vendor (where PIH can locally source some products), or PEPFAR/Global Fund (where PIH secures some products funded by these initiatives). One aspect for using this factor is to identify the lead time associated with a particular product. Because Haitian Vendor and PEPFAR/Global Fund products can be found in country, the lead time for them is shorter. In addition, those products sourced from IDA or Other can be considered to have longer lead times, for reasons mentioned in the Introduction. At this time, breaking the category down even more was not useful. Figure (8) shows the split:

Figure (8): "Sourcing" Segmentation

Shelf-Life

According to general practice by the PIH pharmacist, there is a fairly simple demarcation of two years of shelf life. Hence, I divided this category into only two s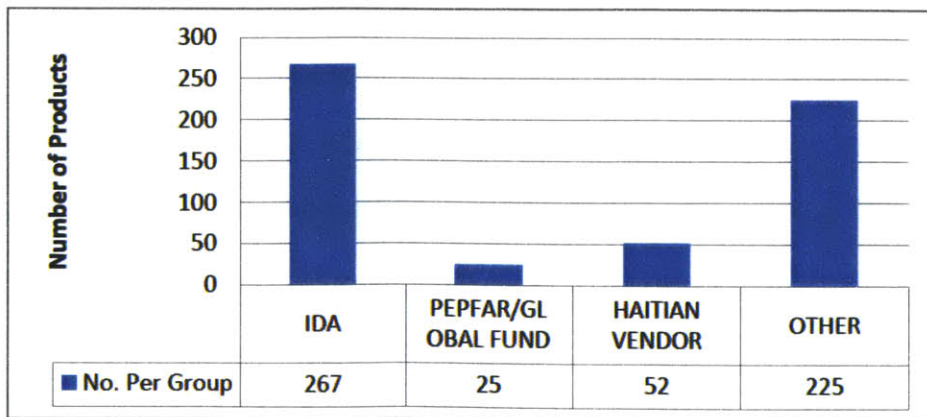egments: "Less than 2 Years" and "Greater than 2 Years." Simply put, this factor will identify those products that PIH should move through the system in less time- stockpiling inventory that may expire for a certain product would not be useful. The breakdown was simply:

≤ 2 Yrs :   44/571 (8%)

> 2 Yrs :   527/571 (92%)

Cold Chain

This factor was again not based on numerical calculations but rather a binary indicator based on PIH input. The resulting breakdown is between those products that require cold chain storage ("Yes") and those that do not ("No"). At this time, each of the main warehouse facilities in use (and planned to be in use in the near future) are capable of providing cold chain storage. Still, this factor is useful to identify those products that require additional care and inventory considerations. The breakdown is as follows:

"Yes" : 28/571 (5%)

"No" :   543/571 (95%)

Crisis

This last factor was again determined by PIH staff. It was deemed important enough to separately identify those products that are necessary to have for crisis events – whether it be another cholera outbreak, civil strife, etc. These products are not solely used for crisis response, but they are products that would be useful in specific crises. Working to reduce the inventory of the Crisis group could end up working against PIH if an emergency demanding that certain product were to erupt. The breakdown is:

Yes :   53/571 (9%)

No :   518/571 (91%)

Combining different factors, a variety of segmentation groups can be established. Certainly single factors could be used, e.g. simply group by the Daily Report, but the best segmentation comes from combining multiple factors. Grouping products based on various factors simultaneously is better done using the database program Microsoft Access Thus, for this project, the initial Segmentation Factors were determined in Microsoft Excel and then, when complete, the results were transferred to Microsoft Access for the actual Segmentation Grouping.

4.3 Segmentation Grouping

Taking the multiple factors described above and turning them into a coherent set of groups is both a science and an art- there are simply so many different ways to do it that initially the task can appear to be overwhelming. This section will provide a couple of examples of segmentation grouping, each with a different focus, to provide descriptions of the process and, in the Results section, the consequences of applying policies to those groups.

To start with, the number of factors mentioned above combined to create 6912 different segmentation groups (2 x 4 x 3 x 3 x 3 x 4 x 2 x 2 x 2). This is more than is practical to apply; PIH is not going to have almost 7000 different supply chain policies for different groups. But in reality, there is not going to be products listed in every one of those categories; there are nearly 14 times more categories than products.

The initial step is to segment using all of the factors in Microsoft Access to see how many of these buckets actually contain products. The result, shown in Figure (10) is 202- using all of the factors, the products fill 202 different buckets. Some of the products are alone in a segment, while some are in smaller groups.

