ORDER FULFILLMENT PROCESSING OF A MULTI-ZONE WAREHOUSE

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ABSTRACT

Inefficiencies in a warehouse that operates multiple zones can create bottlenecks in the order fulfillment process. This study's focuses on the exploration of potential bottlenecks in an agricultural aftermarket company's order fulfillment process and its multi-zone warehouse. Order fulfillment includes stages of order processing, SKU picking and staging from the conveyor zone and the "H" zone, and the final packaging and shipping of the order within the Truck Freight Department. A review of the company's EOP program, and the effects of the program, provides additional insight into our understanding of bottlenecks within a dynamic the system. In doing so, the research will extend the existing knowledge on warehouse management with multiple zones. The conclusion of this paper offers solutions that will alleviate the bottlenecks and improve the overall efficiency of the order fulfillment process within a multi-zone warehouse.

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LIST OF ACRONYMS

BOL – Bill of Lading

BOM – Bill of Materials

B2B – Business to Business

CRM - Customer Relationship Management

CSR – Customer Service Representative

CSV – Comma Separated Value

H zone – Heavy zone

EOP – Early Order Program

OEM – Original Equipment Manufacturer

OSHA - Occupational Safety and Health Administration

PLC – Programmable Logic Controller

SCM – Supply Chain Management

SKU – Stock Keeping Unit

SLAP - Storage Location Assignment Problem

SVA – Shareholder Value Added

CHAPTER I: INTRODUCTION

1.1 Business Evolution

The business reviewed in this document was founded 30 years ago by two farmers that identified the OEM (original equipment manufacturer) steering assembly on an International tractor they operated was not durable enough for the application it was operating in. Through ingenuity, trial and error, they developed a new assembly that provided the durability needed. The farmers soon realized that many of the neighbors had the same issue and those neighbors were asking the farmers to build replacement assemblies for the neighbors equipment. When a person or company replaces an original part, with a modified or duplicated version of the original part, the part is considered "aftermarket". The modified part can be a cheaper version of the original part or a new and improved version of the original part.

The two farmers used this idea to create a new business to supply aftermarket agriculture parts for the surrounding area. The business expanded to include manufacturing of specific products and a purchasing department to purchase supporting products to complement the company's portfolio. The business then added new products to meet the demand for automotive, agriculture, and industrial parts. The sales of belts became a substantial part of the business and belt sales ranged from standard engine belts, to large industrial machinery drive belts, and small belts that are used by OEM vacuum cleaners manufacturers. The new company established a Belt Department to focus on the increased market demand. Even with the creation of the Belt Department the core business remained aftermarket agriculture parts.

The business then expanded its operation during the late 1980's from a simple Quonset building to an 8,000 square foot facility and continued to expand and grow during the 1990's. In 2000, a larger company started a partnership with the owner of the business, which began a period of expansion and business consolidation. The business purchased supporting businesses that were manufacturing products for the primary business and expanded the main operations location with a 300,000 plus square foot warehouse. The business also has nine other warehouse locations in the US, three locations in Canada, providing a total of over 750,000 total square feet of warehouse space. In 2010, the sole founder of the business sold his portion of the business to the larger company. The larger company then took over complete management responsibility and implemented its own processes and procedures with the purpose of increasing profitability of the aftermarket parts business. Examples of these new processes are expansion into large retail store locations, logistics improvements in perfect fill rates help to reduce the number of costly backorders, and logistic improvements in transportation rates to reduce shipment costs.

The implementation of these new processes created substantial growth for the business but the new processes and growth also created challenges for the entire order fulfillment process. Management decided to separate sales department into two channels: 1) The Sales Support Department is focused on processing orders from independent resellers of agriculture parts. This sales channel focuses on independent repair shops, OEM Agriculture and Construction dealers, and salvage yards, among others. 2) The National Accounts Sales Department is focused on large retail store chains and aftermarket part exporters. National Account sales channel requires different focus for both selling product and supporting customer needs. A National Account customer can place smaller orders to

satisfy customers' needs but the majority of orders are large orders that require preparation to fill, package, and ship.

Since 2005 the business's marketing department runs a program during the winter season called EOP (Early Order Program) that will allow customers to purchase products from the business at a discounted rate with special terms. The reason why companies offer discount programs to customers is 1) to improve coordination to increase total supply chain profits and 2) extraction of surplus through price discrimination (Chopra and Meindl 2010). National Account customers are excluded from this program as National Account accounts are already receiving all its orders at a discounted rate based off the purchasing power of each individual account. On one hand, the EOP program and large National Accounts orders have been very successful in creating both scale and profit. On the other hand, both have exposed areas of opportunities to improve efficiency and reduce costs within the operation's supply chain.

1.2 Problem Statement

Multi-zone warehouses need to be able to efficiently pick, package and ship SKUs that come from different zones in the warehouse. A company's business system and processes have to work with precision to be able to coordinate these different zones. The company reviewed in this thesis operates a National Accounts department, and the marketing department's annual EOP, that create large orders within the business system. Some of these orders will need to be staged and held while all SKUs for the orders are being picked, or when the order is waiting for backordered SKUs to arrive. The problem this thesis is attempting to address is the current process of pulling and holding orders that are leading to inefficiencies within a multi-zone warehouse.

1.3 Objective

The objective of this thesis is to explore the issues related to the "bottleneck" within the industrial warehouse system. In doing so, the study will 1) use best practices to investigate and help identify opportunities for improvement, 2) identify gaps in the business's process, 3) establish a framework to solve industrial warehouse "bottleneck" problems, 4) recommend new order fulfillment process will be developed, and a review of current business metrics, will be provided. Process maps will be developed to help identify the current flow of product and information. The thesis will conclude with a recommendation to management on processes that can be implemented immediately.

1.4 Scope

The parent company monitors a division's performance by analyzing the SVA (Shareholder Value Added) which is the percentage of profits above expected profit. In fiscal year 2013, the percentage for the business was just over 1% SVA. The parent company expects all business units within the company to produce an SVA percentage of 7%. In an interview with a Managing Director, the goal for the business is to achieve an SVA target of 10% year over year for continued reinvestment from the parent company and this growth will have to be realized through process improvements (Morgan 2013).

The aftermarket company reviewed in this thesis had net sales during 2013 of $120,000,000. The business has expanded its products over the years and today has an inventory has 160,000 number of stock keeping units (SKU). During the business's 2013 fiscal year, Operations network fill rate was 91% with an inventory turn of 1.04. Management's goal for the department is 93% and 1.2 respectively.

1.5 Contribution

This study offers insight into providing solutions to prevent bottlenecks in an industrial warehouse. The attention paid to the order fulfillment process in this paper will add to the understanding and management of the business's order management and order fulfillment processes. The results of the firm-level study will help to generalize solutions involving the coordination of multiple employees, products and zones in an industrial warehouse.

CHAPTER II: LITERATURE REVIEW

There are many areas that have been studied to help try and understand productivity of the order fulfillment processes and most researches agree that reducing order cycle time is the ultimate goal in order to improve productivity, and to provide the highest cost saving, as human labor adds the highest cost to any operation (L.-D. R. De Koster 2006). The following is a review of some of the recent research on order fulfillment and industrial supply chain management. The review is organized by each discrete function within the warehouse supply chain. This literature review is not intended to be exhaustive, but it does draws from major contributions on research completed on order fulfillment.

2.1 Supply Chain Management Philosophy

A supply chain is defined as all parties involved, directly or indirectly, in fulfilling customer requests. The supply chain includes suppliers and manufacturing, but it also includes warehouses, transportations, retailers, and even the customer (Chopra and Meindl 2010). Chorpa and Meindle 2010 go onto define supply chain management as a business's ability to manage all products, information, funds generated and incurred with the supply chain. When viewed as a philosophy, SCM (supply chain management) views the entire supply chain as one entity, instead of individual group, all completing each groups own function. In a 2001 Journal of Business Logistic article titled "Defining Supply Chain Management" purposed that a SCM has a philosophy of the following characteristics:

1. A systems approach to viewing the supply chain as a whole, and to managing the total flow of goods and inventory from the supplier to the ultimate customer;

2. A strategic orientation toward cooperative efforts to synchronize and converge intrafirm and interfirm operational and strategic capabilities into a unified whole; and
3. A customer focuses to create unique and individualized sources of customer value, leading to customer satisfaction.

This SCM philosophy suggests that SCM should include all logistics, but also all other areas within the business, and a supply chain should also create customer value and satisfaction (Mentzer, et al. 2001).

2.2 Receiving

Receiving is very basic at its core; once product is on the dock, assign it a storage locations (and possibly a new SKU), and move it to the proper storage location as quickly and safely as possible. In an article in the European Journal of Operational Research Gu, Goetschalckz, and McGinnis provides three scenarios to consider helping warehouses decide the best approach for receiving processes based on the information available concerning the incoming shipment (Gu, Goetschalckz and McGinnis 2006):

- Unknown knowledge of arriving product, except the business knows its own warehouse design. This situation usually only arises in public warehouses used by many different people or businesses.
- Basic knowledge of arriving and departing carrier, such as average load size from a specific supplier. This is the most common scenario for warehouses that are company owned or dedicated warehouses.
- Perfect knowledge of the content of each arriving and departing carrier. This scenario usually employs the latest technologies to allow companies to track both inbound and outbound packages down to individual SKUs.

The basic knowledge scenario may be the most common, but with the advances in technology, it is not hard to see that the perfect knowledge scenario will become the standard scenario for warehouses and warehouse companies can also expect more and more businesses to demand that level of detail for products being stored in warehouses.

2.3 Storage Assignments

The concept of "Storage Location Assignment Problem (SLAP)" was introduced by Gu, Goestschalckz, and McGinnis with variations of the application to help warehouses determine the appropriate storage strategy for specific warehouse applications (Gu, Goetschalckz and McGinnis 2006). SLAP has three main categories that it attempts to classify storage depending on the amount of information available: (1) item information, (2) product information, (3) no information. SLAP suggests different strategies depending on the information available for each class. The author detailed three specific versions of SLAP in the research completed: SLAP/II, SLAP/PI, and SLAP/NI.

SLAP/PI (product information) offers the most insight for the problem this paper is trying to offer solutions to. SLAP/PI states that only product information is known about the items that are going to be stored in the warehouse, so product classes are created to help structure the inventory in the most efficient placement for picking. There are many different criteria that can be employed for the product classes, but the author points out the three most popular:

1. Popularity of the product; different classes are assigned to products based on volume. The products with the highest classes (highest volume) are assigned locations that offer the highest picking efficiency.

2. Maximum inventory; inventory is classed by the amount of inventory available and product classes with the least amount of inventory placed in the most desirable locations
3. Cube-Per-Order Index (this is a ratio of maximum allocated storage space to the number of operations, both storage and retrieval, per unit time – COI); COI weights both the product popularity and the storage space required. Product classes are giving a ranking by its COI and the lower COI's are assigned the most desirable locations.

Values similar to Gu, Goetschaleckz and McGinnis are argued by De Koster, Le-Duc, and Roodbergen but classify the storage locations by the process used to determine bin locations (L.-D. R. De Koster 2006). One of the author's arguments is for "random storage" which implies that a specific SKU is assigned to the most logical location within the warehouse even if the warehouse has other inventory of that same SKU already in a specific location. The author states this type of storage assignment policy can only be used when a computer based program is controlling inventory assignments.

