Reverse Logistics Supply Chain Process Modeling and Simulation

by

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Submitted to the MIT Sloan School of Management and the Civil and Environmental Engineering Department in Partial Fulfillment of the Requirements for the Degrees of

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Abstract

As consumer preferences shift towards online shopping and utilizing their homes as fitting rooms, traditional brick and mortar retailers are faced with the challenge to adapt. Many retailers are experiencing a growing number of returned merchandize, many of which cannot be easily resold to consumers due to various supply chain challenges.

This thesis explores the opportunities to improve the consumer returns process and presents methods for modeling the supply chain process for reverse logistics in the retail industry derived from case studies. The model then allows for hypothesis testing. By changing parameters in the model, this thesis further explores the scenarios in which the supply chain process may be improved to increase margin and decrease cost.

The primary recommendations include specific modifications to the current reverse supply chain flow, enabling new channels that improve speed and margin, as well as developing the decision tool further for better accuracy and integration into the supply chain.

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Note on Proprietary Information

In order to protect information that is proprietary to the company that sponsored this project, the data presented throughout this thesis has been modified and does not represent actual values. Data labels have been altered, converted or removed in order to protect competitive information, while still conveying the findings of this project.

Table of Contents

Table of Figures

Table of Tables

Glossary

- DC = Distribution Center
- NM = Net Margin
- B2B = Business-To-Business
- RL = Reverse Logistics
- FS = Factory Store
- FY = Fiscal Year
- SKU = Stock-Keeping Unit
- SO = Store Owned (Regular Retail Stores)
- MSRP = Manufacturer Suggested Retail Price
- High-Heat = Products that are unique in design and only sold in limited quantity in a limited timeframe, and tend to be more expensive than regular products

1. Introduction

As consumer preferences shift more and more from purchasing goods in brick-and-mortar stores to an electronic commerce environment in recent years, so too does the supply chain operations and policies of retailers to adapt and support this evolving trend.

As part of the transition into the electronic commerce area, which is especially true in the apparel and footwear industry, consumers are utilizing their homes as the new fitting room. Traditional brick-and-mortar stores have offered consumers the opportunity to interact with the garment at a more detailed level prior to making a purchasing decision, allowing consumers to experience the texture, color, style, and fit in real life, hence instilling more confidence in the purchase to follow. With the migration to electronic commerce, consumers don't have the same opportunity to interact with the garment anymore. While it's true that more and more retailers are improving their online platform to be more informative regarding their products, the experience still doesn't quite compare with seeing the product in real life. Often, receiving the package at home is the first time consumers see the products they purchased. This larger mismatch between purchasing something consumers think they intend to online and something they know they intend to after interacting with it in the store has created more returns volume than retailers have traditionally seen.

As a result, in recent years more and more focus has been placed on trying to understand the returns space in the retail industry, from consumer expectations, the impact of return policy on consumer behavior, to the effect returns have on the operations and supply chain. This thesis focuses on the supply chain implications of consumer online returns.

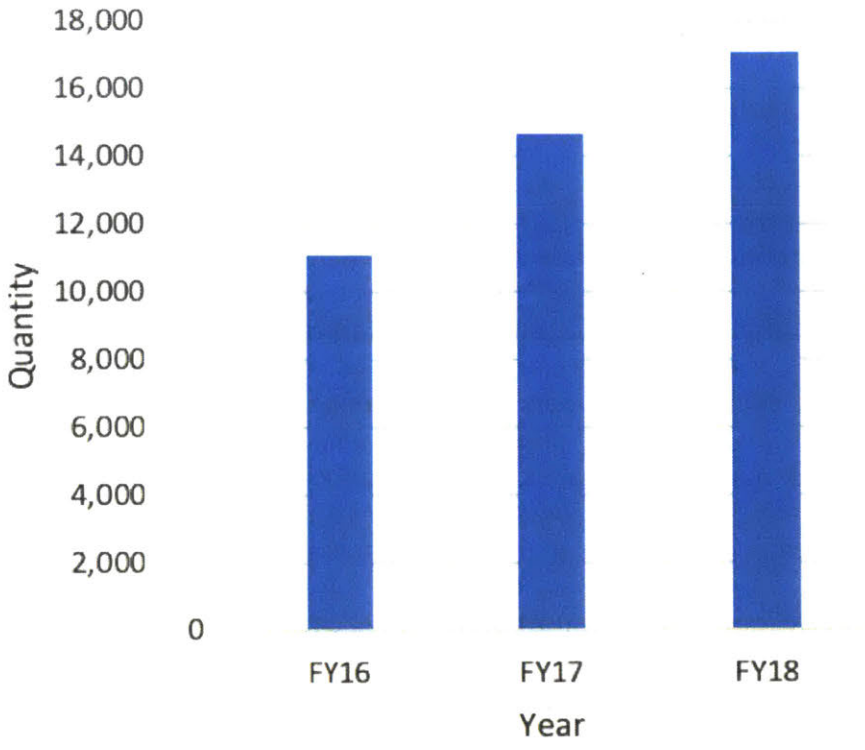

Figure 1. Retailer Online Order Volume by Fiscal Year

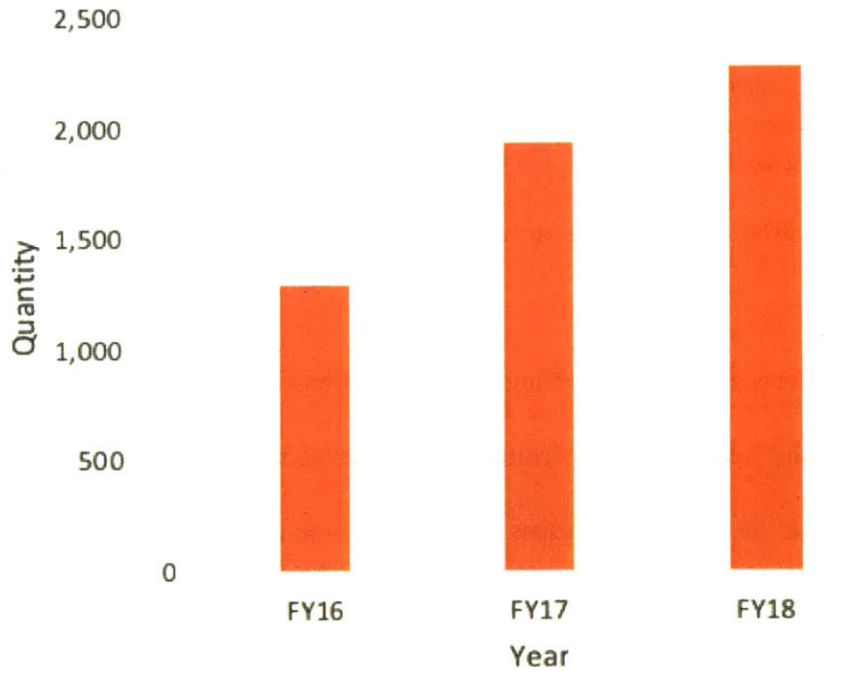

Figure 2. Retailer Online Return Volume by Fiscal Year

1.1 Project Motivation

The motivation of this project arises from companies' growing focus to engage more directly with consumers through a growing online presence and offering more frictionless return policies to take the risk out of shopping online. As a result, retailers are experiencing increasing volume of returns. With this volume increase, it is thus important to understand the current and ideal states for consumer return policies and supply chain processes in terms of cost, margin, consumer friction, and sustainability to ensure that retailers are strategically prepared for the future. Figure 1 and Figure 2 shows the given retailer's digital purchase volume and digital returns volume both rising significantly over the last fiscal years (numbers are disguised). The rate of return has also been rising, from 12.82% in FY16 to 14.57% in FY17 then 14.79% in FY18.

Companies have an opportunity to provide differentiation in the consumer digital returns policy across various geographies, product families, and consumer segmentation. Currently, the retailer's return policy is 30 days free returns via mail or in store. Free returns means free to the consumer, and the retailer assumes the cost of shipping. However, with the differentiation, retailers are presented with the ability to adjust and adapt to achieve more desirable return policies that satisfy consumers' needs better, turn products around faster, generate more revenue, and reduce cost. As an example, intuitively, higher priced products that are only offered in limited quantities in a limited timeframe that have high demand would benefit from a shorter return window so they generate more profit per item, the demand is more time-sensitive, and any returned items in re-sellable condition can expect to be sold with relative certainty. Another example is with the migration to online shopping, more and more information is becoming

available that is easier to collect compared to conventional brick-and-mortar sales, including demographic information about the consumer, past purchasing behavior, and return history. With the help of a wealth of data, retailers can have differentiated policies for different groups of consumers. By identifying return abusers or resellers, retailers have an opportunity to reduce return volume drastically and focus on serving the consumers they value.

Another motivation for this project is to study the potential for customization within retailers' internal supply chain operations. At the moment, at the retailer studied, all returns are processed in the reverse logistics distribution center, with most of digital returns accumulating until becoming out of season and being sold to discount channels. To avoid distribution center capacity issues, obtain higher margin, and reduce the cost to process returns, the challenge to understand and capture the opportunity to improve the reverse logistics supply chain seems more pressing than ever. One such example of a potential opportunity to improve the internal supply chain practice for returns is utilizing the omnichannel capability many retailers have through its store network or forming partnerships with other logistics providers if a retailer doesn't have an existing network of stores. It would be worth exploring the comparison of cost, speed, and margin of in-store returns and returns mailed back to the reverse logistics distribution centers. It is possible that by avoiding transportation costs, distribution center processing costs, and inventory holding costs, as well as the added time before the product can be resold to consumers due to longer transit and processing times associated with shipping returns back to the reverse logistics center.

1.2 Problem Statement

The objective of this project is to gain a better understanding of the current state of the digital returns process, to develop frameworks to assess and quantify the effectiveness of various supply chain initiatives, and to recommend an improved digital returns strategy.

While there are many areas within the realm of returns one could focus on, this thesis project aims to study the supply chain and operational implications of consumer returns from online purchases, and any subsequent consumer policy changes resulting from the operational perspective. This project examines the possibilities within changing the existing supply chain structure to achieve better margin, lower costs, higher speed, and more sustainable dispositioning of returned merchandize. Data is utilized wherever possible and assumptions are made otherwise to the best representation of the process without adding too much complexity. The end goal is making recommendations on proposed near term and long term modifications to the existing practices.

The scope of this thesis project focuses on the geographical area of the United States, the product family of athletic footwear, the product types of non-customized products available on the online platform, and the order types of non-employee purchases. The reasoning for choosing a scope as such is to limit the complexity of the thesis in the initial analysis, while coming up with a framework and way of thinking that could be applied to include a broader scope. Therefore for ease of access to detailed information from stakeholders and distribution centers specific to the North America region, the framework and conclusions discussed in this thesis are based on North America-specific supply chain practices. In addition, to make insights and recommendations as accurate as possible, data sources used excluded those orders and products that may cause bias in the analysis.

1.3 Thesis Structure

This thesis is organized into seven chapters. The content of each chapter is summarized below.

- Chapter 1: The high-level project motivation, problem statement, and thesis structure are presented. This serves as an introduction to the rest of the thesis where more in-depth analysis is performed.
- Chapter 2: A more in-depth look at the background of the retailer is discussed, including company overview, its current return journey from consumer's perspective, and the operations of its stores and distribution centers.
- Chapter 3: A literature review summarizes previous academic research and industry analysis as relates to the motivation, problem formulation, and methodology outlined in this thesis. Topics include e-commerce consume return behavior, multi-channel distribution and logistics, and reverse logistics network design cases.
- Chapter 4: A deeper dive into the current state of the returns process at retailer, including the data sources available, problem formulation, opportunity exploration, and hypothesis generation.
- Chapter 5: Two case studies performed on two separate product families were examined; the methodologies used, frameworks developed, and other insights derived from these case studies are summarized.
- Chapter 6: The decision support tool that resulted from the case studies, including its logic and analysis of the results is presented in this chapter. Though this is only a preliminary version of the tool, the logic will still serve as foundation for future developments and refinements.