CountOfProductID	DailyReport	Usage	UsageCV	Replenishme	Distribution	Sourcing	ShelfLife	ColdChain	Crisis
3	NO	DAILY	HIGH	ANNUALLY	ALL	IDA	>2 YRS	NO	NO
4	NO	DAILY	HIGH	ANNUALLY	ALL	OTHER	>2 YRS	NO	NO
1	NO	DAILY	HIGH	MONTHLY	ALL	HAITIAN VENDOR	>2 YRS	NO	NO
1	NO	DAILY	HIGH	QUARTERLY	ALL	HAITIAN VENDOR	>2 YRS	NO	NO
7	NO	DAILY	HIGH	QUARTERLY	ALL	IDA	>2 YRS	NO	NO
1	NO	DAILY	HIGH	QUARTERLY	ALL	IDA	>2 YRS	NO	YES
3	NO	DAILY	HIGH	QUARTERLY	ALL	IDA	2 YRS OR LESS	NO	NO
1	NO	DAILY	HIGH	QUARTERLY	ALL	OTHER	>2 YRS	NO	NO
1	NO	DAILY	HIGH	QUARTERLY	ALL	OTHER	>2 YRS	NO	YES
1	NO	DAILY	LOW	ANNUALLY	ALL	HAITIAN VENDOR	>2 YRS	NO	NO
2	NO	DAILY	LOW	ANNUALLY	ALL	IDA	>2 YRS	NO	NO
1	NO	DAILY	LOW	ANNUALLY	ALL	PEPFAR/GLOBAL FUND	>2 YRS	NO	NO
1	NO	DAILY	LOW	MONTHLY	ALL	HAITIAN VENDOR	>2 YRS	NO	NO
1	NO	DAILY	LOW	MONTHLY	ALL	IDA	>2 YRS	NO	NO
2	NO	DAILY	LOW	MONTHLY	ALL	OTHER	>2 YRS	NO	NO
1	NO	DAILY	LOW	MONTHLY	ALL	OTHER	>2 YRS	NO	YES
2	NO	DAILY	LOW	QUARTERLY	ALL	HAITIAN VENDOR	>2 YRS	NO	NO
1	NO	DAILY	LOW	QUARTERLY	ALL	IDA	>2 YRS	NO	NO
1	NO	DAILY	LOW	QUARTERLY	ALL	IDA	>2 YRS	YES	NO
1	NO	DAILY	LOW	QUARTERLY	ALL	IDA	2 YRS OR LESS	NO	NO
3	NO	DAILY	LOW	QUARTERLY	ALL	OTHER	>2 YRS	NO	NO
1	NO	DAILY	LOW	QUARTERLY	SPECIALIZED	OTHER	>2 YRS	NO	NO
1	NO	DAILY	LOW	QUARTERLY	SURGICAL	OTHER	>2 YRS	NO	NO
2	NO	DAILY	MEDIUM	ANNUALLY	ALL	IDA	>2 YRS	NO	NO
1	NO	DAILY	MEDIUM	ANNUALLY	ALL	OTHER	>2 YRS	NO	NO
1	NO	DAILY	MEDIUM	ANNUALLY	SPECIALIZED	OTHER	>2 YRS	NO	NO
1	NO	DAILY	MEDIUM	MONTHLY	ALL	HAITIAN VENDOR	>2 YRS	NO	NO

