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TOTAL LANDED COST MODEL FOR A PHARMACEUTICAL RETAIL COMPANY

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ABSTRACT

Total cost models are particularly useful in supply chains, although many companies lack the ability or resources to establish a working model. With increasingly global supply chains, more available data, and a focus on decreasing supply chain cost to increase profit margin, it is becoming more and more critical for companies to implement total cost models into their daily business functions. This thesis will delve into total landed cost research to establish the most effective ways of measuring total cost, thereby providing Company A with a framework to measure supply chain success.

Ultimately, this thesis develops a total landed cost model that demonstrates where costs are incurred throughout two products' life cycles. Based on company interviews, established data sources, and literature reviews, this thesis will identify new ways to look at total landed cost in order to pinpoint areas for improvement along Company A's supply chain.

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Chapter 1

Introduction

Purchasing is one of the most critical functions of an organization, yet purchasing decisions infrequently consider where and to what degree many of their costs are incurred. This can present various issues, including skewed profit margin analyses and sourcing decisions that do not maximize the efficiency of a supply chain. To combat these issues and create a clearer view of a product's actual cost, it is helpful to integrate a total cost model. Here, each step of a product's life cycle is detailed and corresponding activities are costed accordingly. Total cost models pinpoint where exactly costs are incurred, and can in turn help to measure the worth of the product by creating a realistic view of each contributing cost.

Total cost models can be notably more complicated than typical cost models used by companies, and because of this, they are rarely integrated into product management decisions. The factors comprising a total cost model can vary greatly depending on the particular case at hand, further complicating the matter. Life cycle costing itself is defined as "all production-related costs as well as non-production costs such as sales, administration, R&D, customer service, and disposal costs" (Fisher & Krumwiede, 2015). This general structure can further be altered to capture hidden costs or to encompass different product attributes and company needs.

As landed cost models are gradually being recognized for their numerous benefits and are thus becoming increasingly popular, companies are finding new ways to implement them into their daily functions. Though the importance of the total landed cost model is notable, there are pronounced gaps between what technology is capable of doing in terms of calculating total cost and what companies want (Pumpe and Vallée, 2015).

This thesis examines the total cost structure of a supply chain from the point of acquisition to placement at the front of the retail store. It will take a qualitative and quantitative view of a total cost model that extends through to deposition, a view which has not yet been exclusively examined in the literature. Through a case study, the landed cost model will allow a clearer understanding of the supply chain costs that are incurred. Through further research, an Excel model will demonstrate how total cost can be derived from multiple different areas and ultimately demonstrate how the total cost of a product might not be totally reflected in product cost. Finally, a course of action will be offered so that the company in question is able to best analyze their product offerings and act accordingly.

Chapter 2

Background

The Need for a Total Cost Model

The purchase price of a product is not all that it seems. When a company purchases a product, the face-value of that product never fully reflects all of the costs incurred. For this reason, total cost models exist to provide a clearer view of the areas where supply chain costs can be lowered, processes can be streamlined, and the company as a whole can become more efficient.

The need for total cost models exists because of the range of "hidden" costs scattered throughout supply chains. Though their prevalence in different supply chains and companies vary, they tend to occur even more frequently in international supply chains. Some of these costs include the internal costs (such as human resources) associated with working with international suppliers, the cost changes resulting from duties and tariffs, true inventory costs that measure the product cost throughout the length of the supply chain, adjusting costs for quality changes resulting from offshore manufacturing, and varying logistics costs due to unexpected changes in the supply chain (Trent & Roberts, 2017). And the importance of catching and accurately representing these costs is not unnoticed – seventy percent of manufacturing executives cited total cost analyses as one of four capabilities still requiring development to meet supply chain specifications and network development goals (Ferreira & Prokopets, 2009). This clearly indicates a lack of and need for proper cost measurements and systems that are able to measure true total cost.

In practice, all total cost models are classified in the same family of measurements, aptly named cost-based measurements. They aim to look at cost objectively rather than subjectively, and take into consideration the many different areas where costs should be considered.

Figure 1 details the three general categories of total cost models and their corresponding pros and cons:

Categorical		Weighted-Point		Cost-Based	
Advantages	**Disadvantages**	**Advantages**	**Disadvantages**	**Advantages**	**Disadvantages**
• Easy to implement • Requires minimal data • Requires minimal system resources to develop or operate • Low cost to maintain • Good for less-critical requirements	• Less reliable • Mostly broad, subjective assessments • Usually manual, although some may use spread-sheets	• Offers flexibility in assigning weights across categories • Allows ranking of suppliers • Moderate cost to implement • Does not require extensive system support to develop or maintain	• Often focuses on standard performance categories • Qualitative ratings might be inconsistent between raters • Usually requires manual data collection and input	• Provides a total cost approach • Identifies specific areas of supplier nonperfor-mance • Allows objective rankings • Offers greatest potential for long-range improvement	• Usually requires a cost accounting system • High development costs • Cross-functional support required to capture data • Often relies on average rather than actual costs

Figure 1: Total Cost Model Pros and Cons, Trent & Roberts 2017

As shown in the above figure, there are three main categories of total cost models. The first, categorical, refers to rating suppliers on “good, better, best” terms, and overall is considerably less effective than the other two forms of cost-based measurements. Weighted-point systems measure suppliers’ performance across a variety of measures in correspondence to their importance. Cost-based systems can be broken down even further into three types of models. These are total landed cost, supplier performance cost, and life-cycle cost. These generally have overlapping categories, which ultimately results in the familial “cost-based system” grouping. Typically, these are the most expensive and complicated forms of models to produce, although they also tend to benefit companies the most when it comes to pinpointing areas of improvement and streamlining operations (Trent & Roberts, 2017).

