Initial Purchase of Short-Term Life Cycle Products with Uncertain Demand

by

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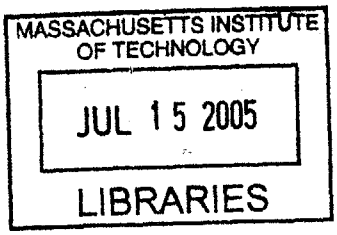

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Abstract

Targus, a consumer products distributor of laptop cases and accessories, lacks formal processes for deciding on initial purchases of short-term life cycle products with uncertain demand. This thesis reviews the current processes for the initial purchases and determines where the Company can reduce inventory risks related to the initial purchase. The research and analysis has three aspects: interviews of eight Targus managers was used to understand current initial purchases practice, a sample of initial purchase data was selected to analyze forecast errors and life cycle management, and the newsvendor problem was applied to the data sample to determine the optimal purchase which was then compared to Targus' purchases. It was found that Targus has a tendency to under-purchase items for the initial purchase and does not establish potential profitability of products prior to introduction. This thesis recommends the Company to incorporate a newsvendor approach as a basis to benchmark its initial purchases for the initial product introduction process.

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Dedication

This paper is dedicated to my wife, Kris, who continues to inspire me everyday.

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1 Introduction

Managing new product introductions is a crucial area of inventory management. If a company over-invests in new inventory, the company could be faced with too much product on hand. This ties up funds, which could otherwise be used, for example, to pay down debt. By contrast, if a company does not invest in enough inventory to satisfy demand, the company will not be able to realize its full potential of sales (and cash flows from sales). Inventory risk is the increased costs associated with having too much inventory on hand, when demand is not sufficient to deplete the inventory, or the loss of margins associated with not ordering enough inventory to satisfy demand – basically the cost of surplus and inventory shortage, respectively. The more the initial decision on inventory levels correctly takes into account demand, the less the risks. But, as demand becomes more uncertain, the inventory risks become greater. This thesis focuses on the initial purchase decision for procuring short-term life cycle products with uncertain demands during the new product introduction process for Targus, a consumer products company located in Anaheim, California. Currently, Targus has inventory risks associated with its initial product purchases. The research on the initial purchase decision will be based on using a newsvendor problem approach. Given the inventory risks that Targus faces with the initial purchase decision, will using a newsvendor approach reduce such risks?

Targus is a privately held, global marketer and distributor of accessories and case products for laptop computers. The Company has regional offices in Europe, Asia Pacific, and North America (US). The research presented here is based on its US business. There are three reasons

why the US is the focus of the research. First, the US represents the region with the most sales. Second, the US is the model for new product introductions. As a matter of practice, new products are released in the US first before being released in Europe or Asia Pacific. The Company has realized that products that were first successful in the US had a higher likelihood of being successful in the other regions. Third, the author has previously been under the employment of Targus and is familiar with the US office.

The reason why Targus agreed to be the focus of this research is because the Company does not go through a formal product introduction process with respect to its initial pre-sales ordering. Since the year 2000, the Company has been faced with management and organization changes. In particular, in the inventory management area, the Company has incorporated new processes to provide a more disciplined approach in replenishing its inventory. However, the process for ordering new products is still lacking a disciplined approach. As a result of several interviews with Targus associates as well as an analysis of the current product introduction process, the ordering process can best be described as informal decision making. For example, studies regarding the potential profitability of new products prior to introduction are not formal processes in the Targus product introduction process.

A second reason why Targus has agreed to be the focus of this research is that the Company has plans to introduce more case and accessories products. Because such items typically have short life cycles and uncertain demands, the risks of not optimizing the probable profitability of a product will increase. For purposes of this research, "uncertain demand" is defined as a product that lacks customer commitments and where final sale is not predictable with full certainty. We will also assume that all newly introduced products in this study will be faced with a potential short life cycle. At Targus, there is no official definition of "short life cycle", so for this research

it will be defined as nine months. Nine months was selected for two reasons. First, a cut-off point for sales needed to be established in our sample, so the nine months for each respective SKU represents the product's selling season. Second, nine months appeared to be a reasonable length of time to establish the Company's purchasing behavior. Some products in our data sample may have a life cycle that ends up being longer than nine months. But, when the Company introduces the product, it is not known if the product will have a life cycle greater than nine months because of inventory challenges, as mentioned below.

The Company does not manufacture accessories or case products. Targus purchases its product for resale from outside manufacturers, most of which are located in East Asia. As a result of the Company (including the US) purchasing its inventory from East Asia, the Company is faced with two challenges with product introductions:

1. For new product introductions, Targus needs to make purchasing decisions before obtaining customer's full commitment on purchasing the new products. The customers typically will not commit too early on new product purchases. The Company does not know with certainty as to how the new products will sell, and is unable to get 100% firm order commitments from its customers. In addition, with the initial order, the Company also needs to consider ordering extra inventory to cover possible customer replenishment orders. These purchases need to be made without the knowledge of true demand.

2. Lead-times range from 60-100 days from the time the inventory purchase order is made with the supplier to the ultimate delivery of the inventory to the Targus Distribution Center. Of this lead-time, 21-24 days is spent shipping the product from East Asia to the US via ocean container shipment.

To address these two challenges, we believe the Company can incorporate a "newsvendor" problem approach in its initial purchase decision. We chose the newsvendor problem for this thesis because the problem is defined as a one-time purchase problem for products with short-term life cycles and uncertain demand. These are the same characteristics that govern Targus' products. A good example as to how the newsvendor problem works is to think about the newsvendor who has to place one-time orders for newspapers everyday with the uncertainty of how many papers he will sell. Using a probability-based approach to forecasting, the newsvendor problem can calculate the probable profits by forecasting enough purchases to maximize profits and minimize costs for either over-ordering or from lost sales from under-ordering. Although the sales placed by Targus are not necessarily one-time orders, Targus' initial orders need to be large enough to load new product on retailer shelves, plus hold additional product in the warehouse to satisfy replenishment orders (if there are any) from customers to avoid stock outs. A stock out is defined as when the Company does not have enough products available to satisfy customer orders. The long lead-time for replenishments is what makes the initial buy behavior for Targus similar to a one-time order in the newsvendor problem. Because Targus faces uncertainty in its demand for the new products, it could take several weeks to receive an order to replenish the inventory. Targus needs to purchase enough inventory to avoid stock outs before the next delivery of product, but not order too much inventory where the Company has to pay for the cost of holding extra inventory (over-ordering). Thus, the importance of the newsvendor problem as it pertains to Targus is the probability of maximizing profits by taking into consideration the losses associated with inventory risks.

The remainder of this research paper is presented in six sections. The literature review, Section Two, is a review of the extended research on the newsvendor problem. Section Three, is an

overview of the supply chain structure and the business processes in current general use as a way to provide context for Section Four, which analyzes the newsvendor approach. Section Five is a summary of the approach to analyze the options to manage inventory risks. Section Six is a summary of the findings, and Section Seven is the recommendations.

2 Literature Review

Many articles have been written regarding the newsvendor problem. Although the newsvendor problem deals with a single ordering decision for a specified selling season, additional research has been focused on extending the newsvendor problem to include multiple-period ordering decisions and multiple pricing decisions during the selling season in order to reduce inventory risks and improve profitability. The literature review in this paper will consider multiple-period ordering and the impact of using pricing to influence demand. Prior research was reviewed primarily to compare how the research relates to Targus and secondly to analyze the conclusions formed from such research.

2.1 Extension of Newsvendor Problem – Multiple Purchase

The first section of this literature review is the research summary for multiple-period ordering for the newsvendor problem. Each of the research is related, in some aspect, to consider additional orders, instead of one optimal order during the selling season (the newsvendor problem only considers one optimal order). The research from these articles relate to Targus' ability to make multiple purchases during the selling season.

Gurnani and Tang (1999) developed a model providing a retailer the opportunity to make two order decisions during a selling season. The second order could differ from the initial order, but its purpose was to fulfill demand for a single selling season. The profit calculation focused on the trade-off between accuracy and potentially higher costs with the second order.

Similarly, Fisher, Rajaram, and Raman (2001) proposed a heuristic that was based on a two-order decision for the newsvendor problem. The second order was made during the selling season and was based on actual observed demand prior to the second order. By using the initial signals from actual demand, Fisher, Rajaram, and Raman found improvements in the purchase decision for the entire selling season. Fisher and Raman (1996) developed a model based on a fashion skiwear company, Sport Obermeyer, to reduce stock outs and inventory obsolescence. As with Targus, the characteristics for product introductions at Sport Obermeyer are uncertain demand and long lead-times. Similar to the Fisher, Rajaram, and Raman research, to reduce the impact of long lead-times, Sport Obermeyer committed more production orders later in the order cycle after observing initial demand. This enabled Sport Obermeyer to include an additional order in the selling season, instead of placing one order for the entire season. Because Sport Obermeyer had actual demand data to consider in making the second order, the result was an improved second forecast and reduction in inventory risk.

Tagaras and Vlachos (2001) developed a model for orders made at regular periodic intervals, plus emergency replenishment orders. Although not necessarily related to the newsvendor problem, this research was based on when an emergency order is expedited to fulfill demand. The research concluded that an inventory system with the option to expedite orders can be more profitable than an inventory system without expedited orders because the cost of expedited orders is less than the cost of stock outs.

The research discussed in the first section of this literature review illustrates that multiple-period orders could reduce inventory risks as the company considers the actual demand early in the selling season. Here, in the case of Targus, depending on the lead-time and actual demand, Targus has the ability to make more than one order in the product's respective selling season.

2.2 Extension of Newsvendor Problem – Pricing to Impact Demand

The second section of this literature review extends the focus of the newsvendor problem as it relates to how pricing impacts demand. The research presented here is similar to Targus' ability to change its pricing during the demand season to try to shift the demand curve.

Subrahmanyan and Shoemaker (1996) developed a model that considered the tradeoff between pricing and inventory orders for retailers. Their assumptions of a lack of demand information, upfront purchasing decisions, and a short selling season are the same problems that Targus faces with its purchasing decisions. Their model had the flexibility to change the pricing and inventory levels throughout the selling season in order to influence demand.

Petruzzi and Dada (1999) analyzed the newsvendor problem when ordering-quantities and selling prices are set simultaneously. In their model, demand is price dependent and if knowledge (such as point of sale information) is incorporated during the selling season, a retailer could adjust pricing to change the demand curve. Similarly, You (2003) concluded that demand is dependent on pricing in the newsvendor problem. Lau and Lau (1988) considered a model where demand varies based on different prices.

Agrawal and Seshadri (2000) also considered pricing to drive the demand decision. In extending the newsvendor problem, Agrawal and Seshadri took into consideration the order decision behavior of the risk-averse retailer. Under a scenario where price impacts the demand, as a retailer becomes more risk-averse, they will order less quantity but sell at a higher price. The important concept here is the tradeoff between pricing and risk.

Khouja (1995) considered discounting prices more than once in the selling season, which leads to an increase in order sizes when compared to a multiple-order newsvendor problem without

price adjustments. The reason is because the lower prices can spur demand leading to an increase in the order size.

As the prior research in this section shows, pricing is an effective lever a company can use to change the demand curve during the selling season because pricing directly influences demand. The next section will discuss the Targus order processes in more detail, including the process for new product introductions, the Sales and Operations Planning Meeting, and replenishment processes.