Figure (9) Screen Shot of Using All Factors

Figure (10) shows an example of one drug (the product that is highlighted above Figure (9) in blue) and how it fits into this grouping.
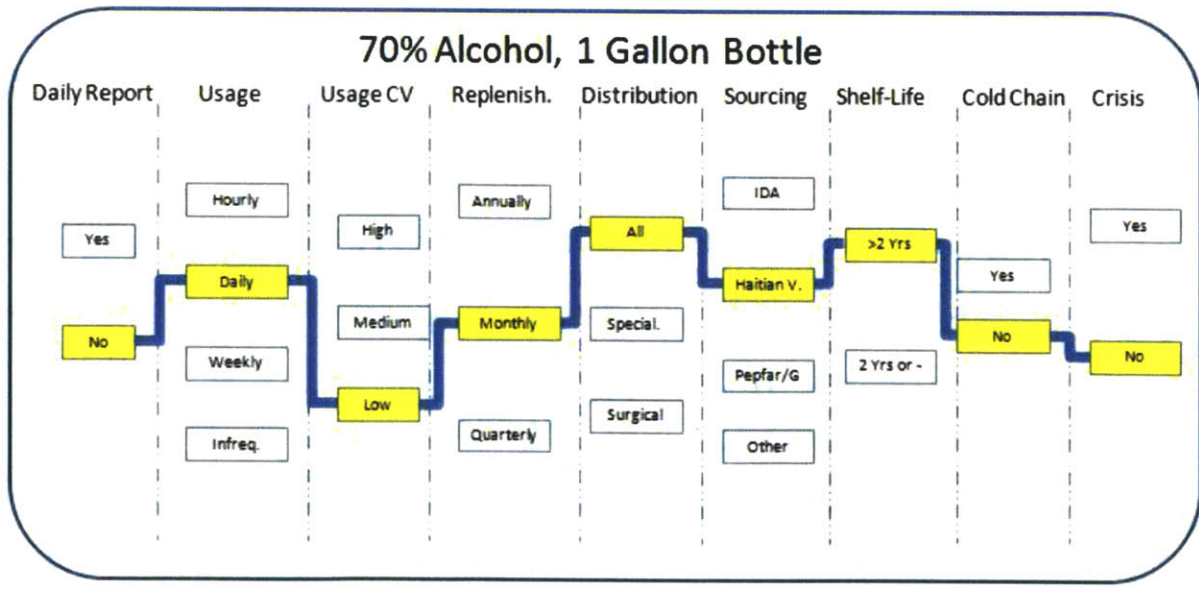

Figure (10) Example Segmentation of 70% Alcohol, 1 Gallon Bottle

202 different buckets is definitely an improvement over 6912, but for only 571 products, this remains a more complicated breakdown than is useful.

The next step is to combine these segmentation buckets into larger groups This sometimes is accomplished by choosing to remove segmentation factors, effectively reducing the number of buckets. Sometimes it is done by combining these buckets. There is no correct approach, but rather a variety of options given your intent/objective. For the purposes of this project, I will describe two different approaches.

An important consideration to remember is the concept "Mutually Exclusive, Collectively Exhaustive." This idea describes the effect applying different segmentation groups to a set of products should have. The groups should be defined enough that products can only be found in one- there is no chance of products moving between groups because the characteristics chosen are not exclusive enough. Also, the groups must, combined, account for all of the products. If the segmentation is done and there are leftover items, the process is not complete enough.

4.3.1 Supply Chain Focus

First, I went through the process with a focus on traditional supply chain characteristics. Basically I approached the problem by looking at which factors would be most useful for developing standard supply chain policies such as safety stock, inventory policy, and order/re-order points Hence, this segmentation relies on the overall demand, lead-time, and variability of demand for a certain product.

Thus, the factors of "Usage," "Sourcing," and "Usage CV" were used to create buckets. The result is shown in Figure (11) and further explanation follows.
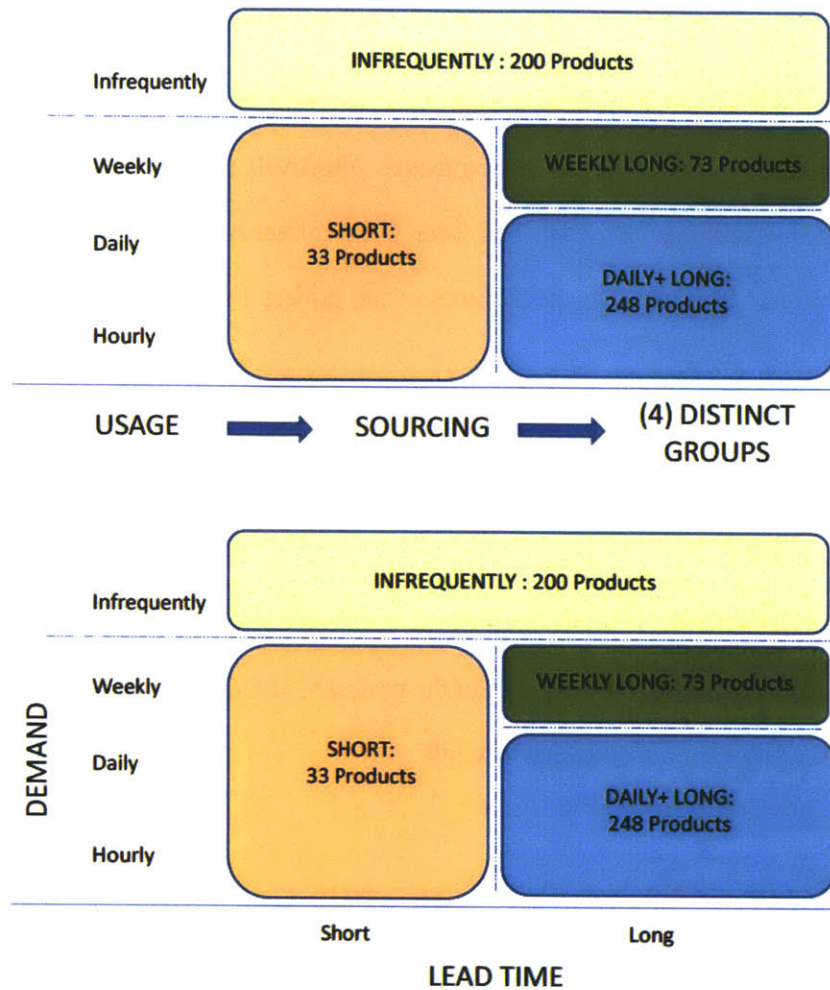
Figure (11) Supply Chain Focus Approach Segmentation Groups