- Chapter 7: The conclusion of the thesis including a list of recommended supply chain and policy changes surrounding consumer digital returns for the retailer is outlined. Future areas of appropriate research are identified, including the possibility of conducting experimentation to validate some of the results obtained from this project. Some ideas for the design of the experiment are discussed.

2 Background

2.1 Company Overview

The company studied is a leading athletic footwear, apparel, and equipment retailer engaged in the design, development, manufacturing, worldwide marketing and sales of its diverse line of products. With revenue of over $30 billion, a market capitalization of over $90 billion, and over 70,000 employees around the world, it is one of the most recognizable brand names in the world.

The company's operation is divided into four geographical areas: North America; Europe, the Middle East, and Africa; Greater China; and Asia Pacific and Latin America. The design and development of new products is primarily located in its World Headquarters in the United States.

The company's success largely resulted from its capability to be innovative in the design and development of its products. New technologies and concepts have continuously created products that push the boundaries of what is possible. At the same time, innovation as well as the company's growth and expansion have created a large number of SKUs and an ever-changing portfolio of products that create unique supply chain challenges. The next sections provide a more in-depth overview of the supply chain of the company as relevant to this thesis to provide context.

2.2 Supply Chain Operations Overview

While this thesis focuses primarily on the reverse logistics supply chain, it is important to have a broader understanding of the supply chain operations as a whole to gain context. In

addition, a successful supply chain is often one where the forward and reverse parts operate cooperatively in an integrated manner.

The design and development of new products are conducted in the United States by in-house design teams. After the conception of designs, they are manufactured by partner factories, most of which are located in Asia. Finished goods are shipped to ports in their respective geographical regions in different markets where the company operates. In some cases, airfreight is utilized as a faster mode of transportation from Asia is needed, but the cost is significantly higher compared to ocean freight in the majority of cases.

In the United States where this thesis focuses on, some of these products are shipped to ports on the west coast then transported to outbound distribution centers located in Memphis, Tennessee. Some of the products are directly shipped from the ports to wholesale customers who placed large orders early in the season to save on transportation and processing cost and time for the company as well as its customers. For purposes of this thesis, products directly shipped from the ports to wholesale customers are not considered as it has no impact on company-owned distribution center operations or the reverse logistics processes.

Memphis was chosen as the location of the outbound distribution centers as it is closely located to the centroid of the population in the United States and conveniently adjacent to FedEx operations.

Once products arrive at distribution centers in Memphis, they are broken down into smaller quantities to be stored then re-combined to a mix of different SKUs to fulfill various orders.

The company sells products through multiple channels. Traditionally, the majority of revenue has been generated through wholesale, where products are sold to third party retailers

like Footlocker and Dick's Sporting Goods in bulk. In recent years, the company is putting more and more focus on its direct-to-consumer businesses – in-store sales from company owned retail outlets and online orders. It has a network of thousands of stores around the world with periodically rotating assortments, as well as discounted merchandize at its factory and clearance stores for out-of-season products. The online platform carries a larger assortment of products including both high-heat and in-season, as well as discounted products.

Once wholesale customers and individual consumers receive their orders, if for any reason they decide to return or reject the products, they will end up in the reverse logistics distribution center located in Indiana. The reverse logistics distribution center will then process all inbound shipments by examining each product for fit of being resold. The re-sellable products are restocked to be purchased by various channels.

2.3 Consumer Returns Journey

This section conducts a closer examination of the returns journey from the consumer's perspective who has placed an order online and has decided to initiate a return. The returns journey from the consumer's perspective can have a significant impact on their re-purchase behavior. Thus it's important to understand the friction points, if any, and how eliminating those will have operational challenges internal to the company. Figure 3 illustrates the returns journey for consumers who purchased products from the retailer studied. It can be considered average in terms of ease of returns among others in the industry. Many of the practices are also considered standard in the retail industry, though changes are taking place rapidly in the company as well as many others in the industry to make the experience as easy as possible. Studying the consumer

journey provides valuable insight into and context for the overall returns operation of the company.

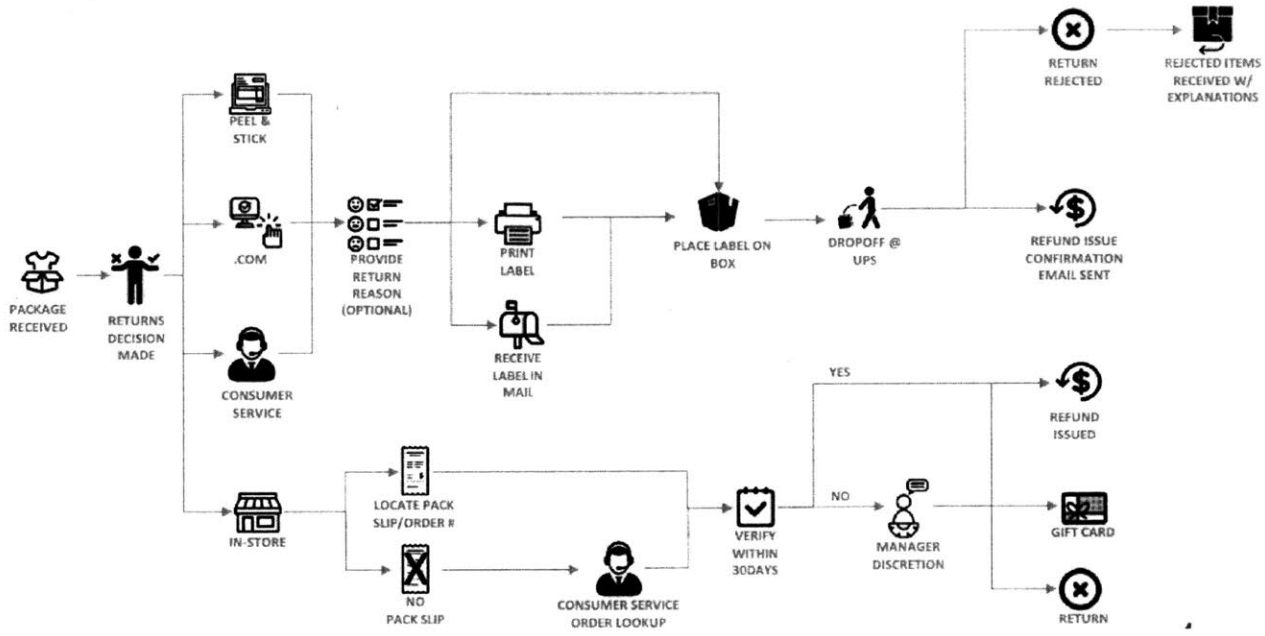

Figure 3. Consumer Returns Journey

As seen in Figure 3, the consumer returns journey involves many steps and possible outcomes. Currently, the company offers free returns within 30 days of purchase. Once the order is received and a consumer decides to initiate a return, they have two methods for making the return. They can bring the item to a store or they may mail the item back through a carrier.

For returns made in store, if a consumer has the receipt that arrived with the package, the store associate will verify the return is made within 30 days of purchase date. Otherwise, the associate will try to look up the order information in the system by contacting consumer services. As long as a return is made within 30 days of purchase, it will be accepted and a refund will be issued regardless of the condition the items are in. If a return is made at longer than 30 days after purchase, the refund will depend on manager's discretion. Usually if the item is unworn and unused, a refund will still be issued. However, the consumer may also expect a refund in the

form of store credit or a rejected return depending on the circumstances. Refunds for in-store returns are issued immediately.

If a consumer doesn't live near a store or simply wishes to mail the item back for return, there are several options to initiate the return; the simplest is to use the label included in the original package. The label is pre-paid and is free of charge for the consumer. Consumer attaches the label on the box and may drop it off at any UPS locations. If a consumer lost the original label, consumer services may be contacted to have a label mailed or emailed to the consumer to attach to the box. Alternatively, consumers may also go online and initiate a return on the website, though feedback has indicated the process is rather difficult.

Once a consumer drops off the package at a UPS location, depending on the geographical area the consumer resides in, it may take anywhere between 3 to 7 days to arrive at the reverse logistics distribution center. Once the returns are received, it will then take up to 2 days for the returns to be processed. During transit and processing, a consumer receives no update on the status of the return. If a return is accepted at the distribution center, an email will be sent to the consumer to communicate that refunds have been issued. If a return is not accepted, the item will be sent back to the consumer with a letter stating the reason for rejection.

There are some points in this process that are known to cause friction to consumers. First, the return initiation process on the website is long and difficult to locate, which in turn drives increased call volume to consumer services call centers. Second, the lack of visibility to consumers in the process after a package is dropped off at the carrier promotes anxiety and also drives increased call volume to consumer services inquiring about the status of the return and refund.

2.4 Distribution Center Operations

The retailer has several outbound distribution centers located in Memphis, TN, including one that is dedicated to consumer digital orders. There is one reverse logistics distribution center located in Indianapolis, IN. Because the analysis of returns disposition will also include re-selling the returned inventory, this section will discuss briefly both outbound and reverse logistics distribution centers to set the context.

Outbound distribution centers of interest primarily consist of a large distribution center mostly focused on footwear and some equipment for wholesale accounts, one mostly focused on apparel for wholesale accounts, and one exclusively shipping digital orders including all footwear, apparel, and equipment to individual consumers. While the vast majority of digital orders are fulfilled by the digital-only distribution center, there is a warehouse system in place where if an order is unable to be fulfilled by the digital-only distribution center due to stock-outs or capacity constraints, another distribution center will pick up the order and fulfill it on a predetermined prioritization.

The digital-only distribution center was brought online in the past few years as online orders grew and as part of the company's strategic focus to focus on direct-to-consumer businesses. It is designed to be small and agile, with frequent communication between the larger wholesale distribution centers should inventory require replenishment. The distribution center handles all single-unit as well as multi-unit orders. Even though an order may consists of multiple items, all items will usually be sent out in one box for the best consumer experience. At the end of the season, any unsold inventory as directed by the appropriate groups owning the product line will be sold to factory stores, clearance stores, or 3rd party discount channels in bulk at a discount.

The operations at the digital-only distribution center consists of areas such as inbound & receiving, case reserves, picking area, sorting, and outbound & shipping that one would expect from a typical distribution center.

The reverse logistics distribution center is located in Indianapolis and processes all digital consumer returns as well as wholesale returns for North America across all product engines including footwear, apparel, and equipment. Prior to it becoming operational in 2018, most returns were processed in another distribution center in Memphis which had experienced capacity constraints. The consolidation of all returns in a centralized facility is expected to reduce cost by pooling resources, streamlining the processes, and applying uniform standards of inspection, storage, and resale of returned inventory, thus reducing cost, improving efficiency, and increasing margin.

The reverse logistics distribution center consists of several areas – inbound and receiving, inspection and refurbishment stations, picking modules, case reserves, and outbound and shipping. The operation is, in a sense, the reverse process of that at an outbound distribution center. As items are received at inbound, each item goes through inspection and refurbishment as needed at the stations manned with a worker. Refunds will be issued here as well. This step usually takes less than a day to complete, after which items are stowed in the picking area or case reserves depending on the amount of a given style and color there are and the forecasted demand for that given style and color. For example, if an item is predicted to be resold relatively quickly, it will remain on the picking module for easier access rather than being stowed in the case reserves where retrieval might take longer. Items that passed inspections will appear in the inventory for customers to order, including wholesale accounts, stores, as well as other

distribution centers. Once items are requested to be re-purchased, they will be sent to the outbound area awaiting shipment.

Currently there is little visibility in the quality of inventory in stock once it passes inspection. Digital sales that are direct to consumers require inventory to be in pristine conditions to avoid any damages to the brand image, and without the guarantee of the quality of inventory at the reverse logistics facility, returned items cannot be resold digitally.

In addition, there is no established ordering process at the reverse facility by the digital outbound distribution centers for replenishment, including transportation, inventory review process, or rules on any cadence, making reselling returned inventory digitally difficult.

Lastly, the reverse logistics facility does not have the capability to process outbound shipment directly to consumers. It is currently not included in the aforementioned warehouse system that locates items in different distribution centers for order fulfillment in case of stockouts. It also does not have capability to meet certain packaging requirements for specialty products.