2.4 Order Picking

The main objective of most warehouse picking operation is to maximize its service level based on its available labor and/or machines and capital (Goetschalckx 1989). Today, warehouses implement multiple different tools to help maximize a company's service level with mechanization but most warehouses still need human labor to complete the order picking processes. Research has been completed by multiple different researchers on the different processes that can be improved to provide the most cost savings and efficiency. Most of these research projects isolate human travel time, of either the travel distance of a

particular picking tour, or the entire travel distance of a complete order, as the area of opportunity to improve efficiency (L.-D. R. De Koster 2006).

2.5 Order Pick Routing

As a business is setting up a new warehouse, or looking to improve the current efficiency of a current operation, pick routing will be reviewed extensively. Baker and Canessa offer opinions into order routing where they suggest using software tools like CAD can provide businesses and in-depth look at a routing design virtually to help determine the best methods available (Baker and Canessa 2007). There are also many publications available that try to provide businesses mathematically solutions to improve routing efficiency. De Koster and Van Der Poort offered algorithms to optimize order picking routes, De Koster, Le-Duc, and Roodbergen offered an algorithm based off research completed, and there are many other algorithms available that a business can use to try and set up routing methods (De Koster and Van Der Poort 1998) and (L.-D. R. De Koster 2006). The many different options offered as solutions to optimize a warehouse order picking routing method led this researcher to believe that as a warehouse designs changes, so would any mathematical solution, which could add extensive cost to any warehouse optimization plan.

Most researchers that have offered mathematical solutions comment that in most situations the best routing method solution is still the basic heuristics solution (De Koster and Van Der Poort 1998). This is primarily because there are items that a mathematical approach can't take into account. An example of shortcoming with this approach is if the order picker does not find the route logical and changes routes on their own (Gademann and Van De Velde 2005). This leads many researchers to believe the heuristic approach of trial and error to find the optimal solution to routing is still a very viable solution (De

Koster and Van Der Poort 1998) and (Baker and Canessa 2007). If a business is looking into rearranging a warehouse that is currently operating, businesses can involve the current order pickers to provide insight, as they are picking orders every day and will have ideas to offer. This also provides a sense of ownership for those employees as the company installs the new routes.

2.6 Order accumulation and sorting

According to most researches, the most prevalent order collecting, sorting, and pack out system requires gathering all the picked tickets for each order, place all those picked tickets on a circular conveyor, and then a sorter will capture all the individual pick tickets to complete the entire order (Gu, Goetschalckz and McGinnis 2006) and (L.-D. R. De Koster 2006). The reason this system is so widely used is due to the fact that it allows the entire warehouse system to be efficient by allowing different order pickers to pick part of an individual order from that zone and then allowing the converging of parts from the individual zone to be combined in the sorting area. Even though sorting may not be very efficient, it's a better alternative than having the order pickers pick a single order throughout the entire warehouse.

There is one area of this type of order accumulation that has to be monitored very closely and that is managing the ability of the sorters to be able to keep up with the amount of parts coming in from the picking zones. If managers don't monitor this and properly assign employees as needed, part totes could start backing up and clogging the system (L.-D. R. De Koster 2006).

During the research of journal documents dedicated to this topic, very little focus was provided on staging and packing items from different zones within the warehouse or

orders that will require multiple packages to be shipped (usually by truck) to complete the order.

2.7 Order Fulfillment Metrics

Businesses use metrics to monitor performance of a team and employees, and to measure those teams and employees against the goals set by management. According to Johnson and Davis most businesses have an abundance of metrics and the goal of management is to review and isolate the metrics to help the business reach its goals. Managers must think of the following:

- Measure only the right things
- Avoid meaningless efforts
- Use the results productively

If managers can focus on these three statements they should be able to identify metrics that are important to the business and also the employees (Johnson and Davis 1998).

Johnson and Davis also argue it is vital to have the same metrics used throughout the company. If an operational manager has a metric centered on item fill rates, and senior management monitors order fill rate, the operational manager can make decisions to modify work flow to support the item fill rate goal, but hurting the order fill rate metric. If leadership can use the same metric throughout the entire organization, and everyone knows the importance of those metrics and what they mean, the overall performance of the business will improve.

CHAPTER III: METHODS

The order fulfillment process for placing, processing, pulling, storing, and shipping both standard orders, and larger orders from the EOP and national accounts, will be described in detail to provide and understanding of the current order fulfillment process.

3.1 Data Collection Methods

3.1.1 People

In order to understand processes within the order fulfillment and supply management chain an operations manager within the parent company was interviewed to provide insight into the perception of issues within the business's main warehouse operation. An interview was conducted with the main warehouse unit supervisor to gain an understanding of the current processes used in standard and truck freight shipping. To gain more insight to processes within the Truck Freight Department (the Truck Freight Department team is the group that packs and loads palletized items that cannot ship via standard carriers), the supervisor within that department was interviewed and daily processes were identified. To understand performance and quality metrics, the company's industrial engineer was interviewed and details were provided concerning department performance. To gain understanding into the order entry and processing, and interview was completed with a CSR (Customer Service Rep) and a national account representative.

3.1.2 Process

To understand the organization of the business's supply chain management, after the interviews with team members, a process map of the organization was created. These process maps were then shared with different owners of the process to insure accuracy. In 2012, the parent company had an employee called a "Process Pro" map out the National Accounts and Sales Support order fulfillment process. These maps were obtained for order

processing knowledge and to identify possible gaps. Operational metrics were provided to understand the current performance of the entire supply chain for order fulfillment. The parent company uses Process Pro's to identify and document processes to complete specific tasks within an organization.

3.1.3 Technology

A copy of the business's 2013 financial reports were obtained (confidential information), including operational metrics, to understand current business performance and the metrics used with employees and management. Data was also requested providing details for the 2011, 2012, 2013, and 2014 EOP. This information was obtained from the business system and supporting tools. The business system is a DB2 database known internally as AS400 which utilizes the ComEdge System. Sales support, national accounts, and operations use CRM (Customer Relationship Management) software from Touchtone Corporation called Wintouch. Other tools used to acquire information were a SQL tool called Squirrel and graphical tool called Tableau. Microsoft Excel will be used to parse and review the data. The warehouse conveyor system is controlled by a combination of PLC controls in communication with Factory Talk Transaction Manager (Rockwell Automation Software). All software programs interface with the AS400 business system.

3.2 Standard Order Processing for both UPS packages and Truck Freight packages.

This section should provide the foundation of the order fulfillment process by detailing the processes followed for both a standard shipping order and a standard truck freight orders.

3.2.1 Standard shipping carrier orders

Standard shipping orders are entered into the business system, either manually or automatically, and they are printed at the start of the shipping zones within the warehouse.

The order is assigned to one or more totes. Totes are plastic containers that are 12”x12”x24” and are used to move SKUs on the conveyor system. The totes are added to the conveyor system and automatically move out to the shipping zones. As the tote moves on the conveyor, it passes through check points to let the operating system knows its current location. As the tote enters a zone that has parts that need to be added to the tote, it stops and the employees in that zone sees the tote number, order number, part number, and bin location on a hand held scanner. Employees then fulfill the order by placing the correct parts in the designated totes. Afterwards, the part number is scanned and the pull process is completed. Each tote will only have parts in it to complete the current order. The operating system now knows that the parts for that order are in that tote, because the order picker assigns it to the tote. Then the tote continues to move by conveyor to the next zone for more parts to be added. If the order is complete, the tote is moved by conveyor to the shipping lanes.

As the tote enters one of multiple shipping lanes, the employees responsible for packing the order reviews the details of the order, including the quantity of totes needed, and employees begins packing the order in shipping boxes. After all the parts have been packed, the box is weighed and documented within the business system. A shipping label is created and placed on the box and moved to the standard shipping loading zone.

Gray colored totes are used to both move SKUs from bin locations to the shipping lane and green colored totes are used to transport replenishment stock back into the lanes. Red colored totes are used to identify standard shipping orders that are designated for overnight delivery. All colored totes are controlled by a conveyor control business system to insure totes travel on the conveyors in a uniform manner and spaced appropriately. The

parts replenishment processes utilizes a system where a specific SKU is not always assigned to the same bin locations. When a new SKU is entered into the system, the business system will determine the most efficient location to place that new inventory. The decision is based on inventory turn, volume, and bin availability.

3.2.2 Standard truck freight carrier orders

As orders are printed that have to be shipped via truck, the order, part number, and bin location are shown on a hand held scanner. The employee retrieves the parts and moves the order, by forklift, to the truck freight shipping lanes. The forklift operator receipts the part into the shipping lanes. The part is visible and traceable within the business system and is accessible by the Truck Freight Department. There it is assigned to one of the lanes. A shipping lane is the location where an order is consolidated and prepped for shipment. Depending on the size of the order, multiple orders can be in one shipping lane. The number of lanes will vary depending on the current volume being processed within the Truck Freight Department. Each order number on the computer lists the total number of pallets and boxes assigned to it. The Truck Freight Department will then bundle the order to prepare it for shipping. This could include totes from the conveyor zone that need to be put in a large box pallet for shipping. Once the department has the order prepared for shipping, it is weighed and documented within the business system, and moved to the area designated for shipping.

The Truck Freight Department is staffed and managed during normal operations by three employees and one supervisor. If the department is operating during a slow period, the employees will be used for special projects, and the supervisor will support other operations. When the Marketing Department releases the EOP for customers to utilize in the winter, the Truck Freight Department is staffed with up to seven people for a five

month period. The extra employees come from other departments, and it can be difficult for those other department supervisors to agree to release employees to support the Truck Freight Department, because that department's daily work load is also increased to support the EOP. For the amount of material moved by the Truck Freight Department, with the support of extra staff during the EOP season, it is apparent the department is being staffed appropriately to handle the workload.

3.3 EOP and National Account Orders

3.3.1 Order Placement and Processing

Large orders can be placed by customers in many different forms, and to help with the understanding of these processes, they will be outlined in detail with the percentage of these orders being placed within the EOP program from the traditional customers, and the percentage of orders place within the National Accounts team.

Table 3.1: 2013 Percentage of Order Type for EOP and National Accounts.

Order Type	EOP	National Accounts
B2B	90%	35%
Phone	5%	5%
Fax	3%	59%
Misc.	2%	1%
Total	100%	100%

- Internet "B2B" form: The business to business website has an online form that customers can use to enter orders by adding individual part numbers with the quantity needed.
- Customer Calls: Customers can call in orders to be placed with a Customer Service Rep or a National Account Sales Representative, which is defined by a predetermined customer classification nomenclature. The customer's order will

include material descriptions, material numbers, and order quantities. The sales representative will enter the order information by line item and quantity.