Working with PIH staff around which groups we ended up with four main groups:

1. Infrequently: All products that were used Infrequently were assigned to this group. Because of their lower demand, The lead time difference was not as critical. This comprised 200 products.

2. Short: The products here have Weekly, Daily, or Hourly Demand and a Short lead-time. For the purposes of this segmentation, this meant products that are sourced from "Haitian Vendor" or "PEPFAR/Global Fund." As described above these two sourcing locations are considered to be local to Haiti, and thus have a much shorter lead-time. This is important because they should be

easier to replenish. Thus, the Short group combined all of the higher demand products with shorter lead-times. In the Short group are 33 products.

3. Weekly Long: Among the products with long lead-time (identified as being sourced from IDA or Other) and at least Weekly Usage, I broke these down into two main groups- Weekly and "Daily+." The Weekly Long category is composed of those products with a Weekly usage and a long lead-time. In the Weekly Long category are 73 products.

4. Daily+Long: They are those with the highest demand (at least Daily Usage) and longest lead-time. These products move through PIH's supply chain the fastest and require the most advance warning for stock-outs, re-orders, and the like. These products should require the most supervision, review, and the most stringent policies. There are 248 products in this group.

At this point, the segmentation could be considered complete, but the "Daily+ Long" group has a large number of products that require the Usage CV factor.. Applying this factor across all of the groups may seem useful, but creating more than just 3-6 groups creates further complexity. In this case, I chose to apply Usage CV only to help break-down the most important group even further, to really flesh out those products that require special considerations and/or policies.

DAILY+ LONG: 248 Products

| | Daily Long High: 20 Products | Daily Long Medium: 62 Products | Daily Long Low: 20 Products | DAILY LONG: 102 Products |

Hourly Long High: 12 Products | Hourly Long Med.: 94 Products | Hourly Long Low: 40 Products | HOURLY LONG: 146 Products

HIGH: 32 Products   MEDIUM: 156 Products   LOW: 32 Products
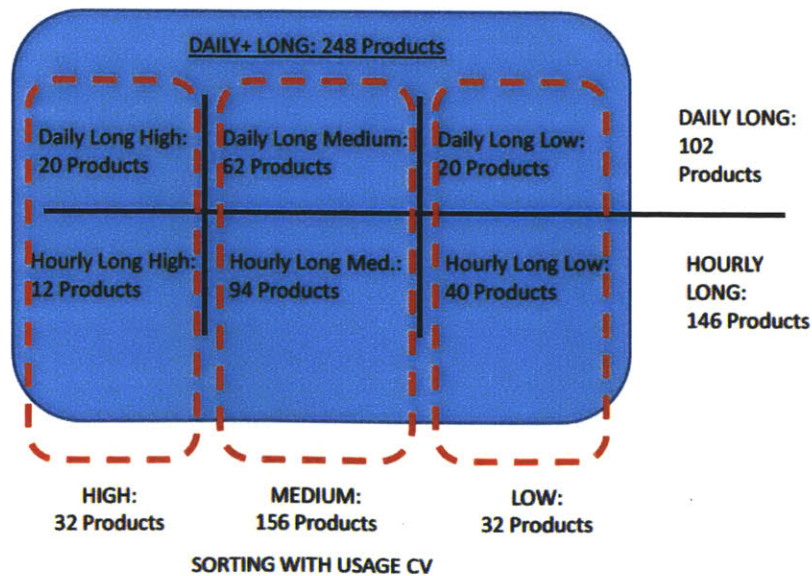
SORTING WITH USAGE CV

Figure (12): Breakdown of Daily+ Long Group using "Usage CV"

Breaking down the Daily+ Long group directly by Usage CV creates six groups overall (3 from the Daily+ Long group) but better highlights those products that require more safety stock, less time between reviews, and possibly higher re-order points. These products would be found in the Daily+ Long "High" (and possibly "Medium" depending on your point of view) - the "High" variability in Demand may dictate different policies than if you had not further broken-down this Daily+Long group.