3 As-Is: Supply Chain Structure and Planning Processes

Section Three outlines the supply chain structure and three current planning processes at Targus. First, is a high-level overview of Targus' US supply chain structure. The purpose of the overview is to provide an overall perspective of the Company's supply chain for cases and accessories. The next three topics in this "As-Is" section is to provide a view of the three types of decision processes the Company makes to plan its purchases. There will be a description of the current process for new product introductions from idea to initial purchase, the process for the Sales and Operations Planning Meeting, and the process for product replenishments.

3.1 Overview of US Supply Chain Structure for Cases and Accessories

The products in the US supply chain are purchased from outsourced manufacturers ("suppliers"). Over 90% of the suppliers for accessories and carrying case products are located in East Asia. Products are shipped via ocean freight to the Port of Long Beach in California, and then trucked to the US distribution center in Anaheim, California. The transportation time takes approximately three weeks. As customers place orders, if the product ordered is available, it is shipped directly to the customers from the distribution center.

Targus describes three main channels to sell its product: Original Equipment Manufacturing (OEM), Retail, and Distribution. The OEM channel includes approximately 15 customers ("OEM customers") who sell the Targus products as if it were their own (i.e. the customer label

is on the product as opposed to the Targus label). The retail channel is where product is sold to retailers (approximately 50 customers), and the distribution channel is where product is sold to distributor companies (approximately 15 customers).

A majority of the products for the US flows through these three channels in the process as described above, except that for some OEM customers, the products are required to be delivered to a third party warehouse (or "hub") that is located near the customer. When the OEM customer submits an order, the product will be "pulled" from this third party hub to fulfill the order. Customer orders in the OEM channel are different from customer orders in the retail and distribution channels. The OEM customers typically generate the sales forecasts for specific product for a specific time period and Targus then bids against competitors to try to win the customer order. Because of the different ordering process and because of the OEM channel's relatively small size to the overall US business (approximately 15%), new product introductions in the OEM channel will be excluded from this research.

Below in Figure 1 is the diagram of the US Supply Chain structure for accessories and cases, the process of which was described above. The OEM channel (outlined as the dotted-lined box) is included for reference purposes only.

Targus US Supply Chain Structure for Accessories and Cases

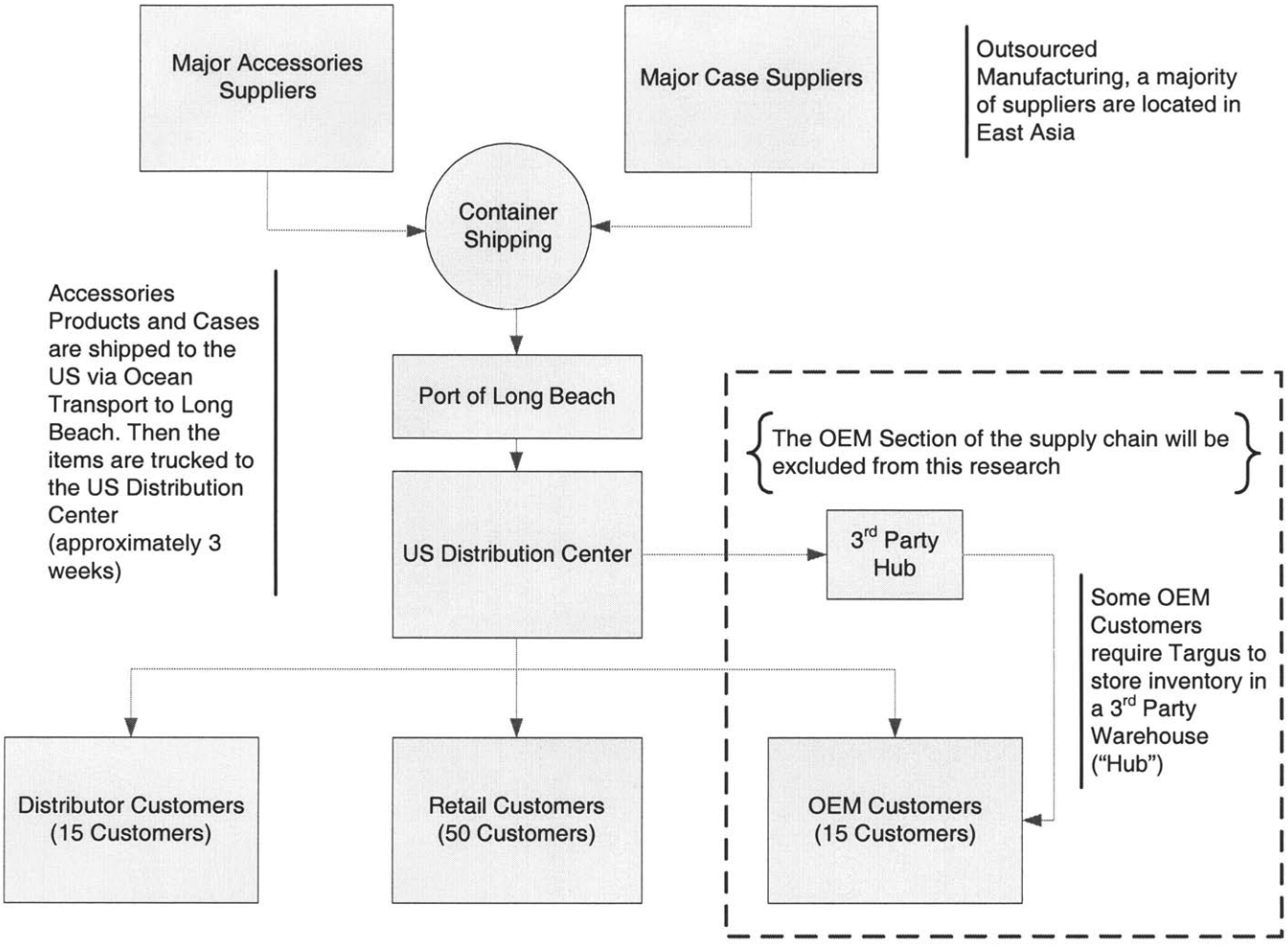

Figure 1. US supply chain structure for accessories and cases. The diagram depicts the flow of product from the suppliers to the customer.

3.2 Current Processes for New Product Introductions

This section will describe the new product introduction process. The process is not entirely formal. The departments involved with the new product introduction process are the Product Management department and the US regional sales team (lead by the VP Retail Sales, VP Distribution Sales, and the VP Alliance Program Sales) and the Operations and Regional Procurement departments (lead by the VP Customer Service & Order Entry, Director of Planning, and the Director of Purchasing). The next three subsections below will outline each of their roles in the product introduction process. The fourth subsection will describe the process flow of the product introduction process, from idea to initial purchase.

3.2.1 The Product Manager Role in the Product Introduction Process

The product managers (PMs) manage the availability of new and existing individual accessories and case products. Pertaining to the new introduction process, "manage" includes communicating to the regions, such as the US, that a replacement product or a new product is available to be introduced as an active stock-keeping unit (SKU) to be sold.

The Product Management department is a global department and is a member of the corporate Company, as opposed to being a regional department within the US. The Product Management department not only services the US, but also Europe and Asia Pacific. Each member of the Product Management department specializes in a specific product line. For example, one PM manages the global line of accessories product input/output devices (such as mice products), while a different PM manages the accessories product line of security devices.

The PM's responsibility is to find new products to be sold by the Company in all of the global regions. Using market research, monitoring competitors, and discussions with suppliers,

customers, and sales associates, and the overall monitoring of the industry, the PMs generate a list of products that are candidates to be sold by Targus. The PM's mandate is to provide a "menu" of product offering, such that the different regions pick and choose from this menu to sell to retailer and distribution customers. In other words, the PMs do not dictate what product each region should sell or market to its customers.

3.2.2 The Regional Sales Team Role in the Product Introduction Process

The regional sales team works with the customers to determine salability of a new product as well as provide the initial forecast for product introductions. The regional sales teams also set selling prices. By setting the prices, the regional sales teams determine the unit gross margins for each product sold. Thus, the PMs are not responsible for the financial performance of the regions and the regions need to come up with the decision as to what to sell and at what price.

Where the process is informal is in the initial purchase decision. The regional sales teams calculate the initial purchases, while the PMs are not involved with the process. The sales teams create the forecasts based on historical run rates of similar product, by the estimated number of new products to be put on the retailer's shelves, or based on customer interests in the product. The forecasts are used to develop purchase orders to procure product from the suppliers.

3.2.3 Operations and Regional Procurement's Role in the Product Introduction Process

The Operations and regional Procurement departments work together to process the initial purchase orders with the supplier. They also work with the regional sales teams on periodic sales forecasts. Once initial orders are placed for new product, the Director of Planning continues to update the forecast every week based on new information provided by the sales

team. If the forecasted demand for the initial sales period changes, then the purchase order delivery dates, and/or quantity are adjusted accordingly, depending on the flexibility of the suppliers. The Director of Purchasing initiates the purchase of the products with the supplier and works on the timing of the delivery of the products through coordination with the regional sales teams.

Next, will be a description of the flow process of the product introduction process.

3.2.4 Detail Flow of New Product Introduction Process From Idea to Initial Buy

The process that will be explained in this subsection is the current process that the US undergoes to introduce a product: from idea to initial buy. The purpose of the explanation is to show the number of different departments involved with bringing a product at Targus to market. The process begins with either the regional sales team or the Product Management department, who proposes an idea for a product to be sold by Targus, based on various resources, such as what competitors sell, suppliers, customers, and internal research. If a member of the regional sales team proposes a product idea, he would present the idea to the product managers (PMs) to research the marketability of the product. The PMs then decide whether to go ahead with the idea of introducing the product. Once the decision to market the product is made, an internal document called the Marketing Requirements Document (MRD) is filled out by the PM, which contains information, including the product description, name of supplier, product cost, and product features. The product idea is then presented back to the sales teams who will determine whether the product will sell. If the sales teams feel the product may not sell, then they either "kill" the product idea, such that there will be no further attempt to push for marketing the product, or the sales teams will ask the PM for more information about the product. If the sales

teams think the product can sell, the next step is for the Chief Marketing Officer (CMO) to review the completed MRD. If the product is an accessories product, then the product may require a factory mold investment, depending on whether the supplier has such a mold (or will create the mold). For example, the shell casing for a mouse product is created from a mold.

Once the MRD is approved by the CMO, then Procurement will take over the process and ensures that all proper documentation is completed prior to purchasing the product. This includes setting up a part number in the accounting system, making sure packaging is coordinated with marketing, and ensuring that the sales team forecasts the initial purchase. After all of the documentation is completed, then Procurement will issue the initial purchase order with the supplier, which includes the number of units to purchase and the timing of the delivery. Figure 2 is the process flow for the new product introduction process. The detail information for this process was obtained via conversations with eight Targus managers: the Global Chief Marketing Officer, Director of Accessories Products, US General Manager, Vice President for Customer Service & Order Entry, the Vice President of Finance, the Director of Purchasing, the Director of Planning, and the Vice President of Alliance Sales.