- Fax Orders: Customers can download a parts list from the B2B website, and then the customer can upload that file into their business system, and they will create orders from the business system and fax that order to either the National Account Rep or the CSR. Customer orders are also submitted as a handwritten document that is faxed and received at the business's offices. From there, the CSRs (for traditional and National Account customers) manually enter the order details into the business system.
- Miscellaneous: the business system provides customers with different options to place orders using unconventional methods that are not commonly used in today's order entry technology. The main option that has the most potential for growth is utilizing comma separate value file (csv). Utilizing the csv upload format is currently an opportunity to replace the existing fax order system with an efficient order entry format to submit customer orders. The csv format provides electronically transferable data from the customer's order system to business system:

As orders are placed into the business system, CSRs places a code on the EOP order that both trigger the discount level of the order and also prevents that order for automatically printing to the warehouse. National Accounts can be printed automatically and sent to the warehouse because there is not discount code for National Account orders, as National Account's profit margin by customer customer's margin discount is built into its pricing structure. All National Account orders are placed via the business system will

have an exception note attached, and this note prevents it from automatically printing, until the Truck Freight Department can process the order.

Once orders are loaded into the business system, the system generates a “save” status indicator and the order is not released to the warehouse. At this time the business system looks at the order and checks inventory. If there are parts for the order that are not in stock at the warehouse, a backorder is initiated to the Supply Management Department for review. Supply management will look at the respected release date of the order, quantity available, quantity currently allocated to other orders, expected ship date of those orders, and expected part replenishment and then make a decision if the current inventory can be allocated to the order placed, because a new supply of parts will be available for future orders. If supply management does not currently have any of the backorder SKUs on order from the vendor, they will initiate a replenishment order.

3.3.2 Order Staging

To release an order, the Truck Freight Department will work with a designated CSR in the Sales Support group to release orders as needed. This occurs via communication (usually phone conversation) between the truck freight supervisor and the CSR that monitors EOP orders in the business system. This process is very straight forward and can work very well, but it also allows the possibility of human error:

- There is a potential for the supervisor or CSR to be out of the office for an extended period of time, which will result in communication and training between the employees that fill that gap.
- Since any individual within the business can view and release an order, there is a potential that an individual can inadvertently release many EOP orders by mistake,

which would overwhelm the zones because of the automation of printing orders, creating extreme bottleneck within the truck freight shipping lanes.

- The Truck Freight Department handles 99% of National Account orders, and some of those orders can be extremely large in line items and size, during the 3 months of EOP, there needs to be coordination between the CSR, National Accounts, and the truck freight supervisor to insure there is adequate shipping lane space for both orders.

Once an order has been release to print, the business system processes the order and determines what areas of the warehouse is pulling the order (conveyor or “H” zone) and then determines the number of totes or tugs needed and assigns the correct tracking number to the individual tote or tug. For this business, the term “print” refers that the order has been processed and is released to the warehouse to begin pulling the SKUs and preparing the SKU for shipment. After the business system assigns all the tote(s) or pallet(s) tracking numbers to the order, the order is displayed on a computer located within the Truck Freight Department, and they assign that order to one of specific lanes within the department.

As the totes arrive at its assigned lane the totes are stacked until they are ready to be unloaded and boxed within the lane. This is the main reason why orders need to be throttled for release, if too many orders are printed within the same timeframe, totes will be stacked within the lanes creating a difficult environment to maintain order integrity and also a safe work zone. While totes are being stacked, any large parts from the “H” zone are properly tagged and placed on tugs and delivered to the truck freight shipping lanes, and staged as close to the assigned lane as possible. This zone is designated “H” to indicate “Heavy”. Items from “H” zone can be combined onto one pallet, within the truck freight shipping

lanes, to help minimize the amount of space needed on the truck (truck freight companies apply rates by spaced used before weight of shipment (Dykstra 2013)). Within “H” zone, they will pick items and place the items on one pallet, but today they are not usually picked in an order that is viable for banding, so the order will have to be repacked before banding of the pallet can occur. This unloading and restacking process is completed by the Truck Freight Department. As the team from “H” zone places the tug within the truck freight area, with the pallet on it, it is scanned by the fork truck driver so the Truck Freight Departments knows the items are available for shipping prep.

3.3.3 Order Packaging and Docking

As totes and tugs start being staged in the appropriate shipping lane the Truck Freight Department will start the process of pack all orders. The business system in the Truck Freight Department will list all the orders currently being processed, including any standard truck orders. The shipping lanes can have a single order within the lane, or it can have multiple orders within that lane, depending on the size of the order itself. All EOP orders are coded within the business system with green shading of the order number. Next to each order number will be all the totes and tugs assigned to that order. As the team starts working on an order, they will write the order number on a sheet of paper located next to the computer, to indicate to other team members that someone is already working on that order. The team will then properly pack all the items from the totes that converged from the different conveyor zones and they will consolidate, where possible, items that arrived on tugs from the “H” zone.

Once the SKUs are packed properly and sealed, they are moved over to a scale to be weighed for shipping. At that time, a BOL (Bill of Lading) is started as the process of completing the order, the proper trucking company is contacted concerning the order, and a

trucking label is created with tracking information attached to it. The order is then moved to a designated area to be stored until it can be loaded on the proper truck. The business's largest shipping carrier leaves a box trailer at the dock all the time, switching it out once a day, allowing orders to be moved directly from the truck freight area straight to the box trailer. This step helps open more short term storage area of completed orders and less labor to move the same completed package multiple times. Once the order is moved to the truck or storage area, the BOL is completed and provided to the shipping company. Today, most of the BOLs are created and submitted directly to the trucking company electronically at the time the order is weighted and completed. With the electronic submission of this BOL, the trucking company at the time of submission effectively takes ownership of the order, even though the actual packages are not in the shipping carrier's possession until they arrive to load the packages.

3.3.4 International Shipping Processes

When the team is shipping product that has a final destination of international countries (excluding Canada) special documentation is needed to complete the order. National Accounts has one person specialized in researching and creating the documentation needed to complete these type of orders. Many of these exporters are trying to combine and coordinate the orders because the orders are being shipped in containers. These exporters are trying to maximize the space used in those containers because they are paying for the entire area. This requires coordination between the exporter, a national accounts representative, the Truck Freight Department, and supply management to fill any outstanding backorders. A national account representative needs to work with Truck Freight Department to determine the size of the packages needed for an order, before that

order is printed, so the exporter can determine is it needs to add or remove items from the current order.

3.4 Backorder Release Processing and Order Discrepancies

Not all orders can be filled as they are entered into the business system. When this situation occurs, the business system creates a “backorder” that needs to be processed. The AS400 will compare the SKU, and the quantity of that SKU, to the quantity available within the warehouse. If the ordered SKU cannot be filled via the warehouse, the AS400 will create an activity to be completed by a backorder processor. A backorder processor will use is an in-house program written to show all the fillable backorders currently in the system, along with inventory from all warehouse locations, the date the backorder was placed, and expected date for additional stock replenishment. A backorder SKU will not show up on the backorder program until supply management procures and receives new inventory to satisfy the back order, or if the SKU is available from another warehouse location.

A backorder processor will use this program to verify that the main warehouse cannot fill the order and locate any other warehouses that have the necessary stock on hand. If another warehouse does has stock on hand, the processor will verify if the main warehouse is expected to receive replenishment stock in the near future, and the processor will determine either to pick stock from another warehouse or wait for additional stock to arrive at the main warehouse. Customers are all assigned a specific warehouse. The warehouse assigned to the customer is usually the warehouse that is located closest to the customer geographically. Backorders will occur in all the warehouses but all back orders are fulfilled by the main warehouse. Backorder fulfillment is completed in this fashion

because all vendor replenishment stock is staged at the main warehouse before sending stock to the other warehouses in the network.

When the processor cannot fill the backorder from other warehouse locations, and the customer is willing to wait for an SKU to be replenished from the vendor, the processor will look at the duration it took to receive replenishment stock once the SKU becomes available. If the SKU is filled within 10 business days the processor will release the SKU to be printed and it will be shipped to the customer. If the SKU is on back order for longer than 10 business days, the customer will be contacted to verify they still need the back ordered SKU. For customers that place an order for a SKU that has no inventory on hand, and the customer was notified that this part was on backorder at the time they placed the order, the customer will not be contacted concerning the backorder.

If the business system shows we have the SKU stocked in the warehouse, but when the warehouse employee that fills the order is unable to find the part in the bin location, the warehouse employee will create an order discrepancy in the business system. When this occurs, a backorder is created. The backorder processor will look for inventory in other warehouses to fill the order. If the SKU is available from another warehouse, the processor will create a new order to ship it from that warehouse, with no freight charges to the customer. If the SKU isn't available in another warehouse, the backorder processor will create a backorder within the business system for the Supply Management Department to source from the appropriate vendor. In both of these SKU discrepancy cases, the backorder processor will contact the account to inform the customer of the situation if that SKU is part of a larger kit that the dealer ordered. If the part is a standalone part, the backorder

processor will not contact and inform the customer of the order discrepancy, because the customer can see the status of the order on the B2B website.

3.4.1 Future Orders and its relationship with Backorders.

As the National Accounts team has expanded over the years, its customers increasingly request orders be placed at a future ship date. This situation is very prevalent for export orders as customers attempt to fill a transoceanic shipping container that will not be available until a specific date, and the customer's available time to fill that container is extremely limited. The business system is not designed to handle future orders, and to insure SKUs are allocated to the future order, the future orders are treated as backorders.

3.5 Metrics utilize to monitor efficiency and performance.

Metrics are standards of measurements, which are used to monitor how well the business functions to meet its goals. National account representatives and customer service representatives place priority on monitoring the ability to answer inbound phone calls within 30 seconds for national accounts and 10 seconds for the CSRs. There is also a goal based on call abandonment rate of less than 4% for national accounts and 3% for CSRs. These metrics are presented to management on a monthly basis for review and are used for making staffing decisions. Order entry errors, from orders that are placed over the phone, are currently captured but there is not a management goal based on these errors. Order entry errors from phone orders are subjective and difficult to measure. A CSR supervisor explained that it can be very difficult to identify if the customer provided the incorrect SKU number or quantity, or if the CSR inaccurately entered the order into the business system (Pedersen 2014). The Sales Support Center has multiple large monitors deployed to share the current status of CSRs and inbound phone calls. These monitors are also used to share training materials and metrics so the employees can gauge the department's performance.

Operations' monitors multiple metrics to help the department understand how well the warehouse functions. Safety metrics is very important to ensure a safe work environment for all employees. Lost-time accidents and OSHA recordable accidents are reported monthly to management. Order fill rates are monitored to provide and understanding of performance by looking at first-fill percentage rate and network fill percentage. The first-fill rate is the warehouse's ability to fill the order with available inventory within the warehouse and network fill rate is the company's ability to fill the order within all warehouses in the network. Both fill rates are monitored on a weekly basis and provided to management and employees. The current goal for first fill rate is 87% and network fill rate of 93%. The business also monitors its inventory turn on a monthly basis with a goal of 1.2.

To monitor individual employee performance, operation's monitors "lines per hour" that an employee will pull, and then average each employee to provide and overall performance of the warehouse. The goal for the warehouse is 14 lines per hour. Inventory Accuracy is also monitored with a goal of 95%. Inventory accuracy is measured by the amount of SKU discrepancies compared to total SKUs shipped. Both lines per hour and inventory accuracy is monitored on a weekly basis and presented to management and employees.

