USING DMAIC IN THE IMPROVEMENT OF AN IN-STORE DELIVERY SERVICE PROCESS

By

KITTIMA LIMSIRIVALLOP

Submitted in Partial Fulfillment of the Requirements for the Degree of
MASTER OF SCIENCE IN SUPPLY CHAIN MANAGEMENT

Martin de Tours School of Management
Assumption University
Bangkok, Thailand

August 2016
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A Final Report of the Six-Credit Course
SCM 7203 Graduate Project

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ACKNOWLEDGEMENT

I would like to take this opportunity to express my gratitude to my family, friends and professors who supported me throughout the course of this Individual study project.

I express my warm thanks to Dr. Scott Roach and Dr. Chanita for their support and guidance and their knowledge and, insight throughout this study.

I would like to express my appreciation to everyone who devoted their time and shared their experiences to help me accomplish this study.

Kittima Limsirivallop
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ABSTRACT

The objectives of this research were to identify problems, find solutions and implement actions to improve the delayed in-store delivery service process that was causing delay to serve the customers at AAA Company. Recommendations, solutions and preventive actions were provided to prevent problems from reoccurrence.

This research applied the DMAIC (Define-Measure-Analyze-Improve-Control) model to improve the in-store delivery service within the staff pick area of AAA Company. The delayed in-store delivery service is likely to have an effect on customers' satisfaction level. The DMAIC model helped the researcher to define the problems of the in-store delivery service, measure the current performance of the service, and analyze the root causes of the problems. The researcher also suggested an improvement plan with recommendations in order to achieve sustainable procedures to improve the company's operations.

The result of the suggested improvement plan has shown significant development in the in-store delivery service serving time. The time required for picking had been cut; therefore, customers' waiting time was reduced. The company needs to continue the improved process and also develop its own processes to cope with future changes. This is to ensure a sustained improvement carried out with practical monitoring to prevent problems from occurring.
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Ms. Kittima Limsirivallop

and hereby certify that the verbiage, spelling and format is commensurate with the quality of internationally acceptable writing standards for a master degree in supply chain management.

Signed ____________________________
(Dr. ____________________________)

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Date ____________________________
CHAPTER I

GENERALITIES OF THE STUDY

Over the past several years, warehousing seemed to play a less important role in supply chain and logistics. This was because of the advancement and development of technology as well as the change in customers’ demand that requires a quick response, just-in-time, order fulfillment, direct delivery and continuous flow distribution (Brockmann, 1999). However, warehousing is actually becoming more and more important since customers request quicker response with greater quality (Brockmann, 1999). In order to become a key player in an industry, manufacturers must be able to satisfy customer needs and wants as nowadays customers want things to be done quickly, at the right time, at the right place with the right quality and most importantly, at the right price. Companies must be able to fill special requirements and look at these requirements as opportunities to differentiate themselves from competitors.

There are several activities taking place in warehousing which can be customized according to customers’ requirements. Therefore, warehouse operations will be driven by the need for speed, customer satisfaction and accurate information. Hence, warehouse operations will need to do more with less, at a faster rate, with fewer errors in order to save costs (Gordon, 1992). Lenius (1998) also suggested that reducing costs by increasing productivity is the coming trend for warehouse operations.

Order picking is an activity through which warehouse employees, referred to as pickers, retrieve goods from a storage area according to purchase orders in order to satisfy customers. It is usually the second to last or the last activity before the goods are handed over to the customers. Order picking is a very labor intensive activity and such accounts for 55% of total warehouse operation costs (Koster, Le-Duc, & Roodbergen, 2007). An inefficient picking process may cause bad customer experiences as well as resulting in higher operating costs. The faster the goods are
picked, the greater the chance to satisfy customers. Order picking is the most labor-intensive task compared to other warehouse activities since it needs to be conducted manually. Therefore, warehousing professionals have determined that order picking should receive the highest priority for productivity improvement (Koster et al., 2007). Improvements in factors influencing order picking productivity and efficiency such as travelling time, item pick time and other activities (Dukic, Cesnik, & Optetuk, 2010) will provide potential for reducing costs and improving customer satisfaction.

As mentioned, order picking can incur more costs compared to other warehouse activities. Therefore, it is very crucial to analyze a company’s order picking costs and the labor time spent on the activity. This analysis is not only needed to reduce costs but also to improve order picking productivity, efficiency and most importantly provide an increased customers’ satisfaction. There are several factors influencing order picking productivity and efficiency, including operating policies, product demand, warehouse layout, racking systems and equipment (Dekker, Koster, Roodbergen, & Kalleveen, 2004).

1.1 Background of the Research

AAA Company is one of the world’s leading companies operating in the furniture industry with more than 361 stores operating worldwide. The company has been operating in Thailand approximately five years and employs over 400 employees, supplying many different types of furniture and home decorative products. The company provides its customers with one-stop-service where they may purchase both furniture and home decoration products under one roof. Currently, the company offers more than 8,000 Stock Keeping Units (SKUs) (Company’s data, 2015).

The company’s product offerings are mainly furniture for living room, bedroom, bathroom, kitchen and dining room, and workspace. Besides furniture, the company also offers decorative items, cookware, tableware, bed linens, cabinets and storage units, and lighting. Products offered are unique in size, weight, height and packaging.
Customers are crucial to the AAA Company’s sales and order picking process especially when purchasing furniture products. This is because customers are involved in many steps of the process; steps that they may not encounter when purchasing furniture from other companies. This is especially true as it relates to the product picking step. Customers will need to select the items that they want and record the location code from the label on the products and then self-pick their products from the storage areas for these items at the warehouse. Products in the self-pick and staff-pick areas are classified based on: the value of the product, dimensions, weight, highly fragile items, sales frequency and whether it is a combination product (must purchase more than two items to complete the product i.e. kitchen products). Self-picked items are lighter, inexpensive, simple combinations, have greater sales frequency and less damage potential.

Therefore, the company has divided its storage into two areas: the customers pick area and the staff pick area. For the customer pick area, the customer picks the products in
this area and then proceeds to checkout. For those items stored in the staff pick area, the staff picking process (referred to hereafter as the in-store delivery service) begins once the customer makes payment to the cashier, at which time a purchase order is issued. The system automatically generates a pick list which is immediately printed at the staff pick station. Once the picker receives the purchase order, the staff record the start time. This starts the actual picking process. This implies that the picker always performs single order picking. Single order picking means that all of the items are picked for one and only one customer at a time. When the picker has completed the pick, the picker will record the finish time and call the checker and hand over the goods to that checker to verify the accuracy and the completeness of the items picked against the customer order. If the order is 100% accurate, the checker will hand over the goods to the waiting customer. Otherwise, the checker communicates to the picker what part of the pick is incorrect or incomplete, and the picker then performs a re-pick process to correct the order. The staff picking procedure is depicted in Figure 1.3
Figure 1.3: Current In-Store Delivery Service Process

1. Purchase order is issued
2. Picker receives the purchase order
3. Picker picks the stock according to the purchase order
4. Checker checks the accuracy of the pick
   - Yes: Picker hands the products to customers
   - No: Checker calls the picker for a re-pick process
     - Picker performs the re-pick process

Source: Adapted from Company’s process
As can be seen in Figure 1.4 below, the number of items sold from storage within the staff pick area has increased constantly over the years from 2012 to 2014. In 2012, the number of items sold was running from 2,000 to 4,000 items per week. This increased from 3,000 to 5,000 in 2013. In 2014, the number of items sold from the staff pick area was up from 4,000 to 6,000 items per week. This increase in purchases of items stored in the staff pick area has affected the performance and quality of the picking activity by reducing performance to levels below where most customers were satisfied.

**Figure 1.4: Items Sold per Week from Staff Pick Area**

Source: Adapted from Company’s data
Figure 1.5: Average Number of Items Picked from Staff Pick Area per Week

As shown in Figure 1.5, the number of items picked within the staff pick area has increased remarkably by almost 2000 items from 2012 to 2013 and approximately 600 items per week more from 2013 to 2014. This graph highlights the need for higher service levels and better performance in the staff pick area in terms of faster picking with perfect order quality and delivery. Sales continue to increase. Therefore, the staff members will need to be able to pick even faster in the future.

Additionally, the number of SKUs continues to increase every year as the business continues to grow in the Thai market. In 2013, number of items increased by 100 SKUs from 2012 totals, and increased by 200 SKUs from 2013 to 2014. It is also expected that there will be a higher rate of visitors (people coming to the store) and a higher visitor conversion rate (converting visitors to customers). Therefore, more customers will need to be served by the staff pick area employees. So the staff pick area and its employees will need to be ready to support the growing business. The number of SKUs is shown in Figure 1.6 below.
The sales trend from 2012 to 2014 indicates that the business has high potential for continued growth. The trend of average items sold per week within the staff pick area increased from 2012 to 2014 as well as the number of different items stored there. Therefore, the company needs to find ways to sustain and/or improve the picking accuracy, speed and quality. Increasing manpower is one solution, but this will result in increased costs and is not the answer to sustained performance in the face of the business’ potential growth in the long run. Therefore, improving productivity is a better option.

1.2 Statement of the Problems

A recent company survey shows that a majority of customers surveyed were not satisfied with the in-store delivery service at the goods handling area. This result was caused by a long waiting time due to the length of time required for products to be picked from the staff pick area. The survey results have shown that a significant improvement in customer waiting time is urgently required. This need for improvement is indicated by fluctuations in customers’ satisfaction levels starting in 2012. The satisfaction level is inversely related to the waiting time. The longer the customers wait, the lower their satisfaction ratings are. The result is displayed as a
percentage out of 100%. The sample size was from 200 to 300 persons. As shown in Table 1.1, in the 2012 survey only 24% of the surveyed customers were satisfied with the in-store delivery service. This indicates that 76% of the customers were dissatisfied with the service. The company's goal was that at least 40% of the customers surveyed should have been satisfied with the service. The target for customer satisfaction level increased from 40% to 46% in 2013. This was because of the business growth trend and growing number of customers who purchased products from the staff pick area. Therefore, we can foresee that improving the customer satisfaction level is very crucial. The 2013 survey shows a slight improvement where 26% of those surveyed reported being satisfied while 74% dissatisfied. The two surveys emphasize that AAA Company urgently needs to improve its in-store delivery service. However, the survey in 2014 shows a remarkable improvement in which 42% of the surveyed customers were satisfied with the service while 58% were dissatisfied. This implies that there is a good possibility that the service can be improved.

### Table 1.1: Customers’ Surveys Results on Satisfaction Level after Using the In-Store Delivery Service at the Staff Pick Area

<table>
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<th>Year</th>
<th>Satisfied Customers</th>
<th>Dissatisfied Customers</th>
<th>Goal</th>
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<tbody>
<tr>
<td>2012</td>
<td>24%</td>
<td>76%</td>
<td>40%</td>
</tr>
<tr>
<td>2013</td>
<td>26%</td>
<td>74%</td>
<td>46%</td>
</tr>
<tr>
<td>2014</td>
<td>42%</td>
<td>58%</td>
<td>46%</td>
</tr>
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Source: Adapted from Company's data

The combination of customer dissatisfaction with the in-store delivery service and the increasing pressure to perform fast and efficient picks due to increases in both the number of picks and the number of SKUs in the staff pick area are problems for AAA Company. Moreover, the business growth trend is an obvious indicator that actions are required to improve the in-store delivery service. Improvements are needed in the
system to speed up the service and raise customer satisfaction ratings. This needs to be done in a productive and sustainable way.

Therefore, this research was designed to improve the in-store delivery service to reduce customers’ waiting time. The paper focused on “What are the root causes of delays in the in-store delivery service at AAA Company and how can the time used to provide this service to customers be reduced?”

1.3 Research Objectives

The research was designed to use the collected data to analyze the root causes of long picking time which leads to low customers satisfaction when they receive service from the staff pick area. The main objectives are identified as follows:

1.3.1 To evaluate the steps involved in current order picking process and identify any non-value added steps and bottlenecks that might slow down the order picking process.

1.3.2 To classify the sales frequency of products within the staff pick area and to measure the current pick time and travel time of picking locations.

1.3.3 To make changes based upon this research to improve the picking and traveling times as an outcome.

1.3.4 To identify the root causes of long waiting times at goods handling area.

1.3.5 To determine an appropriate method for how products should be stacked on product picking equipment (trolley).

1.3.6 To develop a set of actions designed to reduce or eliminate the root causes of the problems identified.

1.3.7 To implement these actions to resolve problems and produce a measurable result.
1.4 Scope of the Research

This study examined the in-store delivery service process of AAA Company in Bangkok. Related information collected from the in-store delivery service process was used for analysis purposes. The AS-IS process was examined to identify and eliminate or reduce problems from the current model. This study determined the root causes that had impacted the performance of the service using DMAIC Model, Pareto Chart Analysis and Cause-and-Effect Analysis and other tools and techniques. Root causes were identified and recommendations for improvement and sustainment of the improved system were made based on the results of the analysis. These recommendations would be implemented and the results would be measured.