When building a total cost model, there are four types of data that can be implemented. The first is tangible data companies can draw from. For instance, this could be considered to be the face-value cost of procuring a good, or the cost associated with holding the item in a warehouse. They have records on file of where the costs are incurred and how much can be attributed to the item. The second type of data is estimated cost based on internal factors, such as the cost of a partial day of labor. Costs are estimated from internal sources and molded to fit a need. The third is data sourced externally. This might not be especially reliable, as the numbers may not actually be applicable to the company and specific model in consideration. Fourth and least reliable of all is the data completely excluded from the model. This information is generally less valuable and pertinent to the company, and leaving it out of the total model makes more sense than procuring the information. Its implementation is simply the knowledge of the cost existing and its potential impact on the total cost model.

After the review of many sources of literature, it is clear that there are many different methods of measuring total cost. End-to-end models can vary drastically in what exactly they aim to measure, complicating the issue further. In addition to these measured costs, there are also statistical methods that can be applied to measure the confidence of accuracy within the total cost models. Figure 2 indicates the actual likelihood of various cost categories to be included in total cost models:

Table 4.2 Percent of Companies that Include a Specific Cost Element in Their Total Cost Models

Cost Element	Percent of Firms
Material/component price	88
Logistics and transportation	72
Exchange rate differentials	59
Supplier payment terms	50
Country specific costs (VAT, customs, etc.)	41
Cost of quality	41
Inventory charges	41
Product qualifications	34
Overhead and administrative costs	34
Increased procurement staff costs	31
Material handling and warehousing	28
Tooling cost	25
Packaging cost	22
Customer service cost	19

VAT, value added tax.

Figure 2: Total Cost Components, Trent & Roberts 2017

The intricacy of the total cost model, the type of data included, and the different cost elements included in a total cost model are up to the company at hand and the particular outcome it is aiming to observe. It is also important to note that even one very thorough costing model might not be suitable for every business decision. A more complex model might be better when making pricing decisions, but sourcing decisions might be executed just as effectively with a less complex throughput model, and in some cases the cost savings might just outweigh the benefits of developing a very detailed total cost model.

Product Total Life Cycle Best Practices

There are virtually endless options when it comes to choosing and building a model for a product's total cost. Depending on the availability of information, the model's intended purpose, the IT systems involved, the product itself, and a variety of other factors, creating a model can become very complicated and costly to produce. When executed well, however, the model can help cut down on extensive product lines and help manage product portfolios, guide strategic decisions, and help with cost and operational control.

Because of the wide array of costing options, it can be hard to know what specifically should be included in any one total life cycle model. Figure 3 below presents a summary of the most commonly used cost categories, as well as a scale to help navigate between more general costs and highly detailed costs. It can serve as one of the primary building blocks of a total cost model.

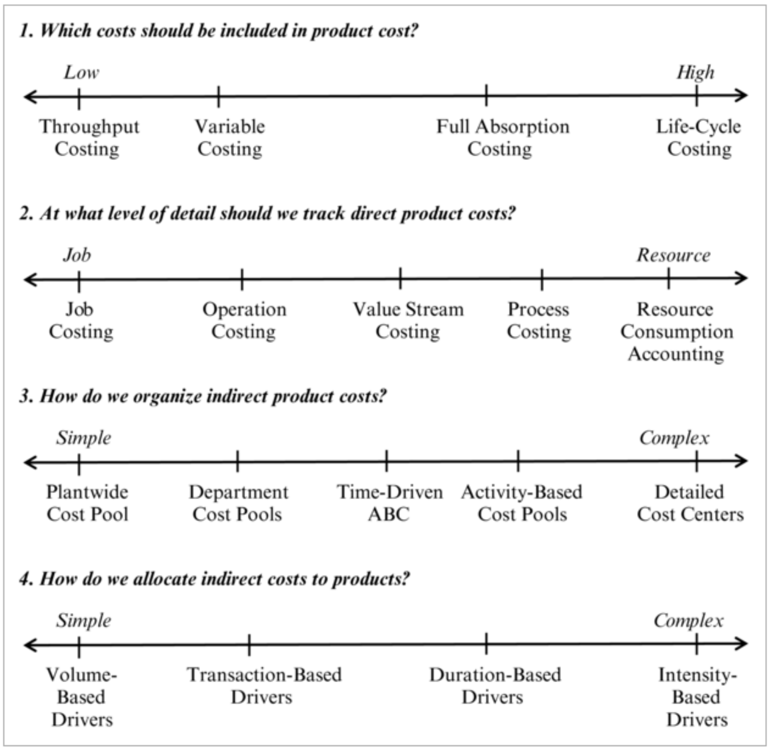

Figure 3: Navigating the TCM, Fisher & Krumwiede, 2015

The first question in Figure 3 refers to the level of specificity a model should have depending on what the desired outcome should show. “High” refers to the level of cost inclusivity, where throughput costing contains the lowest level of cost detail and life-cycle costing the highest in this chart. The second question refers to the source of direct costs. If products are unique, the costs typically fall on the “job” end of the spectrum, whereas resource consumption accounting (RCA) falls at the other end. RCA accounts for fixed and variable costs based on the level of production, and models how resources are consumed by outputs (Fisher & Krumwiede, 2015).