Management also has a goal called "error rate" which calculates the number of errors per 1000 pieces pulled and shipped. This goal is reliant on shipping errors being reported by customers with the order received. The goal is currently 4 errors per 1,000 pieces pulled. The error rate goal is a goal that is utilized by all other warehouses within the corporation and corporate is expecting operations to implement the goal within the

business's main warehouse. Management currently isn't using this metric because they feel the reporting isn't accurate, they are currently averaging 2 errors per 1000 pieces being pulled (Scheetz 2013).

The final metric being monitored by operations is the backorder-cycle-time that monitors the warehouse's ability to receipt in product, process the SKUs, and fill the open backorders with the system. The goal for this metric is eight days and it is monitored weekly for management. The warehouse also has large monitors deployed in the warehouse. These monitors share general business information, upcoming events, and they also will display metrics on the business and warehouse performance so employees have an understanding of how the business is performing.

An investigation into the metrics utilized within this business also shows a segregated approach to the metrics utilized within all departments. This is illustrated in the fact that the sales support team gathers the shipping error data for operations but it is not a part of the sales support metrics. The operations department monitors their own metrics for order fulfillment, but delays in order completion caused back ordered SKUs from Supply Management is not included, that would provide management a complete order fulfillment metric.

CHAPTER IV: ANALYSIS

4.1 Truck Ship Order Fulfillment Process

The review of the process identified possible bottlenecks within the current order placing and processing for large national account and EOP sales orders. To help illustrate the possible bottleneck points, a detailed review of the current process, and a review of the last four years of the EOP program is explored with potential opportunities identified. The analysis will also provide potential changes to the current metrics to monitor the performance of the order fulfillment process. To help identify and illustrate these process bottlenecks, each step of the current process will be scrutinized, and identified in Figure 4.1 that maps out the current order fulfillment process of orders routed through the Truck Freight Department.

4.1.1 Current Truck Freight Department Order Fulfillment Flow Chart

As an account submits an order to the business it is entered into the AS400 business system, the business system will determine if the order needs to be filled via standard shipping or if the Truck Freight Department needs to process some or all of the order. The order entry will be one of three separate order types; 1) a standard order (1b), 2) an EOP order (1c), or an 3) a national account order (1a). As orders are processed, a standard order can differ from a national account order and an EOP order, as this order can be process by the business system with no involvement from the CSR staff (steps 1b to 3c). If the order has special instructions, or SKUs that go into backorder status, then the order will have to be processed by a CSR before the order can be printed to the Truck Freight Department (1b to 2b, then to 3c).

To distinguish special orders from the normal order, the National Account orders are identified and processed by National Account Reps, and EOP orders are identified by

specific program codes that are entered as the order is being placed by the account. All national account orders will be processed by a national account representative (1a to 2a) and all EOP orders will be processed by a CSR (2a to 2b). Once the order is processed by a national accounts representative, or an EOP order is processed by the CSR team, the order will either printed in the warehouse (3c) or the order will be placed in a "hold" status (3a or 3b). An order can be placed on hold for the following reasons:

1. The order has SKUs that are on backorder
2. The order is to be shipped at a future date
3. The Truck Freight Department shipping lanes are full and releasing the order will trigger the shipping zones to continue sending SKUs to the already occupied Truck Freight shipping lanes.

Point number 3 represents a bottle neck within the order fulfillment system. The business has tried to minimize this bottleneck by having Truck Freight Department supervisor work with National Accounts Department and CSRs to "throttle" the release of orders. In the case of EOP orders, a specific CSR is assigned to process all EOP orders so the Truck Freight Department supervisor has a single point of contact to release orders. The Truck Freight Department supervisor commented that this current process also creates a bottleneck as the supervisor will spend time away from the floor "playing phone tag" with a national accounts representative and the CSR that processes the EOP orders, attempting to throttle the orders to maximize the space in the shipping zones. The reason for this "phone tag" is the supervisor is trying to match a specific order size (total number of pieces) to an open area within a shipping lane (Dykstra 2013). The process also creates a bottleneck within the sales support group as the processor will spend extra time searching

all EOP orders on hold to locate an order that fits the space available within the shipping lane (Lutjens 2013).

Once an order is processed and sent to the warehouse, a tote sheet is printed to the proper zone. All SKUs stored in the conveyor zone are procured and sent via conveyor to the Truck Freight Department's shipping lanes (4b). Totes are stored just off the shipping lanes and there can be multiple totes for a single order, within multiple orders in a shipping lane. The Truck Freight Department will distinguish which totes go with the proper order by matching a tote number with the totes listed for the order that is displayed on a monitor within the shipping lanes. All SKUs stored in the "H" zone will be procured and sent via fork truck to the Truck Freight Department's shipping lanes (4a). The "H" zone team will transport SKUs to the Truck Freight Department and stage the SKUs next to the shipping lane. The Truck Freight Department will have to check the paperwork to verify they are staging the correct "H" zone SKUs in the correct shipping lane with the proper order, which can create confusion and is another potential bottle neck for the order fulfillment process.

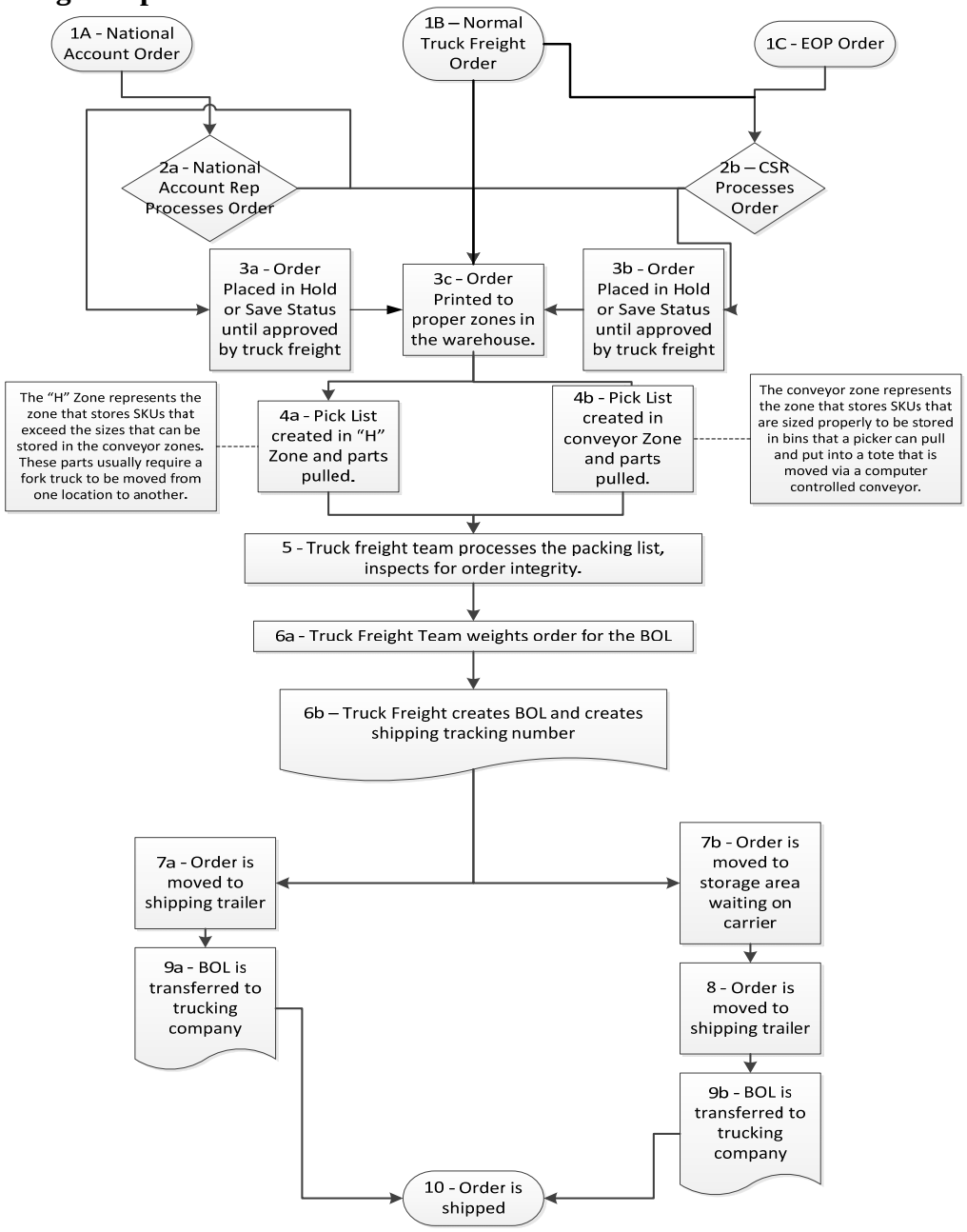
Once SKUs start arriving in the shipping lanes, the Truck Freight Department will start combining and packaging the order in proper sized pallets and/or pallet boxes (5). The "H" zone department will pack multiple items on one pallet before transporting it to the shipping lanes. The "H" zone will load the pallet by SKU number, not by part size, and the Truck Freight Department will usually have to unload and reorganize the pallet within the shipping lane. This process of repacking the pallet creates another bottleneck for the Truck Freight Department. During the process of packaging the order, the Truck Freight Department will create a packing list (list of all the SKUs and quantities for that order) for

the order. Each order has a BOM attached to it, but Truck Freight orders do not indicate the number of individual pallets used to complete the order, and this situation can create a gap for investigators if an account files a shipping discrepancy at a later date.

After the Truck Freight Department packages and secures the order, it will transfer the order to the shipping scale and is weighed (6a). At that point, a BOL (Bill of Lading) is created by the Truck Freight Department (6b).

After the BOL is created the Truck Freight Department will move the palletized items for an order to one of two locations; the order is moved directly onto a shipping trailer that they shipping company will leave docked at the warehouse (7a), or the order is moved to a storage area (7b) until the shipping company arrives to pick up the packages (8). Once the shipping company has the packages loaded onto the shipping trailers, the BOL will be transferred into the shipping company's possession (9a and 9b), except for when companies use electronic BOLs as stated earlier. When the carrier takes possession of the order, the orders status is moved to closed or "history" status within the business system even though accounting may not have settled for the order at that point (10).