1.5 Significance of the Research

This research helps the company to identify the root causes of delays in the picking process by identifying possible problems that can be the major causes of poor performance in the in-store delivery service. This also helps the supervisors and managers to address the root cause of the problems and prevent them from re-occurring in the future. The benefits of improving the order picking process are not only to increase customers’ satisfaction levels but also to improve the productivity level of the pickers.

1.6 Limitations of the Research

AAA Company is an international company operating worldwide; however, this research was only limited to the AAA Company in Bangkok, Thailand. The project focused exclusively on the in-store delivery service and order picking process within the staff pick area which did not involve the purchasing process that customers had encountered before they received the service from the staff pick area. The research was only focused on the picking process and factors that have direct and indirect effect on picking and travelling time. These include storage assignment, travelling time between locations within the area, use of material handling equipment, pickers'
skills and experiences, and other factors are found to have an effect on pickers’ response time.

1.7 Definition of Terms

**SKUs**
A Stock-Keeping Unit or SKU refers to a specific item stored in a specific location (Vermorel, 2013)

**Warehousing**
Activities involving movement and storage of goods on a large-scale systematically and orderly manner making them available when needed (Malhotra, 2013)

**Order picking**
Physical procedure of retrieving stock-keeping units (SKUs) from specified storage locations, to satisfy the customer demands in the fastest and cheapest way (Broulias, Marcoulaki, Chondrocoukis, Laios, 2005)
CHAPTER II

REVIEW OF RELATED LITERATURE

This chapter presents a literature review relating to this study which will enhance the readers' understanding level of warehousing operation and strategy. Theories, tools and techniques described in this section are used to find the best solutions and/or practices to improve the in-store delivery and order picking process and therefore reduce customer waiting time. The paper focuses on several areas including warehousing, order picking and storage policy. A number of process performance improvement techniques such as the Fishbone Diagram and Pareto Charts Analysis are described and used to identify the root causes. Putting all these tools and techniques together, the researcher has been able to analyze, recommend and apply the right method to fix the identified problems.

Warehousing has direct impact on customer satisfaction since warehouse allows stock to be stored such that customers are able to receive the products quickly. As discussed in the introduction, order picking is an important and highly labor intensive part of the warehousing process. Order picking time is considered to be very crucial for manual order picking processes especially when customers are waiting to receive the goods. However, order picking costs and time are directly affected by order picking sequence (Low, Kung, & Huang, 2011) as well as order picking strategy. Storage and product assortment policies are directly related to order picking time since travelling time needs to be minimized to deliver goods to customers on time while maintaining the pick accuracy and quality must be fulfilled (Centeno & Sundaram, 2004).

There are several factors that influence order picking efficiency which is a part of operation procedure: picking strategy, routing policy and product assignment policy. Each of these steps may be influenced by fluctuating product demand, equipment, racking systems and the experience of pickers (Dekker et al., 2004). The first section below describes warehousing, order picking strategy and storage assignment policy as they apply to AAA Company.
This paper uses a process improvement methodology called “DMAIC” to identify the root causes of slow picking and improve the operational procedure of AAA Company. DMAIC is a five step methodology which allows the researcher to Define, Measure, Analyze, Improve and Control the processes. This process improvement methodology employs a number of tools to improve operational procedure. The literature review concludes by exploring each stage of the DMAIC process and the tools that are employed in those stages.

### 2.1 Warehousing

Warehousing becomes more important for most business (in both success and failure) as it provides an intermediate connection among supply chain members (both upstream and downstream) and can reduce costs and improve services (Faber, 2012). Warehousing is mainly used for storing and buffering products. It can be used to store raw materials, semi-finished goods and finished products and “the term warehouse is used if the main function is storage” (Koster et al., 2007). Warehousing helps companies to immediately serve customers with better service reducing the response time required to serve customers. However, warehousing involves costs throughout the process. The main activities of warehousing are described below in the paragraphs that follow.

#### 2.1.1 Receiving

Receiving is the first activity performed in the warehouse. It starts once the goods have arrived and notification is received (Karasek, 2009). This is followed by unloading and verifying physical goods received against documents (Roth & Sims, 1991) and recording information registration in the system (Karasek, 2009). Bartholdi and Hackman (2008) claimed that the receiving process accounts for about 10% of total warehouse operating costs. Costs during the receiving process include labor costs for warehouse and office employees, and the time that the forklifts and trollies are used (Roth & Sims, 1991).
2.1.2 Put-away

The Put-away process starts with removing items from the receiving area and transporting them to the storage area, verifying location (where product should be placed), and then physically putting the products into their assigned locations. Determination of goods storage is done based upon physical dimension, weight along with the physical handling characteristics of the goods (Karasek, 2009). This process is considered to be very important since storage information must be recorded in the system and later used to generate picking lists (Karasek, 2009). In the case of a physical location and system information mismatch, there will be stock inaccuracy issues.

2.1.3 Storing

The storing activity is where items are deposited and recorded either manually or automatically in the inventory system under formal control and with restricted access (Swink, 2011). During this step, products are retained at locations for future use or shipment. The storing activity can have a short duration of only few minutes if items are sold quickly or may be for long period of time such as several months or more.

2.1.4 Picking

Picking is the main activity of warehouse (Koster et al., 2007). The process starts when the picker receives the picking list and continues until all products are picked from their assigned locations in the warehouse according to the customer’s order. It includes when the products are handed to the customers or put aside to be shipped to customers. This is the stage where accuracy and quality of products picked must be carried out, so customers are satisfied (Koster et al., 2007).
2.1.5 Packing

In the case when the products picked are not handed over to the customers but are instead packed to be shipped to the customers is the next step. Packing is when the goods are consolidated and verified for completeness. The orders are then packed and handed over to the shipping department to be shipped to the customers (Karasek, 2009).

2.1.6 Shipping

Shipping ensures that goods are loaded into outbound containers according to packed consignment documentation provided to the transportation personnel (Karasek, 2009). It is the shipping department’s responsibility to verify the orders and ensure the accuracy of the actual units loaded in the transportation vehicle (Swink, 2011). Companies may use different types of material handling such as reach trucks and counterbalances to bring unit loads from locations and load into the transport vehicles (Bowersox, Closs, & Cooper, 2007).

The activities discussed above are the basic activities that most warehouses use in their operations starting from the receiving process until the products are shipped out from dispatching area. However, this study concentrated more on the order-picking activity since it is the most time-consuming activity with the highest operating cost. The researcher believes that by focusing more on the order-picking activity, productivity will be increased which will reduce customer waiting time and thereby improve customer satisfaction for AAA Company.

2.2 Order Picking

Order picking is the activity of retrieving products from storage locations in response to customers order requests (Dukic et al., 2010). The activity is mainly to fulfill customers’ orders but it is a very important step in the overall process since it affects customer satisfaction levels and whether customers will return for future purchases.
(Manning, 2008). Furthermore, Gue, Meller and Skufca (2003) also reported that due to the time consuming nature of order picking, the picking task can have a major effect on customer service. In addition to its effect on customer satisfaction, improvements in efficiency and effectiveness of the order picking process will reduce supply chain and total warehouse operation costs (Peterson, 2004). Coyle, Bardi and Langley (2003) estimated that 65% of the total of all warehouse operating costs are incurred during the order picking activity.

The main objectives in improving the order picking process are to minimize travel time and travel distance (Wutthisirisart, 2010). Tompkins (2003) has broken down and classified the various time components spent by a picker in performing one order picking. According to Tompkin’s research, a pick breaks out as: 50% for travel time, 20% searching time, 15% for actual product picking, 10% for set up and 5% for “other” (See Figure 2.1 below). This implies that reducing travel time can significantly reduce customer order response time. Therefore, this paper focused primarily on strategies and policies related to travel time and distance.

**Figure 2.1: Typical Distribution of an Order Picker’s Time**

![Figure 2.1: Typical Distribution of an Order Picker’s Time](image)

Source: Tompkins, 2003

In addition to the consideration of picking time components as a means to reduce overall picking time, the type of pick can also affect the efficiency and effectiveness
of a pick. Order picking is broken down into two major types: Unit load and less than unit load (Manzini, Mauro, & Alberto, 2005).

1. Unit load. This is where products are picked in full cases like full-pallet quantities. Normally a picker needs to use material handling equipment to perform the pick.

2. Less than unit load. This can be a case pick or broken case (units) pick and the picker may or may not require material handling equipment to do the pick.

Order picking at AAA Company is mainly performed as a Less than unit load where a case pick is the most common. The picker will only have a flat shopping trolley for product movement and no other material handling equipment is used when the actual pick is performed. In this type of pick, pickers require more time to pick and travel and as a result customer waiting time increased. As a retailer, AAA Company is not likely to be able to change from the Less than unit load to a Unit load. However, if they were able to make this change the company could increase its speed of handling, have better space utilization, decrease product damages and improve personal safety. A move from Less than unit load to Unit load is restricted by customers’ demand. Larger demand alone may not let the company change from Less than unit load to Unit load due to the fact that products stored in the staff picking area are mostly combination products (two or more items must be purchased in combination to complete a product).

2.2.1 Order picking system

The order picking system is how the picker obtains the goods within the warehouse. This section will classify the systems used within warehouses. Grosse and Glock, (2012) claimed that orders picked manually is the critical factor requiring more picking time and thereby reducing overall warehouse efficiency. In this section, the researcher explores order picking systems in detail so the reader may understand order picking systems better. This section helps the reader to understand how order picking at AAA Company works, especially the Picker-to-Part order picking system.
Manzini et al. (2005) classified Order Picking Systems into 3 major types: Picker-to-Parts, Parts-to-Picker and the Put System. Please see Figure 2.2.

**Figure 2.2: Classification of Order Picking System**

![Classification of Order Picking System Diagram]

Order picking system (employing human)

- Picker-to-Parts system
  - High-level picking
  - Low-level picking
- Parts-to-Picker system
  - Carousel
  - Automated Storage and Retrieval Systems (AS/RS)
- Put system


Picker-to-parts is the most common order picking system (Yu, 2008 and Koster et al., 2007). It is where the picker picks stock by walking or driving to reach the desired destination and picking the product from its storage location. The time that this system takes depends upon the distance from the order station to the item locations. The picker-to-parts strategy is categorized further into low-level picking and high-level picking (Koster et al., 2007). Low-level picking requires the picker to retrieve goods from storage locations on low-racks, shelves or bins. In high-level picking as the name suggests, items are stored on high racks, shelves or bins. Therefore, the picker needs to travel with a machine such as a reach-truck or crane to reach the products. Low-level picking is more popular as compared to high level picking due to its lower costs (Yu, 2008).

Parts-to-Picker refers to the use of an Automated Storage and Retrieval Systems (AS/RS) and carousels. The AS/RS is a system where aisle-bound cranes travel
horizontally and vertically to retrieve collections of goods from their locations for delivery to the picker. Once the goods arrive at the pick station, the picker picks items according to the pick list then the crane returns the unpicked items back to their storage locations (Koster et al., 2007). A carousel involves shelves and bins rotating horizontally and vertically as a means to pick goods. The system can be controlled manually by a picker or run automatically by the system itself. Parts-to-Picker systems are more expensive but easier to control and monitor and provide greater productivity. Picker-to-parts systems are considered to have less initial costs as compared to the Parts-to-Picker system, but this cost savings is offset because it suffers from greater number of errors.

A Put system is a system that combines the Picker-to-Parts and Parts-to-Picker systems. First, goods are retrieved by either a Parts-to-Picker or Picker-to-Parts system and moved to the picker who will pick the goods and hand the products over to the customers (Put goods into customer carts). This is considered to be a pre-pick process since it is commonly used in cases where there are a number of large orders with a short delivery time (i.e. Amazon warehouse and auctions). This system reduces pickers’ travel time and therefore provides faster response to customers’ orders.

The order picking system is the starting point of the whole order picking process whether it is Parts-to-Picker, Picker-to-Parts or Put. If order picking is a manual process, then manual order picking strategies will apply. Since AAA Company employs a low-level Picker-to-Parts system and plans to keep this type of system in place, this study concentrated on manual order picking strategies as a means to reduce picking times.