The third question to help guide model-building describes where to put indirect costs in the general organization. Indirect costs are typically hard to trace to a specific source, making them difficult to classify and organize. Plant-wide cost pools and department cost pools, where costs are allocated to a single cost pool or separate department-based pools respectively, are the most popular indirect product costing measures that companies use regularly. However, these typically only use one cost driver and therefore distort the view of total cost. Activity-based costing, or ABC costing, is much more accurate and delegates costs to the corresponding activity. Unfortunately, ABC costing is very difficult to implement, as measuring and calculating the exact costs incurred can be expensive and time-consuming (Fisher & Krumwiede, 2015).

Fourthly, building a total cost model requires indirect costs to be allocated to products. This demands that cost drivers are identified. Finding the right cost driver for products is critical in determining the total cost. Volume-based drivers are most commonly utilized with plant-wide and department cost pools, but ultimately the cost driver is determined by the nature of the product. Transaction-based drivers are most likely the best method to use in retail – they typically coordinate well with ABC costing, and include number of setups, design changes, or number of purchase orders. Furthermore, duration measures the time per transaction, and intensity-based drivers track specific activities, such as labor based on expertise and availability (Fisher & Krumwiede, 2015).

Variants and Components of a Total Cost Model:

The Total Landed Cost Model

A landed cost model is a relatively broad term that cannot be singularly defined. This is not surprising considering the varied structures and uses landed costs can be applied to. The Dictionary of Business defines landed costs as "the costs of goods which have been delivered to a port, unloaded and passed through customs" (2017). Francine Ciotti describes total landed cost (TLC) differently as a combination of "all the transportation charges, duties, brokerage fees, packaging costs, currency adjustments and other cost factors that go into an international sale" (1988). Though "landed" suggests international transactions involving duties and tariffs, total landed costs can also be applied to domestic goods. To reflect this, an even simpler definition of landed costs from Simchi-Levi, Simchi-Levi, and Kaminski is "the total cost of purchasing and delivering the product to its final destination" (2008). Because of their vast range of uses, total landed costs can be measured and utilized in a variety of different ways.

Despite their difficulty to capture in a single definition, total landed costs have proven to be exceptionally effective cost measurements and can serve as critical decision-making factors in international sourcing. In fact, studies have shown that over eighty percent of companies that chose to measure total landed costs were then able to lower their total landed costs (Trent and Roberts, 2017). Furthermore, the estimated cost decisions from sourcing product offshore is around fifteen percent. When all costs are taken into consideration and the true cost of the product is measured, however, the actual cost savings of offshoring can reach as low as five percent (Ferreira & Prokopets, 2009). This discrepancy exhibits the importance of accurately measuring landed costs and applying the findings to various supply chain elements.

In this thesis, the total landed cost will be considered as "the sum of all costs associated with obtaining a product, including acquisition planning, unit price, inbound cost of freight, duty and taxes, inspection and material handling for storage and retrieval" (Trent & Roberts, 2017). Each of these components is then broken down further into more detailed individual costs, coming together to form the total landed cost model.

This model is considered to be one of the most important cost-based systems available. It is highly encouraged for any company, from small to large corporation, to measure their total landed costs in pursuit of more accurate and beneficial sourcing decisions.

Total Cost of Ownership

The price of purchasing a single unit is never the true price of that unit, as it excludes many of the critical costs found in the supply chain. Therefore, total cost of ownership exists to present a fuller picture of the cost paid for an item over its entire lifecycle. Sonia Hill in The Encyclopedia of Management defines the Total Cost of Ownership (TCO) as "The overall costs of acquiring, operating, and disposing of capital or investment resources" (2012). TCO is very similar to net present value (NPV) found in finance. It differs from total landed cost because TCO it is typically used when making capital decisions that span longer periods of time, such as facility-related analyses, rather than making every day purchasing decisions.

Popularized in the 1980s because of its application in measuring overall IT costs, TCO is frequently used in management to gauge the use and costs of certain tools. For example, a new IT system comes with a face value. TCO then brings maintenance cost, depreciation, taxation, insurance fees, and fuel costs. It looks beyond the transactional cost to assist in strategic cost management.

Total Cost of Ownership is very closely aligned to many other supply chain measures, including life-cycle pricing and zero-base pricing. Life-cycle pricing de-emphasizes the pre-transaction cost and instead looks at the cost of acquiring, maintaining, and disposing of – all aspects of TCO. However, TCO differs in that it applies to any transaction or purchase and goes beyond fixed assets and capital of the life-cycle pricing model (Ellram, 1998). On the other hand, zero-base pricing looks mainly at the cost to the supplier and the external costs associated with procuring a product or service. TCO takes a more all-encompassing approach to costing.

Literature suggests that there are multiple ways to look at TCO and measure the overall cost of a product or service. In any case, there are generally three main components of the TCO model: purchase price, operating, and disposal costs (Hill, 2012). They are broken down into the following costing arenas as seen in Table 1:

Table 1: Elements of TCO

Purchase Price	**Operating Costs**	**Disposal Costs**
• Market valuation	• Transportation • Installation • Maintenance on operating equipment	• Depreciation/obsolescence value

These functional areas can measure different things depending on the model and final use of the TCO calculation. For example, the cost of evaluating suppliers can sometimes be slotted into the purchase price.