Figure 4.1: Current Process Map for orders processed and shipped by the Truck Freight Department

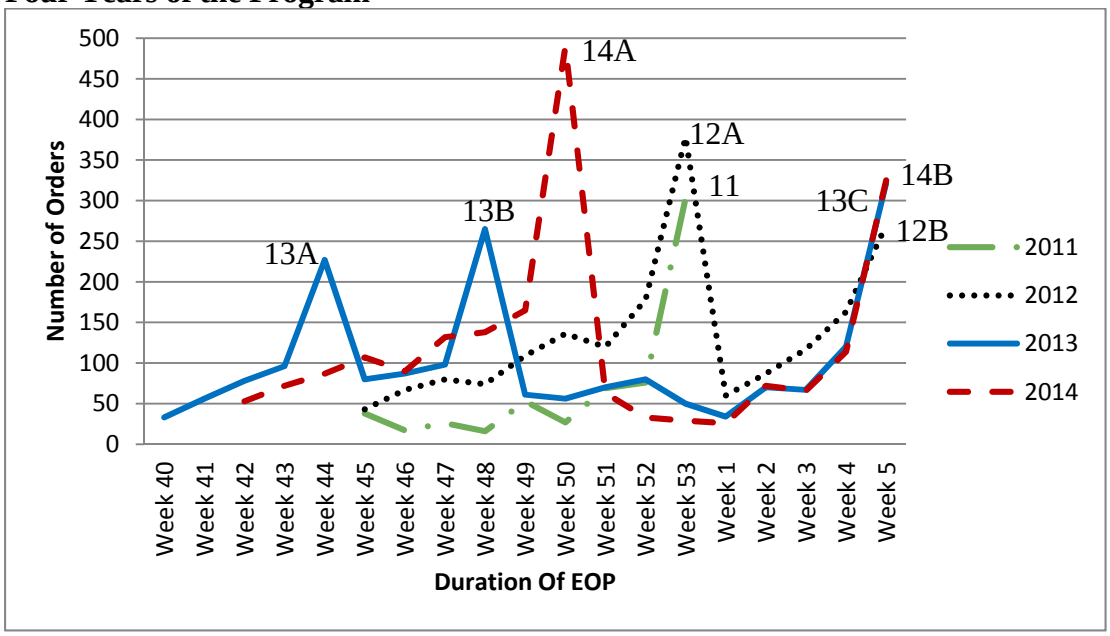


4.2 The EOP Program and the impact on the Truck Freight Department

4.2.1 Historical comparison of EOP Orders and Program Details

The business has been using an EOP program for the for over 10 years, but in the last four years, the marketing department has put more emphasis on utilizing the program to both increase sales and to help "smooth" customer orders for the business throughout the entire fiscal year. In its efforts to increase the EOP program the marketing department has made multiple changes over the recent years to the EOP program, to not only help drive sales, but in an attempt to help spread customer orders throughout all the weeks of the program. The effects of these program changes are displayed in Figure 4.2 below. The vertical axis represents the count of orders per week, the horizontal access represents the calendar weeks the program was available in chronological order, and each line in the graph represents a separate year the program was available. The table also highlights specific points on each line. The significance of these points will be provided in the sections after the graph.

Figure 4.2: EOP (Early Order Program) Count of Order per Week for the Previous Four Years of the Program



In 2011 the marketing department had not put the same emphasis behind the EOP program that it has in recent years by offering enticements in the form of discounts and program terms. The program consisted of an 11% discount if the account paid the full order amount within 30 days of order shipment and a 9% discount if the full order amount is paid within 90 days of order shipment. Orders remained flat during most of the program except week 53 (Figure 4.2, point 11). Week 53 was the last full week in the calendar year and many customers placed orders during that week for tax purposes.

In 2012, the Marketing Department put more of an emphasis on discounts and terms. The program consisted of two deadline dates to qualify for discounts and all order paid within 30 days would receive a 2% bonus. The program terms are outlined in Table 4.1. During the program, a steady increase in order until week 53 again (Figure 4.2, point 12A) for the same reason seen in 2011 but you also see an increase in orders during the last couple weeks of the program (Figure 4.2, point 12B) that is attributed to the higher

discounts and payment terms. The EOP offered in 2012 was also the first year that larger discounts were offered for larger sales orders.

Table 4.1: 2012 EOP Order Program Discounts based on order placement dates.

Order Size	Before Dec 31, 2011	Jan 1 - 31, 2012
$2,500 - $4,999	7%	5%
$5,000 - $9,999	8%	6%
$10,000 - $14,999	10%	8%
$15,000 - $19,999	11%	9%
$20,000 +	12%	10%

In an effort to help smooth orders spikes during the EOP program in 2013, marketing offered 2 separate payment terms and 3 discount rates (Table 4.2). The new program had the desired effects with a peak in orders during week 44 (Figure 4.2, point 13A), a peak in orders two weeks before the end of the calendar year in week 48 (Figure 4.2, point 13B) and finally a peak in orders at the end of the program in week 5 (Figure 4.2, point 13C). The EOP program was extended longer than it was in previous years to provide the necessary gap in program deadline dates. A full month was added at the beginning of the program as compare to the previous years.

Table 4.2: 2013 EOP Order Program Discounts based on order placement dates.

Terms - 30 Days from Order Shipment			
Order size	Nov 30, 2012	Dec. 31, 2012	Jan. 31, 2013
$2,500 - $6,999	6%	5%	4%
$7,000 - $14,999	8%	6%	5%
$15,000 - $24,999	10%	8%	6%
$25,000 +	12%	10%	8%

Terms - No Payment on Order Shipment Until April (or min of 90 days)			
Order size	Nov 30, 2012	Dec. 31, 2012	Jan. 31, 2013
$2,500 - $6,999	2%	2%	2%
$7,000 - $14,999	4%	3%	3%
$15,000 - $24,999	6%	5%	4%
$25,000 +	8%	7%	6%

Feedback from customers and territory representatives after the 2013 EOP program was the details were hard to understand and made it cumbersome to facilitate. The marketing department made a change during the 2014 EOP by implementing two program deadline dates (Table 4.3). The first deadline dates offered a larger discount than the second deadline date at the end of the program. The result of this change was a large spike in orders at the end of the first deadline in week 50 (Figure 4.2, point 14A). During the remaining weeks of the program the orders per week mirrored the orders per week in 2013 (Figure 4.2, point 14B).

Table 4.3: 2014 EOP Order Program Discounts based on order placement dates.

Terms - 30 Days from Order Shipment		
Order Size	Oct 14 - Dec 31, 2013	Jan 31, 2014
$2,500 - $6,999	6%	4%
$7,000 - $14,999	8%	6%
$15,000 - $24,999	10%	8%
$25,000 +	12%	10%

Terms - No Payment on Order Shipment Until April (or min of 90 days)		
Order Size	Oct 14 - Dec 15, 2013	Jan 31, 2014
$2,500 - $6,999	2%	2%
$7,000 - $14,999	4%	3%
$15,000 - $24,999	6%	4%
$25,000 +	8%	6%

4.2.2 Historical EOP Comparison of Number of Orders and Percent of SKUs Shipped in Less Than 30 days.

During the most recent EOP, the expectation from both operations and marketing was to fill all EOP orders, and truck the order, out of the warehouse in less than 30 days. A comparison of the last 4 years of EOP orders was investigated using 30 days as the base line. The aid in this comparison, each year's percentage of SKUs and total pieces shipped

were grouped using less than 30 days and greater than 30 days. This is followed by a comparison of each year's order count compared to the percentage of SKUs shipped in less than 30 days. This is represented on a weekly basis.

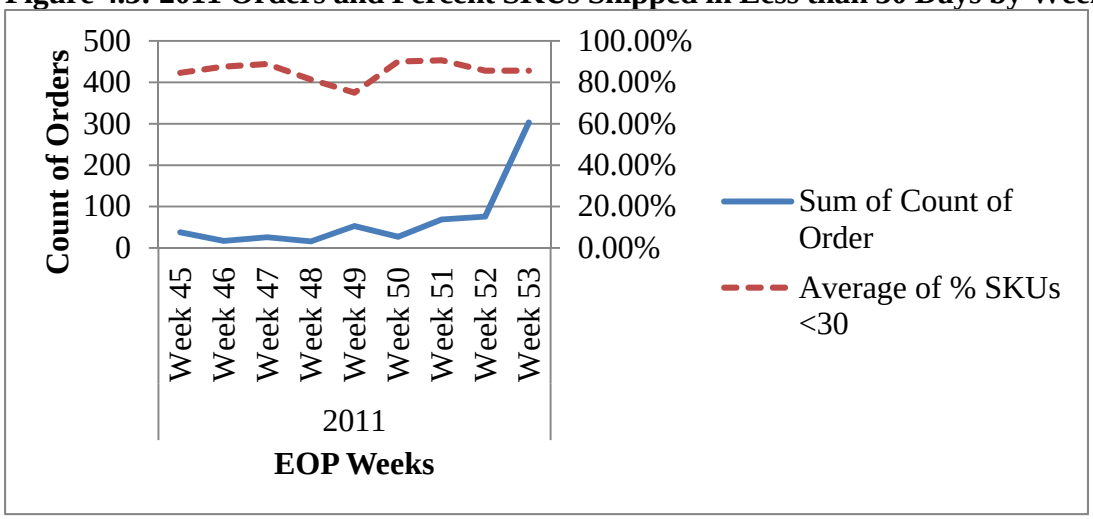
During the 2011 EOP program, the Truck Freight Department average 86% of total SKUs and 88% of total pieces shipped in less than 30 days as shown in Table 4.4.

Table 4.4: 2011 Total Percentage of SKUs and Pieces Shipped in 30 days.

Year	Days	Totals SKUs	Total Pieces
2011	< 30 Days	86.25%	88.32%
2011	> 30 Days	13.75%	11.68%

The week-by-week comparison of the orders and SKUs shipped shown in Figure 4.3 shows that as orders remained flat, the Truck Freight Department maintained a mid-80% ship rate in less than 30 days. A spike in order during Week 49 created a dip in percentage of SKUs shipped down to 75%. It's interesting to note that at the end of the 2011 EOP program there was a significant spike in order placed but the Truck Freight Department maintained an 86% SKUs shipped in less than 30 days for orders placed during that week.

Figure 4.3: 2011 Orders and Percent SKUs Shipped in Less than 30 Days by Week



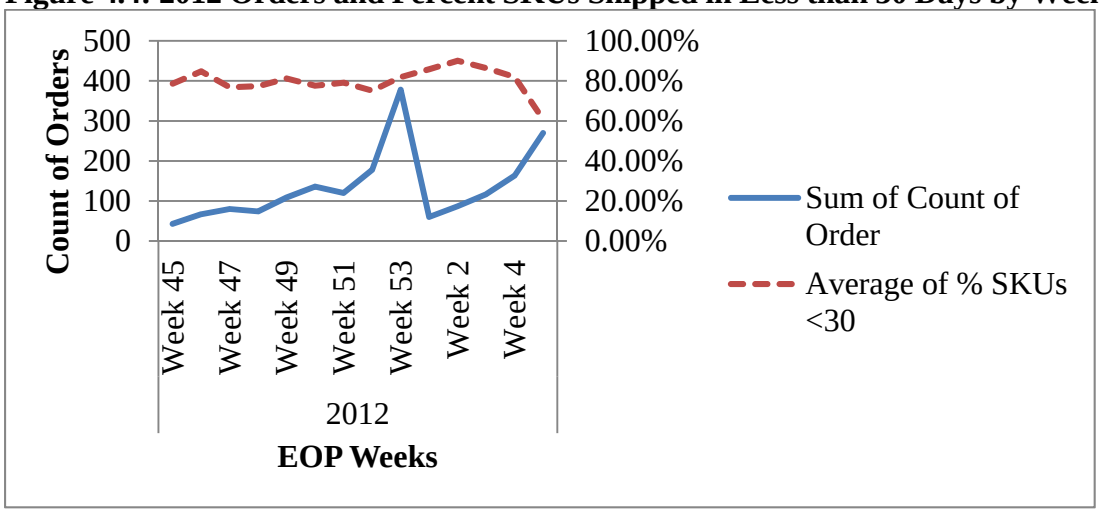
During the 2012 EOP program, the Truck Freight Department average 86% of total SKUs and 86% of total pieces shipped in less than 30 days as shown in Table 4.5.