2.2.2 Order picking strategies

Order picking strategies define how goods are picked within warehouses (Dukic et al., 2010). They are designed with the objectives of reducing cost and order response time while maximizing output (Parikh, 2006). Picking strategy helps reduce travel time through the use of optimal routing strategies (Hong, 2010). There are three types of
order picking strategies: discrete picking, batch picking and zone picking. Each is described in the following section.

2.2.2.1 Discrete picking

Discrete picking is where one picker responds to one pick list and picks all the items listed on that pick list. This is the simplest picking strategy as there is no consolidation and/or sorting required and the picker can work independently. Figure 2.3 depicts discrete picking. It shows that in order to complete Order #1 the picker needs to walk around through aisles to complete the order and when the last item is picked, the picker walks back to the picker station. However, travel distance is the major disadvantage for this strategy. Use of this strategy requires the picker to walk around the warehouse resulting in low productivity.

![Figure 2.3: Discrete Picking](image)

Source: Author

2.2.2.2 Batch picking

A second alternative, batch picking, is where multiple orders are grouped or batched together and a picker picks the listed products in one route. Figure 2.4 depicts batch picking. It shows four orders to be picked by a picker. The picker needs to walk along the aisles to complete the four orders in one round and then bring all items back to the
picker station for the sorting and consolidation processes. The use of batch picking will reduce travel distance per order as travel time is shared between orders. Dukic et al., (2010) claimed that the use of batch picking can save travel distance by up to 80% compared to discrete picking. However, the picker will not be able to contribute to other activities during the pick.

Figure 2.4: Batch Picking

Source: Author

2.2.2.3 Zone picking

The third method, zone picking, is where a picker is assigned to a specific region or area of the warehouse and is to respond to customers’ orders for products stored in that assigned area. Figure 2.5 depicts zone picking. This figure displays how pickers are responsible to pick the products within their designated zone and put the picked items on a conveyor belt for consolidation. The pickers need to pick items according to the pick list using both discrete picking and batch picking but within their assigned area only. This further reduces travel distance and travel time since the pickers need to pick within the assigned area only. However, zone picking requires a conveyor which is used to transfer the picked items to a central location for consolidation purposes. Here, all items from a particular customer’s order are consolidated and handed over to the customer.
The current picking strategy that AAA Company is employing is discrete picking where consolidation is not required. Even though batch picking is a choice that would reduce travel distance and time for each order, AAA customers' orders are not issued in batches. Therefore, the pickers are responsible for one order at a time. The orders are issued when the customers pay. This means that the purchase orders are printed only when payments are made. Therefore, purchase orders are not issued in batches. Another reason that batch picking is not used at AAA is the weight and size of the products carried by the store. Many products are quite large and heavy which means that the pickers need more time for consolidation since each item must be lifted and sorted again at the picker station. Zone picking is also not used due to the nature of products involved and their size and weight. A zone picking strategy cannot be adopted because the warehouse is not designed for a conveyor system to be used.

2.3 Storage assignment policy

The storage assignment policy indicates how products are to be assigned to storage areas. This is normally determined during the order picking design stage (Brynzer et al., 1994). The principal objective of the storage assignment policy is to determine the best way to designate product storage locations which minimize travel distance and travel time (Parikh, 2006). Storage location assignment is based on a number of
variables: sales frequency and accessibility, dimension, weight, racking system, hazard, total incoming quantity per year, etc. (Koster et al., 2007; Dukic et al., 2010). According to Koster et al. (2007) and Parikh (2006), there are several storage assignment policies that are frequently used in warehouses. These include random storage, closest open location storage, dedication storage, full turnover storage and family-based storage. Each of these storage policies is described in the following section.

2.3.1 Random Storage

Random storage is the simplest storage policy that all incoming pallets are just randomly allocated to a storage location at some empty location within the warehouse with no consideration as to the benefits or drawbacks of the assigned location. It provides the highest space utilization with greatest flexibility of changing storage areas within the warehouse (Wutthisirisart, 2010). If a random storage assignment policy is adopted, the warehouse needs to operate with the optimum routing policy and order picking strategy to reduce travel time and distance. Disadvantages of random storage policy are high cost, inefficiency, increased travel distance and increased picking times (Koster et al., 2007). The policy works best when operated in a computerized environment. As shown in Figure 2.6, incoming pallets are assigned automatically to any free location regardless of other factors. For example, the next arriving pallet could be assigned to any white space shown in Figure 2.6.
2.3.2 Closest Open Location Storage

Closest open location storage is where a picker can choose a location to allocate pallets manually. The first location spotted by a picker is allocated as the location of that particular product. Therefore, locations nearby the picker station tend to be full and locations farther away from the picker station tend to be empty. Figure 2.7, depicting the closest open location storage assignment arrangement, shows that the front rows and racks are the first priority for a picker to choose for storage, and racks behind are less used. This means that spaces farthest from the picker station are not fully utilized.

Source: Author
2.3.3 Dedicated Storage

Dedicated storage specifies a location for each product item and that space remains dedicated for that item until the product location is intentionally moved. This means that locations are reserved and no other products can be placed in those locations even when the products designated for those locations are out of stock. Using this method, products are logically grouped and stacking rules are followed (e.g. heavy products are placed at the bottom and lighter products are on top). This has the added benefit that pickers will be familiar with product locations. However, using dedicated storage, the warehouse space utilization is the lowest among all policies. Figure 2.8 shows that all locations are reserved for products a1 to a45 regardless of availability.

![Figure 2.8: Dedicated Storage](image)

Source: Author

2.3.4 Full-Turnover Storage or Volume-Based Storage

Using this storage policy, items with the highest turnover rate are placed near dispatching areas or where the picker can pick them quickly with easy access. Slow moving items are placed at the back of the warehouse area. This minimizes travel distance and travel time for those items with higher demand. This method is best used together with the dedicated storage policy described above. However, the method
requires flexibility since the demand for each product tends to be inconsistent over time. This requires regular product re-slotting due to the changes in ordering patterns based on sales turnover. The main disadvantages are the need for periodic adjustment in storage assignment and the inefficiency of having to move the products that have changes in their rate of turnover. Figure 2.9 depicts that high turnover items are always placed near the picker station.

![Figure 2.9: Full-Turnover Storage or Volume-Based Storage](image)

Source: Author

2.3.5 Family-Based Storage

The concept of family-based storage was introduced by Frazelle and Sharp in 1989. Using this policy, products with the same or similar family groupings and/or related-functions are assigned together. If products are regularly ordered together (such as table legs and table top or items with the same series but different function) they are placed nearby each other in the warehouse. This can reduce the picker travel time and distance. Frazelle and Sharp (1989) claimed that there can be a 30-40% reduction in travel time when a family-based storage policy is applied. Figure 2.10 shows how items in the same family are placed within the same rack or row so that pickers can pick items once purchase orders are received.
Warehouses have different working routines and methods; therefore, companies need to find ways to determine the most efficient and effective storage assignment policy. Product placement and order picking are the key factors influencing order picking time and productivity. The most appropriate storage assignment policy to be used by AAA Company to manage its storage has to be identified to improve picking time and therefore reduce customer waiting time. However, AAA Company needs a way to determine which of the policies discussed above should be used in the company’s warehouse. There are several tools that can be used to determine which policy is the most suitable.

The next section of this study describes and explains a number of tools and techniques that have helped the researcher and AAA Company in the choices to improve the company’s order picking process. Tools and techniques include DMAIC (Define, Measure, Analyze, Improve and Control), Interview, Observation, Cause-and-Effect Analysis and Brainstorming.

2.4 DMAIC

Successful companies comprehend that to sustain businesses and stay ahead of competitors, they need to please customers by persevering to serve goods and/or services that satisfy customers’ requirements and meet or exceed their expectations (Vootukuru, 2006). The quality of goods and services has become increasingly more
important especially in a dynamic environment like the retail business. Efficiency and effectiveness of business processes are vital for day-to-day operations. Therefore, businesses must understand and be able to analyze their policies, procedures and processes. In order to understand and analyze these processes, they must be able to identify and use most suitable tools and methodologies available.

According to Prashar (2013); Mehrjerdi (2011), the DMAIC process improvement method and tools helps to analyze and improve existing business processes. This can result in cost reduction, elimination of defects, improved customer satisfaction, improved cycle time, increased profitability, improvements in on-time delivery, logistics improvement, sales forecasting ability and improved quality of customer service. The methodology is not only used in manufacturing but also in services and in retail businesses (Kumar, Strandlund, & Thomas, 2008). In this research, DMAIC was used to improve the order the picking process and in-store delivery as services of AAA Company.

DMAIC is an empirical data-focused approach that uses mainly quantitative information (Mehrjerdi, 2011). It is an excellent methodology to employ when the root causes are unknown or unclear (Mehrjerdi, 2011). According to Rever (2004), DMAIC is a five step process which comprises of the following elements: Define problem(s), goal(s) and scope(s), Measure the current processes and performances, Analyze to determine root causes, Improve to develop and implement or solutions to fix the root causes, and Control the results so as to sustain the improvements.

In Figure 2.11, Rever (2004) depicted the process through which questions should be asked or focused on in each of the DMAIC steps. Each question addresses the main point or key features of that step so that what is learned in one step is used in the next allowing the process to continue. For example, during define phase, problems should be defined and the scope of the project should be determined in order to collect the needed information during Measure phase. These questions not only to help in the next step but also to ensure the completeness of each phase.
This study used the DMAIC methodology to identify the root causes of the problems that AAA Company is currently facing. This was done by defining the current problems and the scope of the in-store delivery service and order picking process. Measures were made to the current order picking process and performance. This data was analyzed to determine the root causes of the problems identified in the warehouse and its associated picking process. Techniques were then employed to come up with methods to improve the process and develop a plan for implementing the proposed solutions. The final step in the DMAIC process resulted in the development of methods and systems to control and sustain the new improved processes.

In order to provide a better understanding of what is involved in the DMAIC process, the following section examines each of the five steps involved. Also discussed are the tools that are employed in each of these stages in order to accomplish the objectives of each stage.

2.4.1 Define

Define is the first phase of the five steps. Antony, Bhuller, Kumar, Mindibil and Montgomery (2012) stated that the Define phase is used to define the goals, scope and business process requirements. Define uses customer data and feedback to determine problems. This phase allows the company to define the goal or the final outcome to be
accomplished after implementing the DMAIC process. It also serves to limit the scope of the project. Moreover, the focus of this phase is on customers. Customers’ expectations and satisfaction level are very important and must be determined at this stage (Wiesenfelder, 2011). Using DMAIC methodology can help the researcher to identify the root causes encountered when the researcher asks targeted questions. For example:

- What areas of performance cause customers to be dissatisfied with the company?
- What are the measurements used to monitor performance?
- Is data available and easy to obtain?
- Does customer waiting really affect customer satisfaction level?


Once goals, scope and problems are defined, the researcher is able to proceed to the next step of DMAIC methodology, Measure. Information retrieved at this stage will allow the researcher to have a better understanding about customers, as to what has been happening, why it has been happening and how it happened. The major techniques used in this phase are observation and interview to help gather information from users and customers.

2.4.2 Measure

The next step, Measure, uses collected data to map the current process and capture how the process is measured (Measure phase, n.d., para 1). Information must be studied and fully understood to determine not only how the processes work but how well they perform (Wiesenfelder, 2011). During this step, available data is identified and checked for validity (Rever, 2004). In this phase, a tool like Process flowchart is very useful to gather information.
In this phase, the researcher needs to collect information available by retrieving both historical and current information from the company’s database to gain an in-depth understanding. The information obtained in this phase will be used during Analyze step. A main objective of the measure phase is to eliminate unnecessary information and/or input and to collect only related information that focuses on the prioritized problems (Wei, 2010). The process flowchart is the key tool to be used to map the current process so that the researcher gains a better understanding of the current situation.

2.4.3 Analyze

The objective of the Analyze phase is to identify potential root causes. This step is also used to identify and isolate the major causes for which improvements will be formulated. The step is used to help resolve the root causes by analyzing the problems using the data that has been collected in prior phases (Wiesenfelder, 2011). The amount and quality of information collected during the Measure phase is very crucial during the Analyze phase since it will be used to identify the potential root causes and key factors affecting business performance. Potential root causes must be checked against the actual data before confirming that they are the actual root causes. The major tools used during this phase are the Fishbone Diagram to identify the potential root causes and the relationship between cause and effect and Brainstorming to get idea and analyze the collected information.