Once the TCO has been calculated, management can use the cost in various areas such as planning, sustainability, projection of cash flow, equipment and vendor selection, and leasing consideration among others (Hill, 2012). TCO is most useful in industries where technology evolves rapidly and drastically, such as IT.

The most obvious difference between TCO and total landed cost is the lack of focus on the total supply chain. The cost of adding extra touches, lack of focus to time spent in different areas such as warehousing, and the type of transportation, among other things, is largely excluded from the TCO model. On the other hand, total landed cost excludes the cost of the product's decreasing value, as well as maintenance costs and other factors the product or service might include. Like the total landed cost model, complexity and lack of relevant data serve as major barriers to companies that might otherwise find the TCO model useful in daily operations.

Pharmacy and Drugstore Industry Background

While this research can be applied to many different industries, the area of applied focus is within the Pharmacy and Drugstore industry. This industry is described as “retail a range of prescription and over-the-counter medications, health and beauty items, toiletries and consumable goods directly to consumers on a walk-in basis” (Hoffman, 2017). While the research in this thesis does not focus on the drug portion of the company’s activities, it does involve retailing miscellaneous goods including cosmetics, paper goods, and light refreshments.

There is a fair amount of market competition in the Pharmacy and Drugstore Industry. However, because of a fairly high number of barriers to market entry, the three top competitors generate about sixty-two percent of the total industry revenue. Walgreens and CVS are the biggest industry players (Hoffman, 2017).

Success within the Pharmacy and Drugstore industry is dependent on a variety of factors. One of these key factors is the ability to control on-hand inventory. Another important factor is convenience. Consumer purchasing in these stores in mainly driven by easy access to desired products and the store’s ability to maintain a diverse range of products. Furthermore, the industry is expected to undergo growth in the years leading up to 2022 due to favorable changes in healthcare reform (Hoffman, 2017).

Chapter 3

Method and Analysis

Company Background

The company in focus will be referred to as Company A. It is a multi-billion-dollar retail pharmacy and pharmaceutical company. This paper looks at front-of-store inventory only, excluding pharmaceutical products.

Company A has multiple methods of measuring cost, but does not have a model that measures total landed product cost from acquisition to sale based on product flow. Complicating the model, Company A has a vast range of SKUs offered that can all have varying supply chains. There are around eighteen thousand products regularly replenished in any of Company A's retail establishments. Product categories are derived by grouping similar stock-keeping units (SKUs), such as cosmetic items. Some categories can contain many more items than others depending on the item type.

To demonstrate how different items can be from each other, this paper examines two greatly different SKUs – one with a high turnover rate and low cube (a candy peanut butter cup), and one with a low turnover rate and high cube (a wicker coffee table). These differences imply a different number of touches throughout the supply chain and different overall flows due to shipment quantities, replenishment rates, etc. Products with higher turnover will have more touches overall to replenish inventory, driving up labor cost. However, they will also have a higher inventory carrying cost as a result of greater need for safety stock.

Product Flow

In this model, landed cost will be measured from the point of product acquisition to customer purchase or deposition. In about eighty percent of cases, ownership of the product begins upon receipt to the distribution center, therefore eliminating the cost of transportation to distribution center and any liability cost. The below diagram demonstrates the main cost centers of the Total Cost Model. While costs outside of these areas are considered, the cost of labor is derived in each and applied according to product nature.

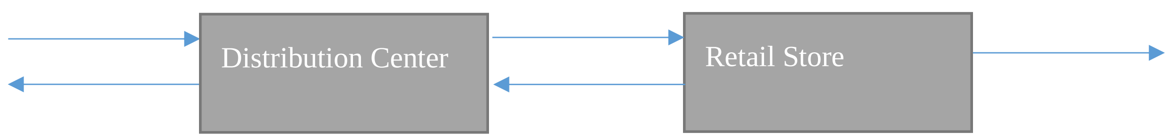

Figure 4: General Flow of Goods

Figure 4 shows the general product flow for any particular item. The flow into the distribution center is typically not considered in the total cost, as ownership is typically gained at the point of delivery to the distribution center. Product flow from the distribution center to the manufacturer is a return for damaged material. Similarly, the arrow flowing from the distribution center to the retail store implies transportation cost that Company A is incurring, as well as returned product from the retail store or product deposition cost. The arrow flowing right from the retail store implies the flow to the end customer. The main cost drivers in the supply chain are costs incurred at the distribution center, the retail store, and the transportation costs. These are broken down further to shape the total landed cost model.

Retail Store Flow

Depending on various product attributes, the flow within the retail store can vary greatly, therefore affecting the incurred costs. The two products examined in this paper (a wicker coffee table and

Reese's Peanut Butter Cups) both have different paths when they reach the retail store and make their way to the front of the store to the customer.