Table 4.5: 2012 Total Percentage of SKUs and Pieces Shipped in 30 days.

Year	Days	Totals SKUs	Total Pieces
2012	< 30 Days	85.51%	85.50%
2012	> 30 Days	14.48%	14.49%

The week by week comparison of the orders and SKUs shipped shown in Figure 4.4 shows that the Truck Freight Department did maintain a low to mid 80% ship rate, even with a large spike of orders placed during the final week of the calendar year, until the final week of the EOP program. For orders placed during the final week of the 2012 EOP program, the percentage of SKUs shipped in less than 30 days dipped to 60%.

Figure 4.4: 2012 Orders and Percent SKUs Shipped in Less than 30 Days by Week



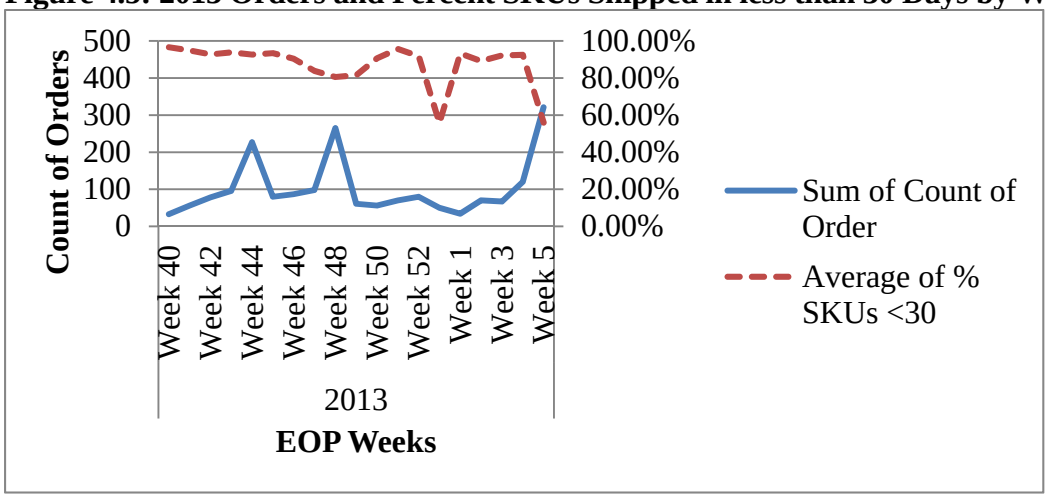
During the 2013 EOP program, the Truck Freight Department average 87% of total SKUs and 88% of total pieces shipped in less than 30 days as shown in Table 4.6.

Table 4.6: 2013 Total Percentage of SKUs and Pieces Shipped in 30 days.

Year	Days	Totals SKUs	Total Pieces
2013	< 30 Days	87.00%	88.06%
2013	> 30 Days	13.00%	11.94%

The week-by-week comparison of the orders and SKUs shipped shown in Figure 4.5 reflects the changes the business made during the 2013 EOP. The count of orders shows a sharp increase in weeks 44 and 48 as each program ended, as well as the spike the last week of the program in week 5. The percent of SKUs shipped within 30 days showed a slight dip during week 48, a large dip down to 56% during week 53, and another large dip to 56% for the last week of the program.

Figure 4.5: 2013 Orders and Percent SKUs Shipped in less than 30 Days by Week



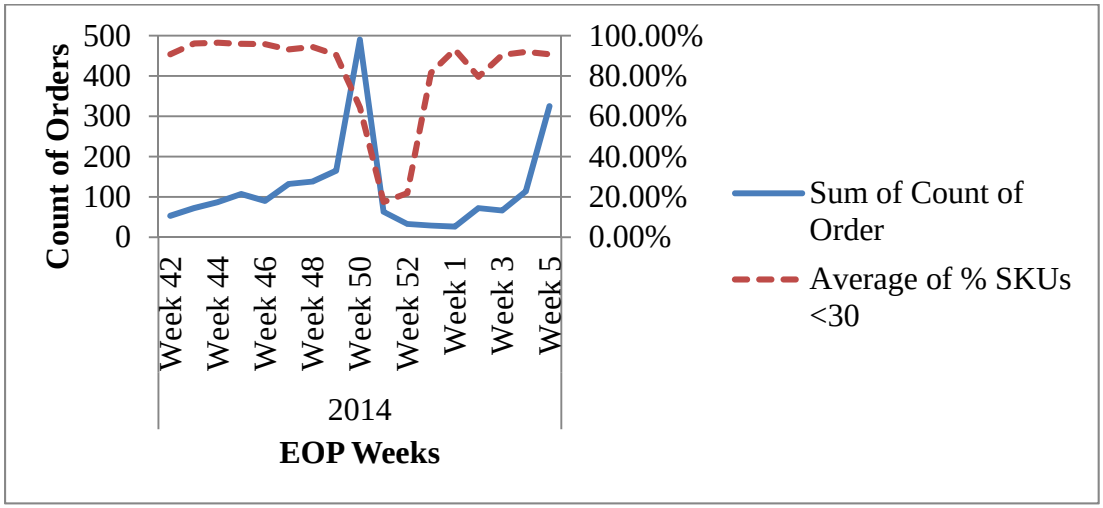
During the 2014 EOP program, the Truck Freight Department average 84% of total SKUs and 84% of total pieces shipped in less than 30 days as shown in Table 4.7.

Table 4.7: 2014 Total Percentage of SKUs and Pieces Shipped in 30 days.

Year	Days	Totals SKUs	Total Pieces
2014	< 30 Days	84.17%	84.41%
2014	> 30 Days	15.83%	15.59%

The week-by-week comparison of the orders and SKUs shipped shown in Figure 4.6 indicates that the 2014 EOP program was similar to the 2012 EOP program with two tiers of the program, the first tier ended midway through and the other tier at the end of the program. This is represented by the two major spikes in orders by week. The comparison of percentage of SKUs shipped in less than 30 days for the orders placed during week 50 through week 52 shows a very strong downward trend. This downward trend is contributed to 2 key factors; 1) the amount of orders placed at the end of the first tier of the program was significantly higher than expected (Pedersen 2014), 2) SKU replenishment parts, that arrived as scheduled by supply management, arrived three week later than needed (Rozeboom 2014).

Figure 4.6: 2014 Orders and Percent SKUs Shipped in less than 30 Days by Week



The comparison of these four years of EOP orders indicates that when orders are fairly consistent, the Truck Freight Department is staffed properly to insure orders are released in a timely manner. The downward trend for shipping in less than 30 days in the last week of each EOP program, especially for the first three years, was expected by the business. Due to this expectation of increased orders, marketing set the expectation that orders placed during the last week of the program, shipment of these orders would be delay longer than expected (Pedersen 2014). The 2014 EOP program did not encounter a large dip in percentage of SKUs shipped during week 51 and week 52 of the program. This can be explained by:

- A larger than expected spike in orders at the end of the first tier of the program.
- At the time of this research, all the orders for the 2014 EOP program were not completed.

To provide some insight into a 4 year average of the Truck Freight Department for EOP shipments, and the Supply Management Department supporting backorders, the

department has achieved 82% efficiency for shipping all EOP SKUs and an 80% rate for all pieces of those orders.

4.3 Backorder Process and Mapping

The backorder process is important in helping both operations and the entire business meet its goals and ensuring this process is operating both smoothly and quickly is vital. To analyze the backorder process, each step will be explained and identified on Figure 4.7 of the process map below.

4.3.1 Backorder Processes and Flow Charts.

As an order is placed into the business system (1) the business system will process every SKU, and the quantity of each SKU, to verify that is has the necessary inventory to satisfy the order within the warehouse (2). If there are not enough inventories to fill the SKU within the warehouse (3a), the business system will create a backorder (3b). If the business system determines that there is enough quantity in the warehouse to fill the SKU, the business system will print a pick ticket to the proper zone within the warehouse (4a). This portion of the backorder process is extremely efficient and the business system performs as expected.

Sometimes the business system's inventory and actual inventory will not match and the business's ability to quickly rectify this error is important to ensure all subsequent orders of that SKU is appropriately handled. After the ticket is printed to the proper zone, the picker will attempt to pick that SKU from the proper bin (4b), if the picker is unable to locate the SKU within its bin location an order discrepancy will be entered into the business system (4C). After the discrepancy has been entered into the business system, and depending on the SKU and quantity, operations will deploy an employee to investigate why there is an order discrepancy (4d). If operations is unable to rectify the inventory

discrepancy they will notify supply management of the situation (4e) to replenish the inventory discrepancy within the warehouse.

In both scenarios discussed for steps 3a and 4c listed in Figure 4.7, the business system will then search other available inventory from other warehouse locations (4). If the other warehouse locations do not have the proper inventory to satisfy the order, supply management will be contacted to procure new inventory to satisfy the order (5a). At the same time, the business system will also be updated to allocate the next available inventory to the current order(s), ensuring these orders are satisfied before any new orders are placed.

The Supply Management Department will check the SKU against current orders placed with vendors (5b). If supply management currently has replenishment stock on order, the status of the order will be investigated to get an expected arrival date for the stock. If the SKU's expected arrival date is unknown, or months in future, the supply management team will attempt to source enough pieces of the SKU from a vendor (not always the current vendor) to satisfy the backorders within the business system.