4.3.2 Process Focus

What was especially interesting in the course of this project was that when the segmentation factors were created and complete, I developed an application of those factors as described in the Policy section based on developing data to dictate policies. When presented with the same segmentation factors, PIH personnel approached the problem in a Process-focused way. That is, they created a segmentation set-up that identified different processes that the different products go through to get to the end-user in Haiti. In this manner, the process of the supply chain was prioritized over the resulting policies that could be developed. I will discuss this difference in approach further in the Results/Recommendations sections,

but now I will describe an alternate segmentation grouping, again using the factors already described.
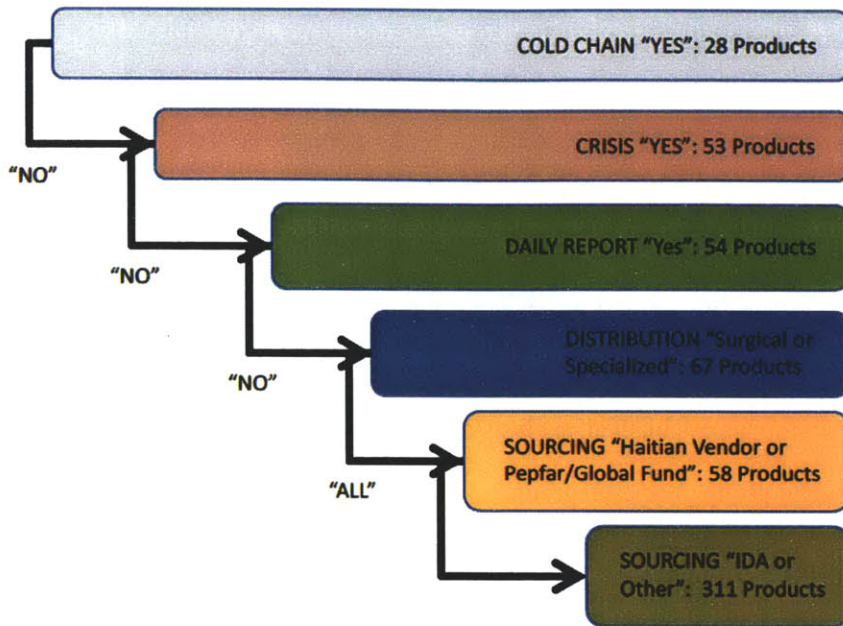
Figure (14): Process Approach Segmentation Groups

In this approach, most factors are included, but in a less over-lapping method. This allows for certain process characteristics, i.e., whether sites need a product to treat crises that could break out at any time, to be highlighted and not then muddled by further grouping/re-grouping.

For example, in this method it is important to know the intended use of a product. Rather than grouping products by quantifiable factors such as demand and demand variability, this seeks to identify them by a more subjective classification. Questions under this approach would be similar to:

- "How many sites need this product on hand?"

- "Is this product essential to have in stock regardless of how often it is used?"

- "Does this product require specialized handling or have a unique use?"

These questions, and many more similar to them, are ones that the personnel at PIH handle every day, and when they think of segmentation, they think of identifying products by the answers, not by certain supply chain calculations or formulas.

In addition, the general approach used to develop this breakdown was different. For the policy application, I started with a list of factors that I thought would help decide some objective policies. As described previously, first I used Usage, then Sourcing, and finally, as necessary, Usage CV. However, for the process approach, the starting point was not developed using the factors but rather by which groups PIH needs to be able to identify; for example, those products that are "General Need to Have" at all sites. Then, with the final six groups established, analysis/discussion was completed to decide which factor best answered that particular group. For each group:

1. Cold Chain: Cold Chain factor "Yes." These products require cold chain storage throughout their time in the supply chain. While PIH's warehouse facilities all have some cold chain capability, the staff still wanted these products easily identified.

2. Emergency Medication: Crisis factor "Yes." This was developed only after the PIH team identified this requirement.

3. General Need to Have: Daily Report factor "Yes." The Daily Report should identify those priority products that need more frequent review/evaluation.

4. Specialized: Distribution factor "Specialized or Surgical." Again, this factor is being used in an indirect manner- by highlighting those drugs needed only at certain locations, the staff hopes to create a group of unique products.