During this stage, the researcher is able to analyze the collected information and identify potential root causes and actual root causes of the problems. The conclusions reached during this phase are used during the next step, Improve, to find possible solutions to eliminate or mitigate and develop preventive processes to keep the same problems from reoccurring.
2.4.4 Improve

The main objectives of the Improve phase are to propose solutions to identified root causes, to evaluate the proposed solutions, to select the best solutions and to implement them. (Cheshmberah & Nabavi, 2014). During this phase, Brainstorming is crucial as new ideas and solutions are needed.

Beady (2005) and Pande, Neuman, and Cavanagh (2002) recommend that “Thinking outside the box” will generate creative ideas and solutions and/or eliminate ideas and solutions that are not applicable. Information, ideas and solutions must be listed, linked, analyzed and brainstormed before ideas are abandoned. This allows assumptions to be challenged and discussed before the final solutions are chosen. Once a shortlist of solutions is ready then it is time to do the final revision and select the best solution. Comparisons are made between the current process and the To-Be process using the Process flowchart to distinguish the two processes. At this time, several questions should be asked about the proposed solution. For example:

- Will the solution eliminate the root causes? (Beady, 2005)
- Will the solution reduce picking time?
- Will the solution prevent problems from reoccurring? (Beady, 2005)
- Will the solution improve customer waiting time?

Once solutions are selected, a pilot test should be conducted to observe how well each works, what works well and what needs modifications to improve the efficiency and effectiveness (Beady, 2005). During the pilot test, more data is collected as additional information to support the full implementation. Beady (2005) and Pande et al. (2002) claimed that two steps should be completed before the solution is fully implemented. These steps are development of training materials and kits like checklists, manuals and other needed documents and resources and use of the new processes as the regular working processes and routines so that obvious problems can be identified and fixed.
2.4.5 Control

The objective of DMAIC is not only to eliminate the weaknesses and the improve process but also to control the process so that it continues running well in the long term (Mishra & Sharma, 2014). The major aim of the Control phase is to standardize, monitor and integrate changes after implementation (Antony et al., 2012). Therefore, processes must be documented and ownership of every process must be well established (Atkinson, 2014). Ownership of the process means that there is a responsible person, functional area of the store or department that ensures that processes are completed correctly and on time. There will be a need to set up metrics to measure whether the process is efficient and effective in actual operation. (Atkinson, 2014).

DMAIC is a tool that allows a company to Define and learn its current process, Measure performances of the process, Analyze strengths, weaknesses, opportunities and threats of the process to identify the root causes. It is important to improve the current process by implementing the newly invented or modified process and control to ensure the sustainability of the process. However, there is no one-size-fits-all solution with DMAIC. Therefore, companies must find the most suitable solutions and tools to fix their problems.

2.5 Tools (Observation, Interview, Process Flowchart, Cause-and-Effect Analysis, Pareto Chart Analysis, Brainstorming, and Nominal Group Technique)

Customer long waiting time causes customer dissatisfaction which leads to negative consequences for the business. Therefore, AAA Company requires tools to identify both the root causes of its problems and to analyze those causes. The researcher previously discussed the tools that were used in this study to improve the order picking process of the company. These tools were used to find ways to make the process more effective and efficient and thereby increase the speed of in-store delivery and reduce customer waiting time.
The next section describes and explains the tools used in the various steps of the DMAIC process. Tools discussed in this section include Observation, Interview, Process Flowchart, Cause-and-Effect Analysis, Pareto Chart Analysis, Brainstorming and the Nominal Group Technique. The tools were used to identify the root causes, analyze problems and propose solutions to mitigate and/or solve the current problems being faced by the company. The main purpose of using all these tools was to answer two related questions: 1) What are the causes of long picking times and 2) how can picking times be improved?

2.5.1 Observation

Observation is a methodology used to collect data and/or information by keeping record through watching others’ behavior, events, and physical characteristics in either a natural or contrived setting (Data Collection Methods for Program Evaluation: Observation, 2015). Observation allows researchers to document behavior, activities and other aspects without considering willingness and responsiveness of others through ‘seeing’ and ‘listening’ (Powell & Steele, 1996).

According to Wilson (2014), observation can be classified into two types: disguised observation and undisguised observation. Disguised observation or covert observation is when no one is aware that he or she is being observed while undisguised observation is when everyone is aware that they are being observed. Covert observation provides additional benefits to the researcher because the subjects are more likely to behave naturally. However, there are significant ethical concerns regarding privacy in using this method.

Observation of order picking and in-store delivery activities were conducted using both disguised and undisguised methods to determine the current process of in-store delivery and the activities involved. Then, the information was used to map out a Process Flowchart that was used to help identify the problems. In this study, the researcher also used Interviews as a support tool to collect additional information.
This involved interviewing the order pickers to identify the obstacles that they have encountered in the picking process.

2.5.2 Interview

Interviewing is a method of researching by having conversations and/or asking quantitative and/or qualitative questions with the key participants (Data Collection Methods for Program Evaluation: Interviews, 2009). Wilson (2014) stated that interviews are mostly targeted for use in qualitative research strategies and allow the interviewer to gain an in-depth knowledge of the thoughts, attitudes, perceptions and beliefs that a respondent may have toward the particular topics.

There are three major types of interviews: Face-to-Face interviews, Telephone interviews and Focus group interviews. In this research, the researcher focused on only one type of interview which is the Face-to-Face interview. This tool was used to gain inside information from the interviewees.

A Face-to-Face interview is a session arranged for the purpose of direct meeting between two or more persons (the interviewees) and an interviewer (Wilson, 2014). The interview allows the researcher to ask in-depth questions and and it allows those being interviewed to elaborate on specific questions and information. The interviewer can immediately address the interviewee if questions or answers are unclear or ambiguous. This reduces the chance of misunderstanding. Therefore, the data collected is more likely to be accurate (Doyle, 2016).

The people who were interviewed were from two different groups: in-store customers who have received in-store delivery services and workers who provided in-store delivery services to customers. The customers interviewed must have received the in-store delivery service and they included both satisfied customers and dissatisfied customers. The workers who took part in the interview must have had provided in-store delivery service to customers and been able to completely describe each step of in-store delivery process including the order picking procedure.
2.5.3 Process Flowchart

A Process Flowchart is a diagram that uses symbols to portray activities in a work flow process (Basic Tools for Process Improvement, 2011). A Process Flowchart maps how things work, what information is needed and who is involved in each step of a process by defining the elements of the service process including input, output and decision making (Young, 1991). The diagram shows how steps link and/or fit in a process and is commonly used to document the process and demonstrate how the process works (Flow Chart, n.d., para 5).

Young (1991) stated that the Process Flowchart is an effective tool used in DMAIC to improve service quality and in turn, customer satisfaction. The flowchart guides all aspects of service delivery from start to finish. The Process Flowchart is constructed to map out the working process as a means to analyze this process so that problems and weaknesses are identified. Table 2.1 displays common symbols used to depict activities or tasks of steps in a process.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Starts/Ends" /></td>
<td>Indicates both starting point and ending point of a process</td>
</tr>
<tr>
<td><img src="image" alt="Activity or step" /></td>
<td>Represents individual activity or a step in a process</td>
</tr>
<tr>
<td><img src="image" alt="Decision point" /></td>
<td>Represents a decision point in a process, for example, Yes/No. The diamond must be labeled with at least one possible answer.</td>
</tr>
</tbody>
</table>
The Process Flowchart was used by the researcher and the AAA Company employees to visualize their AS-IS in-store delivery process. The AS-IS process, together with information collected during observation and interview sessions, showed where the improvements were needed. Then, the Cause-and-Effect Analysis was conducted to gain an in-depth understanding of the problems in the process and their likely causes. The Process Flowchart also provided for an opportunity to compare the steps in the AS-IS with the TO-BE process.

The next section discusses Cause-and-Effect Analysis which was used to analyze the AS-IS in-store delivery process.

2.5.4 Cause-and-Effect Analysis

Cause-and-Effect Analysis is a tool designed to detect the potential root causes of problems with constructed relationships such as service processes (Doggett, 2005). Cause-and-Effect Analysis uses a tool known as Ishikawa diagram or informally, as Fishbone Diagram. The concept behind the tool is to construct a diagram showing relationships between possible causes and an effect which has as its aim to encourage discussion and educate others about processes and problems (Doggett, 2005).

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direction</td>
<td>Indicates direction flow from one step to the next</td>
</tr>
<tr>
<td>Delay or wait</td>
<td>Indicates where activities or steps are delayed or have to wait until the next process step can be performed</td>
</tr>
<tr>
<td>Document</td>
<td>Symbolizes a transition or output of a hard copy</td>
</tr>
</tbody>
</table>

Source: Adapted from Chand, 2015
Fredendall, Patterson, Lenhartz and Mitchell (2002) claimed that Cause-and-Effect Analysis is an exercise for use in quality brainstorming sessions since it allows researchers to identify and discover root causes for a particular problem.

The Cause-and-Effect Analysis intends to be used to investigate what, why and how things or problems arise and find out how to avert problems from happening again (Hambleton, 2005). The diagram visually ties problems with possible related causes. This helps to explore real issues behind the problem through exploration and brainstorming (Simon, 2012). In order to get effective results and/or actions, companies should focus on their priority problems that need urgent attention to be solved.

As you can see in Figure 2.12, the Fishbone Diagram is divided into two parts which are the head and the bones. The head represents the “effect” or “problem” while the bones signify potential “causes”. The bones of the fish help categorize the probable causes and visually demonstrate interrelated causes. The major factors that influence the effect are labeled at the end of each bone. Each bone represents a major causal factor with potential sub-causes related to that factor. These potential causes are referred to as Primary causes. Sub-causes are referred to as and Secondary causes. Major factors that are often used in business related issues are Equipment, Process, People, Material, Environment and Management. Once the major factors are listed, Brainstorming is conducted to identify the primary and secondary causes for each major factor. The listed causes should be those that provide significant influence on the effect.
Synder (2012) states that Cause-and-Effect Analysis, at the simplest level, can identify a single cause directly related to one particular effect. At more complicated levels, one cause may be linked to multiple effects or one effect may have multiple causes or there may be multiple causes that lead to interrelated effects.

According to Wilson (2013), a group of 3 to 10 persons should be selected. They should come from different levels and/or positions in the organization. It is crucial that this group is posed with a very clear problem, topic and/or question to be addressed. For AAA Company, the group of selected people was employees who are very familiar with the in-store delivery system such as experienced pickers.

To conduct Cause-and-Effect Analysis, the effect part (represented by the “head”) must be clarified and be very specific. Then, major factors leading to that effect are identified and listed on the end of the bone. For example, in Figure 2.12, People is one of the six factors listed as leading to the effect. The next step in the use of this diagram is for the team members to use Brainstorming as a tool to generate possible causes. Once the causes are listed, they must be prioritized. The factor placed nearest to the head implies that it has the greatest impact on the effect or problem under
consideration. The results of the brainstorming process must be visually demonstrated so that the team members are able to gain more understanding regarding the causes.

After conducting Cause-and-Effect Analysis, many problems were identified that could be fixed. However, not all problems have the same urgency for solution. In this study, the researcher used a Pareto Chart Analysis to prioritize the problems that needed immediate solution. The next section describes what a Pareto Chart Analysis is.

2.5.5 Pareto Chart Analysis

Pareto Chart Analysis is a graphical tool used to demonstrate the relative importance between data and used to identify and prioritize causes of a problem (Finn, 1995). It shows the frequency of effects or problems in rank order from the highest to lowest. Then the 80-20 rule is applied. The 80-20 rule states that 80% of problems encountered are the result of 20% of causes (Pareto Chart, n.d., para 2). Pareto Chart Analysis is used in many industries including manufacturing and the service sector to prioritize the causes to be addressed (Rouse, 2011).

Figure 2.13 shows an example of a Pareto Chart Analysis depicting the different causes of customer complaints. The left side of the bar graph shows the most frequent reason for customer complaints with the number of complaints declining as you move to the right side of the graph. The left axis depicts the frequency of the actual complaint while the right axis represents the percentage. The 80% line extended downward shows that 80% of the complaints are caused by four major causes designated as the 'Significant few.'
A Pareto Chart Analysis was used in this study to prioritize the causes discovered during the Cause-and-Effect Analysis session. This allowed the researcher to identify which problems should be addressed first to solve the majority of the in-store delivery delays.

The next section explains the Brainstorming tool used in conjunction with Cause-and-Effect Analysis.