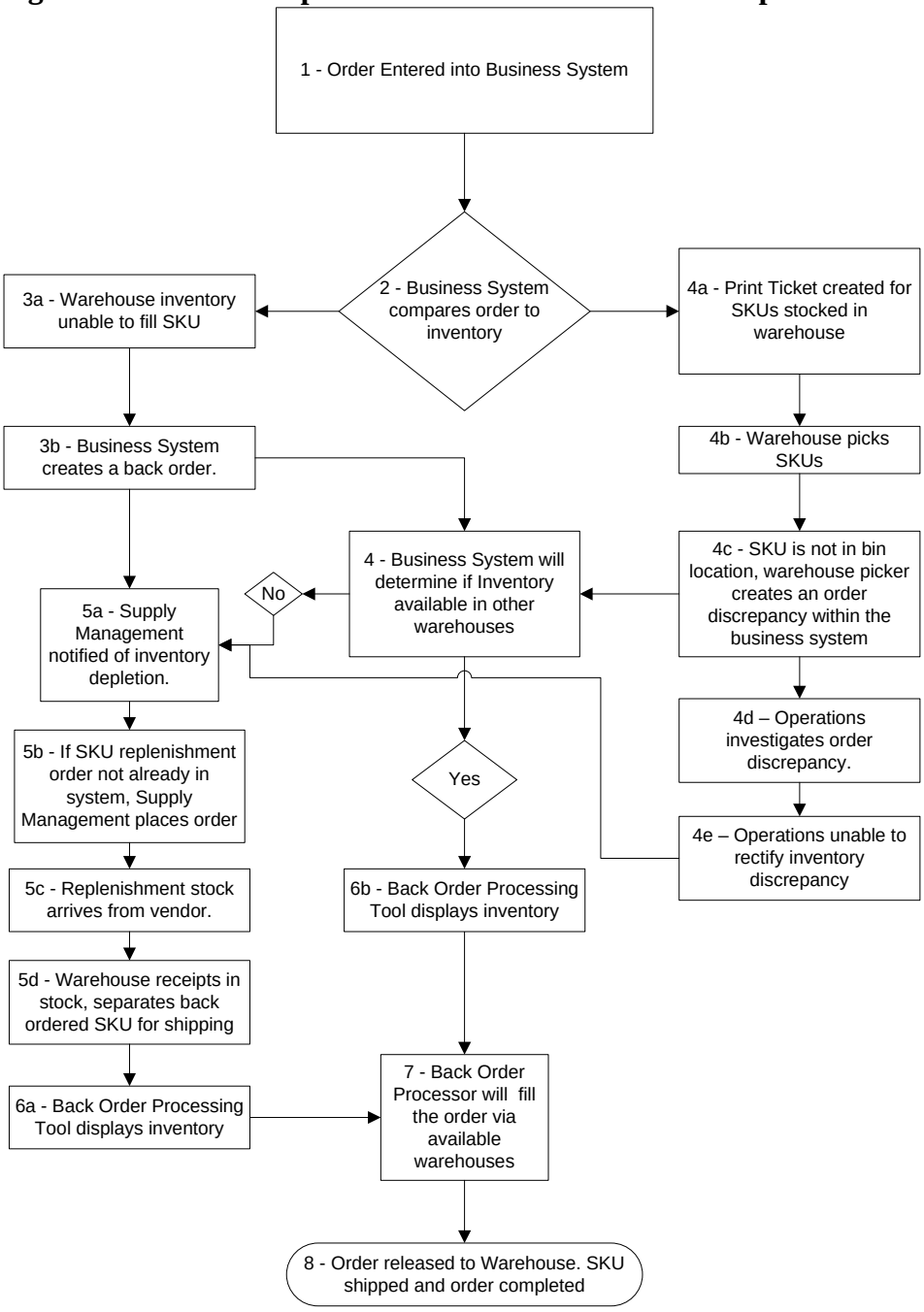
When the replenishment stock arrives from the vendor (5c) the warehouse will receipt in the SKUs. If the vendor order is small, or the order is just to support the SKU backorder, it is easily identified and moved to a bin specified for backorders (5d). If the order is part of a large vendor order, any backorders will be identified as the order is processed and receipted into the warehouse, and moved to a bin specified for backorders (5d).

Once the SKU is scanned into either its proper bin, or the bin identified for backordered parts, the business system will create an activity within the backorder processing tool to allow the processor to complete an activity (6a). If the SKU's backorder

is older than 10 business days, the processor will contact the account and verify if the customer still wants the SKU. If the account still wants the backordered SKUs, the processor will release the order to the warehouse (7). The warehouse will pull, pack, and ship the order completing the backorder process (8).

When the business system identifies that there is not enough SKU inventory in the warehouse to fill an order, it will create a backorder (3b) and then check for available inventory from other warehouse locations (4). If there is inventory in other warehouse locations, the business system will create an activity in the Backorder Processing Tool (6b), and the processor can fill the order with inventory from other warehouse locations. For multiple different reasons, the processor may determine not to fill the backordered SKU from other warehouse inventory. For this reason, the business has decided that the backorder process cannot be completely automated at this time, and having a processor investigate backorders where inventory is available in other warehouse locations is a business priority. If the processor decides not to fill the backorder from another warehouse, the processor informs supply management the SKU has not been filled. If the processor can fill the order from another warehouse, and decides the business case is important enough to support this, the processor will release the order (7). The warehouse will pull, pack, and ship the order completing the backorder process (8).

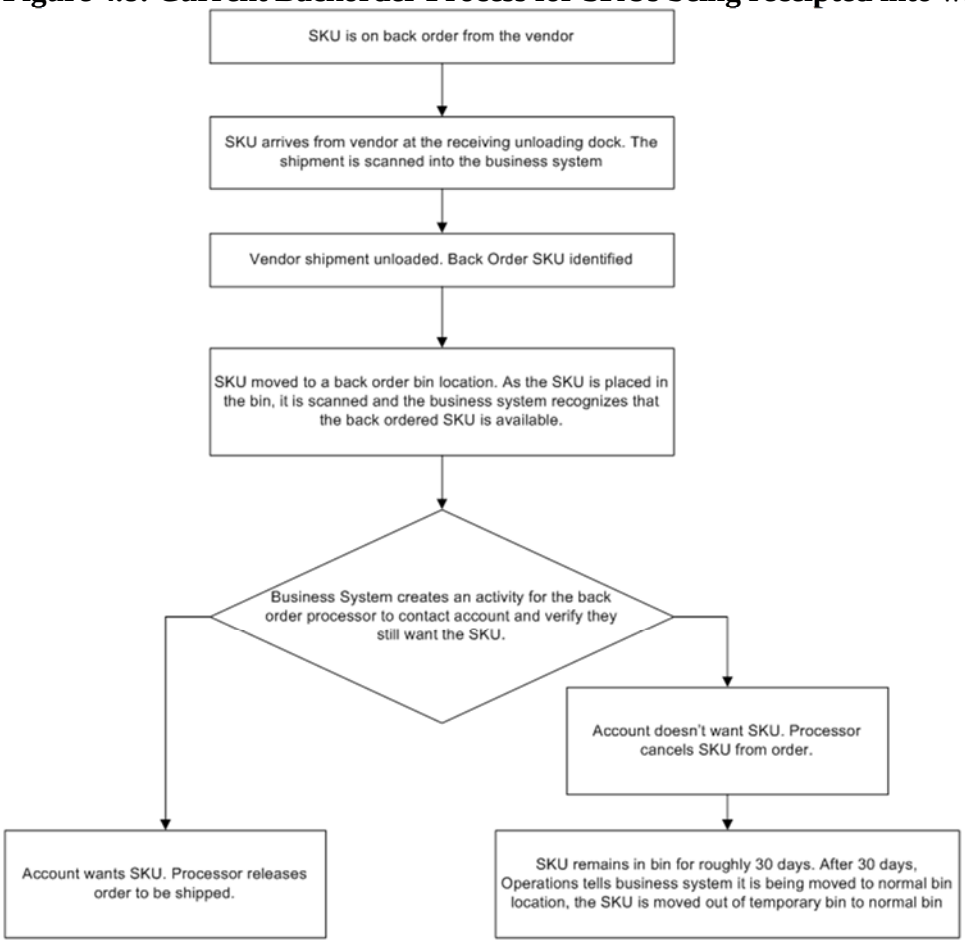
Figure 4.7: Process Map for Backorders and Order Discrepancies.



A CSR supervisor stated the process for receipting in backordered SKUs was modified in 2013. This modification was to contact the account once the backordered SKU

had arrived at the unloading dock (via receipted packing list), but because of the business system limitations of the new process, the process was reverted back to the original process represented in Figure 4.8 (Pedersen 2014).

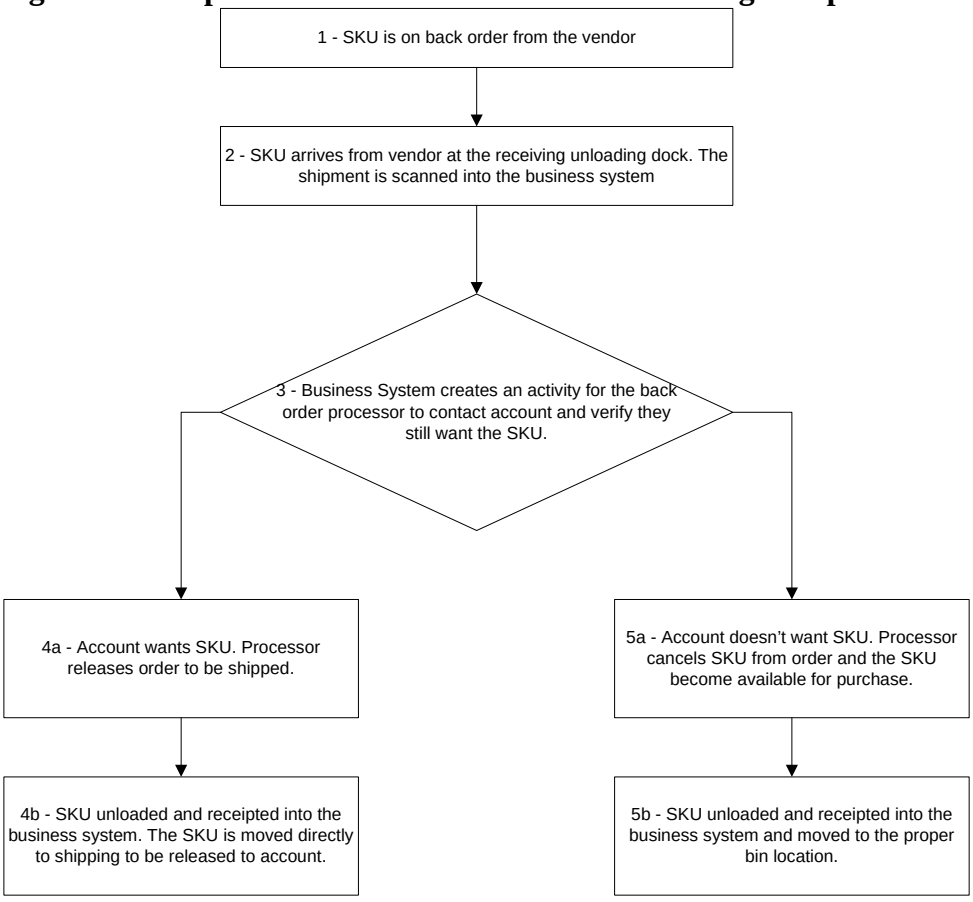
Figure 4.8: Current Backorder Process for SKUs being receipted into warehouse



If the business attempts to resolve these business system limitations and re-implemented the new backorder process, operations could see a significant improvement in backorder processing time (Figure 4.9). If the business system can identify that a backorder SKU is listed on the packing list as a vendor shipment arrives at the unloading dock (2), the business system can release an activity to the backorder processing tools at that time (3),

allowing the backorder processor to contact the account and verify they still want the SKU shipped. If the account does want the SKU (4a), the processor can release the order to shipping, allowing the receipting team to immediately move the SKU to the shipping lanes as it is receipted off the dock (4b). If the account indicates that the SKU is no longer needed (5a), the processor will remove the SKU from the order, and the SKU will be moved to a normal bin location as it is receipted into the warehouse (5b). The re-implementation of this back order process will allow a quicker release for back ordered SKUs, which will result in a higher customer take rate of the back ordered SKU, which will help increase sales and operating SVA.