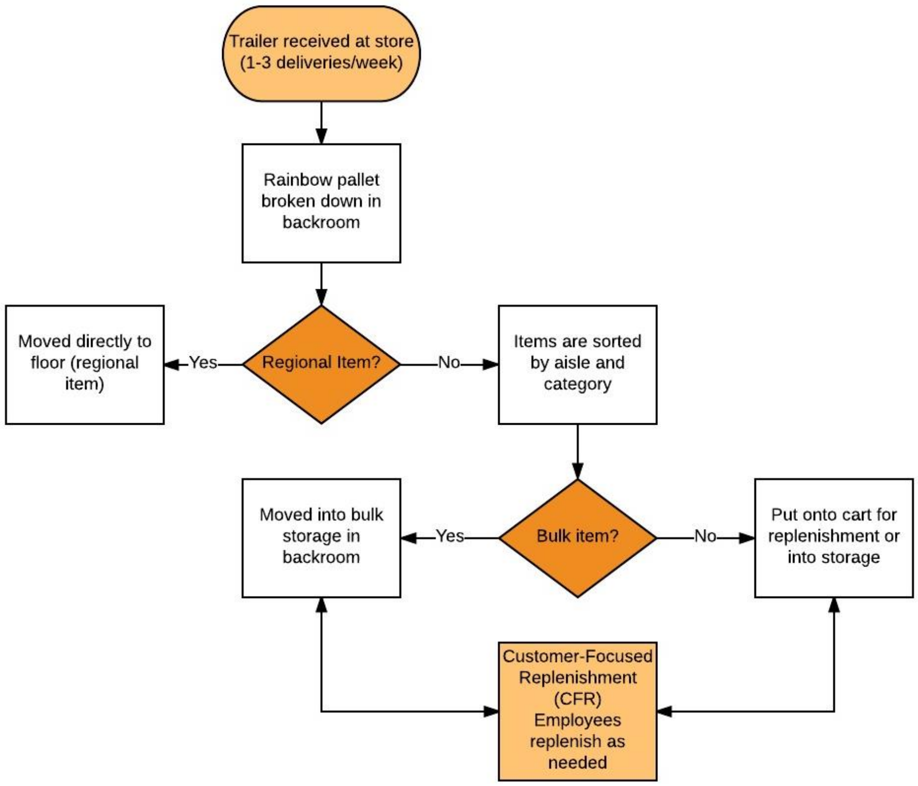

Figure 5: Retail Store - Product Flow

Figure 5 outlines the path that the wicker coffee table and the candy take once they hit the retail store. First, the products are received via truck into the backroom of the retail store. Depending on the store's capacity and level of activity, a store can receive anywhere from one to three shipments per week of product. When the products reach the store, there is no sorting or scanning that takes place. Instead, inventory is moved after a ship job is run at the distribution center. This is updated hours after delivery. Nothing is touched on delivery day in terms of updating inventory information.

Next, pallets are broken down. Both of the SKUs examined are fulfilled in the distribution center before they are sent to stores, and are packaged in totes or cases according to their category. Typically, smaller items will be packaged by tote. Multiple SKUs can be found in any one tote. Bulk products will have been placed in cases, or loose in totes.

Next, the product is sorted. Items are organized by aisle and category in the backroom before being placed on carts. Regional items, such as the wicker coffee table, would then be moved directly to the floor to either an end cap location or an aisle location. In contrast, the peanut butter cups, which will have been packaged by tote, are either put into backroom shelving or moved to the front of the store.

In the case of the peanut butter cups, the items are wheeled to the front of the store. An inner pack of 10 might replace the candy under the register according to their assigned shelf location.

If the items are stored in the backroom, there is a need for some sort of replenishment process. The two main processes utilized by stores are “quick pick” and “push overstock.” Both are employee driven. Quick pick occurs when employees scan items, recognize store promotion or need, pick items from the backroom and replenish accordingly. Quick pick targets “holes,” or empty slots in inventory. Push overstock, on the other hand, involves stores taking backroom merchandise to the front of the store about once a month to account for sitting product. This is prompted by cycle counts, which are either corporate-driven or store-driven. Replenishment is typically done by one or two aisles at a time depending on product amount. Product in the backroom is sorted by category, facilitating replenishment as aisles are also maintained by category. In addition, multiple items are worked at a time. During replenishment, the store associate is expected to move all backroom product to the shelf, or all of the product that will fit on the shelf.

Distribution Center Flow

Products can also flow differently through distribution centers depending on their attributes. Through conducting a series of in-house interviews, a general flow chart for the two items (the candy and the wicker coffee table) was constructed.