2.5 Store Operations

The retailer studied has hundreds of stores in the United States. The network of stores include factory stores, clearance stores, and regular retail stores.

Factory and clearance stores account for the majority of the store operations. Factory stores typically carry out-of-season products at a discount of somewhere between 25% to 40% off the original price. Assortment is limited, but usually still curated and each style has a good selection of sizes and colors available to consumers. The location of these stores can be urban or suburban, sometimes in an outlet mall. The target market is consumers who are seeking good

value. Clearance stores also carry only out-of-season products, but with a deeper discount compared to factory stores. Assortment is more limited, and there is less guarantee on the sizes and colors of a given style. Clearance stores are usually located in outlet malls, and the target market is consumers who seek good value and are willing to spend some time browsing through a large selection of items for the possibility of great finds.

Regular retail stores account for a small percentage of the geographical footprint of stores, however they are important representations of the company's brand. These stores are almost always located in highly urban and desirable areas with a great deal of traffic and visibility. The store front and interior design of the stores are usually very appealing, and the assortment includes only the newest in-season products carefully curated to meet the demand of the market in which it serves. The sizes and colors available for a given style is usually quite extensive, and the shopping experience very pleasant. The target market is less price-sensitive consumers who closely follow the company's new releases and engage with the brand, and tourists.

The returns process from the consumer's perspective at any store is typically the same. However, after the store receives the returned inventory, the process differs greatly depending on the type of the store. If an item is returned in-season to a factory or clearance store, most likely the item is not in the assortment of these discount stores, and thus will remain in storage to be sent to the reverse logistics distribution center for further processing on a certain cadence. If an item is returned in-season to a regular retail store, if the item is in the store's assortment, it will be added to the assortment available to be sold to consumers immediately; if it's not in the store's assortment, it will be kept in storage and shipped to a factory store on a certain cadence. Each retail store has a factory store they work with to unload excess inventory, out of season

products, or returned products. If an item is returned out-of-season to a factory or clearance store, the item will be added to the clearance rack at an appropriate discount available to be sold to consumers immediately. If an item is returned out-of-season to a regular retail store, it will almost always be sent to its corresponding factory store. The table below provides an overview of this process.

Despite the rules, the reality of what happens to most returned items to stores is difficult to track down as data is limited beyond the receipt of the items. Often, store managers make individual decisions as to which items to keep and send back to the distribution center, especially at a factory store level. In addition, there is little differentiation in processing different groups of products. Since factory stores represent the majority of the stores footprint, and most returns are made when they are still in-season, the policy of shipping all in-season returns to factory stores to the reverse logistics distribution center represents an opportunity to provide more clarity to factory store management regarding the processing of such returns. This opportunity will be discussed in more detail in Section 4.

	Factory/Clearance Store	**Regular Retail Store**
In-Season	Ship to reverse logistics DC on certain cadence	- If in assortment, sell in store immediately; - If not in assortment, ship to factory store on certain cadence, then shipped to reverse logistics DC from factory store on certain cadence

Out-of-Season	Sell in store immediately	Ship to factory store on certain cadence, then sold in factory store

Table 1. Returns Processing In Stores

3 Literature Review

The challenges around increasing consumer returns and consumer purchasing behavior shifting to online shopping rather than going to brick and mortar stores are a common problem faced by an increasing number of companies in the industry. However, reverse logistics supply chain has existed in many other industries as well, including those in business-to-business (B2B) transactions. The remainder of this chapter is devoted to reviewing existing research literature on the trends and insights of consumer returns in the electronic commerce industry, as well as any learnings in the field of reverse logistics process flow design and modeling.

3.1 Electronic Commerce Consumer Returns

The growth of electronic commerce in recent years has prompted much research into its effects on consumer behavior and in turn, its impact on retailers' operations, pricing decisions, policy formation, and marketing efforts.

As pointed out by N. Ertekin, the returns experience, particularly in-store returns experience of a consumer can have lasting effects on a consumer's lifetime value and repurchasing behavior [1]. The paper focuses on the less discussed aspect of how returns may influence consumer's future behavior, rather than the factors that influence consumers to initiate a return. The findings presented in the paper provides an additional benefit of encouraging in-store returns – that a positive experience of returning to store would persuade consumers to make repeat purchases more frequently beyond the immediate operational benefits this thesis is hypothesizing.

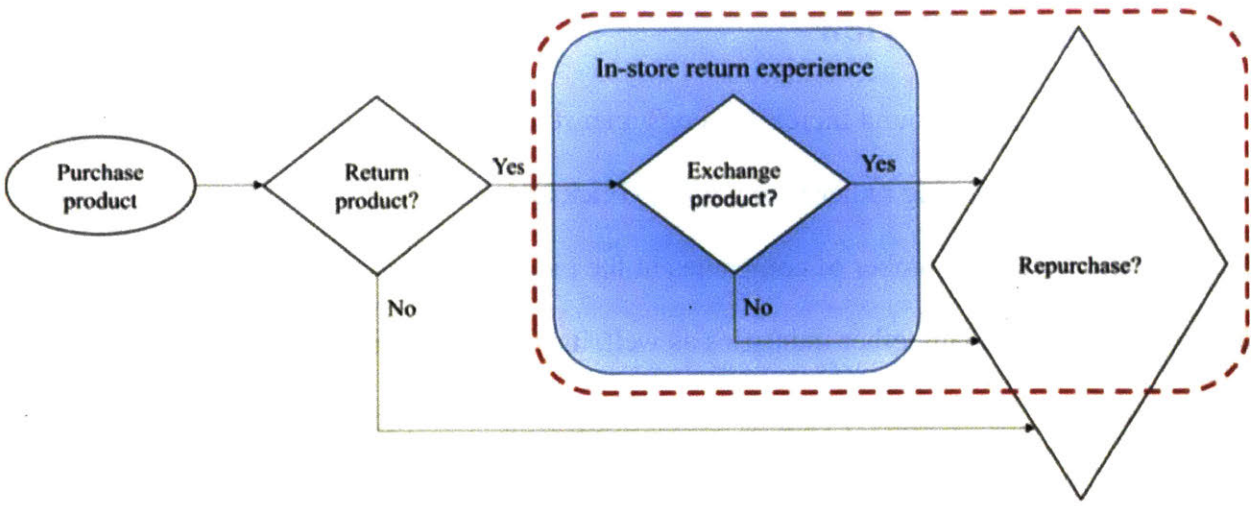

Figure 4. Firm-Customer Interaction Flow as presented by N. Ertekin [1]

In Figure 4, Ertekin demonstrates the various points of decisions for the consumer from the retailer's perspective, each of which provides an opportunity to influence the consumer on future behavior. When the consumer purchases the product, he/she forms an opinion about the retailer. If a return is initiated, the returns or exchange experience will in turn affect the repurchase behavior. In a sense, when a consumer initiates a return, it provides a retailer another chance to make a good impression. Thus how a retailer handles the returns experience is of significant importance to its success in the long term.

3.2 Reverse Logistics Supply Chain Network

The design of reverse logistics supply chain networks is an area with much interest and academic research. Even though many of the articles are not related to consumer digital returns, insights could still be derived from studies conducted on other reverse logistics networks.

A. Ang et al. discusses the design of reverse logistics networks in omni-channel environments much like the retailer studied. The framework introduced in the paper, as shown in Figure 5, can be useful to utilize when designing reverse logistics networks. Additionally, the

methodology used in the paper has provided inspiration for this project. In the paper, A. Ang et al. started with utilizing case studies to develop key areas to focus on and a framework to assess various aspects of the supply chain. The case studies provided useful factual foundation for further analysis [2].

	1. Collection and Inspection		2. Sorting and Testing		3. Processing		4. Storage
	In-House	Outsource	In-House	Outsource	In-House	Outsource	Central warehouse or nearby store
Centralized							
Decentralized							

Figure 5. Conceptual Framework for Designing Reverse Logistics Networks [2]

Z. Zhou et al. discussed a cost-based modeling of reverse logistics value flow analysis. Compared to A. Ang et al.'s research, this takes a more quantitative approach in framing the resign of reverse logistics supply chain networks. He argues that in a closed-loop supply chain, each step will incur cost and add value. Using a cost accounting optimization model of reverse logistics, a firm may optimize its costs and revenues if it takes into account the supply chain holistically [3].

4 Current State Characterization

In this section, the current state surrounding digital returns will be discussed in more detail, starting with the available data sources, explorative statistics, opportunity identification, hypothesis formation, and finally a brief discussion of the methodology and approach that will be explored more in-depth in later sections.

4.1 Data Sources

There are several sources of data to utilize related to digital consumer returns, including digital order information, digital order status information, reverse logistics distribution center inventory information, distribution center sales information, store information, and membership information.

Digital order information is a comprehensive list of the sales of each item on various digital platforms including .com and app orders. The information captured include everything from the date and time of order; shipping address; billing address; detailed information about the items such as style, color, size, product subgroups, gender, season, and quantity; sale price; discount amount; membership number; etc..

Digital order status data include much less information about the details of the orders and much more regarding the process an order goes through and time stamps at each step, as the name would suggest. It provides valuable insights into the journey each order takes from order placement, to being released to warehouse for fulfillment, awaiting shipment, picked up by carrier, delivery attempts, and most importantly, returns information. The returns information includes date and time of returns receipt at warehouse, inspection results, refund initiation, as

well as date and time of in-store returns. This data can be linked to the digital order information by order number, thus providing a complete picture as needed.

The reverse logistics distribution center, though having been only operational for a short period of time and still undergoing ramp-up in terms of receiving digital returns, has data regarding the amount of digital returns each month it processed that were deemed to be in re-sellable condition, as well as average time it takes to process each item. The distribution center also has data about the capacity utilization at various stages of operations, thus providing additional motivation for faster and more efficient disposition of returned inventory to avoid capacity constraints.

Each distribution center has data around the shipments to various customers – sale price, quantity, products, customer name, location, time of sale, etc.. This information is useful because it provides a picture of the margin at different stages of a product's lifecycle.

Store information is a list of factory, clearance, regular, and employee stores the company owns and operates in the United States that includes address, geographical coordinates, store type, and store name. This information helps gain insight into the locations of consumers relative to store locations to explore the possibility of increasing the proportion of in-store returns.

Finally, membership data contains basic demographic information about the member that are useful for market segmentation and analysis.

4.2 Returns Statistics

Using the data sources available described in the previous section, some exploratory analysis is performed to gain a more data-driven understanding of the current state.

The overall return rate for North America in fiscal year 2018 in terms of the number of orders is 14.8%, 13.4% in terms of the number of items, and 14.9% in terms of purchase price. Return rate for each of these metrics has been rising each year, while starting to level off from fiscal year 2017 to 2018. The slight discrepancy in return rate across these metrics might indicate more expensive items are returned more frequently, as return rate is a higher percentage of total value returned compared to the number of items returned. Similarly, as return rate is higher for the number of orders than the number of items, we deduce that there are more returns that came from multi-item orders than single-item orders, and that not all items in these multi-item orders were returned.

After getting an initial understanding of the operations around returns, the first area to explore is if there is indeed an opportunity to resell returned products faster. If most returns are made a long time after order date, the direction of the project would be completely different. Using digital order status data, we are able to gather this information.

Figure 6 shows the days it took for returns to be received at the distribution center for all orders placed in fiscal year 2018. The x axis shows the number of days between order placement and return receipt at the reverse logistics distribution center, and the y axis shows the number of orders. The yellow bars indicate returns that were received within 30 days of order date, which account for 82% of total returns volume. Most returns were received 12 days after order date. Given that a typical season is 3 months long, this statistic shows there is indeed opportunity to process and resell returns faster at in-season margins.