Figure 4.9: Proposed Backorder Process for SKUs being receipted into warehouse



4.3.2 Forecasting and its effects on order completion

A business's ability to properly forecast expected orders is an important process to help maintain customer satisfaction in having the right inventory at the right time. In the case of an EOP, customer expectations are set that an order will be delayed, but most accounts are still expecting orders to be shipped within a timely manner. The business is efficient in shipping over 80% of all EOP SKU's in under 30 days, but the business's ability to procure and ship the last 20% of the order can take an extended amount of time. Table 4.8 displays the percent of completed order grouped less than 30 days, less than 90 days, and then all orders over 90 days. Table 4.9 compares the average days it takes to fully complete an EOP order for that EOP year. The 2014 EOP was not represented in the tables 4.8 and 4.9 because there are EOP orders that are not completed at the time the tables were created.

Table 4.8: EOP Completed Order Shipment Percentage by Group Days by Year.

EOP Year	<30	< 90	> 90
2011	12.9%	48.2%	51.8%
2012	7.7%	28.3%	71.7%
2013	19.5%	58.1%	41.9%

Table 4.9: Average EOP Completed Order Days by Year.

EOP Year	Average Days
2011	59
2012	80
2013	52

Tables 4.8 and 4.9 indicate that it can be a lengthy process to fill all the SKUs on an EOP order. This is ultimately a small percentage of the entire order, but the order will remain outstanding until it's completed and customer satisfaction will decrease the longer it

takes to complete the order. The business also runs a risk of the account not needing the SKU once it becomes available and the SKU is returned to stock.

4.4 Metrics to Monitor the Order Fulfillment Process.

4.4.1 National Accounts and Sales Support Metrics

Since the National Accounts Representative and CSRs are employees of a call center environment, monitoring the employees Average Speed of Answer of inbound phone calls, and the Abandonment percentage rate of those inbound phone calls, is very important to maintain customer satisfaction and these metrics should remain in place. A process to capture shipping errors as customers report the errors is very important to the entire order fulfillment process and needs to be investigated. Both National Account Representatives and CSRs are responsible for documenting any shipping errors, for both the carriers and the warehouse, and having a process that will easily categorize shipping errors is very important. Another process that could be implemented is to have key personnel within National Accounts and the Sales Support group to be the go-to persons for all CSRs to get the support needed to categorize shipment errors, and to review the log weekly looking for areas of opportunity.

4.4.2 Operation Metrics

The warehouse's operational metrics are currently aligned with the business objectives and are being captured and calculated in a timely manner. Employing software that can automatically capture, calculate, and display the results is an important step to ensure repeatable accuracy in the numbers and to relieve this work from the supervisors (Rozeboom 2014). The "Error Rate" metric is vital to comparing this warehouse's performance against other warehouses within the entire business structure. As stated in section 3.4, management feels that the current Error Rate is understated by 50%, and isn't

reporting the metric due to this situation (Scheetz 2013). Having a collaboration effort between Sales Support group and operations will be vitally important to ensure that this becomes a metric that management will trust and utilize.

The Truck Freight Department is affected by the influx of EOP orders depending on program incentives deadline dates. The EOP metrics should be developed to monitor the Truck Freight Department's performance on a daily basis during the EOP. Those metrics could also be displayed throughout the entire year, and since there is a large monitor posted in the Truck Freight Department shipping lanes, the performance of the Truck Freight Department could be posted for the team to monitor daily.

Any backorders of SKUs is monitored and reported by supply management and is not included with the entire order fulfillment process, as each department only reports metrics that effect that particular department's metrics within the order fulfillment process. Business management could benefit from monitoring the entire order fulfillment process by providing metrics that shows the performance of order completion from placement, to processing, packaging, backorders, to shipment of the completed order. Another benefit that the business will realize from having organizational metrics, instead of segmented metrics from each department, would be more of a team effort as the business works to resolve issues within the supply chain.

4.4.3 Future Orders and its effect on the backorder metrics

The business system currently handles all future orders, most of these orders are for export accounts that require an entire order shipped at an exact time, as a backorder within the business system. The business system is not set up to support future orders, so to make sure that the SKUs are allocated to the future order, the SKUs for the order are coded as backordered parts. This situation will skew the business metrics to monitor its ability to

minimize backorders and the fulfillment of backorders. If the business system can support future orders the business would have more accurate information for true backorders. The business will also have the ability to measure the number, and dollars, of orders that are placed as a future order.

CHAPTER V: CONCLUSION AND DISCUSSION

The objectives of this thesis were to explore the bottlenecks within an industrial warehouse. A literature review was completed to help identify the best practices within the industry and new supply management processes explored. From this research, very little information was identified concerning a multi-zone warehouse operations. An agricultural aftermarket multi-zone warehouse was studied and the processes were identified and mapped to locate potential bottlenecks. An investigation of the business's EOP program was detailed to provide insight to the effects on the Truck Freight Department. From this research, the following recommendations are being proposed to help the business eliminate bottlenecks in their current operation:

- Fax Orders – to help improve efficiency within the National Account Department and Sales Support group, have the teams start supporting and recommending customers utilize the csv file uploading process that the IT has been implementing. Implementation of a process to incentivize National Account customers to utilize the business's B2B for order placement will result in efficiency improvements through a reduction in errors, a reduction in paperwork, and allowing employees to focus on increasing sales within the organization.

- Order picking within the “H” Zone – today, the pickers in the “H” zone will pick the SKUs based on an illogical order. This creates a situation where heavier parts could be placed on top of fragile parts and delivered to the Truck Freight Department. The Truck Freight Department will then have to repack the SKU’s to prevent shipping damage. If the business system can create a pick ticket based off of size and weight for products in the “H” Zone, and have the pickers pull the SKUs according to the business system, this should limit the Truck Freight Department’s time spent to repack SKUs from the “H” Zone.
- EOP Order Release – the business system is set up to release all orders as soon as they are entered into the business system. This overloads the Truck Freight Department during the EOP program. In this situation, CSRs will hold orders within the business system. Once the Truck Freight Department can handle more orders, they will contact the CSR to release orders from the business system. The entire order fulfillment process for EOP order release into the warehouse zones is an inefficient process that takes the coordination of multiple groups to insure the release of orders is handled properly. To increase the efficiency of all departments within order fulfillment, create an “Order Staging” area within the business system that will allow the CSRs to release all orders. EOP ordered are coded in the business system, so the business system can capture the EOP orders in the staging area. The Truck Freight Department then could match orders, based on quantity, to the available space with the shipping lanes.

- Truck Freight Department BOL – when an account submits an order discrepancy, the CSR cannot access the number of packages/pallets shipped for an order completed by the Truck Freight Department. If the business system can capture the BOL, and make it available to the CSRs, the investigation of the order discrepancy will be improved allowing for quicker problem resolution.
- Backorder processing as SKUs are received from vendors – as highlighted in section 4.3.1 and Figure 4.9, having the business system create activities for the backorder processor when the vendor order is received at the unloading dock, can improve operations' ability to quickly and efficiently process the SKU to complete the backorder. With a quicker notification of received back orders, the customer acceptance of back order will increase, resulting in increased sales and SVA.
- Future Orders – need to be able to handle a future order separately from a backorder within the business system. The current system makes it difficult for management to accurately monitor the true backorders in the business system.
- A review of the metrics needs to be completed. A report to management that includes order completion, including backorders and warehouse efficiency, can provide more insight into business performance. The business will also see an improvement in teamwork if the metrics shown more as organizational metrics instead of the current segregated metrics being utilized today.

Implementing these changes in the business system will be time consuming and costly but the efficiency improvements that will be gained from the process changes will provide a positive ROI and an impact on SVA. An increase in customer satisfaction will also be realized by the efficiency gains earned with the removal of the bottlenecks within the order fulfillment system. These changes would also improve the processes within multiple departments of the business, improving employee satisfaction and employee retention, which is the goal for every business.

The goal of this thesis was to review a multi-zone warehouse's process and look for bottlenecks that affect performance of the warehouse. Mapping out the current processes, reviewing the effects of the business's EOP program, and a review of the current backorder processes, all identified current bottlenecks with this business's multi-zone warehouse. The literature review and interviews with the business's employees help provide insights and solutions to the bottlenecks, and those solutions were provided above, allowing all the objectives of this thesis to be met.

CHAPTER VI: OPPORTUNITIES FOR FUTURE RESEACH

In order to fully understand the financial gains that can be realized by implementing the recommendations provided in this thesis, a study would need to be completed that incorporates cost of human power, SKUs pulled, packaged, and shipped per the appropriate time frame, and estimated shipping damages because of current inefficiencies that are currently being absorbed by this warehouse operations. During this study, a review of the expected gains by implementing the process improvements would also need to be completed to fully realize the ROI for the same time frame. The cost of implemented these improvement also need to be factored into the ROI, and most improvements require only IT involvement, requiring an estimated cost from the IT department to implement the necessary changes into the business system.

WORKS CITED

Baker, Peter, and Marco Canessa. "Warehouse design: A structured approach." *European Journal Of Operational Research*, 2007: 425-436.

Chopra, Sunil, and Peter Meindl. *Supply Chain Management.* New Jersey: Pearson Education Inc, 2010.

De Koster, Le-Duc, Roodbergen. "Design and control of warehouse order picking: A literature review." *European Journal Of Operational Research*, 2006: 481 - 501.

De Koster, Rene, and Edo Van Der Poort. "Routing orderpickers in a warehouse: a comparison between optimal and heuristic solutions ." *Institute of Industrial Engineers, Inc.(IIE)*, 1998: 1-13.

Dykstra, Sarah, interview by Kurt Anderson. *Truck Freight Department Supervisor* (12 12, 2013).

Featherstone, Allen. "Economics of the MAB program." *Economics 101*, 2010: 40-72.

Gademann, Noud, and Steef Van De Velde. "Order batching to minimize total travel time in a parallel-aisle warehouse." *IIE ,* 2005: 63-75.

Goetschalckx, M., Ashayeri, J. "Classification and design of order picking systems." *Logistics World*, 1989: 99-106.

Gu, Jinxiang, Marc Goetschalckz, and Lean F McGinnis. "Research on warehouse operation: A comprehensive review." *European Journal Of Opererational Research*, 2006: 1-21.

Johnson, Eric M, and Tom Davis. "Improving Supply Chain Performance By Using Order Fulfillment Metrics." *National Productivity Review,* 1998: 1-14.

Lutjens, Jodi, interview by Kurt Anderson. *Customer Service Representative* (12 13, 2013).

Mentzer, John T, William DeWitt, James S Keebler, Soonhong Win, Nancy W Nix, and Carlo D Smith. "Defining Supply Chain Management." *Journal Of Business Logistics, Vol 22, No2*, 2001: 1-26.

Morgan, Tommy, interview by Kurt Anderson. *Director WW JDM, BL & All Makes Parts* (11 25, 2013).

Pedersen, Crystal, interview by Kurt Anderson. *Customer Support Supervisor* (Febraury 27, 2014).

Rozeboom, Travis, interview by Kurt Anderson. *Operations Supervisor* (March 12, 2014).

Scheetz, Randall, interview by Kurt Anderson. *Operations Manager, All Makes* (July 18, 2013).

Wyant, Robert. "Personal Communication." Minneapolis, February 12, 2011.