New Product Introduction Process Flow from Idea to Initial Buy for Case and Accessories Products

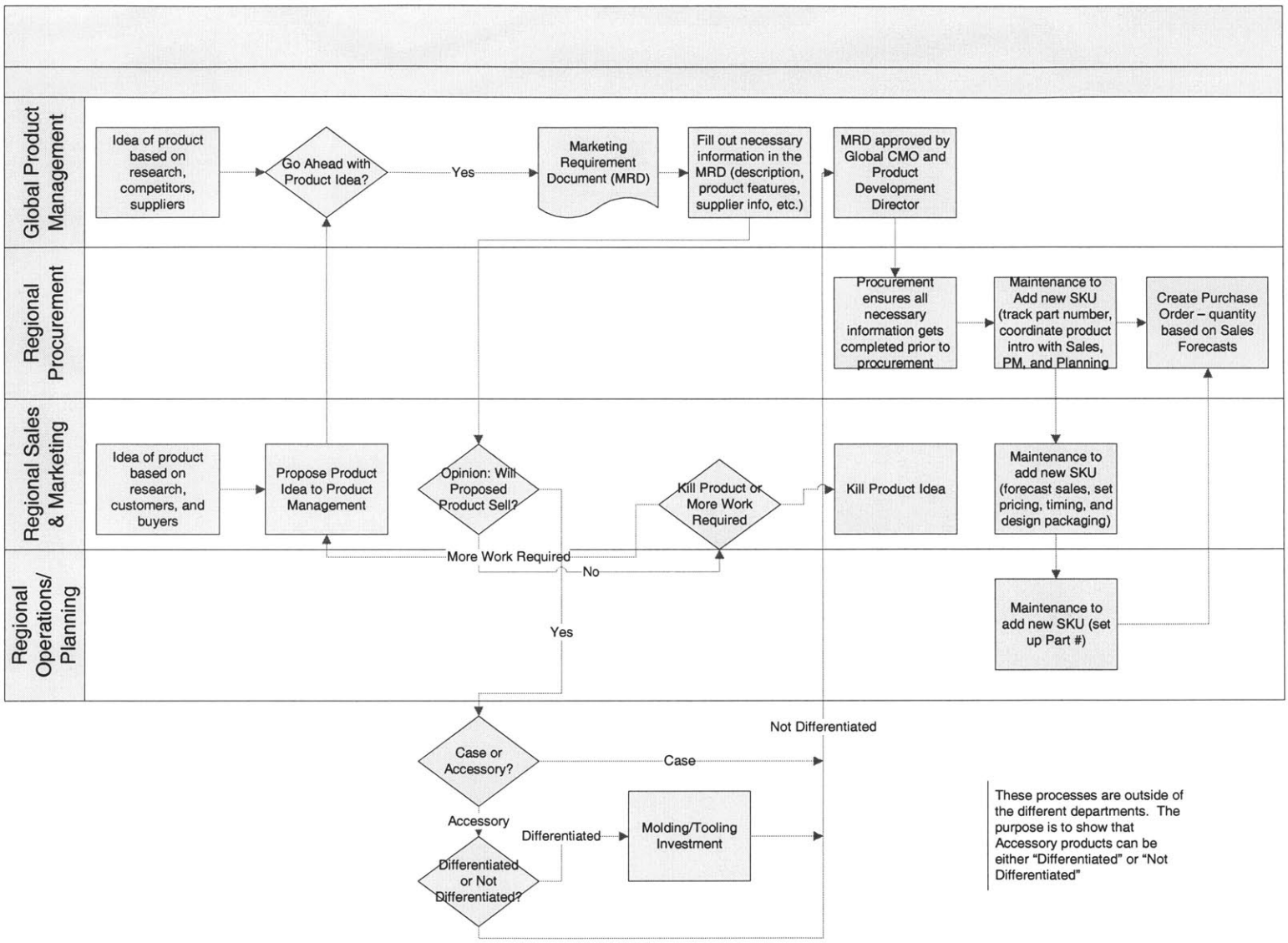

Figure 2. This figure represents the detailed flow of the new product introduction process for the US, from idea to the initial purchase. The initial forecast for the product introductions are provided by the Regional Sales & Marketing Team.

Life cycle management is also an informal process and not described in the new product introduction process flow diagram. But, during the selling season for each respective product, life cycle management is important to ensure that not too much inventory will be left over when the product becomes obsolete. The regions do not have a formal life cycle management policy when introducing a new product into the market, such that the Company manages the timing of product introduction and reducing the inventory for the replaced product. Included with life cycle management is a formal markdown policy and in determining what pricing adjustments need to be made to control the levels of inventory through the selling season. The potential profitability was never planned for each product prior to its introduction. So no formal decision process is in place to assess how profitable a product is and how should the Company strategically phase the product out of its inventory. This was a concern that was mentioned by two of the interviewees in this research.

3.3 Sales and Operations Planning Meeting (SOP)

The SOP meeting is a monthly meeting with the goal of aligning the three different US plans: the purchasing, sales, and financial plans. The purchasing plan is defined as the expected inventory purchase forecast, by SKU. The sales plan is the sales forecast by customers, and the financial plan is the total sales and other financial operational data based on the latest forecasts as prepared by Finance. The associates involved in the SOP include the US General Manager, Vice President for Customer Service & Order Entry, the Vice President of Finance, the Director of Purchasing, the Director of Planning, and the top sales associates for the Retail, Corporate Distribution, and OEM channels.

The data used for this meeting includes the most current revenue forecasts by customer and product shipments history. Prior to the meeting, the SOP team requires the sales teams to provide forecasts. The sales teams have available to them the previous six months of sales to calculate the forecasts as well as point-of-sales information from the major customers. Forecasts are prepared at the customer and SKU levels in both units and dollar sales. The sales teams take into consideration for the sales forecasts qualitative information, such as seasonality trends. The purpose of the forecasts is to provide the SOP team with forecasts for the top 20 selling SKUs for each major customer. The Director of Planning summarizes this data into a report for the meeting.

The Director of Planning presents the summarized sales data during the SOP meeting. During the meeting the SOP team reviews the forecasts of major customers. Adjustments are made to the forecasts (raise or lower) based on the discussions during the meeting. Then the SOP team agrees on the maximum and minimum sales range for each customer account. These limits prevent the sales teams from being too aggressive or too conservative with their forecasts.

Once the sales forecasts are set, the other plans are synchronized accordingly. For example, the sales amount for the purchasing plan agrees with the financial and sales plans, whereas prior to the meeting, each sales figure for the respective plans could have been different. This process is not necessarily related to the introduction of new product, but product introductions may be discussed. However, the PMs are not represented in the SOP meeting.

3.4 Current Processes for Product Replenishments

The current process for product replenishments applies to the new product introductions as well as to current selling product. Once a product is first introduced, it is monitored for potential

replenishments based on sales forecasts. The Company currently practices a base-stock periodic inventory system when replenishing product. Under this practice, product replenishment decisions are performed once a week. The base-stock includes the base inventory level, which covers forecasted customer replenishment sales until new orders arrive, plus a level of safety stock to cover unexpected orders. The associates involved in the process are the Director of Purchasing and the Director of Planning. The "tool" used during the process is the Master Planning Schedule (MPS). The MPS is a database that shows the historical and forecast sales by SKU. Using historical data and current sales forecasts, the Director of Purchasing and Director of Planning forecast the inventory levels to determine a purchasing plan.

The process is as follows: The Director of Purchasing, runs the MPS data report. The report, which includes sales forecasts, is used to help make decisions such as: purchase more inventory products (create purchase orders), "pull in" (expedite existing orders), "push out" (delay shipment of existing orders), or cancel, if possible, existing orders. The forecasts are based on run rates as well as specific adjustments (increase sales for seasonality, for example) to the forecasts. A "run rate" is defined as the forecast calculated by using the current trend of historical data. Each supplier is different, but is usually flexible with changing production commitments in case the Company has to expedite an order or cancel an existing order. The ability for the Director of Purchasing to change the purchase order depends on where the supplier is with the production process. If the supplier already began production, it may be difficult for the supplier to push out, pull in, or cancel the sales order. If Targus purchases product based on the MPS forecasts, but now have too much product because the forecast run rates were too high, the Director of Purchasing will go to the supplier to see if they can cancel any unfilled purchase orders. If the Company is unable to cancel an order, the sales team will help to deplete inventory

via sales deals with specific customers. This process is equivalent to the multiple-period ordering decision as mentioned in the literature review in Section Two (except the practice includes order cancellations). The forecasts for new products to be introduced are reviewed along with existing product, and the Company takes into consideration any types of demand signal (i.e. conversations with the sales teams) to modify its forecasts. This process shows that the Company has the ability to adjust its inventory purchases during a product's life cycle.

Because of long lead-times, the Company "buys to" forecasts. This means that the Company will purchase the inventory using Company forecasts, not based on a customer's specific order. The Company's inventory practice for procurement uses "ABC" classification. Under "ABC", each SKU is assigned a code of either A, B or C. "A" inventory represents 80% of the forecast sales and are considered to be high sellers; "B" inventory is 15% of the forecast sales, and "C" inventory is the remaining 5% of the forecast sales. The ABC classification is updated quarterly in the Enterprise Resource Planning (ERP) system. The ERP system is the accounting and operations software that governs all financial reporting, customer orders, and inventory-tracking for the Company. The ABC codes help the purchasing team to determine the replenishment decision, which includes the order quantity and the timing of when to purchase.

The Purchasing department reviews the inventory forecasts and purchase plan for all SKUs every week, regardless if products are classified as A, B, or C. The intent is to purchase "A" inventory each week, based on an "order up to" inventory practice. An "order up to" inventory practice is when orders are placed to replenish the inventory levels based on a predetermined base-stock. For example, if the base-stock inventory level as agreed by the Director of Purchasing for SKU *XYZ* is 50 items and there are 40 items on hand or on order, then the Company will order 10 additional items to bring the inventory back up to the base-stock level of 50 items (40 + 10).

For "A" inventory, the Company's policy is to carry an inventory level that is equivalent to four weeks of forecast sales. The Company's policy is to purchase "B" inventory every two weeks in order to carry an inventory level equivalent to six weeks of forecast sales. For "C" items, the Company will purchase inventory once a month. The "C" inventory is less of a priority than "A" and "B", and the Company prefers to carry an inventory level equivalent to eight weeks of forecast sales. Although quantities for "C" inventory are usually small, the Company will still purchase "C" level inventory to maintain its base-stock level.

The next section will cover the newsvendor approach for Targus with respect to reducing risks for the initial purchase decision for new product introductions.

4 Using the Newsvendor Approach to Reduce Inventory Risks

This section summarizes the potential for the Company to incorporate the newsvendor approach when preparing the forecasts prior to the initial purchase of cases and accessories product.

As described in Section Three, the current practice to forecast new products is not very formal. The forecasts are made by the sales teams and can be based on a variety of methods, such as run rates and customer feedback. The Company should consider using a probability-based calculation, the newsvendor problem, to establish the initial forecast in order to calculate the order size for the initial purchase. By incorporating the newsvendor problem approach, the Company can formalize the forecast process and use a more fact-based approach to forecast the new products. The newsvendor problem takes into consideration the uncertainty of demand and the potential profitability for each SKU. Thus, the problem considers statistical data to calculate a probability-based optimal order size. However, before making the recommendation, we need to understand the issues with the current forecast processes.

The next section, Section Five, will cover the research methodology for this paper. Then based on the results of the research, as will be described in Section Six, we will discuss recommendations.