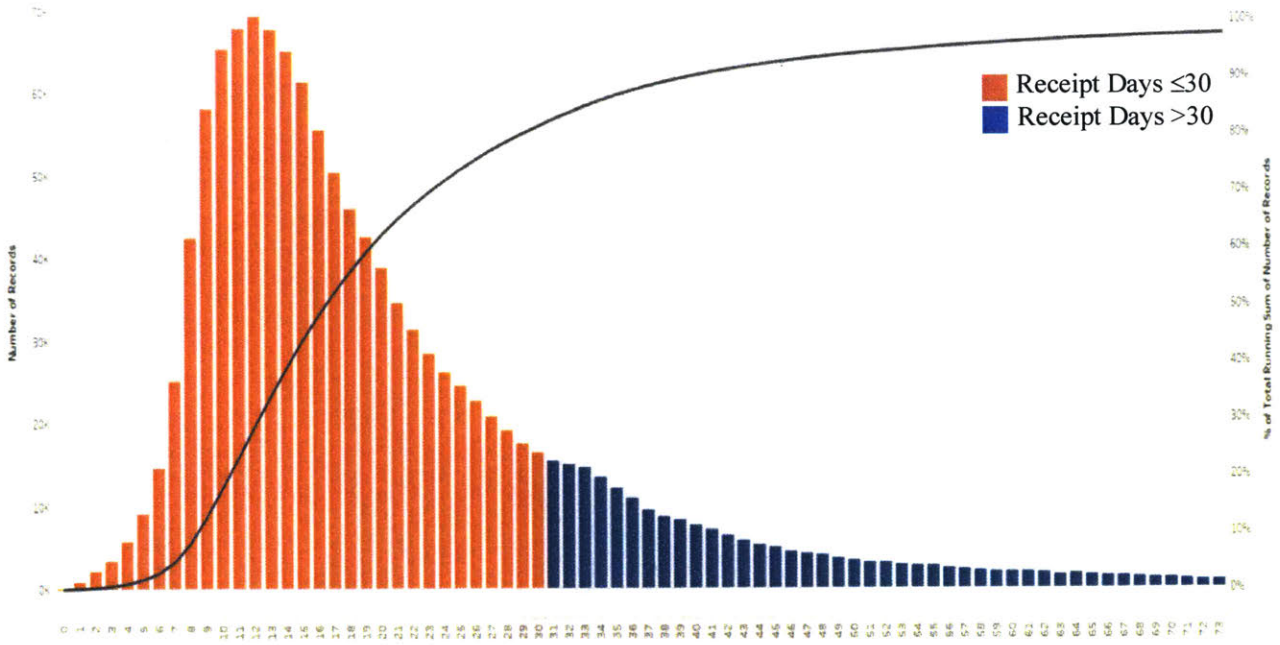

Figure 6. Number of Orders vs Days Between Order Placement and Return Receipt at Reverse DC in FY18

There is limited visibility of returned products once they are stored in inventory with other products of the same style and color. However, conducting interviews of the stakeholders involved in reselling the returned inventory revealed that most inventory will accumulate in the distribution center until one or two weeks prior to the end of its season, at which point it will be made available to factory stores, clearance stores, and third-party discount stores. The returned inventory is usually available for sale when they are in-season as well, but stores and other distribution centers rarely purchase them as the quantities are usually too low for each size and color for a given style.

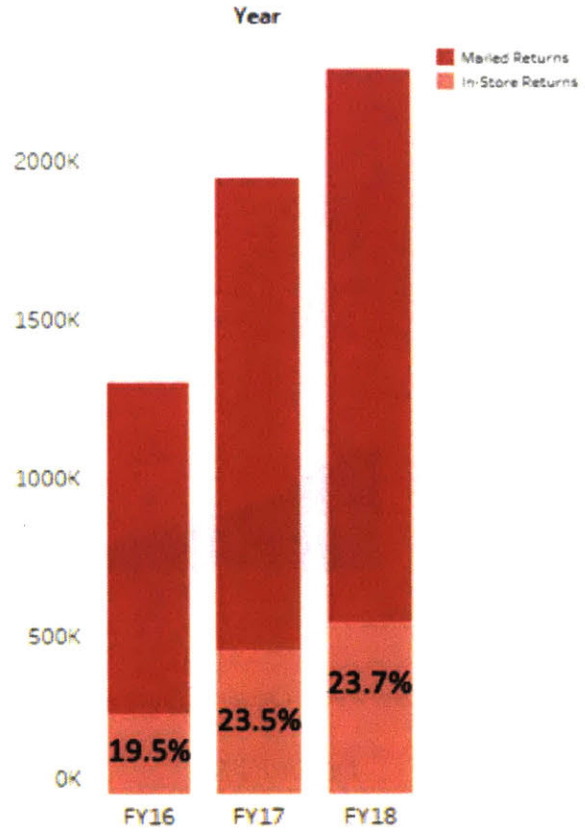

Figure 7. Mailed Return and In-Store Return Volume by Year

Next, we want to explore in-store returns. While there is no data on the store an item is returned to, there is data around which items from which orders were returned to store and the time.

Figure 7 shows that for the retailer the total volume of returns for the past three fiscal years for orders placed on the online platform, broken down into two categories – returns that were made to a physical retail store, and returns mailed back to the distribution center using the shipping label included in the package. The absolute number of in-store returns are on the rise, which by itself is not significant since the order volumes are increasing too. However, the percentage of in-store returns as a fraction of total returns is rising as well. This might indicate that more stores are opening in areas where there are higher concentrations of population and where consumers of this brand resides, which would be in line with the strategic locations the

company likely chose to open new stores. But this could also mean that consumer preferences are shifting towards in-store returns for faster refund, less uncertainty regarding the return being accepted, and perhaps the opportunity to try on other sizes and colors in the store.

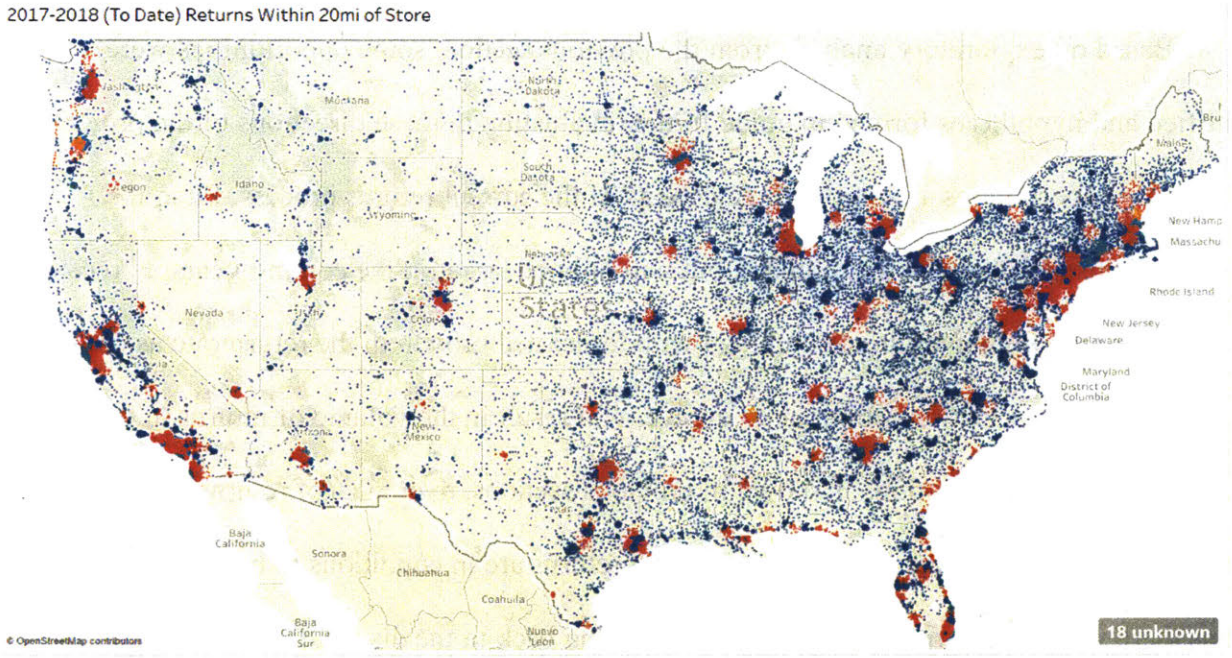

Figure 8. Mailed Returns Origin Mapping

Figure 8 shows a map of the locations of orders that made a return in 2017 and 2018 to the distribution center via mail. Each dot represent a zip code, with the size of the dot representing the amount of orders in that specific zip code. The colors represent whether they are located within 20 miles of a store, and what type of store it is. Red means factory store, orange employee store, teal regular retail store, and blue denotes not having a store within a 20 mile radius of the zip code. Not surprisingly, largest clusters and largest sized dots are located in densely populated metro areas. But mapping the orders also shows that over 70% of the mailed returns were made from locations within 20 miles of a store. This represents an opportunity to

explore the implications and benefits of in-store returns in more depth to assess whether the company should encourage more consumers to bring returns to store.

4.3 Opportunities and Hypotheses

Based on exploratory analysis from the previous section, some opportunities were identified and hypotheses formed to guide further evaluation in these directions of the project.

The opportunities arise from three aspects of the current returns process. First, the volume of returns is large at the moment, but will only be larger in the coming years. Forecasted growth in overall digital volume, combined with forecasted growth in the return rate as consumer preferences and expectations continue to evolve, will result in the volume of returns to grow at an even faster rate. In addition, as shown in previous sections, over 80% of returns are received within 30 days of order date, and over 80% of all returns are in conditions to be resold. This means there will be significantly more returns coming back to the distribution center in a timely manner in a condition to be resold to consumers.

Second, the current returns process offers little differentiation across geographical areas, product families, consumer segmentation, and time in a product's lifecycle. The supply chain network of the company is large and complex, including multiple steps and echelons like factory stores, regular retail stores, reverse distribution centers, outbound distribution centers, and third party retailers to name a few. There is an opportunity to provide more differentiation and design a more customized internal process to handle returned merchandize.

Lastly, the urgency to improve the existing returns process is higher than ever. Not only is the initiative in alignment with the overall corporate strategic roadmap of focusing more on engaging directly with consumers and growing its online presence, the reverse logistics

distribution center is already experiencing capacity constraints on its picking modules due to the volume of digital returns.

Based on the opportunities, three hypotheses were formed. First, we hypothesize that there are benefits to capture more margin by reselling the returns made to the reverse logistics distribution center via mail faster and in larger quantity. Currently, most returns remain in the distribution center until nearly becoming out-of-season to be resold at a deep discount. Intuitively, reselling them earlier will result in higher sale prices and thus higher margins for the company.

Second, utilizing the network of stores will improve margin, reduce the time of returns processing, and save cost compared to mailed returns to warehouse. In-store returns, if managed properly, have the potential of reducing additional shipping and processing time and cost associated with a mailed return, as well as increasing the amount of traffic to a store, shown to frequently result in additional sales.

Lastly, the ideal future state of returns is a real-time, item-level routing system that has visibility of the inventory levels at various echelons of the network, market demand estimates, as well as consumer and product information to provide accurate, time-sensitive decisions on where an item should be sent when returned. An example of this could be a high-heat, high-priced item that is being returned by mail from a consumer in a major metropolitan area where demand for such an item greatly outweighs the supply and it has sold out completely in the local stores. Instead of treating this item like every other return to be mailed back to the distribution center in Indianapolis, a better alternative could be to ship it to the nearby store who is experiencing a stock-out of this item, or sending the consumer a coupon for bringing the item to the store him/herself in exchange for a discount.

The last hypothesis is, in many ways, related to and an extension to the first two hypotheses. It represents a longer-term goal for the company as it evolves and improves its supply chain operations to process returns in a way that is not only faster, more efficient, and more economical for the company, but will also be more sustainable and even result in a better consumer experience.

4.4 Methodology and Approach

With the opportunities and hypotheses in mind, this thesis then takes the approach as outlined below.

First, case studies are conducted to narrow down the scope to one or two products and map out exactly what happened to these products. This provides a good framework of the existing network flow, which can then be used in future analysis. The case studies subjects reflect the product groups the project intends to focus on.

Second, using the framework developed in the case studies, we may then test the first two hypotheses by revising various parameters of the network flow to examine the effects of the changes on the total cost and revenue for the given products.