Procurement Process: Sourcing factor, by Long & Short (Long = IDA or Other, Short = Haitian Vendor or Pepfar/Global Fund). While earlier the focus was on a simple lead-time breakdown. In this case the focus is on whether the PIH team in Boston normally handles the procurement or if the ZL personnel in Haiti can/do. Through this method, the PIH staff is able to better identify those products that require special attention and/or different processes through some or all of their supply chain. In this regard, the method is effective for high-lighting certain characteristics. However, it still leaves a

somewhat incomplete segmentation in the final group (Group #6, colored gray in Figure (14)). With more than 300 products in this final category, this method leaves over half of all products being grouped together in a segment. The likelihood of certain policies pertaining equally to all of the products in this group is low additional segmentation is needed. But with the Process method already producing six groups to this point, additional segmentation may quickly erase the usefulness of this procedure.

4.4 Policy Assignment

Supply Chain Policies

In order to quantify the benefits of the segmentation approach, it was necessary to continue the process described so far and actually develop supply chain policies from it. An example of how this can be done follows, using the "Supply Chain Focus Approach" earlier.

Figure (15) illustrates the segmentation groups with the corresponding policies written in each box; they are described below:

R: Assigned based on group
L: Assigned based on Sourcing (IDA or Other = 4,
Haitian Vendor or Pepfar/Global Fund = 1)
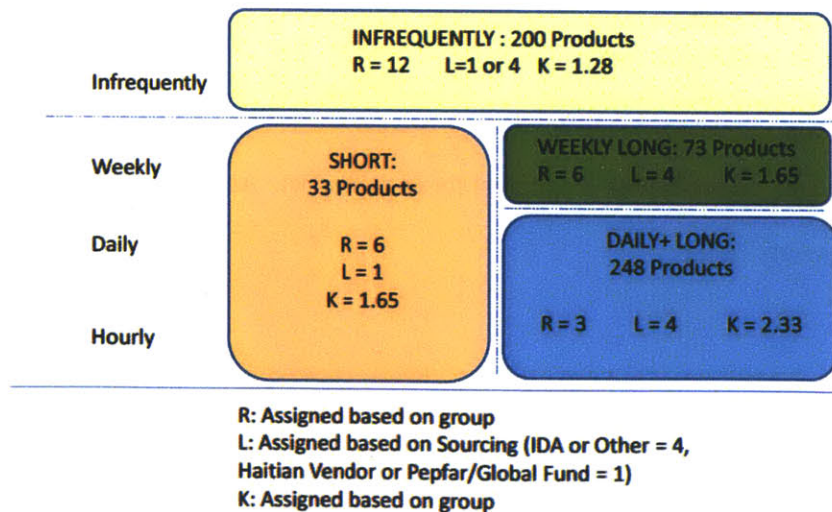K: Assigned based on group

Figure (15) Supply Chain Policies Assigned to Segmentation Groups

K Values: These values are assigned based on the group to which a product was classified. The K values corresponded so that groups with a higher throughput (i.e. Usage) and a longer lead-time (identified through Sourcing) were given higher K values. The K values selected for this graph are meant to be illustrative- they are only an example of how the process would look and what the effects would be.

Lead-time: This is simply based on previous experience. For those products that are sourced from either IDA or Other (Long) an $L = 6$ was assigned. This corresponds to the fact that IDA generally takes about 6 months to bring an order to Haiti. For those products that are sourced from a Haitian Vendor or Pepfar/Global Fund, an $L = 0.5$ was assigned. This corresponds to the fact that these drugs are usually able to be procured in country, and thus have a lead-time of only 2 weeks (or 0.5 a month). If in the future, these lead-times change, then PIH can simply change these values to match the procurement reality.

Review Period: These were assigned to products based on products' demand, or Usage factor, and Sourcing. Products that move through the supply chain system faster, and cannot be replaced as quickly, should have their inventory reviewed more often, and the R values were assigned to reflect that. However, products with a short lead time need not be reviewed as often even if they have high demand, as it takes less time to replace inventory.