5 Analyzing Options for Managing Inventory Risks

Two types of analyses were performed to analyze the Company's options for managing inventory risks. The first type was a data analysis, which is considered in the subsection below. It describes the collection and analysis of the sample data. The second type was to apply the data to the newsvendor problem in order to form the basis for calculating an optimal forecast, a benchmark for comparison with Targus' product introduction forecasts.

5.1 Data Analysis

The purpose of the data analysis was to determine the purchasing behavior of Targus. There were three different analyses performed on the data sample. The first analysis was to determine Targus' forecast errors on its new product introductions. Based on the results of this test, we were able to determine the magnitude of the current forecast errors. For this research, the Targus' initial product forecast is synonymous with the initial product purchase because the Company forecasts what they intend to purchase from the suppliers. The second analysis was to determine how many actual months of sales it took to deplete the initial sales forecast. Based on the results from this test, we were able to determine how often Targus over or under-orders its products based on how many months it took to sell out of the initial purchase. The third analysis was to determine whether the Company made any markdowns on product during the selling season. The reason for the markdown analysis was to conclude whether the Company tried to

initiate a higher demand for its product by reducing prices. Prior to testing, however, a list of the sample data needed to be compiled.

For this research, a list of new product introductions were created because Targus does not maintain a list of newly introduced products. Sales data was pulled out of the Targus sales database for the months October 2003 through March 2005. We chose October 2003 as the initial month because this was the first month of the 2004 fiscal year. The reason for excluding data prior to fiscal year 2004 was due to concerns expressed by the Director of Planning. If we used data prior to fiscal year 2004, we would have been analyzing irrelevant management practices, because planning and procurement policies and processes had changed. The sales data included the historical invoiced sales in units, sorted by both stock-keeping unit (SKU) and months. A rule was established defining the sales introduction date as the first sale occurrence in the sales database per respective SKU. For example, if the initial sales date for SKU "*XYZ*" was October 2003, then, the product introduction date was considered October 2003. The sample must have at least nine months of actual sales history, which is this paper's definition of the selling season. For example, if the initial sales date for SKU "*WXY*" was December 2003, then we considered the sales period as December 2003 through August 2004 or nine months of sales. The cutoff date for a product to be categorized as a new product was July 2004 because if we were to select any SKU that was introduced after July 2004, then we would have ended up with less than nine months of sales history (which violated our new product rule). Data that was further excluded from the sample were pure OEM-related sales because as noted in Section 3.1, OEM sales were excluded from this research.

Additional data needed for the sample was forecast information, qualitative information, and product type identification.

First, the forecast information was needed for the sample because the Company does not have a consistent means of tracking the forecasts made for the initial product introduction. The reason is that forecasts are updated every week and past forecasts are not analyzed or compared to actual sales to determine forecast errors. Therefore, for purposes of this research, a rule was established to define what the initial forecasts were for each of the SKUs in the sample. All historical purchase orders were pulled for the sample data and sorted by date. The purchase order reflects the total number of units for each respective SKU ordered from a supplier. To determine the initial forecasts, all of the purchase orders made prior to the first customer order date (not date of shipment) were aggregated to determine the initial forecast. This initial forecast calculation method was chosen because the date of the first customer order was the first firm order that the Company received for the respective SKU. Prior to the first customer order date, the Company did not have any firm orders to influence the forecasts. This method was based on the assumption that Targus orders what they believe they will sell; not knowing how many months it would take for the item to sell out. The Company has opportunities to replenish the inventory if demand exceeds the forecasts, but this was not considered in calculating the initial forecast.

Second, additional qualitative information was needed for the sample in order to further refine our analyses to determine purchasing behavior. With Targus' assistance, SKUs were classified as either "replacement" or "non-replacement." A replacement SKU is a new product that is "replacing" a current selling product. There are several reasons why the Company will introduce a new replacement SKU for an existing product line. For example, there could be a change in a product's feature, such as an additional pocket added on to the case, or the Company can introduce a storage device with more memory to replace an existing product. A non-replacement

SKU is a product that is completely new to the Targus line and the products include features that are different than what the Company currently sells. The Company does not maintain a list of products under this type of classification. However, for this research, the SKUs in the sample were categorized in this fashion because we wanted to see if purchasing behavior differed for products that were completely new to the Company ("non-replacement") vs. products that had sales history for similar items ("replacement").

Third, the product type needed to be identified in the data sample for further refinement of determining purchasing behavior. For example, we could analyze whether purchasing behavior differs between cases and accessories. The products selected in the sample include both case and accessories products. The case products, of which a majority contain either leather or nylon materials, are designed to hold a laptop computer (or cameras and multimedia products, such as DVD players). The case products include notebook cases, backpacks, camera cases, and multimedia cases. Targus designs the case products and the Company works closely with the case suppliers to create new products to be introduced.

Accessories products are a variety of different types of products designed to work in conjunction with a laptop computer. The accessories product categories (with examples) are: input/output devices (mice), security (cables to lock up the laptop from theft), storage (memory sticks), power (adapters to power the laptop), lifestyle (monitor stand or headphones), and connectivity (hubs to link a monitor or printer to the laptop). Targus has three sources for obtaining accessories products. The first source is that a supplier approaches the Company with a product that has already been developed and the potential supplier is looking for a marketing partner. A second source is a newly, "differentiated" product that the product manager (PM) wants to introduce, but the product does not exist in the market. A third source is a "me too" product, where Targus

wants to introduce a product into the market and the supplier already has the capabilities to develop the product. Typically, the "me too" product is already marketed by a competitor. Depending on the source of the accessories product, the new product introduction process will differ; but, generally, the forecasts are not affected. The main difference between a "me too" product and a "differentiated" product is that the differentiated product will take longer to bring to market. The differentiated product is newly introduced so the Company or the supplier needs to make an initial investment to create molding so that the factories can create the product. The factories also have to retool a new process to create such a product. For the "me too" products, the factories have already developed the product and the Company purchases the product from the outsourced suppliers with "Targus" imprinted on the product.

Taking into considerations the rules for creating the data sample and the qualitative information defined for each SKU, the data sample included 118 individual SKUs with product introduction dates falling in the range of October 2003 through July 2004.

Figures 3.1 through 3.3 summarize the data sample by product type and by the qualitative information ("attributes"). Of the 118 SKUs, 46 or 39% of the total sample were accessories products and 72 or 61% of the total sample were case products. Furthermore, the total number of non-replacement SKUs was 54 items or 46% of the total sample and the total number of replacement SKUs was 64 or 54% of the total sample. Figure 3.1 summarizes the split between cases and accessories, Figure 3.2 summarizes the split between replacement and non-replacement products, and Figure 3.3 shows the sample data as allocated among cases replacement, cases non-replacement, accessories replacement, and accessories non-replacement.

Allocation of Accessories vs. Cases SKUs in the Data Sample

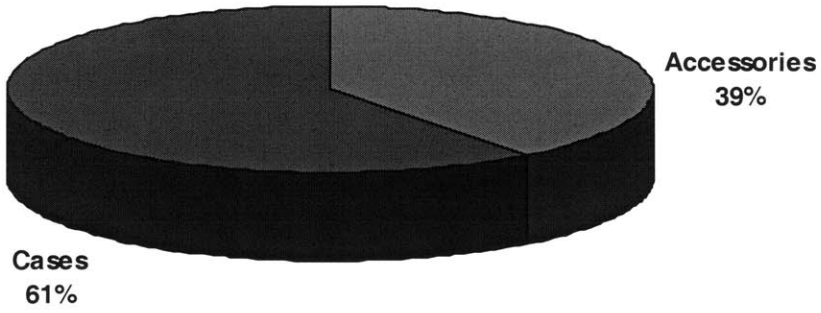

Figure 3.1. The chart represents the allocation of the 118 items in the data sample between cases and accessories.

Allocation of Replacement vs. Non-Replacement SKUs in the Data Sample

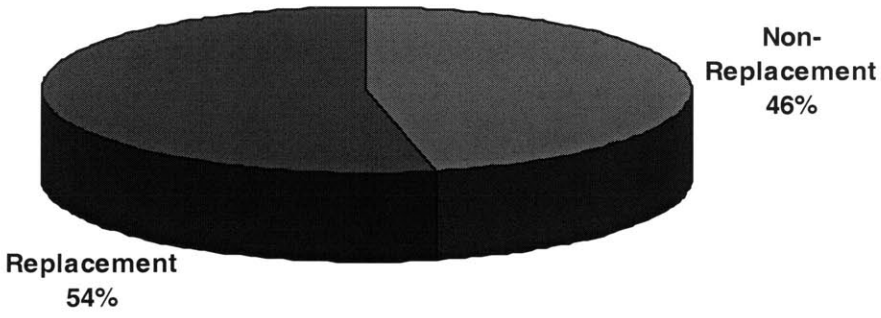

Figure 3.2. The chart represents the allocation of the 118 items in the data sample between replacement product and non-replacement product, for both cases and accessories.

Figure 3.3 below divides up the accessories and cases and further categorizes these types by its two main attributes: replacement and non-replacement. Of the 118 items in the sample, there are 31 accessories non-replacement SKUs (26% of the total sample), 15 accessories replacement SKUs (13%), 23 cases non-replacement SKUs (20%), and 49 cases replacement SKUs (41%). A majority of the case products introduced in the data sample were replacements and the majority of the accessories products introduced in the data sample were non-replacements.

Allocation of Cases Replacement, Cases Non-Replacement, Accessories Replacement, and Accessories Non-Replacement SKUs in the Data Sample

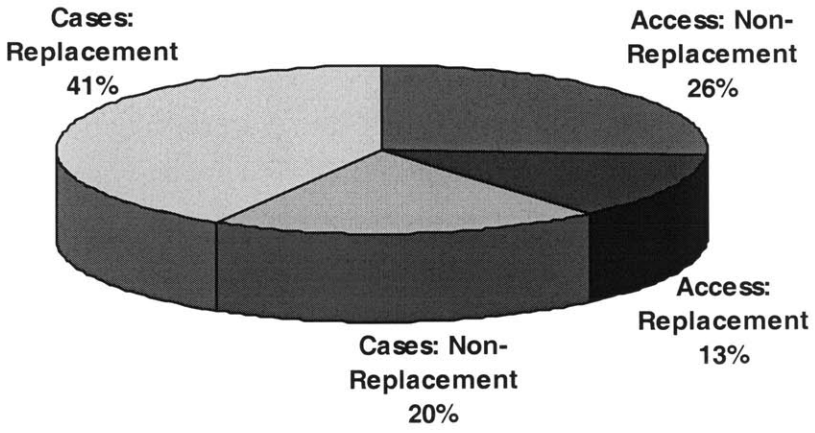

Figure 3.3. The chart categories the data sample based on two combined attributes for cases and accessories: cases replacement, cases non-replacement, accessories non-replacement, and accessories replacement product.

For "differentiated" vs. "me too" products, only six items were described as differentiated out of 118 SKUs. This represented 5% of the total sample. Because of the low number of differentiated SKUs, the data was kept in the sample, but no specific analysis was performed on the "me too" vs. "differentiated" products.