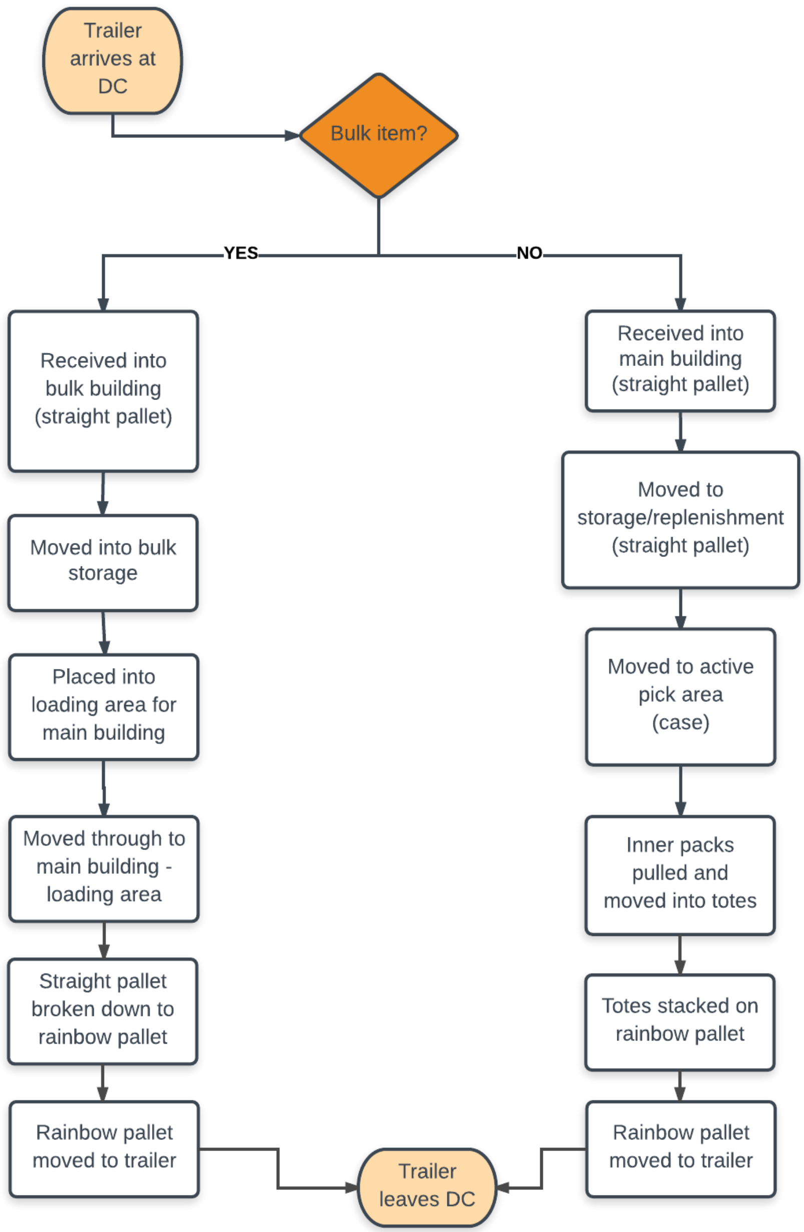

Figure 6: Distribution Center - Product Flow

Figure 6 depicts two distinct paths that a product can take in a distribution center. Firstly, the product category is considered. If the item is a bulk item, it is typically not received directly into the main DC building and is first taken into a bulk storage building. There, it might be moved into storage. It is touched again when it is placed, still in straight pallets, into the loading area for the main building. Next, it is moved through the main building to the loading area. Then, the straight pallet of bulk items is broken down further so that it can be shipped on a rainbow pallet. That rainbow pallet is then moved onto a trailer and shipped to stores.

Conversely, non-bulk items are deposited straight into the main building after receipt at the DC. These items are then moved in their straight pallets to a storage area. The product is broken down into cases as needed before it is then moved into to the loading area. From the cases, inner packs are taken out and totes are created. These totes are then stacked on a mixed rainbow pallet before they are moved to the trailer for shipment.

There are certainly other paths that items can take through a distribution center. However, based on the particular SKUs examined, these are the most applicable paths.

Total Landed Cost Model

The entire landed cost model is essentially built upon three main cost drivers; space, labor, and time. These cost drivers are then examined and built upon to construct cost categories. These categories allow costs to directly be associated with different areas and activities within the supply chain, such as distribution center costs or retail store costs. Within these higher-level categories, cost inputs are broken down further to reflect important expenses incurred throughout the products' life cycles.

This total landed cost model could be considered a hybrid of sorts. It is essentially a cost-based total cost model, which, as detailed previously, locates where costs originate based on certain categories. However, it also demonstrates how longer paths through supply chain areas (the distribution center and the retail store, in this case) affect total cost. For example, bulk items such as the coffee table encounter more touches than a fast-moving low-cube item, therefore increasing the labor cost through the distribution center. Furthermore, storing items that move faster through the store mean there are not only extra touches but that the items take up valuable space in the backroom of the store. The model also incorporates elements from Joseph Cavinato's total cost hierarchy model (2007). It incorporates the price of the item, details the cost of actually procuring the item, the landed costs (movements through the DC and the retail store, in this case), some operation costs, and the logistics cost.

One of the most critical building blocks of this model was based on Ruamsook, Swan, Thomchick, Young, R., & Thomchick's presentation at the CSCMP Annual Conference in 2007. In their updated view of the landed cost model, they detailed six main cost categories. These have been altered in the following model to reflect not only the movements of the particular SKUs, but the information available through the company. For reference, their original defined cost categories were Price, Transportation, Customs Duties, Inventory Management, Administrative Overhead, and Risk. However, these items were not moving internationally, therefore eliminating the need for various cost categories. The categories were then pared down further to better suit the company and items in question. The individual cost inputs within each category were derived from available information as well as best practice information. These were to be input by the company as needed.

Cost Category Breakdown

The main categories for the total landed cost model are derived from three essential underlying cost drivers. These are space, time, and labor. Throughout each step of the product life cycle, these cost drivers can be captured and observed in various ways. To then measure the total cost elements, there are additional cost inputs that help to scale the impact of different business processes.

Ultimately, the cost categories established in this total landed cost model are Price, Transportation, Distribution Center, Retail Store, and End of Life costs. When combined together, the categories should be able to depict not only total landed cost, but also the total amount of time the product spends moving through the supply chain, the amount of labor required for certain turnover rates and item sizes, and the cost of space required for products with different attributes. These in turn help to show different life cycle qualities of the product, such as remaining shelf life, labor savings possibilities throughout the supply chain, and flooring options.