2.5.5 Brainstorming

Brainstorming is a powerful tool that helps to generate new ideas, solutions to problems, and can be used to motivate and develop teamwork (Chapman, 2016). Brainstorming encourages members to come up with ideas through discussion then reach a conclusion as to the best possible outcome. It suggests that the session should be very open and any inappropriate assumption should be immediately eliminated (Brainstorming, n.d., para 5). The ideas and solutions expressed during the session should not be criticized, critiqued or rewarmed since judgements can hinder the production of creative ideas about how the problem can be solved.
Brainstorming with different parties involved with the in-store delivery service should generate creative solutions from different parties due to their different experiences. It is very important that all ideas generated during the session are visible to all participants. The ideas should be recorded as they are produced. The record was used to identify problems, develop improvement strategies, and determine solutions for reducing the length of time required in the in-store delivery process.

However, researchers may not be able to collect all needed information by conducting Brainstorming alone. There is a possibility that participants might be unwilling to share due to social criticism. Therefore, the next section explains a more structured way of Brainstorming called the Nominal Group Technique. The Nominal Group Technique can be conducted together with Brainstorming session.

2.5.6 Nominal Group Technique

Nominal Group Technique is a more organized method as compared to normal Brainstorming (Nominal Group Technique, n.d., para 2). It employs a small-group discussion to reach a consensus. This technique gathers information by generating, recording, discussing and voting on the ideas it produces (Gaining Consensus Among Stakeholders Through the Nominal Group Technique, 2006). The technique prevents domination of the discussion by a single person, and it helps to inspire inert group members to contribute to the discussion. It then allows the group to prioritize solutions that are believed to be the most suitable (Sample, 1984).

According to Nominal Group Technique, (n.d., para 3), the Nominal Group Technique allows each individual participant to share ideas in writing. Then, each person takes a turn reading their ideas aloud. The ideas are to be written visibly so that all members can see. Then, the ideas are clarified and discussed. Asking questions or comments is a way to develop understanding and share ideas. All the ideas are listed then independently and anonymously voted by members to form a shortlist of what the group has voted to be the best ideas.
Conducting the Nominal Group Technique, together with Brainstorming, assisted the researcher to collect quality data, organize ideas and prioritize solutions.

2.6 Summary

This chapter described and explained warehousing in general to draw the readers’ attention to the research focus area which, for this research, is the order picking part of an in-store delivery process. Surveys conducted by AAA Company showed that customers are waiting too long before receiving goods from the company warehouse. Since long waiting times affect customer satisfaction, the lengthy process of order picking as part of in-store delivery service required examination.

Order picking was explained as a process of retrieving goods from the warehouse area and delivering them to the waiting customers. The researcher has described and explained order picking systems, order picking strategies and storage assignment policies. The topics should help the reader to understand more about order picking and how each topic directly impacts the order picking process.

In this chapter, the researcher also explained the tools that were used to identify and solve in-store delivery service problems in this research. This discussion was conducted to help the readers understand the purposes of each of these tools and how they were employed in the research. The tools discussed included DMAIC (Define-Measure-Analyze-Improve-Control), Interviews, Observation, Process Flowchart, Cause-and-Effect Analysis, Pareto Chart Analysis, Brainstorming and the Nominal Group Technique. The main tool, DMAIC, was used in conjunction with the others as each step of DMAIC process was performed. During the Define phase, observation and interviews were used to identify the potential problems that had been occurring. The Process Flowchart was developed and used during the Measure phase to map out the AS-IS in-store delivery process. This flowchart was then used in the Analyze phase. Information collected during the Define and Measure phases was used for analysis purposes as input for the Cause-and-Effect Analysis tool: the Fishbone Diagram. The Pareto Chart Analysis was then used to prioritize causes. Finally,
Brainstorming and the Nominal Group Technique were used to generate new ideas and solutions to the problems to be addressed.
CHAPTER III
RESEARCH METHODOLOGY

The study is meant to analyze the order picking process of AAA Company with the intention of improving the in-store delivery service. In particular, this study has examined the order picking response time since it has a direct impact on customer waiting time, and in turn, customer satisfaction. The warehouse is located within the company store. However, this research was only focused on the areas that were picked by AAA staff.

This chapter focuses on the use of tools and methodology discussed in Chapter II which are DMAIC (Define-Measure-Analyze-Improve-Control), Interviewing, Observation, Cause-and-Effect Analysis, Pareto Chart Analysis, Nominal Group Technique and Brainstorming. All these tools were used to identify the problems, areas for improvement and solutions to improve the in-store delivery process of AAA Company. Steps and tools used are shown in Table 3.1

<table>
<thead>
<tr>
<th>Process</th>
<th>Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Define</td>
<td>Interview, Observation</td>
</tr>
<tr>
<td>Measure</td>
<td>Process Flowchart</td>
</tr>
<tr>
<td>Analyze</td>
<td>Cause-and-Effect Analysis, Brainstorming, Pareto Chart Analysis</td>
</tr>
<tr>
<td>Improve</td>
<td>Brainstorming</td>
</tr>
<tr>
<td>Control</td>
<td>Brainstorming</td>
</tr>
</tbody>
</table>

Source: Author
3.1 Define Problems

The Define phase was used to identify and describe the problems occurring in the in-store delivery service of AAA Company. The researcher used two methods to collect information and to identify problems: Observation and Interview. Observation was conducted at AAA Company’s warehouse by covertly observing employees involved in the in-store delivery process and customers who were receiving the in-store delivery service. Afterwards, the researcher interviewed both staff members and customers about the service process that they provided and received, respectively. The findings were then used for analysis in the later phases.

3.1.1 Observation

The observational data was collected at the AAA in-store warehouse. The researcher observed approximately 50 customers from the 15th of October 2015 until the 31st of December 2015 on both weekdays and weekends. The data was collected only in the evening (17.00 – 20.00) because it is the busiest time of the day. The in-store delivery process that was captured by observation is shown in Figure 3.1.
Figure 3.1: Process Flowchart of In-Store Delivery Service

<table>
<thead>
<tr>
<th>Purchase Order</th>
<th>Store’s Warehouse</th>
<th>Customers Receiving Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payment made at Cashier</td>
<td>Pickers receive Purchase orders and register start time in the warehouse system</td>
<td>Customers contact staff/ personnel for goods pick up</td>
</tr>
<tr>
<td>Purchase orders automatically printed at Picker station</td>
<td>Picking process</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Double checking process</td>
<td>Customer receives product</td>
</tr>
</tbody>
</table>

Source: Author

Figure 3.1 shows the in-store delivery process starting from the time when the customers make payments. When this is done, purchase orders are automatically printed at the picker station. Then, customers will contact employees at the checker counter to get queue numbers (see Figure 3.2). Once the pickers notice that a pick list has been printed, they record the picking start time at the picker station which starts the actual picking process. As soon as the pickers have finished the picking process they will return to the station and record the finish time. Then, a checker goes to the
picker station to do a double check of the items picked to insure quality. Once the check is completed, the products are handed to customers.

*Figure 3.2: AAA Company In-Store Delivery Area*

Source: Author

The researcher found that the average picking time of pick lists with less than 15 items varied from about 5 to 15 minutes including the time taken for the double checking process. However, there were some purchase orders in which the customers had to wait longer than 15 minutes. It was observed that out of 50 customers, 35 customers purchased combination products (i.e. Kitchen furniture, Wardrobe furniture and a mix of furniture products like big sofas and mattresses with other Bedroom furniture). Customers were required to wait for more than 15 minutes to receive these picks.

The purpose of this observation was to understand the in-store delivery service process and to gain some knowledge of possible problems that might cause customer long waiting time and result in AAA Store’s high in-store delivery dissatisfaction rate. The next section, Interview, has made the researcher to understand more about the in-store delivery process.
3.1.2 Interview

Interviewing the target groups allowed the researcher to discover specific information regarding the in-store delivery service and the order picking process. Customers and workers were asked different sets of questions as shown below.

Customer interview questions included:

- What types of products did you purchase?
- How long did you wait to receive the products?
- How friendly and helpful were the staff members?
- Are you satisfied with in-store delivery? If yes, how satisfied are you and why do you feel satisfied with the process? If no, what caused your dissatisfaction?

Worker interview questions included:

- On the average, how long does it take the pickers to pick the products/items?
- On the average, how many purchase orders does each picker receive per day? Does the number vary on weekdays to weekends? If so, by how many?
- Do pickers stand by at the picker station when they are not picking? If no, how does a picker know when to receive a purchase order?
- What information is needed for picking? Does the pick list contain all the needed information?
- What are the steps in the full in-store delivery process?
- How long does each step in the in-store delivery take?
- Does this time vary on different pickers?
- What are the causes of late delivery?
- What are the reoccurring problems in the in-store delivery process?
- What do you think are the causes of these problems?
- Can workers handle these problems when they occur without instructions from supervisors?
- How is the performance of the in-store delivery service measured?
- Are there additional parts of the in-store delivery process that should be measured? If so, which ones and how do you feel they should be measured?
- What are the KPI (Key Performance Indicators) of the in-store delivery service?
- On average, how long do checkers take for the double checking process?

From the 3rd of November to the 31st of December 2015, the researcher collected data by selectively interviewing both customers and staff/personnel. First, interviews were conducted with customers who were receiving the in-store delivery service during the time that the interviews were being conducted. It was found that customers who purchased products numbering from 1 to 15 pieces had no problem with long waiting time. Their waiting time varies from about 5 to 15 minutes. However, customers who purchased more than 15 items (normally combination products) had to wait longer.

The majority of customers who were required to wait for more than 15 minutes purchased the combination products. Customers who were interviewed expected to wait around 5 to 10 minutes for those purchases that totaled fewer than 15 items and a bit longer for more than 15 items. The group of customers interviewed that purchased more than 15 items (normally combination products) to wait for 20 minutes at a maximum. They were not notified how long the waiting time would be. As a result, they expected to wait no more than 20 minutes regardless of how many items they purchased.

The researcher also conducted interviews with employees who were involved in the in-store delivery process. Eight employees were interviewed: six out of fifteen pickers and two out of five checkers. The interviewed supervisors (two pickers) have several years of experience in order picking and are very familiar with the company’s in-store delivery process. The senior employees (two pickers and one checker) each has one to two years of experience while the junior pickers (two pickers and one checker) each has less than one year with the company.
First, the two supervisors of the picker team were interviewed. The interviews covered each of the steps involved in the in-store delivery process in detail starting from when the purchase orders are printed all the way to the point where customers receive their products. Many subjects were covered including the time it takes for each step and what the KPIs are for the in-store delivery process. The only KPI was reported to be a 7+1. This means that the time allowed for the first item is seven minutes and then one minute is added for each additional item. For example, if a pick list contains five items then the products should be delivered to the customer within 11 minutes (7 + 1 + 1 + 1 + 1 = 11).

The next question was about the possible problems occurring in each step and if the pickers were able to solve them without instructions. Supervisors disclosed that senior pickers are able to manage most of the problems that occur during the operation but not the junior pickers. Junior pickers still needed instructions from senior pickers or supervisors and this does delay the in-store delivery process. Supervisors also pointed out that pickers’ performances are not strictly monitored to determine whether they have met the KPI and there is no clear action if the performance does not meet the company’s standard.

The second group of employees interviewed was senior pickers. Two senior pickers were asked about the reoccurring problems: what they are and the frequency of the recurrence. Two junior pickers were also interviewed and asked about any difficulties they may have when performing order picking.

The information obtained from the junior pickers was more extensive as compared to the senior pickers. Junior pickers revealed that they have difficulty in picking products due to the fact that they do not know the product dimensions from reading their pick lists. Sometimes, they have to rearrange the products on the trolley while performing the pick because heavier products are picked after lighter ones. They also commented that sometimes they could not pick the products themselves because the products are too heavy. Senior pickers recognize most of the products on the list and
are therefore able to plan what to pick first. Additionally, they have developed tricks to pick heavy products alone.

However, there are some common difficulties faced by both senior and junior pickers. Problems common to both picker groups included product storage assignment of high turnover products (that sell more than 10 pieces in a week) and combination products. Some high turnover products are placed very far from the customer receiving area and combination products are not grouped together. These cause pickers to take more time to pick these products. Pickers also revealed other issues such as stock at picking locations being inaccurate, purchase orders occurring in greater number than planned (which resulted in manpower shortages) and checkers that are not immediately available to perform the double checking process.

Last, the two checkers were interviewed. One was a senior and the other was a junior checker. The senior and junior checkers were interviewed together. The senior checker revealed that there are five members in the team-two seniors and three juniors. Checkers must perform the double checking process to ensure that the products picked by pickers are correct which means the right items at the right quantity.