Given these assignments, Microsoft Access will automatically combine them and the products' characteristics produce the specific re-order point for each product. An example is included in Figure (16) for the Infrequently Group.

| zTableDAILYHOURLYLONG | zTableINFREQ | zTableSHORT | zTableWEEKLYLONG | Query6 | | | | |

ProductName	StDevMonthly	AvgDemand	Leadtime(L)	ReviewPeriod(R)	KPolicy	SafetyStock	OrderPoint
Acetazolamide 250 mg Tablet	197.0901	146	1	4	1.28	1,261	1,991
Acetone 1 l Bottle	3.399702	5	1	4	1.28	22	47
Acetylsalicylic acid 500 mg Tablet	1143.049	1410	1	4	1.28	7,316	14,366
Akineton 5 mg 5 mg Ampulle	0	5	1	4	1.28	0	25
Akuchek-CRP Latex Test 1 (item) Other	0	100	1	4	1.28	0	500
Akuchek-RF Latex Test 1 (item) Other	70.00357	50	1	4	1.28	448	698
Alcool Prepads 1 (item) Other	18.98119	46	1	4	1.28	121	351
Alcool acide 1 l Bottle	1.292546	2	1	4	1.28	8	18
Amikacin 250 mg Ampulle	0	908	1	4	1.28	0	4,540
Aminophylline (25mg/ml) 10 ml Other	31.81943	48	1	4	1.28	204	444
Aminophylline 100 mg Tablet	621.7828	1093	1	4	1.28	3,979	9,444
Amphotericine B 50 mg Ampulle	0	9	1	4	1.28	0	45
Ampicillin 500 mg Other	109.988	121	1	4	1.28	704	1,309
Anesthesia Circuit 1 liter- Infant 1 (item) Other	2.065591	3	1	4	1.28	13	28
Anesthesia Circuit 3 liter - Adult 1 (item) Other	2.948035	4	1	4	1.28	19	39
Anti-AB antigen 10 ml Bottle	4.061617	4	1	4	1.28	26	46
Antigen Determine Hepatitis B 1 (item) Bottle	79.83015	106	1	4	1.28	511	1,041
ASO (IMMUNOLEX) 50 (item) Other	53.24002	70	1	4	1.28	341	691
Atropine 5ml (0.4mg/cc) 5 ml Ampulle	6.082763	6	1	4	1.28	39	69
Atropine eye drops 0.25% 10 ml Other	38.00313	23	4	4	1.28	389	573
AZT+3TC 60/30 mg 90 mg Tablet	0	120	4	4	1.28	0	960
AZT+3TC+NVP 60/30/50 mg (Junior) 140 mg Tabl	0	300	4	4	1.28	0	2,400
Biperiden 5 mg Ampulle	1.643168	4	4	4	1.28	17	49
Bipuvicaine (5mg/ml) 1 (item) Ampulle	19.44994	22	4	4	1.28	199	375
Bistouri 22 22 (size) Other	0	100	4	4	1.28	0	800
Blade 22 1 (item) Other	0	20	4	4	1.28	0	160
Bovie 1 (item) Other	21.34815	64	4	4	1.28	219	731

Figure (16) Example of Microsoft Access Calculating Policies (Infrequently Group)

| zTableDAILYHOURLYLONG | zTableINFREQ | zTableSHORT | zTableWEEKLYLONG | Query6 | | | | |

ProductName	StDevMonthly	AvgDemandMonthly	Leadtime(L)	ReviewPeriod(R)	KPolicy	SafetyStock	OrderPoint
Acid benzoic 6%+ Acid salicilic 3% 40 mg Othe	82.20135	90	4	3	2.33	1,341	1,971
Acyclovir 200 mg Tablet	1899.728	30	4	3	2.33	30,985	31,195
Adhesive tape 5cm / 5m 1 (item) Other	143.7446	3096	4	3	2.33	2,344	24,016
Adhesive tape 2.5in x 5 m 1 (item) Other	311.0275	158	4	3	2.33	5,073	6,179
Adrenaline (1mg/ml) 1 mg Ampulle	58.66087	11	4	3	2.33	957	1,034
Albendazole 200 mg Tablet	4396.125	65	4	3	2.33	71,701	72,156
Albendazole 400 mg Tablet	1785.055	87	4	3	2.33	29,114	29,723
Aluminum Hydroxide and Magnesium Hydroxi	79677.88	138	4	3	2.33	1,299,546	1,300,512
Aminophylline 25 mg/ml 10 ml Ampulle	99.73959	206	4	3	2.33	1,627	3,069
Amox-Clav 500 mg Tablet	3775.467	11	4	3	2.33	61,578	61,655
Amoxycillin 500 mg Tablet	59471.81	3407	4	3	2.33	969,985	993,834
Ampicillin 1 g Other	1571.206	477	4	3	2.33	25,626	28,965
Applicator monte - not sterile 1 (item) Other	1856.617	1208	4	3	2.33	30,281	38,737
Applicator monte - sterile 1 (item) Other	876.1075	1682	4	3	2.33	14,289	26,063
Applicator not monte - not sterile 1 (item) Otl	1561.503	75736	4	3	2.33	25,468	555,620
Aspirin 100 mg Tablet	9851.611	3589	4	3	2.33	160,680	185,803
Atropine (1 mg/ml) 1 ml Ampulle	93.693	1068	4	3	2.33	1,528	9,004
sterile pot 120 ml Bottle	714.3638	1446	4	3	2.33	11,651	21,773
Benzyl Benzoate Lotion 25% 1 l Other	107.6333	131	4	3	2.33	1,755	2,672
Betadine iode 10% 1 (item) Bottle	143.0932	32	4	3	2.33	2,334	2,558
Blade 1 (item) Other	4154.925	3540	4	3	2.33	67,767	92,547
Blood tube purple 1 (item) Other	2390.849	1038	4	3	2.33	38,995	46,261
Blood tube red 1 (item) Other	2346.735	18040	4	3	2.33	38,275	164,555
Bromocryptine 2.5 mg 2.5 mg Tablet	1615.739	2816	4	3	2.33	26,353	46,065
Butylscopolamine 20 mg Other	1131.329	3327	4	3	2.33	18,452	41,741
Butylscopolamine 10 mg Tablet	17229.16	18631	4	3	2.33	281,008	411,425
Carbomazepine 200 mg Tablet	2186.964	55518	4	3	2.33	35,669	424,295