As mentioned earlier, the selling season was defined as nine months of "demand" for each respective SKU based on when the SKU was first introduced. Demand is unknown and not tracked by Targus, therefore, for this paper, demand was defined as actual shipped sales. The problem with this definition is that there is no measurement of stock outs. The Company does not keep historical stock out data when demand (or sales orders) is greater than supply. During the nine months of demand, Targus has opportunities to replenish its orders, because the lead-time is typically less than 100 days or three months time frame, well within the nine months time period for the sample. "Replenish" is defined as purchasing additional inventory from the suppliers to meet demand. Earlier, in Section 3.4, the replenishment process decision was described. However, for purposes of this paper, since the sample data deals with new products, any replenishments or purchase order cancellations made during the nine-month period is the opportunity for the Company to try to meet demand within the sales period, as noted in the prior research review as multiple-period ordering.

5.2 Newsvendor Problem Data Analysis

Using the data as described in 5.1, an optimal forecast quantity was calculated based on the newsvendor problem. This was calculated to try to assess Targus' ordering behavior because the newsvendor optimal order per SKU takes into account the optimal expected profit that could be achieved based on the profitability potential of the order decision as described in the newsvendor problem. In calculating the newsvendor problem all of the SKUs in the sample that were marked down in order to facilitate selling of the items were pulled out of the sample to calculate the optimal order. There were nine SKUs that were marked down. Discounting the product price created a situation where the cost of overage was not a cost to Targus, but the Company was still earning margin on the liquidation sale. This goes against the assumption needed to apply the

newsvendor problem approach. Since there were only nine SKUs, pulling these out of the data sample for purposes of the newsvendor calculation did not significantly change the results of the calculation, and the total number of SKUs for the calculation was now 109 (118 less 9).

The variables needed to calculate the newsvendor problem include the selling price, cost of sale, the salvage value, the sales mean, and the standard deviation of the forecast errors for each SKU. The selling price for each SKU was calculated based on the average selling prices for the first three months of sales of the selling period. The cost of sale for each SKU was similarly calculated. If there was less than three months of sales during the first three months of the selling period, then the average was taken on the first two months. The salvage value was based on an estimated value that was provided to us by the Vice President of Finance. The Company does not formally track liquidation costs or salvage values. Based on his estimates, the salvage value for cases were 30% of the selling price and for accessories, 10% of the selling price. Once the average selling price, average cost of sale, and the salvage values were calculated, then we could calculate the cost of overage, cost of underage, and the critical ratio. The cost of overage is the cost of too much inventory as a result of over-ordering, such that inventory supply is greater than demand. This is calculated for each SKU in the data sample as: average cost of sale less salvage value (as shown in Equation 1). The cost of underage is the cost of not having enough inventory to meet demand or it is defined as a stock out cost, where the Company could not realize the sale because there was no inventory to meet demand. This is also calculated for each SKU and is the average selling price less average cost of sale (as shown in Equation 1).

Equation 1: Cost of Overage and the Cost of Underage

$$\text{Cost of Underage} = (\text{Average Selling Price}) - (\text{Average Cost of Sales})$$

$$\text{Cost of Overage} = (\text{Average Cost of Sales}) - (\text{Salvage Value})$$

The critical ratio is important for the newsvendor problem because the ratio compensates for the profitability aspect of an inaccurate forecast. This ratio considers the tradeoff between the costs of overage vs. the cost of underage. For example, if the critical ratio is over 50%, then the optimal order will be higher than the mean forecast average because the cost of a stock out is greater than the cost of overage. In other words, it makes more financial sense to potentially over-order because the cost associated with a stock out is greater than the cost of a lost sale. Similarly, if the critical ratio is less than 50%, then the optimal order will be less than the mean forecast average because the cost of an unsold item is higher than the cost of a stock out. The ratio is defined in Equation 2 as the cost of underage divided by the sum of the cost of overage and the cost of underage.

Equation 2: Critical Ratio

$$\text{Critical Ratio} = \frac{\text{Cost of Underage}}{(\text{Cost of Underage} + \text{Cost of Overage})}$$

The newsvendor optimal order is Q*. This research calculated the optimal order via a spreadsheet function in Microsoft Excel,© which is shown under Equation 3. The "NORMINV" represents the normal inverse function and the critical ratio is the ratio as noted in Equation 2, above. The μ_x and the σ_x are the mean (for demand) and the standard deviation of the forecast error, respectively.

Equation 3: Newsvendor Problem, Optimal Order Quantity (*Q)**

$$Q^* = \text{NORMINV}(\text{Critical Ratio}, \mu_X, \sigma_X)$$

In calculating the newsvendor problem, the expected sales ("mean") and the standard deviation of forecast errors from the mean for each SKU needed to be determined because the Company does not maintain this type of data. In order to calculate the mean, the forecast error percentages for each SKU needed to be calculated first because the forecast error percentage is used to calculate the sales mean. Equation 4 is the calculation of the forecast error. The calculation is the Targus forecast less the actual sales divided by the actual sales. The Targus forecast is the initial forecast as defined in Section 5.1. The Actual Sales is the sales for the selling season, which is the total sales for the first nine months.

Equation 4: Forecast Error Percentage

$$\text{Forecast Error} = (\text{Targus Forecast} - \text{Actual Sales}) \div (\text{Actual Sales})$$

After calculating the forecast error percentage, then the sales mean was calculated. Using the equation in Equation 5, the mean is equal to the Targus Forecast divided by one plus the Category Mean Error. The sales mean equation is based on the forecast error percentage averaged for the four different attribute categories of the data sample (i.e. the Category Mean Error): accessories replenishment SKUs, accessories non-replenishment SKUs, case replenishment SKUs, and case non-replenishment SKUs.

Equation 5: Sales Mean

$$\mu_X = (\text{Targus Forecast}) \div (1 + \text{Category Mean Error})$$

Prior to calculating the standard deviation of sales in Equation 6, we first needed to calculate the standard deviation of the error. The standard deviation of the error is based on the standard

deviation of the forecast errors percentages as noted in Equation 4 for each SKU within the four categories. Using the results of the standard deviation of the error for the four categories, the standard deviation of sales is the average category standard deviation multiplied by the sales mean.

Equation 6: Standard Deviation of Sales

$$\sigma_X = \text{(Average Category Standard Deviation) x } (\mu_X)$$

Using the critical ratio, the mean, and the standard deviation of sales, the newsvendor optimal order (Q^*) was calculated for Targus (refer to Equation 3 above) for each SKU and then the results were summarized in the four categories: accessories replacement, the accessories non-replacement, cases replacement, and cases non-replacement SKUs.

When calculating the optimal order (Q^*) for Targus, three assumptions were made. First, there is no scale in shipping costs. Therefore, for this research, if orders increased or decreased, the shipping costs will still remain the same and not add any more or less costs to the SKU. This is important because in determining the unit cost for a SKU, all costs, including the shipping costs to bring the product to the US, are included in the unit cost. The unit cost impacts the cost of underage. Second, the Company typically incurs variable charges for selling product to retailers. The variable charges, noted as "advertising" costs, are costs charged to Targus for each respective SKU sold to the retailer. These costs are for placing product in the retailer stores, a share of advertising costs to market products, etc. The advertising costs are specific to each retailer and the costs can vary from 5% through over 20% depending on the contract with the retailer. For this research paper, we chose 15%, which is the total average per the US financial statements. Since the costs are deal-specific to the customers, the Company is not able to

determine how much advertising expenses a respective SKU will incur (nor does the Company track such information). In calculating the newsvendor problem, these costs reduced the average selling price by 15% for all SKUs.

The final step with the newsvendor problem was to calculate the profit associated with the optimal order. The purpose of the calculation was to show the magnitude of the difference between the optimal orders and Targus' orders, given the probability of sales. Profit per the newsvendor model was calculated, using a normal distribution formula (Please refer to Equation 7 below for the newsvendor profit calculation, using Microsoft Excel ©). The formula takes into consideration the probable order less the probable number of items unsold based on the given standard deviation and mean.

Equation 7: Profit Calculation for the Newsvendor Problem

$$\text{Profit} = (\text{Optimal Order}) - ((\sigma_X) \times ((z) \times \text{NORMDIST}(z, 1, 0, \text{True}) + (\text{NORMDIST}(z, 0, 1, \text{False})))$$

Where, $z = \dfrac{(\text{Optimal Order} - \mu_x)}{\sigma_X}$ and

NORMDIST (z, 1, 0, True) = standard cumulative normal distribution

NORMDIST (z, 1, 0, False) = standard normal density function

Note: The "True" and "False" on the NORMDIST function determines whether the distribution is cumulative or not. If "True", then the distribution is cumulative; if "False", then the distribution is not cumulative

6 Summary of Findings

This section is a summary of findings based on the analysis of the sample data and newsvendor calculation as described in Section Five. The subsections below summarize the results for the different data analysis, including forecast errors, months of sales, markdowns, and the newsvendor problem calculation. The final subsection forms a conclusion regarding the data results.

6.1 Data Results – Forecast Errors

Table 1 below represents a summary of the forecast mean errors and the standard deviation of the forecast errors. The mean was calculated based on the average forecast error percentage for each SKU and then the forecast error percentages were summarized under the four attribute categories of accessories replacement, accessories non-replacement, cases replacement, and cases non-replacement products. The forecast mean error measures the tendency of Targus' forecasts away from the mean. For example, if the forecast mean error is 10%, then Targus' forecasts have a tendency to be 10% higher than the sales, on the average. The standard deviation measures the variability of the Targus forecast errors. The higher the standard deviation, then the higher the variability will be. This equates to the magnitude of the error.

The mean error for the non-replacement SKUs for both accessories and cases (-30% and –24%, respectively) show a higher average forecast error rate than the replacement SKUs (-14% and -19%, respectively). What this means is that the Company has a tendency to be under forecast at

a higher level for the non-replacement SKUs when compared to replacement SKUs. However, in measuring variability, the average standard deviation for the forecast errors are higher for the replacement SKUs for both accessories and cases (83% and 93%, respectively) when compared to their non-replacement counterparts (58% and 59%, respectively). Although the average forecast mean error is lower for the replacement products, the variability is higher.

Table 1. Forecast Errors were calculated for each SKU in the data sample. The Mean and Standard Deviation were summarized for the respective categories. The sample size of 109 items excludes the nine markdowns.

		Forecast Errors	
	Sample Size	Mean	Standard Deviation
Accessories:			
Replacement SKU's	10	-14%	83%
Non-Replacement SKU's	30	-30%	58%
Total Accessories	40	-26%	64%
Cases:			
Replacement SKU's	48	-19%	93%
Non-Replacement SKU's	21	-24%	59%
Total Cases	69	-20%	84%
Total:			
Replacement SKU's	58	-18%	91%
Non-Replacement SKU's	51	-28%	58%
Total	109	-23%	77%

The following charts, Figures 4.1 and 4.2, show the magnitude of forecast errors for the entire data sample (Figure 4.1) and the number of SKUs in the different categories of forecast errors for cases replacement SKUs, cases non-replacement SKUs, accessories replacement SKUs, accessories non-replacement SKUs (Figure 4.2). The number of SKUs reflect a majority of the forecast errors in the –30% to –80% (magnitude of errors) range; this shows the Company's

tendency to under-forecast. The pattern is similar for all of the data points in the different categories. Note that there are seven SKUs that reside over the 100% forecast error range.