Both senior and junior checkers stated that there are no problems checking a short pick list, but a pick list that contains combination products can sometimes be a problem. They stated that it takes more time checking the combination products because this involves an extensive list of items that need to be checked manually and documented against the actual products picked. It is also often problematic for checkers to check all products stacked on a trolley (see Figure 3.3). The packages of combination products have no unique identifying marks; therefore, checkers need to be extra careful in checking these items. As a result, it can take longer time in comparison to checking other products.
Checkers also disclosed that sometimes checkers are unable to cope with the workload, especially during the busiest periods since there is only one checker per shift (one checker in the morning and one in the afternoon). From time to time, a checker will need to call for back-up to support the double checking process. This back-up employee will be from another functional area of the store and therefore there is a possibility of delaying the service.

The information collected from observation and interview was used during the Measure and Analyze phases of the DMAIC process which helped AAA Company understand its current process, problems and eventually has come up with solutions.

3.2 Measure Current In-Store Delivery and Order Picking Process

The Measure phase was used to measure the performance of the in-store delivery service and order picking process. This was done using the data collected from the previous section, Define, through the use of the tools of observation and interview. In this section, the researcher focuses on the overall in-store delivery process and elaborates more on the picking process of purchase orders that include the purchase of
combination products. Tables 3.2 and 3.3 below provide data that was recorded when pickers received the pick lists that included combination products. The number of items picked was 50 items and the KPI indicates that products should be handed to customers within 56 minutes.

Table 3.2: Time of In-Store Delivery Service (During Weekdays)

<table>
<thead>
<tr>
<th>Step</th>
<th>#</th>
<th>Activity</th>
<th>Senior picker</th>
<th>Junior picker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>#1</td>
<td>#2</td>
</tr>
<tr>
<td>1.</td>
<td></td>
<td>Picker receives pick list</td>
<td>5 minutes</td>
<td>2 minutes</td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td>Picking process</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td></td>
<td>Pick up trolley</td>
<td>47 minutes</td>
<td>50 minutes</td>
</tr>
<tr>
<td>2.3</td>
<td></td>
<td>Pick up goods</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.4</td>
<td></td>
<td>Double checking</td>
<td>9 minutes</td>
<td>8 minutes</td>
</tr>
<tr>
<td>2.4.1</td>
<td></td>
<td>If correct, proceed to 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.4.2</td>
<td></td>
<td>If incorrect, calls pickers and return to 2.3 then 2.4 (On average)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td>Customers receive products</td>
<td>66 minutes</td>
<td>65 minutes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Average time used</td>
<td>65.5 minutes</td>
<td></td>
</tr>
</tbody>
</table>

Source: Author
The Tables above show the total process time of in-store delivery from the time a picker receives the pick list until the customers receive their products during weekdays (Table 3.2) and weekends (Table 3.3). For weekdays, the researcher found that senior pickers take 65.5 minutes on average to perform the pick while the junior pickers take 73.5 minutes on average. There is an eight-minute deviation between senior and junior pickers. For the weekends, senior pickers take 75 minutes on average while junior pickers take 85 minutes on average, a difference of 10 minutes. The in-store delivery service is the last service that customers receive from the company before leaving the store. Long waiting time after hours spent in selecting products can directly affect customer satisfaction.
3.3 Analysis

The objective of this study was to identify the root causes of customers’ dissatisfaction when they receive the in-store delivery service. Data collected from Observation, Interview and the Process Flowchart was used in the Analysis phase. The analysis process was used to identify the root causes of the problems, so effective solutions could be developed.

3.3.1 Brainstorming

A Brainstorming session was conducted to generate ideas and learn the opinions of both experienced and junior employees. The researcher selected five employees who were involved in the in-store delivery process (one supervisor, two experienced pickers, one junior picker and one senior checker) to brainstorm and scrutinize each step of the in-store delivery service. The intention of this session was to identify the causes of delay in the in-store delivery service which lead to long waiting time for customers.

On the 7th of January 2015, the researcher arranged a meeting with the five selected employees to brainstorm ideas of what were the major and minor causes of delays in the in-store delivery service. The researcher presented the findings from Define and Measure phases to the members. During the presentation, the members were allowed to comment and discuss these findings. The junior and senior pickers commented that most of the time that they have to pick combination products, they have to walk back and forth as the products to complete the combination products are scattered around the warehouse. The junior members mentioned that they also have to sort products on trolleys since they are unable to balance the trolley because lighter products are picked before heavier products.

The supervisor also provided information supported that the storage assignment policy of the warehouse which was not properly implemented since most of the time,
new products are assigned to locations regardless of their grouping and/or pick up rate.

3.3.2 Nominal Group Technique

Group discussion was not the only technique used to gather data from the participants. Individual expression was also used to encourage each participant to give ideas and opinions anonymously that may not have offered in the group setting. This also helped to avoid the chance that one person would dominate the discussion. The participants were each assigned to a computer and requested to record their thoughts and opinions and then submit the researcher who summarized the information into points. This method allowed participants to explicitly share in-depth information allowing the researcher to obtain more accurate information.

The opinions and ideas retrieved from the Nominal Group Technique were similar to the information collected from the Brainstorming session. The major concern was regarding the time the picker spent travelling to finish picking the products in the pick lists.

The information obtained during the Brainstorming and Nominal Group Technique session with the participants is listed in categories and sub-categories using Cause-and-Effect Analysis. In this manner, the potential causes are more easily visualized. The constructed diagram is shown in the next section.

3.3.3 Cause-and-Effect Analysis

A Cause-and-Effect Analysis fishbone was constructed during the brainstorming session to identify the root causes of delay in the in-store delivery service. Figure 3.4 shows the constructed diagram where the ‘fish head’ represents the effect or problem which is ‘Delay in in-store delivery service’. The participants who were involved in the brainstorming session provided evidence of four potential major factors which are People, Management, Process and Equipment. These factors are indicated at the end
of each ‘bone.’ Then the participants elaborated on each factor in detail to find the primary causes and sub-causes, if any.

**Figure 3.4: Cause-and-Effect Analysis of In-Store Delivery Service**

![Diagram of Cause-and-Effect Analysis]

Source: Author

The Cause-and-Effect Analysis diagram shown above has provided the researcher and AAA Company a clearer picture of the problems with the in-store delivery process. In the section below, the researcher provides additional analysis of the data collected regarding the four major categories of problems.

Details of each cause are described below:

3.3.3.1 Process
Current storage arrangement is not designed to enhance picking productivity in the area. As can be seen in Table 3.4, items in the staff pick area were categorized into three types: slow moving items where products are sold at a rate of 0 to 4 pieces per week (displayed in green), normal moving items where products are sold at a rate of 5 to 10 pieces per week (displayed in yellow) and fast moving items where products are sold at a rate of more than 10 pieces per week (displayed in red).

**Table 3.4 Classification of Current Product Assortment by Sales Frequency**

<table>
<thead>
<tr>
<th>Color</th>
<th>Piece sold per week</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>0-4 pieces</td>
<td>Slow moving item</td>
</tr>
<tr>
<td>Yellow</td>
<td>5-10 pieces</td>
<td>Normal moving item</td>
</tr>
<tr>
<td>Red</td>
<td>More than 10 pieces</td>
<td>Fast moving item</td>
</tr>
</tbody>
</table>

Source: Author

Figure 3.5 and Figure 3.6 depict current item placement within the staff-picking area. In this area, there are two levels of picking storage. The lower picking level is listed as 00 and the upper picking level is listed as 10. Both picking levels are accessible without using an automatic machine. The researcher found that fast moving items are placed all over the warehouse on both levels. This means pickers spend more time travelling from the picker station where the pick list is printed, to reach the areas where the fast moving items (displayed in red) are stored as well as the storage areas for the normal moving items (displayed in yellow). There is no clear product arrangement system that determines whether products are placed according to sales frequency, family or product dimensions.

Moreover, the floor space of the warehouse is not efficiently used. As shown in Figures 3.5 and 3.6, there are white “free spaces” randomly disbursed around the warehouse floor. Some of these free spaces are allocated to fast or normal moving items because the quantity of these items at times requires more than the original
space allocated to that item. Other free spaces have no items assigned to them and are just open areas.

**Figure 3.5: Current Product Assortment within Staff Pick Area at Level 00**

(A larger version of this figure is displayed in Appendix A.)

![Figure 3.5](image)

Source: Adapted from Company’s data

**Figure 3.6: Current Product Assortment within Staff Pick Area at Level 10**

(A larger version of this figure is displayed in Appendix B.)

![Figure 3.6](image)

Source: Adapted from Company’s Data
Figure 3.5 and Figure 3.6 show that currently, fast and normal moving items are scattered around the warehouse on both levels. Therefore, pickers have to spend more time picking these items and customers have to wait longer. For example, a fast moving product is purchased more than 10 times in a week. This means that the picker has to walk a longer distance at least 10 times every week to reach that product. Therefore, moving the fast moving products to locations providing easy and fast access will reduce picker travel time.

The warehouse has no clear routing policy. Figure 3.7 shows the main walk-way. This runs from the starting point and follows the long way depicted by the blue arrow. This is the way the pickers walk and all pickers use this walk way to reach the outermost locations. Pickers always begin their picks at the furthermost location. This means that once the picker reaches the rack area, then they will turn. They then start the picking process without considering the product shape, weight, height and that they need to stack the heaviest product on the bottom level of the trolley and lighter items on top.

**Figure 3.7: Routing**

Source: Author
Stock accuracy is the other important area that affects order picking performance. Stock accuracy includes lost items, wrong location of product placement, and damaged items (in case of low stock item). For example, when there are only two pieces of the article left in the warehouse and a customer purchases the two pieces, the picker will realize that the two pieces cannot be handed over to the customer if there is damage. Therefore, the customer is dissatisfied. In this case, the damaged items should have already been removed from the system. The picker needs time to solve the above described issues. Often, issues of this type may result in customers not getting the products for which they already paid. Therefore, the customers experience a longer wait, decreased satisfaction and the productivity of the picker declines.

3.3.3.2 People

Pickers lack product knowledge, so sometimes they pick light items before heavy items. For example, a pick list may contain an order for a big size product that is stored near the picker station together with small size product. The inexperienced pickers pick the product from the furthermost location and then the one at the nearby location does not notice that it is not possible to put both items on one trolley. Once the pickers realize the error, they have to unload the light items, load the heavy items and reload the light items on top.

Furthermore, pickers in the area do not only perform picking activities, they also have to perform other tasks such as replenishment, buffering products on pallets and other ad-hoc activities. Therefore, pickers are not standing-by at the order pick station. This means that they require more time to walk from some random position within the warehouse when a picking list is printed. There is also no signal for the pickers to know that there is a picking order waiting to be picked. So, sometimes customers have to wait longer as the pick starts as soon as the list is printed.

Ergonomics is also an issue for the pickers. This is because many of the products are heavy and there is no machine to support this weight during the pick. Sometimes, pickers get back injuries due to physical lifting of a product that is too heavy. This
causes the next problem which is high staff turnover. High staff turnover slows down the in-store delivery service since new staff members need time to learn the process.

Checkers are not trained how to handle the situation when customers approach to receive their queue number. Customers expect to be informed how long they will be required to wait without having to ask. However, checkers do not inform customers about the approximate time that they should expect to wait.

3.3.3.3 Management

The company's order picking KPI (Key Performance Indicator) is seven minutes for the first item plus one minute per additional item on the picking list. For example, if there are ten items on the picking list then the pick time allowed is $7 + 9 = 16$ minutes. This is regardless of product dimensions and level of picking difficulty. With the current product placement, this requires a highly skilled and experienced picker in order to achieve the goal since the picker needs to plan how products should most efficiently be picked. Poor product placement takes a longer time for the picker to pick items. Therefore, the order picking KPI will not be achieved. However, the KPI is not properly monitored. This is evident since problems were not identified and no action was taken when the customer survey indicated high levels of dissatisfaction.

Insufficient manpower is an issue because staff/personnel need to handle other tasks. Ordinarily, only 1-2 staff members are allocated to the morning shift when it is less busy and 3-4 staff members are allocated for the afternoon and evening shift. The morning shift must replenish goods to pick locations and buffer locations and then clean up the area. They must get these tasks accomplished even though order picking is the first priority. If the tasks are not completed then the staff in the afternoon shift must continue until these additional tasks are finished.

As stated earlier, product knowledge is very important for pickers in order for them to perform the order picking service efficiently. However, there is no training provided for the pickers. Pickers have to learn from experience until they can recognize the
product names and then know the product's size, weight and shape. Learning in this manner usually takes 2-3 months for fast learner and even longer for the others. This affects the speed of service provided to customers; therefore, waiting time is directly impacted.