Once a process is developed, the analysis can be expanded to include other product families and even geographical areas for broader insight into the returns process.

Finally, based on the model and network developed, a preliminary decision tool can be created for returns routing to test the last hypothesis and serve as a foundation for reaching the ideal state of a more agile, individualized, and real-time routing of returns.

This is an iterative process – as more information is uncovered in the process, the initial framework is revised to ensure accuracy, while assumptions where data and information is unavailable or too complex to model are made appropriately.

5 Case Studies

This section discusses the first step in the approach – conducting case studies. Until this point, much of the analysis has been qualitative, with some very high-level understanding of the overall returns statistics and processes. To understand at a product level what exactly happened and how it impacts the company's bottom line, case studies serve the purpose well. In addition, it allows for a deeper dive into developing a detailed network of the complex flows a returned product can go through.

5.1 Case Selection

In the selection of the first case, much was taken into consideration, including the return rate, size of the opportunity, product line, order characteristics, etc.. First, products that have atypical return rate may not be a good representation of the wider range of products the company carries and could indicate other factors at play such as poor quality. The cases selected both have return rates that are relatively in line with the overall 13-14% return rates.

Second, the cases selected should be ones that could be scaled up relatively easily to other products with similar characteristics. Therefore the focus is preferably on a segment of the company's portfolio that has much potential impact in terms of volume and sales. Both the cases selected represent the footwear line, which make up the majority of the company's revenue and volume each year.

Third, in terms of product lines, the cases selected represent two of the most popular lines – high-heat limited edition launch products and basic running shoes. Together they account for a large proportion of the sales in footwear.

Lastly, the order characteristics of a product can have a significant effect on the returns characteristics of the product. For this reason, the two cases selected have drastically different order characteristics as will be demonstrated in the next section, and yield interesting comparisons as a result.

5.2 Launch Product

The first case studied is a launch product. The rest of this thesis will refer to the launch product case as Case 1. The product was introduced relatively recently in March 2018, and was for sale until July 2018. Overall return rate for this product is 13.7%.

Figure 9 shows a network diagram of the quantities of returns that were dispositioned through various channels, which is used as a basic framework for future analysis as well. The percentages represent the quantity that went to each channel relative to the overall quantity of products sold. Red texts denote costs associated with each step, while green denotes sale price or revenue from each step. Yellow arrows mean steps that, per analysis, represent the biggest opportunities for impact. The parentheses after certain steps denote the season in which they were sold in – active or in season usually means higher prices, while inactive or out of season usually means they are sold at discounts. FS means factory stores, and SO means regular retail stores (Store Owned) as listed in the Glossary section.

For example, in Figure 9, out of the total number of units sold, 10.3% were returned to the distribution center, and 8.1% of the total number of units sold were then dispositioned to factory stores when they were out of season at an internal hash price – meaning a lower price for products that don't have full sizes and colors compared to products that have the complete

selection of sizes and colors for each style. After that, 8.1% of total number of units sold were sold to consumers again out of season at clearance prices, usually a 25% – 40% markdown.

As the store return flows are a bit more complex, we will explain it in more detail here. The 2.2% of units sold that were returned to FS stores while active (in-season) were all shipped to the reverse logistics distribution center, which were then blended into the same flow as the mailed returns. The 0.9% returned to SO stores while active were treated differently depending on which SO stores they were returned to – about 0.1% were resold to consumers while active, and the rest 0.8% were shipped to a nearby FS store, then shipped to the reverse logistics distribution center.

Incorporating the volume, cost, and revenue information at each step, the total cost and revenue for both distribution center returns and store returns were then calculated to compare the difference. For proprietary reasons, the exact cost and revenues are not shared. However, merely based on percentage, we may see that in this case, only 0.1% of the total volume sold, which accounts for less than 1% of the total volume of returns for mailed and in-store combined, were sold back to consumers at full price. This is shown in the lower right section of Figure 9 as highlighted in blue. This represents an opportunity to increase the number of returns sold while still in season.

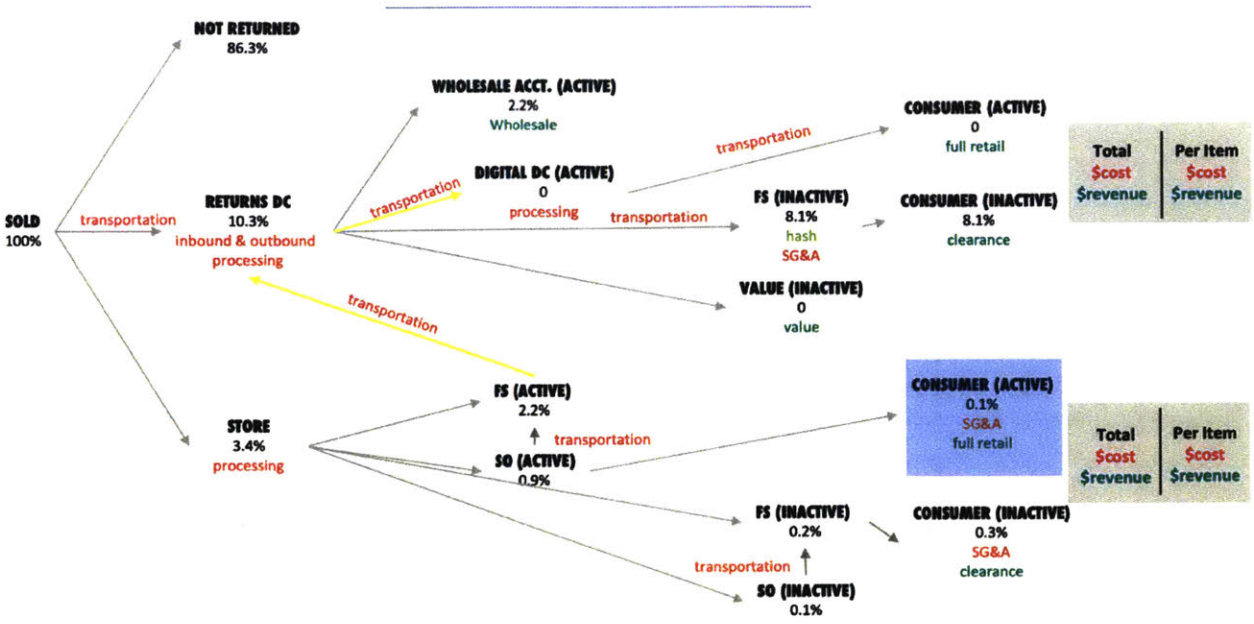

Figure 9. Case 1 Base Scenario

Next we want to explore the order and returns profiles of the product. Figure 10 and 11 show the sales and returns quantities, respectively. After analyzing other high-heat products, these profiles seem fairly typical. There will first be a test launch of the product to gauge interest and test out any logistical issues that may exist. This is the first wave in Figure 10. A major launch will follow weeks or months of marketing and the product will usually sell out. This is likely the second and largest wave of orders in Figure 10. Then there may or may not be subsequent smaller launches to sell any remaining inventory left in the warehouses. The returns characteristics as a result of this ordering behavior is thus also in waves. There are small quantities of returns after the test launch; however, the majority of returns were made after the main launch event, and tails off over a few months. The grey lines in Figure 10 and 11 indicate the product offer date and end offer date. As can be seen, most returns were made well in advance of the end offer date, while a small percentage were made after the end offer date.

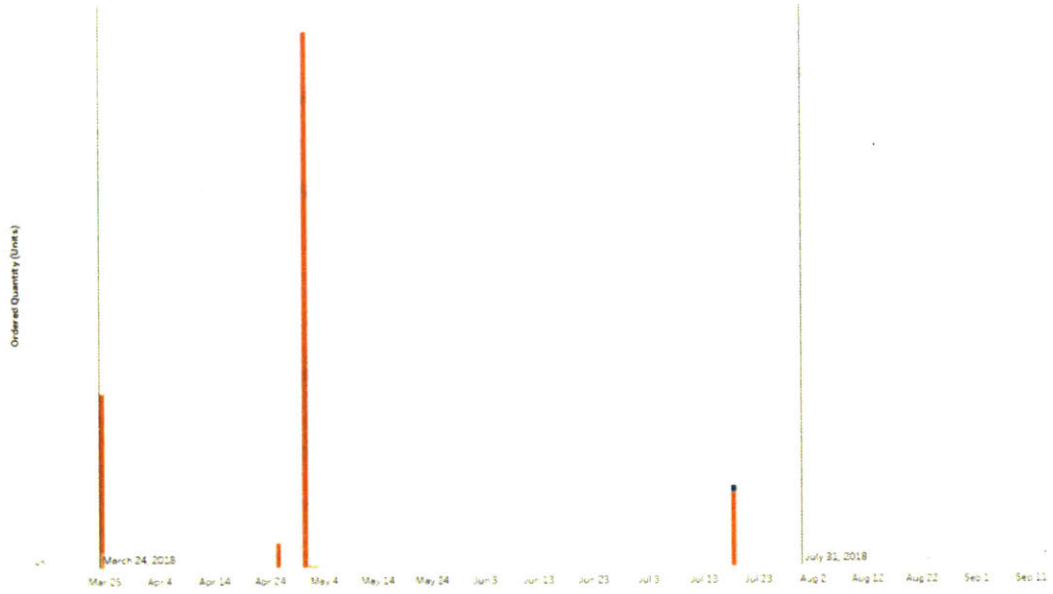

Figure 10. Case 1 Digital Sale Quantities

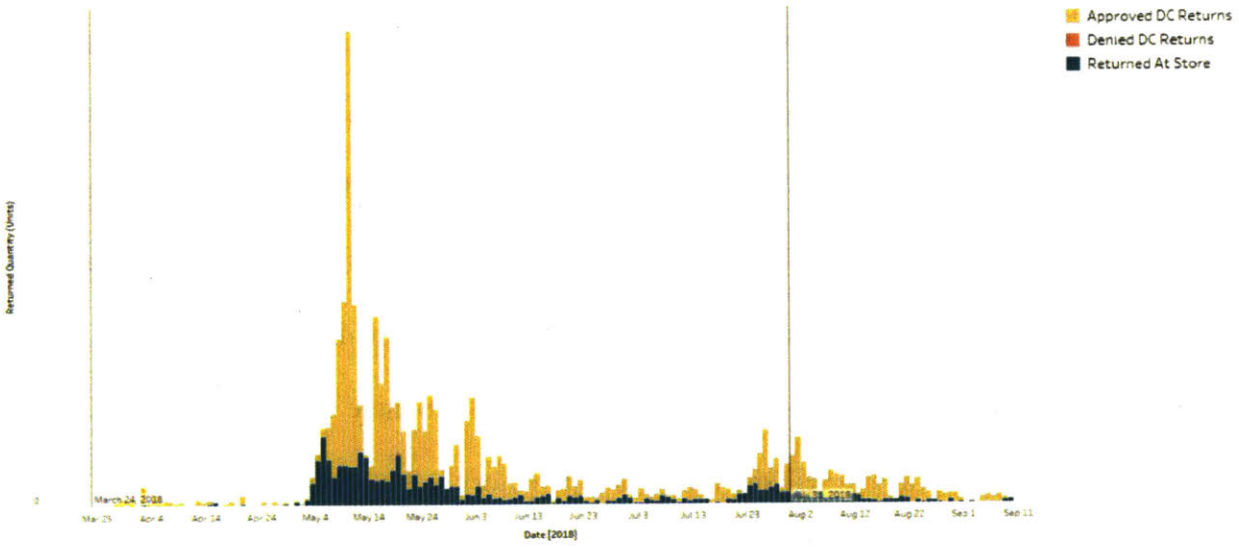

Figure 11. Case 1 Digital Return Quantities

To explore in-store returns, similarly, we want to verify that there is a good percentage of customers who made returns who resided close to a store. Indeed, in this case 81% of all mailed returns were made from zip codes within 20 miles of a store, as shown in Figure 12.