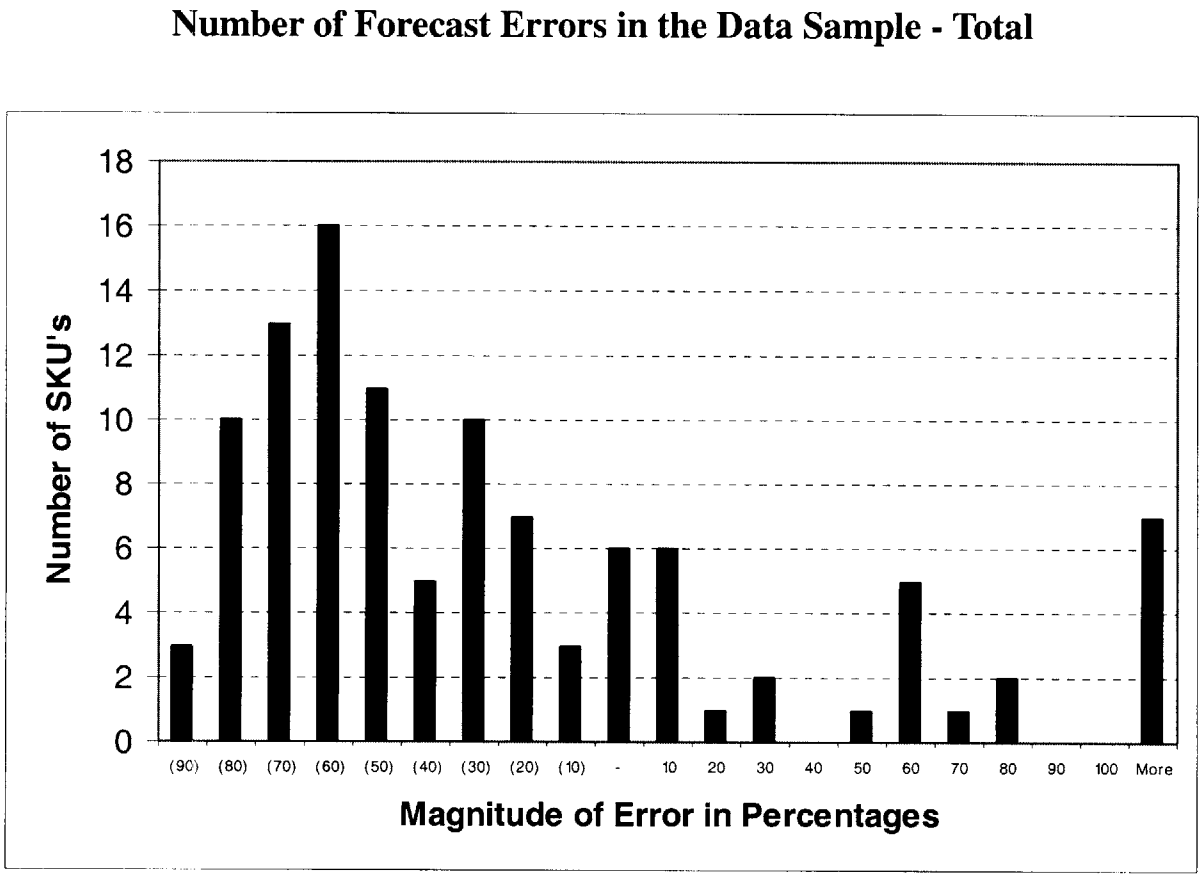

Figure 4.1. The chart represents the forecast error distribution for the 109 items in the data sample (sample excludes the nine markdown SKUs). Targus has a tendency to under-forecast, as represented by the pattern of the large number of forecast errors less than 0%.

Number of Forecast Errors in the Data Sample – By Category

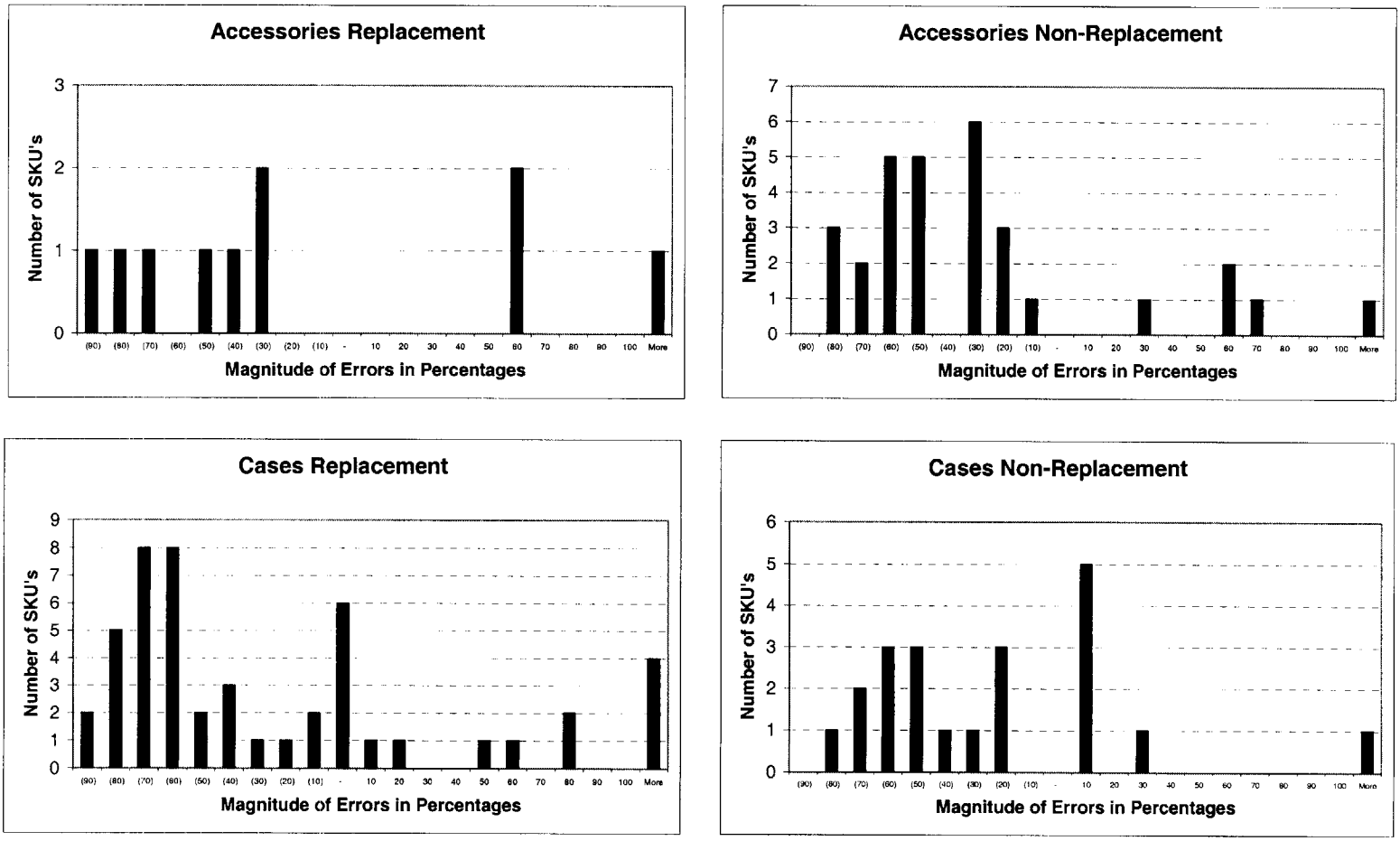

Figure 4.2. These four charts represent the forecast error distribution for the 109 items in the data sample (sample excludes the nine markdown SKUs) for the four types of categories: accessories replacement, accessories non-replacement, cases replacement, and cases non-replacement SKUs. The purpose of these four charts is to provide a further breakdown of Figure 4.1 to show that the tendency to under-forecast, as represented by the pattern of the large number of forecast errors less than 0%, is consistent within the four different categories.

6.2 Data Results – Months of Sales

In analyzing the sample data further for the number of months of sales to sell out of the initial forecast, the research shows 22% of the data sample items not selling out beyond month nine.

The cumulative percentage sold out by month shows the total months to sell out of the initial order. The actual sales by month were compared to the initial forecasted order and then the number of months to deplete the order was calculated. Figure 5.1 shows the cumulative percentage of SKUs sold out vs. the number of months it took for the SKU to be sold out for accessories and cases. Figure 5.2 shows the cumulative percentage of SKUs sold out vs. the number of months it took for the SKU to be sold out for replacement and non-replacement SKUs. For example, in Figure 5.1, approximately 50% of all case SKUs in the data sample sold out of its initial Targus purchases in months 3 to 4 of the selling season. By the time we reached month nine, approximately 80% of the accessories products sold out of its initial purchases, 20% did not sell out. For cases, approximately 75% of the products sold out by month nine, 25% did not sell out. The pattern for cases and accessories were similar. For replacement and non-replacement SKUs, in Figure 5.2, the patterns were also similar.

Accessories and Cases Cumulative Percentage of SKUs Sold Out by Month

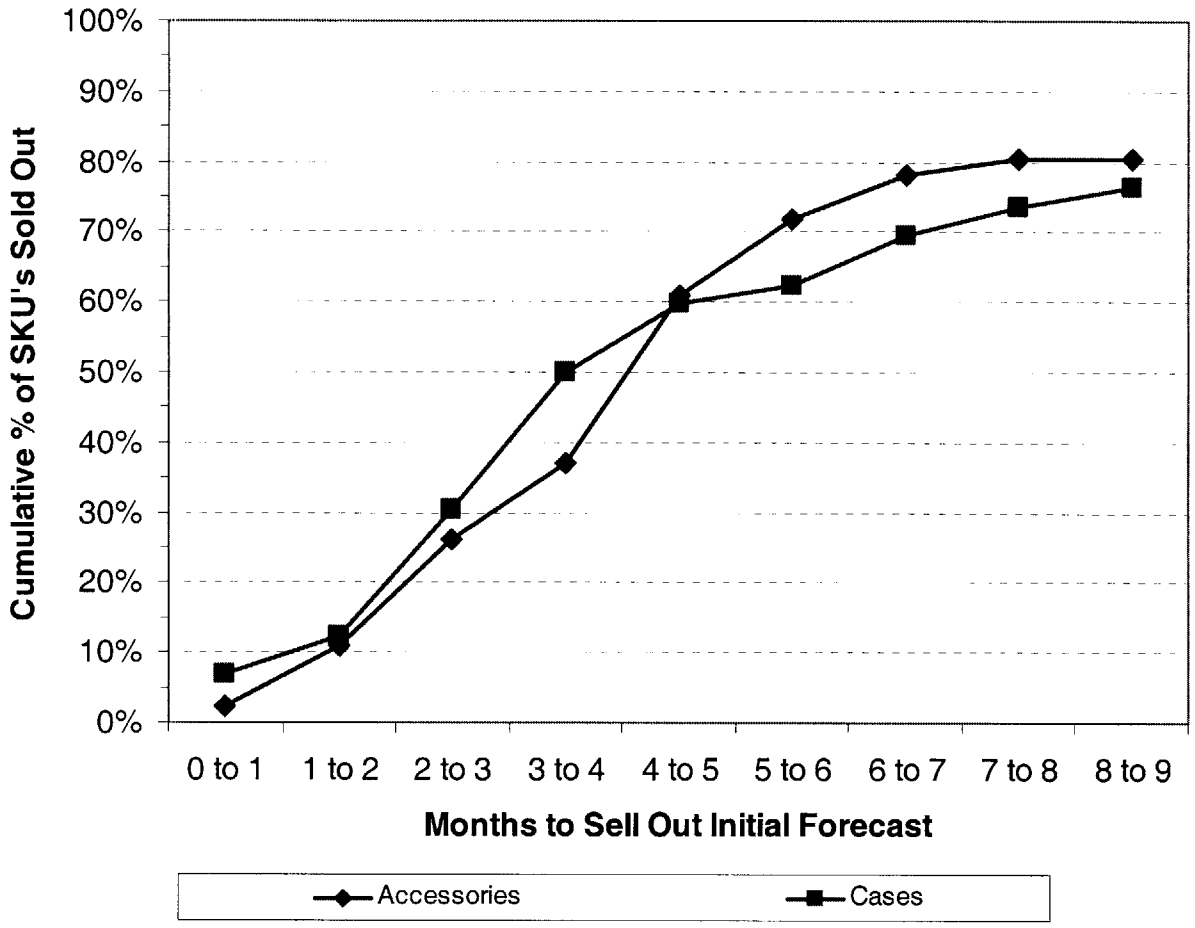

Figure 5.1. This graph represents the cumulative percentage of items that sold out when comparing the actual months of sales to the initial purchase for total accessories and total cases. For example, by months 8 to 9, 80% of the accessories in the data sample sold out of its initial purchases.