3.3.3.4 Equipment

Pickers do all the picks by walking with a shopping trolley. When picking, the pickers need to use their hands to pick products that may weigh more than 20 kg. The pickers also need to push a trolley (see Figure 3.8) along to pick other products. If the sizes of products are bigger than the trolley (such as sofa and mattress), the pickers need to spend time walking back and forth to place the first trolley, grab a second trolley and continue to pick the rest of the order. Moreover, in the case of an oversized product (the product is bigger than the trolley), the pickers need two trolleys to pick one product (see Figure 3.8). Inexperienced pickers may not know that the pick requires two trolleys. Therefore, more travel time is required to go back and get a second trolley once the situation is realized.

Figure 3.8: Trolley Used During Pick

Source: Taken from Company's Warehouse

There is no labor-saving machine to support pickers when they pick heavy products. Therefore, pickers need time to pick, pull and push products by hand. Some products
take time to be pulled out from the picking area because they have other products stacked on them. All case pick orders are put on a trolley since they will be handed directly to the customers. It would be inappropriate to put the products on pallets and use a hand jack to transport them to the customer receiving area.

The researcher found a number of causes that contribute to delays in the in-store delivery service of AAA Company. However, it is not possible to fix all of the problems. Therefore, the researcher used Pareto Chart Analysis to identify the most often recurring problems for which to find solutions. Identification of the problems to be addressed was part of the improvement process and is discussed in the next chapter.

3.3.4 Pareto Chart Analysis

In the previous section, Cause-and-Effect Analysis was used to define the relationship between causes and the effect. There were a number of causes identified in that process. Therefore, a Pareto Chart Analysis was used to categorize the problems for review and help to point out the more prevalent problems, so the researcher could see to it that they are causes resulting in the most problems addressed.

The researcher collected data from thirty occurrences of delayed in-store delivery which included only customers who purchased combination products. The Pareto Chart Analysis was then used to rank and point out the most frequent causes. Table 3.5 shows that out of thirty occurrences, twelve were caused by long travel time. Pickers traveled around for excessive periods of time to pick different items within the warehouse. Six cases were caused by incorrect stocking at picking locations. Eight more cases were classified due to poor product knowledge. This included picking light items before heavy ones (which requires time to restack the trolley) and being unaware that two trolleys were required (requiring an additional trip to pick up a second trolley). There were two cases of incorrect or incomplete picks where an error was made in picking and the picker needed more time to go back and fix the order.
The final two cases occurred when the number of pick lists was higher than expected due to increased sales.

Table 3.5: List of Causes and Frequency

<table>
<thead>
<tr>
<th>Causes</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delay in picking time caused by long travel time (Storage assignment policy)</td>
<td>12</td>
</tr>
<tr>
<td>Stock integrity</td>
<td>6</td>
</tr>
<tr>
<td>Incorrect pick / Incomplete pick</td>
<td>2</td>
</tr>
<tr>
<td>Pick light items before heavy items (Lack of product knowledge)</td>
<td>5</td>
</tr>
<tr>
<td>Unaware that two trolleys are required to pick huge items (Lack of product knowledge)</td>
<td>3</td>
</tr>
<tr>
<td>Insufficient manpower (Number of pick list more than expected)</td>
<td>2</td>
</tr>
</tbody>
</table>

Source: Adapted from Company data

The causes were plotted in a graph similar to the one shown in Figure 2.13 to point out the most frequent causes of delayed in-store delivery service (see Figure 3.9). The cumulative percentage shows that 40% of the problem was due to long travel time. Long travel times are caused by inefficient storage assignment policies. A total of 67% was due to the combination of travel time and lack of product knowledge. When stock integrity issues were added, these three factors accounted for more than 80% of the problems.
3.4 Improvement

After analyzing the collected information, the researcher and employees have identified the root causes of delays in the in-store delivery service as shown in Cause-and-Effect Analysis. The next section discusses how the researcher worked with the staff to identify potential ways to improve the three problems identified in the Pareto Chart Analysis and reduce the time required for the in-store delivery service.

3.5 Control

The Control section shows the actions suggested by the researcher to ensure that the in-store delivery service is improved in a sustainable manner. If controls are not instituted, delivery times are likely to return to their former level over time.
3.6 Summary

In this chapter, the researcher used several tools to conduct the DMAIC (Define-Measure-Analyze-Improve-Control) process. DMAIC was used to identify the root causes of the delays in the in-store delivery service with the aim to reach the best solutions to address the problems. Tools used in different phases to conduct the DMAIC were Observation, Interviews, Process Flowchart, Cause-and-Effect Analysis, Pareto Chart Analysis, Brainstorming, and the Nominal Group Technique.

In the Define phase, observation and interview were used to collect information from both the customers who received the service and the employees who provided the service to those customers. The collected information was used to map the current process flow of the in-store delivery service process as shown in Figure 3.1. The Measure phase was conducted to measure various aspects of each step of the in-store delivery service process. The findings of the Measure phase are depicted in Table 3.2 and Table 3.3. The data was used during the Analysis phase to perform the Cause-and-Effect Analysis (Figure 3.4). Brainstorming and the Nominal Group Technique sessions were conducted to identify the potential root causes. Then, the researcher prioritized the problems to be addressed using Pareto Chart Analysis (Figure 3.9). In the next two phases, Improve and Control, the researcher provides solutions for improvement and a plan to implement them in a manner that will sustain the improvements once they are implemented.
CHAPTER IV

PRESENTATION AND CRITICAL DISCUSSION OF RESULTS

This research project has attempted to improve the overall performance of the in-store delivery service of AAA Company by reducing the service time and thereby improve customers’ satisfaction level. This chapter discusses the in-store delivery improvement process to eliminate or mitigate the problems discussed in Chapter III. The researcher has provided corrective actions and recommendations to improve the in-store delivery service and keep those improvements in place. In this chapter, performance is measured and the controlling and monitoring processes are discussed.

The improvement process is meant to reduce the in-store delivery process time, eliminate unnecessary activities during the service and resolve the problems currently faced by AAA Company. The root causes have been categorized in Chapter III using Cause-and-Effect Analysis and have fallen into the areas of Management, People, Equipment and Process. The major problems have been identified within the in-store delivery services which caused delays in the order picking time thereby affecting customers’ waiting time and satisfaction level. The root causes have been identified using interview, observation and brainstorming with relevant customers and staff. The three methodologies have allowed the researcher to understand the current situation and the problems and challenges being faced by AAA Company.

4.1 Improvement

The main propose of the improve phase of DMAIC is to improve processes and resolve the problems identified in the in-store delivery of AAA Company. This section addresses those improvements.

Figure 3.4 displays the major problems which have been categorized into four areas: Management, Equipment, People and Process. Table 3.5 shows that delay in picking
time is due to long travel times (Process) and lack of product knowledge (People). These are the top two reasons that cause the delays in the in-store delivery service of AAA Company. The researcher has focused on the efforts to resolve the two problems with corrective actions and proposed measures to monitor and control the process. Management issues include how the working processes are managed and how the results of service time are monitored as well as the trainings provided to the pickers. The working process is first addressed to reduce delays in the order picking time. Monitoring the results is covered in the next step, Control. The researcher has found that solving the Equipment issue could not be accomplished during the time of the research since this would require an extensive investment in order to fix the issue. However, the researcher has not only resolved the major causes but where possible, also has eliminated some additional minor causes that have affected service time.

4.1.1 Storage Assignment Policy

As illustrated in Figure 3.5, the warehouse does not have a clear method of assigning where products are to be stored within the warehouse. The frequently sold products, indicated in red, are scattered throughout the storage locations.

On the 2nd and 9th of March, 2016, the researcher has arranged a meeting with the warehouse supervisors to work on product assortment in the warehouse. From the interview with the supervisors, it has been determined that products stored within the staff pick area are mainly combination products. The term “combination products” means that the products are meant to be sold together in order to form a single product. The combination products are sold by function and family. Therefore, the products should be grouped by function, family and then by sales frequency. For example, “family A” group stored in rack 58 includes the highest turnover articles and are shown in red (sold more than 10 pieces per week: a fast moving item). These items are to be placed next to the main aisle, followed by the articles that are sold 5-10 pieces per week (marked in yellow) followed by slower selling items which are shown in green (sold less than 5 pieces per week) all as shown in Figure 4.1.
Moreover, the researcher has categorized the product types stored within the warehouse area. This information is shown in Table 4.1.

**Table 4.1: Types of Products Stored within the Warehouse Area**

<table>
<thead>
<tr>
<th>Product Types</th>
<th>Number of items</th>
<th>Area Occupied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kitchen furniture</td>
<td>891</td>
<td>52.3%</td>
</tr>
<tr>
<td>Living room furniture</td>
<td>395</td>
<td>23.2%</td>
</tr>
<tr>
<td>Bedroom furniture and Mattresses</td>
<td>191</td>
<td>11.2%</td>
</tr>
<tr>
<td>Workspace furniture</td>
<td>117</td>
<td>6.9%</td>
</tr>
<tr>
<td>Bathroom furniture</td>
<td>67</td>
<td>3.9%</td>
</tr>
<tr>
<td>Dining and Outdoor furniture</td>
<td>35</td>
<td>2.1%</td>
</tr>
<tr>
<td>Children’s furniture</td>
<td>9</td>
<td>0.5%</td>
</tr>
</tbody>
</table>

Source: Adapted from Company data

Table 4.1 shows that Kitchen, Living room and Bedroom furniture occupy around 87% of the warehouse space. Therefore, the researcher has focused on these three product types. This means that the researcher has started to re-allocate these three product types before the others. The rationale is that the Kitchen, Living room and Bedroom furniture require a much greater area compared to the other types of furniture.
However, during the time of the research, the Company’s management has decided to reduce the area of the staff picked section. Two-hundred and fifty-three items have been removed from the warehouse area. Table 4.2 shows the items remaining in the staff pick section before the actual implementation.

Table 4.2: Types of Products Remained within the Warehouse Area

<table>
<thead>
<tr>
<th>Product Types</th>
<th>Number of items</th>
<th>Area Occupied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kitchen furniture</td>
<td>891</td>
<td>61.4%</td>
</tr>
<tr>
<td>Living room furniture</td>
<td>288</td>
<td>19.8%</td>
</tr>
<tr>
<td>Bedroom furniture and Mattresses</td>
<td>133</td>
<td>9.2%</td>
</tr>
<tr>
<td>Workspace furniture</td>
<td>39</td>
<td>2.7%</td>
</tr>
<tr>
<td>Bathroom furniture</td>
<td>66</td>
<td>4.5%</td>
</tr>
<tr>
<td>Dining and Outdoor furniture</td>
<td>27</td>
<td>1.9%</td>
</tr>
<tr>
<td>Children furniture</td>
<td>8</td>
<td>0.6%</td>
</tr>
</tbody>
</table>

Source: Adapted from Company’s data

Table 4.2 shows the items that are left in the warehouse after removing the other pieces of furniture. Kitchen furniture, Living room furniture, and Bedroom and Mattresses furniture occupy a big percentage of the staff pick area. These categories now comprise 90.4% of the total space. Therefore, the planned action to re-allocate the largest three product types remains.

The implementation phase of the improvement process was conducted from the 10th of March until the 31st of March 2016. As stated in Chapter Three, the warehouse has no clear product arrangement. Therefore, the Improve phase has attempted to work on product arrangement within the warehouse. The result of the rearrangement is shown below in Figure 4.2 and Figure 4.3.
Figure 4.2: Final Storage Assortment at Level 00
(A larger version of this figure is displayed in Appendix C.)

Source: Adapted from Company's Data (see Appendix 3)

Figure 4.3: Final Storage Assortment at Level 10
(A larger version of this figure is displayed in Appendix D.)

Source: Adapted from Company's Data
The products are grouped according to function, family and sales frequency as shown in Figure 4.2 and Figure 4.3. To complete a kitchen, customers need basic combination like, kitchen frame, kitchen door front, kitchen drawer, kitchen shelf, kitchen work top, and kitchen fittings. Therefore, all the kitchen combinations are grouped close to one-another to reduce pickers’ travel time. For example, in Figure 4.4, the researcher has grouped the kitchen products in racks 54 to 60. The kitchen frames are allocated to racks 59 and 60. This is because the kitchen frames are heavy and must be put on the trolley first. Racks 58 and 57 contain kitchen doors, kitchen drawers, and kitchen shelves. The researcher has not only sorted by function but also by family. For instance, all door fronts named BODBYN are allocated in rack 57 from row 5 to row 10.