Figure (17) Example of Microsoft Access Calculating Policies (Daily+ Long Group)

This straight-forward example shows the end of one iteration of the segmentation process. At this point, this paper has taken over 550 products in Partners In Health's supply chain in Haiti and:

1. Developed common characteristics by which the products could be defined, both individually and in groups.

2. Provided examples of how to best combine these factors into actual, useable segmentation buckets.

3. Provided an example of assigning supply chain policies to these different groups and the results of such an example.

5. Recommendations/Conclusions

This project was meant to establish the validity of applying segmentation practices to a non-profit, healthcare supply chain, specifically that of Partners In Health. Building especially upon the research work done in the previously-described USAID paper (Allain et. all 2010) and Tailored Logistics paper (Fuller, O'Conor, & Rawlinson 1993), this project added to these and other works by actually going through the process of implementing a couple segmentation approaches to a non-profit organization. This paper details the effectiveness of doing so, provides instruction on the steps necessary to do so, but it does not fully flesh out all areas of impact of segmentation nor does it fully consider all obstacles to implementation.

For example, with multiple warehouses coming on-line in the very near future (Mirebalais joining St. Marc, Port-Au-Prince, and the main Cange Depot), there is certainly benefit in evaluating the prospect of different segmentation groups being held at different locations. For example, under the Supply Chain Focus Approach outlined above, PIH may find it useful to establish inventory stocking policies that reflect these segmentation groups- placing, for example, the Daily+ Long Group (fast-movers) at the Port-Au-Prince warehouse for quick turn-over to sites through Haiti. Also, Cange Depot could be used as a storage point for items being held typically for longer periods of time, such as the Infrequently and/or Weekly Long Group.

For this paper's purposes, there are two competing approaches to segmentation under these circumstances - the Supply Chain Focus vs. Process Approach. The fact that neither is easily identified as better than the other presents the option that some combination of the two would work best. However, how best to combine the two approaches is outside the scope of this project and should be examined in the near future before critical decisions are made at Partners In Health or sites in Haiti. Alternatively, other approaches undoubtedly exist and should be examined prior to inventory decisions being implemented.

Also, the assignments of values (especially lead-time (L) and review period (R) above) were assumed to be deterministic. In reality, these two times are somewhat variable across different sources and even different products. PIH should attempt to work with its suppliers, especially IDA, in order to bring some stability to its orders and deliveries. Especially useful would be if PIH and/or IDA could concentrate on those products that require the most supervision, both because of their demand characteristics as well as their intended use.

Lastly, the segmentation groups and factor defined in this paper can possibly be utilized in other manners than defined here. For example, as brought forward by PIH staff, the ability to quickly sort and identify products by certain characteristics may be useful in other management practices, such as verifying existing policies like the Daily Report. Ideally, this report lists all products in the PIH supply chain that have been deemed important enough for more continuous supervision, either because of the impact of a stock-out, high demand, or long lead-time to replace them (or a combination of the three). Sorting through the database will allow PIH to routinely fix/update the Daily Report as they are able to quickly identify products that are not on the Daily Report, but should be as they have certain characteristics (and vice versa).

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