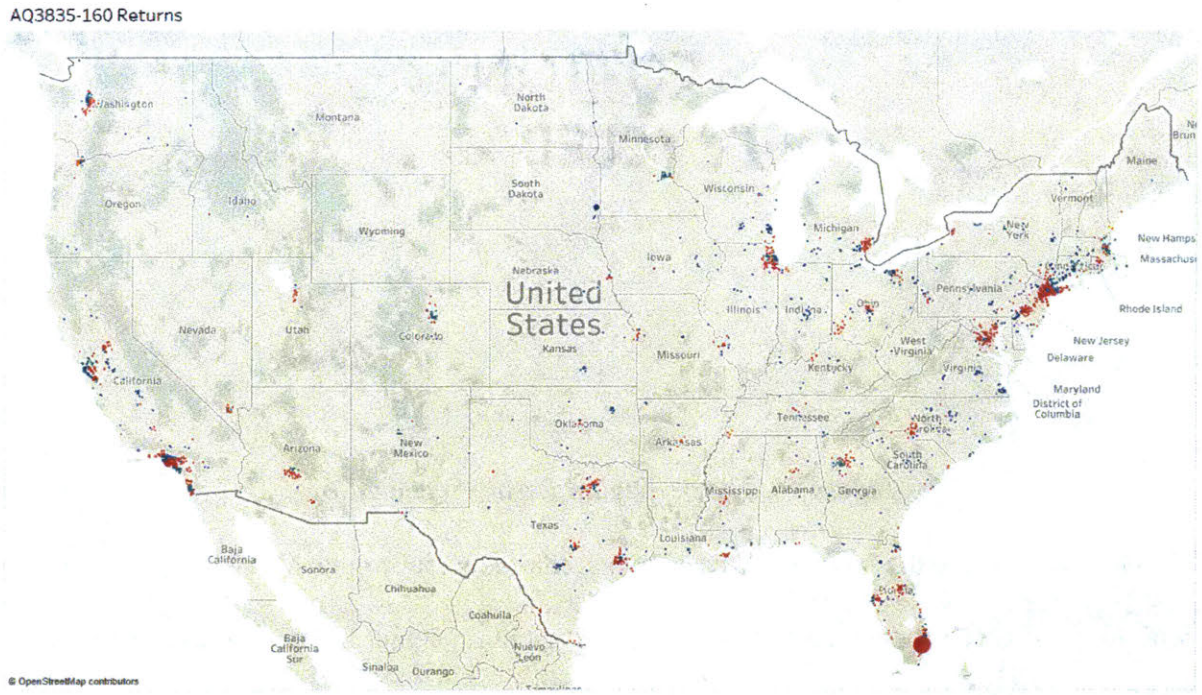

Figure 12. Case 1 Returns Locations

Next, we want to understand the type of stores consumers reside close to. Table 2 shows the type of stores consumers reside close to as a percentage of total returns made. Among the returns that were mailed close to a store, the majority of them were close to a factory store. This is important because it will help shape the strategy accordingly.

Store Type	**Percentage of Total Mailed Returns**
None	18.92%
Employee Stores	0.63%
Factory Stores	56.03%
Regular Retail Stores	24.42%

Table 2. Case 1 Mailed Digital Returns Proximity to Stores by Store Type

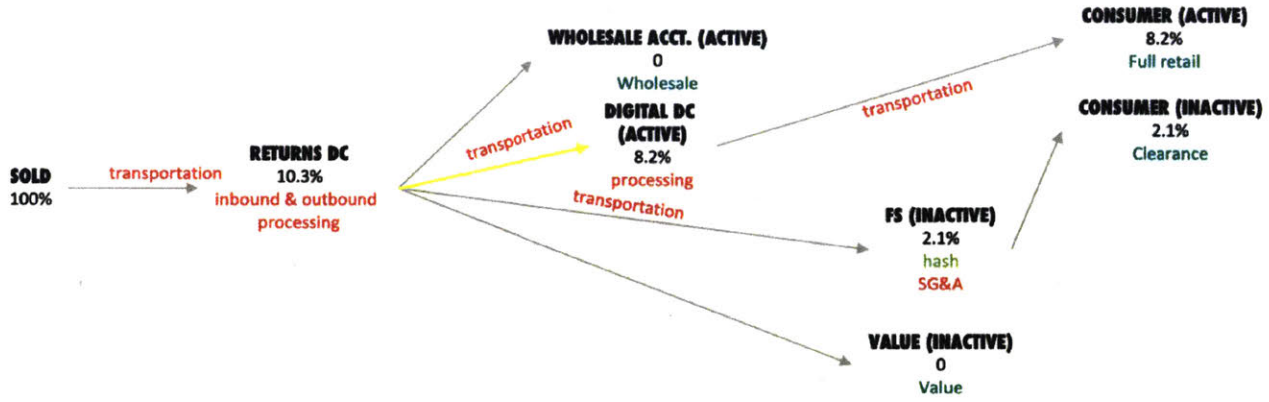

Figure 13. Case 1 Digital Resale Scenario

After assembling the facts of the case, two scenarios were simulated. First, the dispositioning of more product through the digital distribution center for faster digital resale was explored. In this scenario, it is proposed that a weekly cadence to ship products is set up between the reverse logistics distribution center and the digital outbound distribution center. This allows for the reverse logistics distribution center to send any inventory they accumulate as they receive the returns to be resold quickly. To calculate the effect, we first use the returns receipt data presented in Figure 11. We take the amount of returns in re-sellable condition received prior to the end offer date minus 20 days of lead time for processing and transportation. This adds up to 8.2% of total sales. We then transfer them to the digital outbound distribution center instead of accumulating in the reverse logistics distribution center to be sold out of season to factory stores. the amount of products that would have been sold to consumer at in-season prices dramatically goes up. Figure 13 shows the results of this change. Despite additional transportation and processing costs associated with the digital outbound distribution center, this scenario still proves to be profitable. Analysis shows that given 100% sell-through rate, there will be a 79% margin improvement compared to the base scenario. More realistically, at 40% sell-through rate, there

will still be a 23% margin improvement. The next paragraphs will explain in more detail how these numbers were arrived at.

The sell-through percentage is defined as the percentage of inventory that ends up getting sold at a given price. For example, if there is 100 units of Product A at full-price at a store, 40% full-price sell-through means 40 units will be sold at full price at this store. The 60 units that didn't sell will then be put on clearance. If clearance sell-through is also 40%, then 24 units will be sold at clearance price. The remaining 36 units will be sold off to 3rd party discount retails or otherwise dispositioned.

For the 100% sell-through scenario, we assume that all transportation costs are the same across each shipment, denoted as C_t; all processing costs are the same at each echelon, denoted as C_p; SG&A cost at stores are C_{sga} ;and the full retail and clearance prices denoted as P_{fr} and P_c, respectively. We can then calculate the margin in the scenario illustrated in Figure 13 as

$$Total\ Revenue - Total\ Cost =$$

$$(8.2\% * P_{fr} + 2.1\% * P_c) - (10.3\% * C_p + 8.2\% * (C_t + C_p + C_t) + 2.1\% * (C_t + C_{sga}))$$

The percentages come from the percentages of total units sold that went through each channel. The revenues and costs are then weighted by these percentages to get the overall expected margin per unit. We can compare this margin to the margin calculated similarly from the base case in Figure 9. So the 79% margin improvement is obtained as the following. If X is total revenue minus total cost for the Figure 9 case, and Y is the total revenue minus total cost in this case, then $79\% = \frac{Y-X}{X} \times 100\%$.

For the 40% sell-through scenario, however, only 40% of the products are sold at their normal prices. As the cost component is not exactly known due to limited knowledge of the inventory transfer process of unsold goods at various steps, we assume it remains the same for

now. For example, the transfer process of the 60% unsold inventory is not exactly clear, so the cost involved in that transfer at each step is unknown and assumed to be 0 for now. This can be added later easily, though. Let's denote sale price to value channel retailers as P_v. Hence we can calculate the expected margin from the returns process per y unit sold for the 40% sell-through case as

$$Total\ Revenue - Total\ Cost =$$

$$(8.2\% * 0.4 * P_{fr} + (2.1\% + 8.2\% * 0.6) * 0.4 * P_c + (2.1\% + 8.2\% * 0.6) * 0.6 * P_v) -$$

$$(10.3\% * C_p + 8.2\% * (C_t + C_p + C_t) + 2.1\% * (C_t + C_{sga}))$$

, where added costs can easily be added in once details are known.

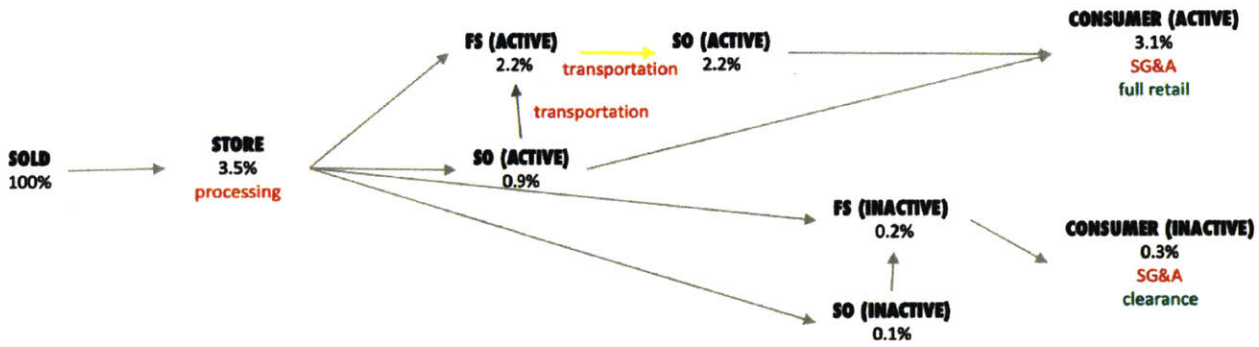

Figure 14. Case 1 In-Store Returns Scenario

We next study another scenario of in-store returns, as illustrated in Figure 14. Currently, the margins on in-store returns are low because most returns were made to factory stores, which will then transfer the returned inventory to the reverse logistics distribution center to be combined with other units returned via mail. This step incurs additional time and cost in the supply chain. Under the assumption that stores can be given more specific instructions on products where there is a known demand as to which regular retail store it can be sent to, that product can then be resold in season at a regular retail store that carries it as part of its

assortment. Figure 14 shows a new store-to-store transfer route as highlighted in yellow from FS (Active) to SO (Active) that did not exist in the base case shown in Figure 9. This allowed the returns to factory stores in season – FS (Active) on the Figure above, corresponding to 2.2% of sales, to be sent to regular retail stores instead of the reverse logistics distribution center.

Given this information, we study the effect of transferring all in-season returns at the factory stores to a regular retail store that carries that particular style taking into account lead time as well. Calculations are conducted in a similar manner as the previously demonstrated example. For best case of 100% sell-through, we see a 109% margin improvement on in-store returns. Even at a more realistic sell-through rate of 40%, there is still a 44% margin improvement. This is calculated in a similar fashion to the example from the previous scenario.

5.3 Base-Inline Product

The second case involves a running shoe that represents a classic and popular style. Over 28,000 units were sold digitally over its lifecycle; over 2,000 units were returned via mail; and over 700 units were returned to a store. The MSRP for this product was $130, however compared to the first case, this product went through phases of discount following full-price sale. The product was offered at full price from April 2016 through February 2017, after which it was sold as a clearance item until May 2017. Overall return rate is slightly lower for this product at 12%. The reasons could be that this is a style that has existed for some time now, and though there are updates periodically, most consumers are likely familiar with the size and fit.

First, the base scenario is studied. All of the in-store returns were shipped to the reverse distribution center, where they were combined with the mailed-in returns. The reverse distribution center sold the majority of the returned items to factory stores for out-of-season

sales. The remainder of the returned units were either donated or sold to third party discount retailers. In this case, none of the returns were sold to consumers in-season, representing a significant opportunity loss of margin on those items. Figure 15 shows this process.