Within each cost category, there are cost inputs that will help to measure the cost of the steps in the products' life cycle. The cost inputs are mainly based upon the foundational cost drivers labor, space, and time. Then, when combined, these inputs should show where different costs are incurred along the supply chain. Calculations are not recorded in the model, but the inputs should be good representations of what the total measure needs. The landed cost model developed by this thesis can be seen in Appendix A and will be discussed below.

The Price cost category simply measures the traditional cost of the item. Because neither of the modeled SKUs are international items, possible cost inputs such as tariffs and processing fees were excluded. The resulting category is a reflection of the annual purchase cost of the item.

Next, the Transportation cost category reflects the movement of the item from the distribution center to the retail store. Because Company A is only responsible for the item at receipt at the distribution center, inputs measuring transportation cost before that moment in time are irrelevant. Furthermore, international costs are disregarded. The key cost inputs for this category are as follows: insurance, packaging, transit cost, and transit time. Labor and space in this category would be reflected through the transit cost. Transit time is a key element in measuring ultimate life cycle time. If Company A were to further develop the model, it would most likely include international fees to incorporate imported items.

The Distribution Center cost is one of the key elements that makes this particular total landed cost model unique, as it distinguishes products based on their attributes. The cost inputs in this category are: number of pallet touches, number of case touches, number of tote touches, the time spent in storage, as well as the cost per square foot of space. As mentioned in the Distribution Center Flow section, bulk items are separated initially into a bulk building rather than the main building. Because of this initial separation, bulk items such as the wicker coffee table incur more pallet touches than would a typical fast-moving, low-cube item like the candy. This discrepancy between pallet touches, case touches, and tote touches implies that labor is more heavily weighted towards bulky, slow-moving items. Furthermore, holding items for longer periods of time incurs extra costs. Lastly, the cost per square foot of space is important to include as a cost input because bulkier items prevent space from being dedicated to other items. This input could eventually determine whether the price per square inch of item is worth holding the item at all. With these cost inputs in consideration, one would expect bulkier, slow-moving items to incur a higher labor and space cost and spend more time moving through the distribution center than their small, fast-moving counterparts.

The Retail Store is the second most critical unique element of the total landed cost model because it differentiates items based on specific attributes, and is completely unique to Company A and their supply chain flow. Cost inputs in this category are receipt at store, bulk item and seasonal item categorization, the time to stage a product, time the product spends in store, the number of pallet touches, the number of case touches, the number of tote touches, location on the floor, and the cost per square foot of store space. These inputs allow for a better understanding of how space, time, and labor affect total landed cost in the customer-facing side of the supply chain. After receipt at the retail store, items are separated based on their size or current need in the front of the store. Generally, bulk items are moved directly to the floor. In the case of the wicker coffee table, the item is taken directly from the backroom to the stock floor, not only saving space in storage, but also skipping extra touches that the candy encounters. With items that are neither bulk nor seasonal items, rainbow pallets are broken down in the back of the store and separated by floor section. Then, employees will either move the product to storage or will put the items on carts and replenish to the front of the store. The more an item is touched, the higher its relative cost will be. However, moving only one item at a time to the front of the store can be costly because it takes up more time and therefore labor. Without knowing the direct inputs, it is unclear whether moving the product directly to the floor or moving it more frequently through shorter touches is more economical. Understanding the cost per square foot of retail store floor space is also critical, as retail floor space cost can vary greatly and affect the cost of the item. For example, the peanut butter cups, while taking up less space, are most likely costlier to stage than the coffee table because of their prime positioning under the cash register. In comparison, the wicker coffee table is floored at an end cap - still more expensive than an aisle position, but less expensive than the cash register positioning. Overall, it is unclear whether the candy or the coffee table would have a higher retail store cost. Predictively, it would be the peanut butter cups due to high number of touches required to break the item and then move it to its costly place at the front of the store.

The last cost category identified in the total landed cost model is End of Life (EOL). This category accounts for any item returns, item disposal due to expiration dates or faulty products, and returns to the original vendor. This category will help to balance profit margin, and prevent from skewing the perceived success of a product.

In conclusion, this model's success is largely dependent on finding accurate cost inputs and tracking different products across their lifecycles to understand the true total cost. There are thousands of variations on products, as well as distribution center and retail store locations, that can affect changing inputs and therefore affect the view of a product's total landed cost.

Chapter 4

Conclusion and Recommendations

After reviewing literature and conducting conversations with people involved in different areas of the organization, it is clear that a total landed cost model could be invaluable to Company A and serve as a helpful source of information. The journey from acquisition to end-of-life isn't generally looked at from a labor, space, and cost perspective, but taking these underlying cost drivers into consideration would help Company A to make informed procurement decisions, as well as a variety of supply chain engineering decisions. When implementing supply chain routes for future products, understanding how different product attributes drive costs could help to minimize the supply chain path's cost and maximize total profit.

To implement this method of cost measurement, it is crucial that Company A establishes a new method of gathering information. Aside from total labor costs or from a specialist understanding product flows, there is no accessible way to clearly allocate costs along the supply chain. For example, there is no way to see that a product is broken down three times in the distribution center, but breaking it down from a pallet is the most expensive part of the process. Therefore, finding a way to populate the cost inputs is critical, though not examined in this thesis. The success of the model is ultimately dependent on the reliability of the inputs Company A is able to populate.