Replacement and Non-Replacement Cumulative Percentage of SKUs Sold Out by Month

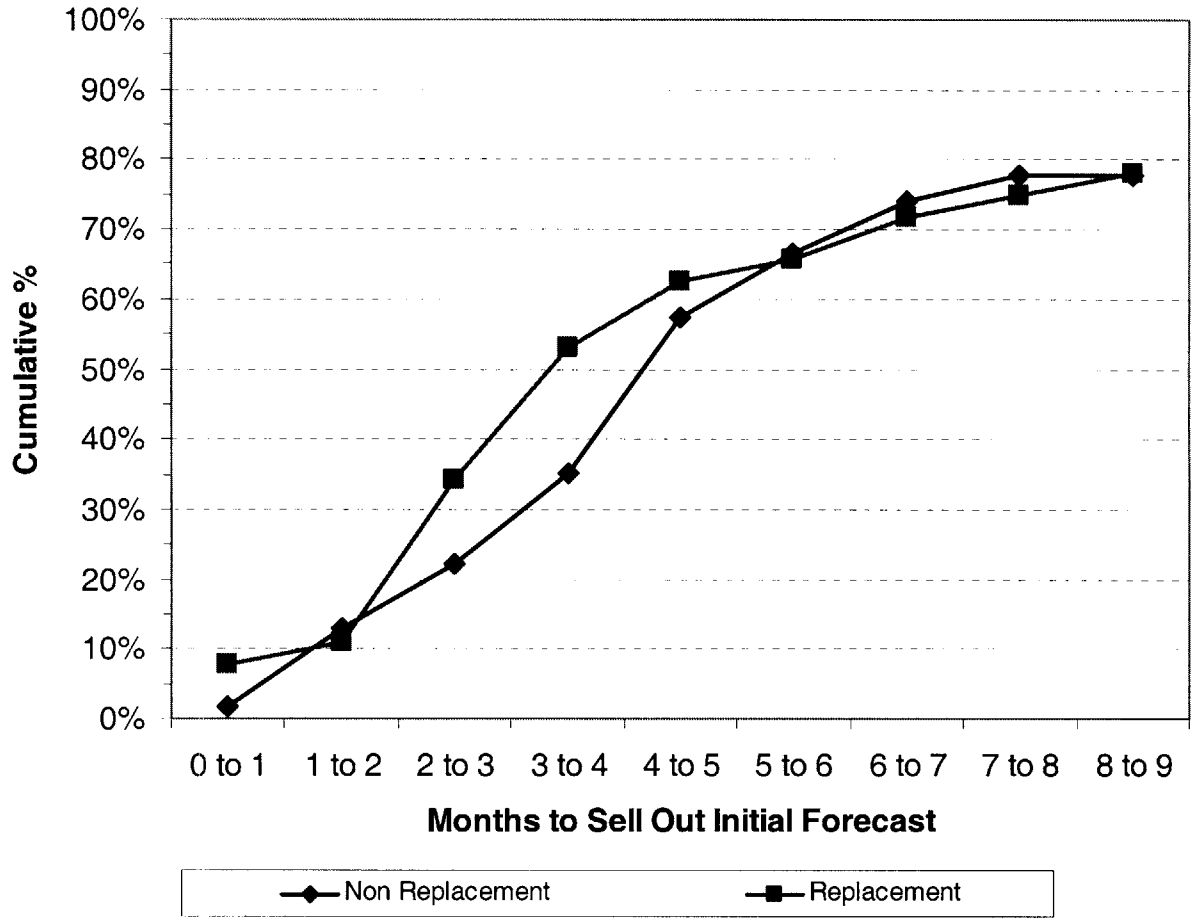

Figure 5.2. This graph represents the cumulative percentage of items that sold out when comparing the actual months of sales to the initial purchase for non-replacement and replacement products. Thus, by months 8 to 9, 78% of the non-replacement SKUs in the data sample sold out of its initial purchases.

Figure 5.3 shows the cumulative percentage of SKUs sold out vs. the number of months it took for the SKU to be sold out for accessories replacement vs. accessories non-replacement SKUs and cases replacement vs. cases non-replacement SKUs. For example, for accessories replacements, approximately 60% of all replacement SKUs sold out of its initial purchases in months 5 to 6 of the selling season. Approximately 85% of accessories non-replacement product sold out by month nine, 79% of the cases replacement product sold out of its initial purchases by month nine, 72% of the accessories replacement product sold out of its initial purchases by month nine, and 70% of cases non-replacement sold out of its initial purchases by month nine. Figure 5.3 below summarizes the trend.

Accessories and Cases Replacement vs. Non-Replacement Cumulative Percentage of SKUs Sold Out by Month

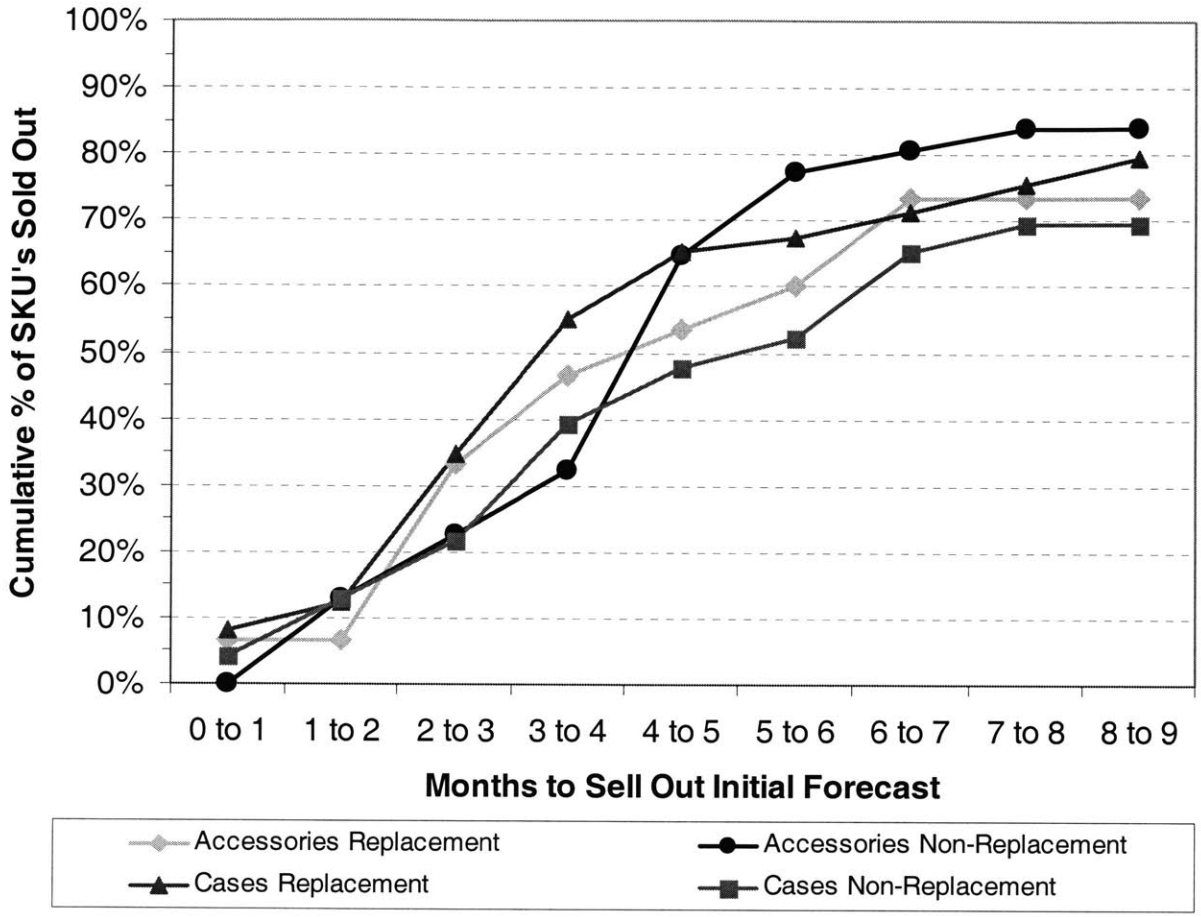

Figure 5.3. This graph represents the cumulative percentage of items that sold out when comparing the actual months of sales to the initial purchase for replacement and non-replacement product. All four categories of product are summarized on one chart to show that there is not much deviation from the four categories.

Based on Figures 5.1, 5.2, and 5.3, the data shows that despite a nine-month selling season, regardless of replenishment or canceling of purchase orders, the Company was unable to sell out of its initial purchases by the ninth month for 22% of items introduced. Although the forecast

errors show a tendency to under forecast, which means that the Company will likely sell out a majority of the time, a significant percentage of items are still not selling out by month nine. In reviewing Figures 5.1, 5.2, and 5.3, there is no pattern of behavior to differentiate between cases vs. accessories and replacement vs. non-replacement SKUs.

6.3 Data Results – Markdowns

Markdown data was analyzed in the data sample. Since the Company does not maintain a list of markdowns, a rule was established such that any price decreases of 10% and over during the selling season was classified as a markdown. According to the data, there were a total of nine items or 8% of the total data sample that were marked down. Of the nine items marked down, six were accessories products and three were case products, and six items were replacement SKUs and three items were non-replacement SKUs.

For the accessories products, one item was a non-replacement SKU and five items were replacement SKUs. In further analysis of the accessories, all of the markdowns were for storage products. There were no markdowns for security, power, lifestyle, input/output, and connectivity. For the three items marked down for cases, two items were non-replacement SKUs and one item was a replacement SKU. Furthermore, for the three case items marked down, two were for camera and one was for multimedia. There were no markdowns for notebooks and backpacks.

Table 2 is a detailed list of the nine markdowns.

Table 2. The table provides a detailed list of the nine SKUs in the data sample that were marked down.