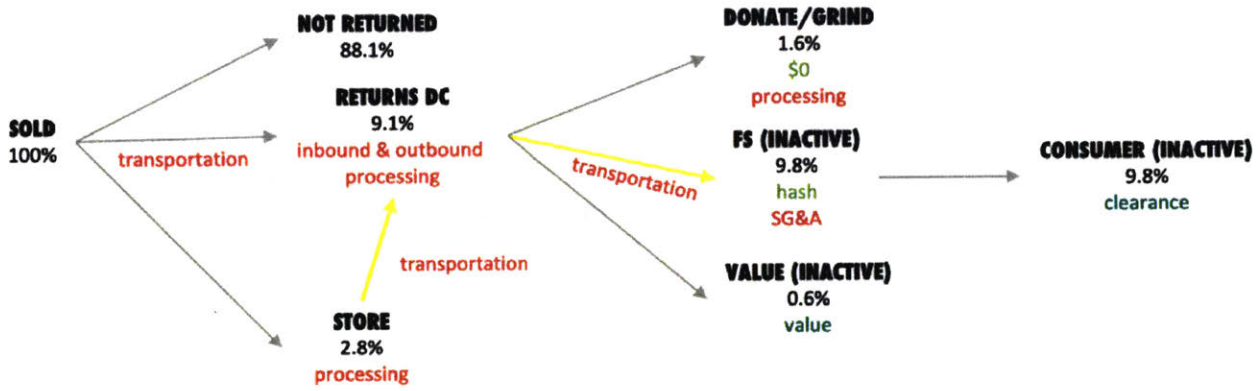

Figure 15. Case 2 Base Scenario

To understand the order and returns profiles of this product, we look at the quantities sold and returned similar to the first case. Figure 16 shows the sale quantities with respect to time, while Figure 17 shows the return quantities. The gap in sales in Figure 16 is likely due to stockouts; that is, this could be a time during which the available sizes and colors were too limited to be sold. But once inventory levels were restored, the product was able to be resold again. Nevertheless, the sales pattern is quite different from case 1 in that it is much more evenly distributed in time, resulting in a more even returns profile as well. The yellow lines in the figures represent the times of transition – the first of which represent the beginning offer date, second the date it became a clearance item, and third the end offer date after which consumers may no longer order the product online. Again, the majority of returns were made in season and even prior to the clearance date.

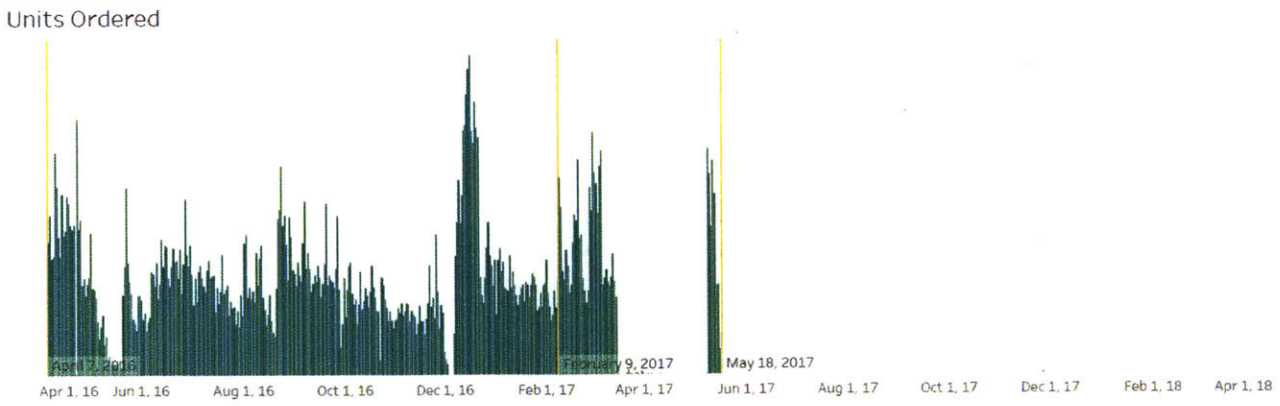

Figure 16. Case 2 Sale Quantities

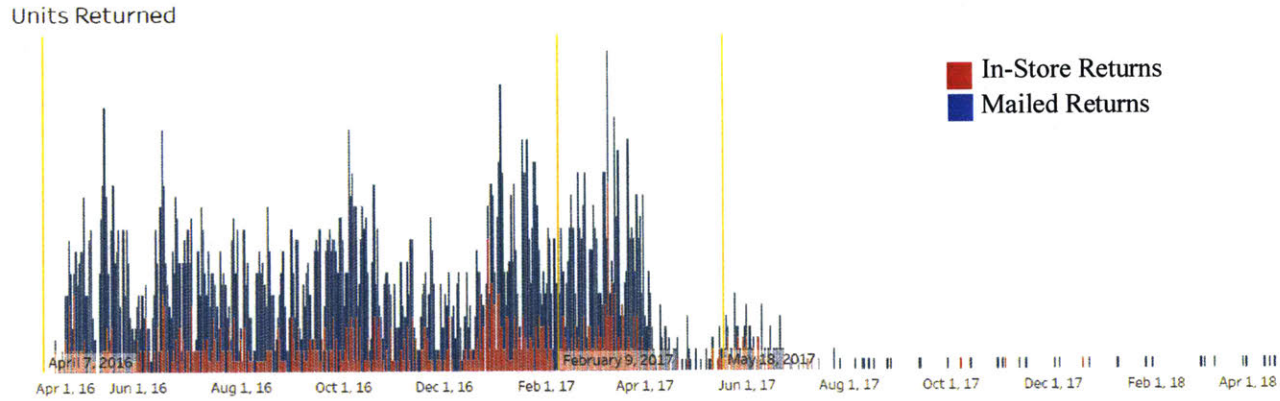

Figure 17. Case 2 Return Quantities

Because this case has some unique characteristics not captured in the first case, we want to get a sense of the price decay curves in various sales channels over time for full-priced and clearance periods, as well as post-end-offer-date prices. Figure 18 shows the sale prices for digital consumers, the wholesale prices to wholesale customers, and the sale prices to factory stores and third party retailers. The digital sale price stayed at MSRP until the product went on clearance, at which point the price dropped to around $100. For wholesale customers, during season, price stayed around $61 then decayed to around $40 on average during clearance. The last channel saw much lower prices at below $30 per unit; for the factory stores this only

represents the internal sale prices. Consumers may expect to pay around $85 from factory store purchases.

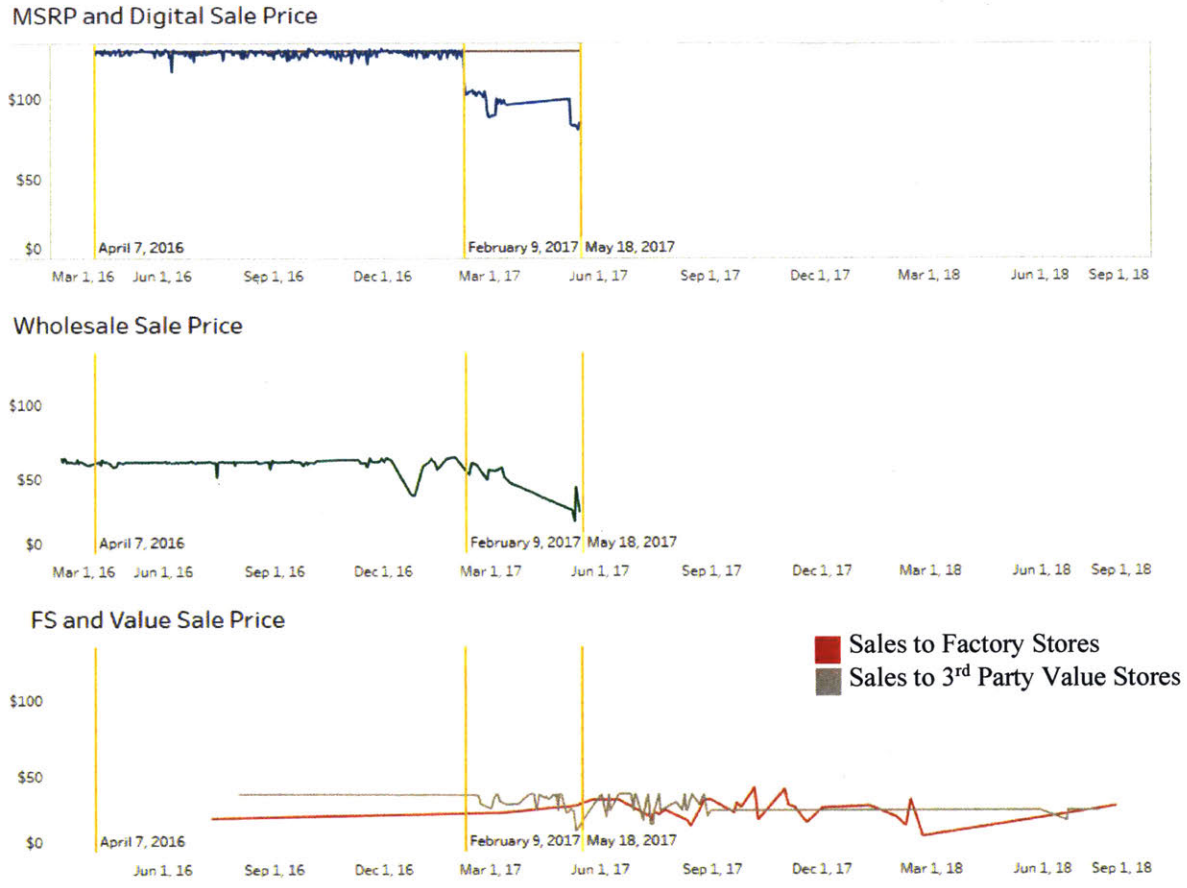

Figure 18. Case 2 Sale Prices

Similar to the first case, we next simulate the scenario where more returned items were resold online through the digital outbound distribution center. We utilize the data used the return data shown in Figure 17 to calculate the total amount of units that could be diverted. We divert to the digital outbound distribution center all units in re-sellable condition that were returned prior to the end-offer date minus a processing lead time of 20 days. We assume these units can all be sold at full-price, and recalculate the margin. We find that there would be a 45% margin improvement in the best case scenario of 100% sell-through. In a 40% sell-through scenario, there is a 20% margin improvement. Figure 19 illustrates the changes in percentages through

each channel and in each phase of the product's lifecycle – similar to Figure 16 and 17, the period between the first two yellow lines (April 7, 2016 to February 9, 2017) is when the product was offered on full-price in season, the period after that (February 9, 2017 to May 18, 2017) is when the product was offered on clearance price in season, and the period after the last yellow line (after May 18, 2017) is when the product was out of season.

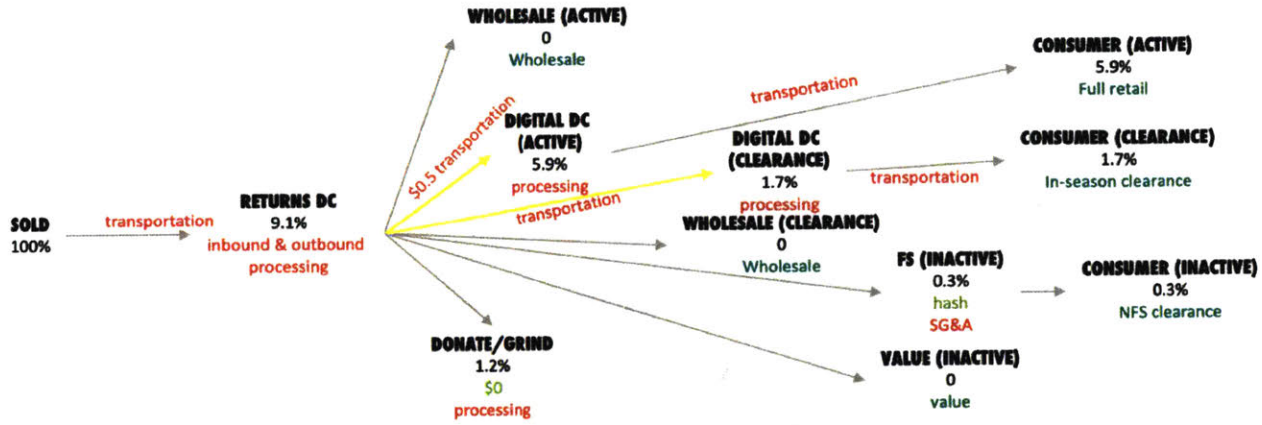

Figure 19. Case 2 Digital Resale Scenario

Similarly, if clearer guidelines were established in the store transfer process, particularly for factory stores, Figure 20 shows the improved store transfer quantities where more products are resold to consumers faster and at a higher price. Overall, for best case of 100% sell-through, this results in 97% margin improvement. For a more realistic sell-through rate of 40%, there is still 61% margin improvement, which is quite significant.