Overall, implementing this total landed cost model would likely be a long-term and potentially costly process. However, successfully integrating it into regular business functions could express a multitude of benefits and help drive success in the future.

Appendix A

Total Landed Cost Model

Instructions: Fill in required values in unshaded cells ONLY.				*Calculated values output cells are in those areas*					Shaded
Header Information									
Name of Item				Date of Analysis					
SKU Number									
SKU Category									
Data Entry Section (All in US$)				**Calculation Section**			**Output Section**		
Price									
Price per unit	$			Annual item price	$				
Number of units per year									
Transportation Cost				Annual trans cost	$				
Insurance cost									
Packaging Fee	$								
Transit Cost	$								
Transit Time									
Distribution Center Cost				Annual dist cost	$				
# Pallet touches									
# Case touches									
# Tote touches									
Time in Storage		hours							
Cost per ft^2	$								
Retail Store				Annual retail cost	$				
Receipt at Store	$								
Bulk item? 1=Yes, 0=No)									
Regional Item? (1=Yes, 0=No)									
Time to Stage Product									
Time in Storage									
# Pallet touches									
# Case touches									
# Tote touches									
Position on floor (front of store, aisle, back, etc.)									
Cost per ft^2	$								
							Total Annual C	$	
End of Life (EOL)							Total Cost per	$	
Average returns to vendor				Annual EOL Cost	$	101500	Increase over	%	
Average customer returns									
Average rate of disposal									

BIBLIOGRAPHY

A. Pumpe and F. Vallée, "Total Landed Cost for international sourcing decisions," *2015 International Conference on Logistics, Informatics and Service Sciences (LISS)*, Barcelona, 2015, pp. 1-6.

Cavinato, J. L. (1992). A total Cost/Value model for supply chain competitiveness. *Journal of Business Logistics, 13*(2), 285.

Center for Supply Chain Research, Penn State University, 2007.

Ciotti, F. A. (1988). Learning the lore of landed costs. *Chilton's Distribution, 87*(9), 90.

Collin, Peter. Dictionary of Business (1). London, GB: A&C Black Business Information and Development, 2009. ProQuest ebrary. Web. 26 January 2017.

Ellram, L. M., & Siferd, S. P. (1998). Total cost of ownership: A key concept in strategic cost management decisions. Journal of Business Logistics, 19(1), 55-84.

Ferreira, J., & Prokopets, L. (2009). Does offshoring still make sense? *Supply Chain Management Review, 13*(1), 20-n/a.

Feryal Erhun, and Sridhar Tayur. “Enterprise-Wide Optimization of Total Landed Cost at a Grocery Retailer.” Operations Research, vol. 51, no. 3, 2003, pp. 343–353.

Fisher, J. G. and Krumwiede, K. (2015), Product Costing Systems: Finding the Right Approach. J. Corp. Acct. Fin., 26: 13–21. doi:10.1002/jcaf.22045

Pharmacies & Drug Stores in the US. Rep. no. 44611. N.p.: n.p., n.d. *Ibisworld*. Web. 5 Feb. 2017.

Ruamsook, K., Swan, P., Thomchick, E., Young, R., & Evelyn Thomchick (2007). *Landed Cost Model Update.* Presented at the CSCMP Annual Conference.

Simchi-Levi, David, Philip Kaminsky, and Edith Simchi-Levi. *Designing and Managing the Supply Chain: Concepts, Strategies, and Case Studies*. Boston: McGraw-Hill/Irwin, 2008. Print.

"Total Cost of Ownership." Encyclopedia of Management, edited by Sonya D. Hill, 7th ed., Gale, 2012, pp. 1022-1024. Gale Virtual Reference Library. Accessed 25 Jan. 2017.

Trent, Robert, and Roberts, Llewellyn. Managing Global Supply and Risk. Ft. Lauderdale, US: J. Ross Publishing Inc., 2008. ProQuest ebrary. Web. 29 January 2017.

van, d. H. (2009, 12). Getting to total landed cost. *Supply & Demand Chain Executive, 10*, 23-25.

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Dell Inc. **Round Rock, TX**
Supply Chain Enablement Intern *May 2016 – August 2016*

- Created an action items tracker, schedule, and risk register to communicate progress and expectations to a global team of 25 individuals and to gain executive level approval for project advancement
- Constructed phase exit documentation critical to the Customer Fulfillment Choice Program
- Facilitated the update of an information base through reassessment of topic areas and information analysis, which resulted in simplified information access and a 38% improvement in data coverage
- Initiated user acceptance test scenarios and led daily calls with functional stakeholders to validate testing deliverables

Discovery Robotics **Pittsburgh, PA**
Business Development Intern *May 2015 – July 2015*

- Leveraged industry data to determine the automated industrial floor cleaner's total addressable market opportunity
- Established customer profiles and market segmentation reports to refine marketing and product plans
- Assessed options for email service providers, social media outlets, and product naming techniques
- Implemented mobile website by selecting a service provider and designing the layout

LEADERSHIP EXPERIENCE

Operation Beautiful **University Park, PA**
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- Elected to be President of the student-run organization that supports positive body image
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Penn State IFC/Panhellenic Dance Marathon (THON) **University Park, PA**
Mentorship Chair and OPPerations Committee Member *September 2014 – February 2016*

- Ensured logistical effectiveness of THON, the largest student-run philanthropy in the world, and related events

Scholar Advancement Team **University Park, PA**
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Marketing Chair and Member *May 2016 – Present*

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