Sample #	Case or Accessories	Type	Attribute
1	Accessories	Storage	Replacement
2	Accessories	Storage	Replacement
3	Accessories	Storage	Replacement
4	Cases	Camera	Non-Replacement
5	Accessories	Storage	Replacement
6	Cases	Multimedia	Replacement
7	Cases	Camera	Non-Replacement
8	Accessories	Storage	Non-Replacement
9	Accessories	Storage	Replacement

Only a relatively small percentage of the total sample experienced markdowns. That is not to say that all items should have experienced markdowns. There were no policies that defined when markdowns should occur and at what magnitude. However, by analyzing the data, only certain products (accessories storage and camera and multimedia cases) experienced markdowns, even though there were some other types of products (backpacks, notebook cases, and accessories lifestyle), which did not experience markdowns, but had over nine months of sales from the original forecast.

6.4 Newsvendor Results

Based on the newsvendor problem calculation, Table 3 shows the critical ratio for each of the four category attributes. The cases, with a critical ratio of 53%, are higher than the accessories at 34%. Within the case categories, both cases non-replacement at 57% and cases replacement at 51% are higher than the accessories non-replacement at 33% and accessories replacement at 41%. What this means is that the Company experiences a higher inventory risk by over-ordering

accessories (relative to the sales mean) as opposed to under-ordering accessories and the Company experiences a higher inventory risk by under-ordering cases as opposed to over-ordering cases (relative to the sales mean). In other words, with a critical ratio over 50%, the cost of under-ordering is higher than the cost of over-ordering in that it is costlier to lose the margin from the sale than it is to liquidate the surplus inventory. If the critical ratio is lower than 50%, then the cost of over-ordering is higher than the cost of under-ordering.

Table 3. The table summarizes the critical ratio for the different categories of the data sample. A critical ratio greater than 50% will reflect an optimal order greater than the sales mean, similarly, a critical ratio less then 50% will reflect an optimal order less than the sales mean.

	Critical Ratio
Accessories:	
Replacement SKU's	41%
Non-Replacement SKU's	33%
Total Accessories	34%
Cases:	
Replacement SKU's	51%
Non-Replacement SKU's	57%
Total Cases	53%
Total:	
Replacement SKU's	50%
Non-Replacement SKU's	42%
Total	45%

In reviewing the newsvendor calculation for the optimal initial order size (Table 4), Targus has a tendency to over-order replacement SKUs and under-order the non-replacement SKUs. For accessories replacement SKUs, Targus' forecasts were 17% higher than the optimal order and for cases replacement SKUs, Targus' forecasts were 21% higher than the optimal order. The profit impact for over-ordering replacement SKUs was a loss of $211,600. For accessories non-replacement SKUs Targus' orders were 9% lower than the optimal order and for cases non-replacement SKUs Targus' orders were 34% lower than the optimal order. The impact of the under-order non-replacement SKUs resulted in a loss of profit of $317,600.

Table 4. The data sample was applied to the newsvendor problem and the results were summarized in the table noted below. Targus' orders and the probable profits from the forecasted orders are compared to the optimal forecasts and the respective optimal profit calculation.

	Unit Orders (000's)				Profit Calculation (000's)			
	Optimal	Targus	Difference	%	Optimal	Targus	Difference	%
Accessories:								
Replacement SKU's	50.8	61.3	10.4	17.0%	$ 93.8	$ 70.1	$ (23.6)	-34%
Non-Replacement SKU's	285.9	262.2	(23.7)	-9.0%	$ 1,457.8	$ 1,399.0	$ (58.8)	-4%
Total Accessories	336.8	323.5	(13.3)	-4.1%	$ 1,551.6	$ 1,469.1	$ (82.5)	-6%
Cases:								
Replacement SKU's	461.3	583.5	122.2	20.9%	$ 1,119.5	$ 931.6	$ (187.9)	-20%
Non-Replacement SKU's	315.8	235.2	(80.5)	-34.2%	$ 2,132.4	$ 1,873.7	$ (258.7)	-14%
Total Cases	777.1	818.7	41.6	5.1%	$ 3,251.9	$ 2,805.3	$ (446.6)	-16%
Total:								
Replacement SKU's	512.2	644.8	132.6	20.6%	$ 1,213.3	$ 1,001.7	$ (211.6)	-21%
Non-Replacement SKU's	601.7	497.5	(104.2)	-21.0%	$ 3,590.2	$ 3,272.7	$ (317.6)	-10%
Total	1,113.9	1,142.3	28.4	2.5%	$ 4,803.5	$ 4,274.4	$ (529.1)	-12%

Despite the fact that Targus' orders vary from the optimal order, the two areas with the highest profit impact are both with the cases. With a critical ratio of 51% for cases replacement SKUs an over-order relative to the sales mean is not necessarily a concern because of the high potential profitability from sales when compared to the accessories. But, in reviewing the cases non-replacement SKUs, the critical ratio is higher at 57%, but the Company is under-ordering by 34%. What the results do not show is that after the initial order is made, the Company has the opportunity to place additional orders to meet unplanned higher demand.

The newsvendor results show that the Company is 12% less profitable using its current method of forecasting and the lower profits are due to a combination of over-ordering replacement product and under-ordering non-replacement product.

6.5 Data Results – Summary

This subsection summarizes the results of the data analysis and findings based on the interviews. The new product introduction process is challenged with several factors: long lead-times on orders, lack of customer commitment leads to uncertain demand, and the lack of uncertainty as to how long a product will sell. These challenges lead to inventory risks.

The Company does not use probability-based forecasting, such as the newsvendor problem, and forecasts are based on the regional sales team's expectations as what they believe will sell given customer feedback and historical run rate data on existing product. Thus, there is no profitability analysis during the initial product introduction process, such as a review of the critical ratio. Because there is no profitability analysis, there is no inventory risk analysis.

What the data results show is that 22% of the total cases and accessories products do not sell out of its initial purchases by month nine of the respective SKU's selling season. In this case, the Company over-ordered 22% of the product and under-ordered 78% of its products. But, one of the tools that the Company has available when demand is greater than inventory is to place replenishment orders. This is evident by the fact that 78% of the SKUs in the data sample had actual sales higher than the initial purchases – new products had to have been purchased during the selling season to meet the demand.

7 Recommendations

The research question addressed earlier in this paper was: given the inventory risks that Targus faces with the initial purchase decision, will using the newsvendor approach reduce such risks? In answering this question, the approach taken in the data analysis and interviews was to determine purchasing behavior and processes to find where the inventory risks at Targus are. This section serves two purposes. First, the section will provide a list of recommendations for Targus to consider based on the research analysis, and second, the section includes areas of future study.

7.1 Incorporate the Newsvendor Approach in the Product Introduction Process

Based on the findings, Targus should consider incorporating the newsvendor approach as a method to formalize its initial ordering for the new product introduction process. In Section 6.4, the newsvendor optimal profit calculation was 12% higher than the Company's. If the Company were to place orders closer to the optimal, the profit impact would have been a 57 basis point improvement to gross margins and a 300 basis point improvement to the Company's operating profits. The newsvendor problem takes into consideration the uncertain demands and the potential profitability of the products to calculate a probability-based optimal order. Thus, the Company would have the ability to assess the profitability of its initial order based on the impact the costs of overage and underage have to the optimal order calculation. The Company can then

compare this optimal order calculation against the forecasts as provided by the sales teams to see if it makes sense, vis-à-vis, newsvendor logic.

The Company should consider setting up a system to calculate the newsvendor problem at the same time that the regional sales teams provide their forecasts for the new product. This should be an independent calculation performed by the Planning group.

The difficulty in implementing such a process, however, is that the Company does not maintain statistical data, such as the mean forecast error, standard deviation of forecast errors, cost of overage, and cost of underage. Therefore, for our recommendation to be feasible, the Company should consider tracking such data, by SKU. Not only should the Company track the data, but they should also analyze the data. By analyzing the data, the Company can hopefully learn from past mistakes and refine the forecasts even further by using facts from the data analysis. The statistical data can then be used to forecast similar products.

There are three additional issues with respect to implementation: incorporating a system to track the statistical data, determining who will analyze the data, and which products are appropriate for the newsvendor calculation.

First, in order for the Company to track the statistical data, they need to incorporate a system to track the information. A "system" is defined as processes, not necessarily the technology to track the data. Currently the Director of Planning maintains forecast data, but does not analyze it. One issue with the forecast data is that it changes weekly. The Company needs to determine at what point it makes sense to establish the cut-off to define the final forecast to be used to place an order. Then once the forecast information has been set, the actual data needs to be compared against the forecasts at timely intervals. Then, when new products are being considered for

introduction, the Company should use the analysis to see how the forecasts made at the time of initial order compare against actual sales.

Second, the Company needs to determine who should analyze the statistical data. In recognizing the additional work required to track the statistical data, it is not immediately known who will perform these extra duties. The tradeoff between the additional costs required for the labor to perform the analysis should be compared against the benefit of improved forecasts.

Third, it is not appropriate for the Company to incorporate the newsvendor problem to all new products. For example, we excluded OEM products from this research and, therefore, we do not recommend that OEM products should be applied to the newsvendor problem. The accessories and case products used for this research are sold in the retailer and distribution channels. These are the products that the Company should use the newsvendor approach to benchmark its initial forecasts. The type of products that makes the most sense is with cases non-replacement SKUs. The reason is that the critical ratio at 57% for cases non-replacement is the highest on average in the sample, yet, Targus' orders were 34% less than optimal. If the Company were to have incorporated the newsvendor approach, then the orders would have been higher. The reason is that for such a high critical ratio, it is not a business concern to over-order the high critical ratio items because the cost of overage is less than the cost of underage. The product that makes the least sense to use the newsvendor approach is the accessories non-replacement SKUs. The critical ratio is 33% for such products, and for such low relative profitable items, the Company has a tendency to under-order anyway, as demonstrated from the 9% difference between the newsvendor optimal order and Targus' orders in Table 4. For low critical ratio items, it is not a business concern to under-order the low critical ratio because the cost of overage is higher than the cost of underage.

7.2 Areas of Future Study

The recommendation in this paper addressed the Company's challenges with its informal pre-sales forecast process. However, there are four areas of inventory risks that the Company should address.

1. The Company should review the possibility of incorporating an inventory life cycle management policy. As described in Section 3.2.4, the Company does not have a markdown policy in place. In this research, only nine markdowns were observed out of 118 data items, yet 22% of the product did not sell out of its initial forecasts by month nine. It was not conclusive in this research as to whether a markdown should have been applied to the 22% of the data sample that were considered to be slow-moving. The Company should study the financial impact of implementing life cycle management to its products.

2. Three of the administrators interviewed for this research expressed a concern over the lack of a cannibalization analysis when analyzing new product to be introduced. The Company may not be optimizing the timing of the release of new product. The Company should consider reviewing the potential issue of cannibalization and also the inventory management of the current product that the new product will be replacing.

3. In the survey of literature, the issue of multiple-period ordering was considered to lower inventory risks as additional orders were made once a company received information regarding the true demand. This reduces inventory risk because the process reduces the significance of the role of uncertainty with the initial forecast calculations. Targus should look at the possibility of adjusting its initial orders, perhaps reducing the initial orders for

high cost product, and then consider a replenishment order once demand becomes better known early in the selling season.

4. Two of the interviewees expressed concern over the lack of profitability analysis prior to the introduction of the product. The Company should consider incorporating a profitability analysis prior to introduction. This type of analysis would consider the inventory risks as associated with the costs of overage and underage.

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