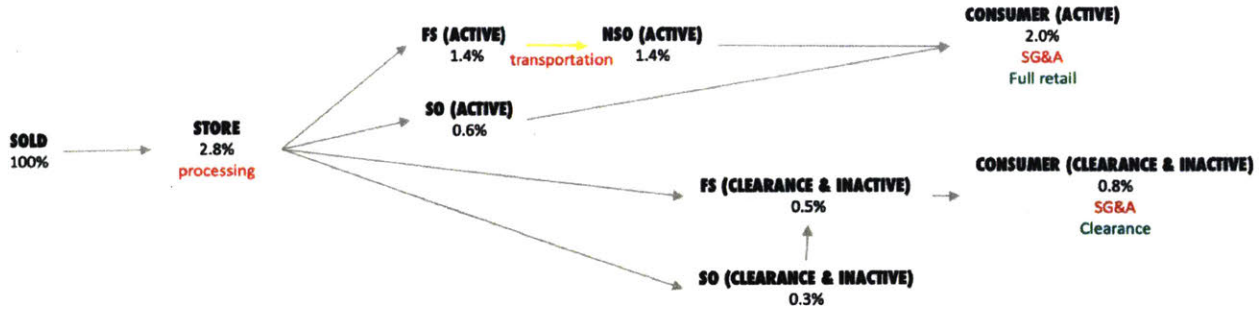

Figure 20. Case 2 In-Store Returns Scenario

5.4 Summary of Learnings

Both cases demonstrate significant margin improvement opportunities for implementing changes in the existing supply chain network flow. Some major learnings are:

First of all, the development of a framework to base analysis on. The network diagram has been a valuable tool to quantify existing opportunities, test out different scenarios, and build business cases.

Second, enabling the disposition of returned products through the digital outbound distribution center and at a faster speed presents significant margin improvement opportunities. Some of the factors that will enable this capability include equipping the reverse logistics distribution center with refurbishing capabilities on returned inventory for digital quality, as well as being able to provide visibility into the inventory levels at each grade of quality.

Third, establishing clearer guidelines for the stores, particularly factory stores, on which products to transfer to which retail stores, and which ones to send back to the reverse logistics distribution center would provide opportunities to sell more returned inventory at a higher price and lower processing time and cost compared to current practices. This will also require stores to

have the capability to refurbish returned products to re-sellable conditions and the capacity to process and store additional inventory.

The case studies provided a good insight into the quantitative impacts of making certain changes to the supply chain. To scale up the analysis for a broader footwear product line by taking into the calculation the quantity sold in fiscal year 2018, we obtain 21% annual margin improvement for implementing the first recommendation above, and 54% margin improvement for establishing the second recommendation above.

6 Proposed Decision Support Tool

The case studies explored and confirmed the value from some near-term supply chain changes; however, in the long term the ideal state is an individualized intelligent routing system that provides real-time decisions on the disposition channel of each product. This section discusses the decision tool in more detail.

6.1 Decision Logic

The basic logic of the decision tool is presented in Figure 21. The decision variable is return routing destination, and the objective function is to maximize margin, which is calculated by revenue minus cost. Due to limited data, store capacity constraints are not captured; however, it could be easily incorporated once data is available.

The interpretation of Figure 21 is that for any given return, it is evaluated in a series of conditions as outlined in the boxes above the bottom row shown in the flow chart. Depending on the answers to the questions, it will arrive at one of the boxes in the bottom row. The bottom-row box will then describe the path the product will follow for each possibility of initial return location. Each of these paths incur different costs and have different margins. Recommendations are then made based on the most economical return location. For instance, if the date of return is after the end offer date, the return will be categorized into the right-most box on the bottom row. This means if the return is mailed, it will be sent to the reverse logistics facility, subsequently sold to factory stores, and sold for 40% at the factory stores; if the return is made to a factory store, it will be sold right there at 40% off; if the return is made to a regular retail store, it will be transferred to a nearby factory store, then sold there at 40% off.

The tool starts by assessing whether there is already more inventory in the supply chain than demand. If there is, then the best disposition channel should be to send to factory stores because if returned to the reverse logistics distribution center, the return will be sent to the factory stores eventually regardless. This is represented by the lower right box in Figure 21. The tool will assume a different set of paths for each destination a return is sent to before it reaches a consumer again, and calculate the cumulative cost and final sale price for each destinations, and recommend the most economical destination. In this case, regardless of where the consumer returns the item to, the final point of sale to the consumer is always at a factory store, thus making returning the item to the factory store the most economical choice which makes intuitive sense as well.

Similarly, the logic applies for returns of products that have excess demand. Depending on the time the return is made and its availability in retail stores, different routing options are analyzed and compared. For example, if a product with strong demand is returned in season and in fact, prior to 20 days before the end offer date, which is the lead time to ship and process the return to be resold, we now examine its availability at retail stores. If the consumer lives within 20 miles of a retail store that carries the product, then intuitively the best destination is to route the product to that retail store to be sold at full price. The decision tool would support this intuition as well, because if the product is sent to the reverse logistics distribution center, it will then be routed to the digital distribution center to be resold online, incurring additional shipping and processing cost. Similarly, if this item is instead returned to a factory store, under the assumptions that more streamlined store transfer system is in place from the case study findings, we may assume the factory store will transfer the product to the retail store to be resold at full price, thus making it less economical.

The rest of the decision logic follows a similar pattern of reasoning and calculations.

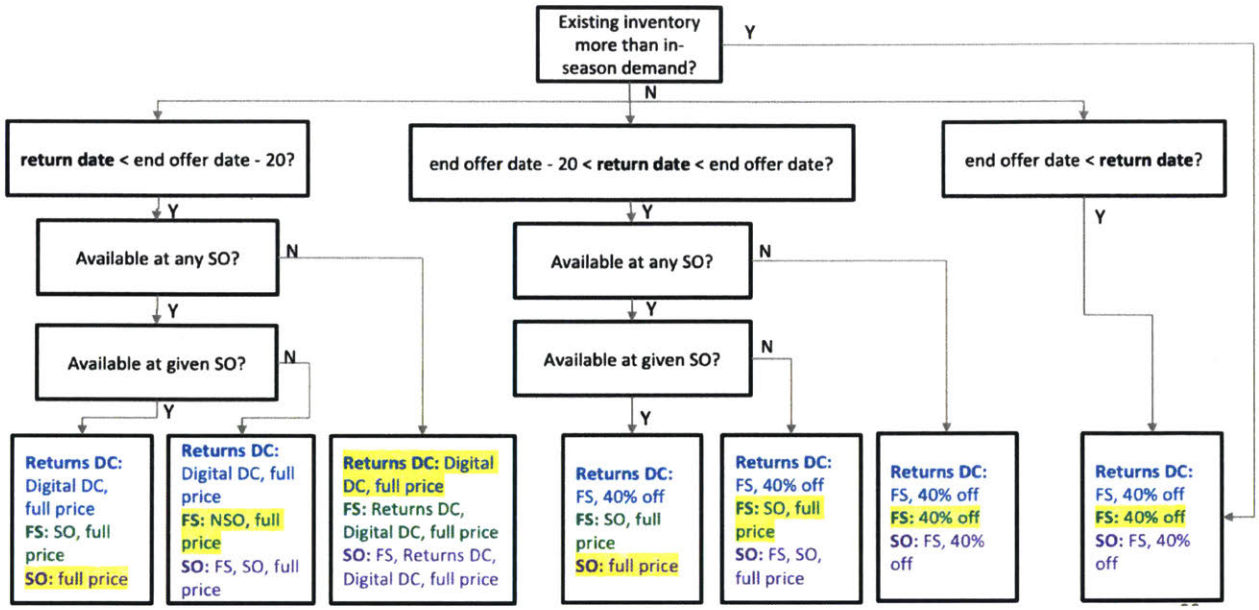

Figure 21. Decision Support Tool Logic Flowchart

6.2 Limitations

There are several limitations of the decision tool. First, the tool is not yet integrated into any production system and the language in which it is written makes it difficult to explain intuitively to end users.

Second, the tool does not take into consideration constraints such as store capacity limits and shipping capacity constraints, both of which are realistic considerations that could impact the decision significantly.

In addition, the tool assumes 100% sell-through as long as demand is greater than supply, which might not be realistic. On top of this, real demand and inventory information across whole supply chain is assumed to be known, while it may be difficult to obtain such information.

Lastly, the tool does not take into consideration lost demand due to inventory unavailability. This is a limitation because the potential demand could be larger than the forecasted or observed demand had there been enough inventory to accommodate the demand.

7 Future Work and Conclusion

This section concludes the major findings and discusses future opportunities to build upon the work presented in this thesis.

7.1 Analysis Improvements

The analysis was based on a number of assumptions that would benefit from further validation. For example, much of the cost information regarding transportation and processing was an estimate from interviews with stakeholders and taken as average. There is also much information missing from the store operations side like which inventories are carried at which stores, as well as the reality of what happened to much of the returns made to stores. The analysis could be improved by obtaining data behind store inventory transfers, sales information, and inventory levels. With these additional information, the case studies as well as the decision tool could be greatly improved in accuracy.

7.2 Experimentation

As part of the results validation process, experimentations may be conducted to gauge consumer reactions to certain proposed policy changes, specifically around in-store returns, because the different processing of returned mailed back to the distribution center does not affect consumer perception and experience.

Because of the benefits of in-store returns to the company, as well as consumers preferring the peace of mind of getting instant refunds on their returns, an experiment may be

helpful in understanding how consumers may react to incentives to bring certain items to a nearby store.

The design of the experiment involves multiple aspects including cohort selection, incentive structuring, results analysis, etc. and is beyond the scope of this project.

7.3 Implementation

The three main recommendations that result from this project are enabling faster digital resale of returned inventory to distribution center, establishing clear guidelines to factory stores on returned inventory transfers, and implementing a decision tool on real-time item-level routing of returned inventory.

There may be challenges to implementing the recommendations, many of which have been discussed in the prior sections of the thesis. However, based on the analysis presented in this thesis, the benefits will outweigh the challenges of implementation.

7.4 Conclusion

To reiterate the three main recommendations that arose from this thesis work, they are:

- Enable faster digital resale of returned inventory to distribution center
- Establish clear guidelines to factory stores on returned inventory transfers
- Implement a decision tool on real-time item-level routing of returned inventory.

The consumer returns space is an area most retailers have not studied extensively and thus much work still remain to be conducted on this topic. This thesis serves as an entry-level analysis on the operational and supply chain aspects of returns, and the findings demonstrate that

it is possible to take actions to modify the current supply chain to achieve higher margins on returns as well as improving the consumer returns experience.

References

[1] N. Ertekin (2018). "Immediate and Long-Term Benefits of In-Store Return Experience", *Production and Operations Management*, January 2018.

[2] A. Ang and A. Tan (2018). "Designing Reverse Logistics Network in an Omni-Channel Environment in Asia", *LogForum Scientific Journal of Logistics,* 2018.

[3] Z. Zhou, Y. Cai, Y. Xiao, X. Chen, and H. Zeng (2018). "The Optimization of Reverse Logistics Cost Based on Value Flow Analysis – a Case Study on Automobile Recycling Company in China", *Journal of Intelligent & Fuzzy Systems,* 2018.