Figure 4.4: Diagram of Kitchen Storage Assignment after the Implementation

![Diagram of Kitchen Storage Assignment after the Implementation](image)

Source: Adopted from Company’s data

However, assigning products according to their function and family does not allow all the high turnover items to be located close to the main aisle. This is because not every product within the family has a high turnover rate.

4.1.2 Routing

As mentioned earlier, the warehouse has no routing policy because there is no clear product grouping. After the storage assignment policy is put in place, a routing policy is constructed automatically due to product placement. As can be seen in the sample
of kitchen furniture, an S-Shape routing is created for pickers when picking kitchen furniture. See Figure 4.5.

**Figure 4.5: Example of Routing when Kitchen Furniture Picked**

Source: Adopted from Company’s data

After implementing the change of product assortment within the warehouse, the warehouse supervisors has organized training sessions to educate all pickers on the products’ new locations. Re-allocating the products, as indicated in Table 4.2, helps by grouping all the product family items stored in the warehouse area. It also sorts products by function and size respectively. Categorizing products into functions and families is designed to improve the pickers’ travel time.

4.1.3 Trainings

Training is essential for employees to improve their skills and performance and thereby improve the in-store delivery service for customers. It is recommended that AAA Company has to provide training to its employees throughout the year. During the research, there have been two trainings conducted to improve the service. This training has included product knowledge training and on the job training. Moreover, the training is not only to improve pickers’ competence but also to improve safety for pickers.

4.1.3.1 Product Knowledge Training
Product knowledge is identified to be the second highest reason causing delays in the in-store delivery service. There are two types of training developed to improve product knowledge: product training sessions and on the job training. The product knowledge training sessions are being conducted by product experts (Salespersons). These sessions are scheduled in advance with the Learning and Development Department. Due to the time constraints, on the job training had started before the product knowledge sessions were conducted by the experts.

On the job training is a method where pickers are trained briefly in meetings conducted by warehouse supervisors. This is combined with actual hands on training when performing order picking to serve customers. Supervisors train pickers regarding the product placement within the warehouse. For example, bedroom products are mainly placed in rack 61 and kitchen products are placed in racks 54 through 60. Supervisors also train pickers about the rack types used within the warehouse. There are two rack sizes used in the warehouse: 120 cm long and 210 cm long. Products with a frame length greater than 120 cm are to be placed in the 210 cm long rack and the rest are to be placed in the 120 cm long rack.

On the job training began on the 11th of April, 2016, and continued until the 9th of May 2016, and has included continuous consultancy with the supervisors as needed. After the training, the same group of employees (two supervisors, two junior pickers, two senior pickers and two checkers) who was interviewed before implementing the storage assignment policy and on the job training was interviewed again. This was done to capture their opinions and obtain feedback from the 10th to 27th of May. During the same period, the researcher has also interviewed customers who used the in-store delivery system. The questions asked were similar to the questions asked before the implementation. This was done to compare customer feedback before and after. The questions asked to the employees are listed below.

Worker interview questions are the following:
- On average, do pickers feel that they are faster in picking items after the change was implemented? Do you know whether your performance has improved?
- Does the product assignment help to improve the travel time and if so, how?
- How long does each step in the in-store delivery service take after the change was implemented?
- Does the time still vary from different pickers after the change was implemented?
- What are the causes of late delivery after the change was implemented?
- What do you think are the causes of these problems?
- Can workers handle these problems when they occur without instructions from the supervisors?
- Did the performance of the in-store delivery improve after the change was implemented?
- On average, how long do checkers take for the double checking process?

The two supervisors revealed that after the implementation of the storage assignment policy and on the job training, the junior pickers have faced fewer problems when performing the order picking service. The junior pickers are able to solve basic problems without the assistance of senior pickers and/or supervisors which has reduced the time required to perform the service and therefore has diminished customers’ waiting time.

The two junior pickers informed the researcher that after the training, they have gained knowledge about product information and product allocations. They have learned about the types of products and where they are allocated. It takes time to learn about all the products but it helps them to do a better job of stacking on the trolley. The two senior pickers related that after the storage assignment was put in place, they become more productive because the travel time has been reduced. The combination products are grouped together and high turnover items are located closer to the picker station.
Both senior and junior pickers have mentioned that they spend less travel time to pick the goods. This is especially true when the order lists contain combination products like kitchen cabinets or bedroom furniture. This is because these products are now grouped close to each other.

The last group to have been interviewed was the two checkers. The junior and senior checkers stated that after the product assignment was changed, pickers are more likely to stack lengthy packages on the bottom and rarely stack them on top of short packages. This allows checkers to check the products more conveniently as compared to the prior product assignment method. This is especially true for the combination products. Additionally, the number of checkers has increased from one to two per shift which helped speed up the checking process.

The feedback from the employees who are involved in the in-store delivery service has confirmed that the AAA Company has benefitted from the new storage assignment policy. Furthermore, it now provides regular training to its employees so that they are better able to productively perform the in-store delivery service leading to an improved level of customer satisfaction.

Next, the researcher has also interviewed the customers who received the in-store delivery service. Questions asked to the customers are listed below.

Customer interview questions are as follows:

- Did you purchase products from the staff pick area prior to the 10th of March 2016? If yes, when was it done? Were you satisfied with the in-store delivery service?
- What types of products did you purchase? Were these items similar to what you purchased before?
- How long did you wait until the products were received this time? Was it longer than what you had experienced previously?
- Are you satisfied with the in-store delivery service? If yes, how satisfied are you and why do you feel satisfied with the process? If no, what causes your dissatisfaction?

The research has focused on interviewing customers who purchased combination products to find out their feedbacks. Fifty customers have been interviewed. Only 10% or five customers out of 50 customers have received the in-store delivery service before 10\textsuperscript{th} March 2016. However, all of them have purchased different types of products. For those customers who have received the in-store delivery before the 10\textsuperscript{th} of March, they stated that they have received the service in 2015 and have only purchased non-combination products for which they were satisfied with the waiting time. The customers have commented that lately when they purchased combination furniture like kitchen or wardrobe, they had a waiting time of between 30 and 60 minutes on the average.

In order to assess the results of the improvements, order picking time was monitored from the 10\textsuperscript{th} of May until the 30\textsuperscript{th} of May 2016. This was done to see whether the actual order picking time has improved. The results are shown in Table 4.3 and Table 4.4 below.

Table 4.3: Results of the Time of In-Store Delivery Service (During Weekdays) after the Storage Assortment Implementation

<table>
<thead>
<tr>
<th>Step</th>
<th>#</th>
<th>Activity</th>
<th>Senior picker</th>
<th>Junior picker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>1\textsuperscript{st}</td>
<td>2\textsuperscript{nd}</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 minutes</td>
<td>1.5 minutes</td>
</tr>
<tr>
<td>1.</td>
<td></td>
<td>Picker receives pick list</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td>Picking process</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td></td>
<td>Pick up trolley</td>
<td>25 minutes</td>
<td>28 minutes</td>
</tr>
<tr>
<td>2.3</td>
<td></td>
<td>Pick up goods</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.4</td>
<td></td>
<td>Double checking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.4.1</td>
<td></td>
<td>If correct,</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
2.4.2 If incorrect, call pickers and return to 2.3 then 2.4 (On average)  

<table>
<thead>
<tr>
<th>Step</th>
<th>Activity</th>
<th>Senior picker</th>
<th>Junior picker</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Picker receives pick list</td>
<td>1.5 minutes</td>
<td>1.5 minutes</td>
</tr>
<tr>
<td>2.</td>
<td>Picking process</td>
<td>2 minutes</td>
<td>2 minutes</td>
</tr>
<tr>
<td>2.1</td>
<td>Pick up trolley</td>
<td>30 minutes</td>
<td>40 minutes</td>
</tr>
<tr>
<td>2.3</td>
<td>Pick up goods</td>
<td>6 minutes</td>
<td>5 minutes</td>
</tr>
<tr>
<td>2.4</td>
<td>Double checking</td>
<td>6 minutes</td>
<td>6 minutes</td>
</tr>
<tr>
<td>2.4.1</td>
<td>If correct, proceed to 3</td>
<td>6 minutes</td>
<td>6 minutes</td>
</tr>
<tr>
<td>2.4.2</td>
<td>If incorrect, call pickers and return to 2.3 then 2.4 (On average)</td>
<td>5 minutes</td>
<td>5 minutes</td>
</tr>
<tr>
<td>3.</td>
<td>Customers receive products</td>
<td>42.5 minutes</td>
<td>54 minutes</td>
</tr>
</tbody>
</table>

Average time used: 37 minutes 47 minutes

Source: Author

Table 4.4: Results of the Time of In-Store Delivery Service (During Weekends) after the Storage Assortment Implementation
The researcher compared the result between before and after the implementation of the storage assignment policy. The result has indicated that there is a significant improvement in the picking time for both Weekdays and Weekends. The picking time was reduced by 28 minutes during Weekdays and 31 minutes during Weekends. The result is shown in Figure 4.6.

**Figure 4.5: Comparisons Result between Before and After Implementation**

<table>
<thead>
<tr>
<th>Weekdays</th>
<th>Weekends</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Before</strong></td>
<td><strong>Before</strong></td>
</tr>
<tr>
<td>65.5 - 73.5 min</td>
<td>75 - 85 min</td>
</tr>
<tr>
<td><strong>After</strong></td>
<td><strong>After</strong></td>
</tr>
<tr>
<td>37 - 47 minutes</td>
<td>42.25 - 54 min</td>
</tr>
</tbody>
</table>

Due to time constraints, the expert training took place on the 4th, 5th, 7th and 8th of June which was after the picking time results were monitored. However, information gained in the research has shaped the training to help pickers to improve their picking service even more. The training has covered the top three product types: kitchen products, living room products and bedroom products that occupy the staff pick storage area the most.

The researcher has arranged a meeting with the experts prior to the training session to express the concerns identified in the research when the pickers perform the order picking to serve customers. The concerns were about product knowledge including
basic product combinations and commonly purchased combinations and also about size, length and weight of products.

In the product knowledge training sessions, pickers have been trained by experts who have expertise in product dimensions and in the various possible product combinations. For example, an individual picker has learned about the combinations required for kitchen cabinet. This consists of the frame, the door front, drawers, shelves and hinges. The pickers have not only learned about the combinations but also the sizes of the combinations. For instance, the kitchen frame is 220 by 60 cm and 60 by 80 cm and the door front is 80 by 40 cm, 60 by 40 cm and 40 by 40 cm.

Moreover, the trainers have also taught pickers how they can look at the product name to quickly identify the product types along with product sizes. For example, from a product named XX FRAME H CB FRD/OV 60X60X200 WHITE AP CN, pickers can quickly identify that the product is a kitchen frame and the size is 60 cm wide, 60 cm long and 200 tall. Looking at the name allows a picker to immediate identify the kind of product that needs to be picked; therefore, pickers can plan what to pick first.

4.1.3.2 Ergonomic (How to Lift) Training

AAA Company has already scheduled a training twice a year to ensure that employees know how to lift products. For example, when picking goods off the floor, pickers shall bend their knees and keep their back straight and then lift the products. However, the researcher has suggested that the training be increased to three times a year due to high turnover rate of pickers resulting from lifting-related injuries. Moreover, the company also provides back support to prevent back injury, but pickers hardly use due to sweat, heat and discomfort when lifting products. The company has considered changing the back support with better quality then educates the benefits and encourages the pickers to always use the back support.

4.1.4 Key Performance Indicator(s)
In addition to the existing KPI for in-store delivery, other KPIs have to be put to a place that is designed to monitor and track performance on a number of key factors. The first factor is the quality of the picks. Quality in the in-store delivery system is defined as speed and accuracy. Since pick start time and stop time are collected as a part of the process, weekly random samples of pick times by employee will be collected and compared to the standard for speed. In order to track accuracy of the picks, an additional step in the picking process will be for the checkers to note the number and type of errors encountered in the checking process. This will be collected for each picker. A final immediately instigated KPI is for lifting-injuries. The goal for this highly important indicator is that there will be no lifting injuries incurred in the picking process. All injuries will be immediately reported to the supervisor and an investigation will be made into the cause of the injury so that prevention techniques can be incorporated into the product-lifting training every fourth month.

On the picking-process side, additional KPIs have to be developed in the areas of modifying the stock allocation plan for sales frequency, identification of damaged goods found in the picking process and utilization and availability of pick-enabling equipment.

The stock allocation plan has to be reviewed once a month by warehouse supervisors. The supervisors have to retrieve the sale records from the past four weeks to confirm that the sale of products continually increases and there is a need for the products to be re-allocated. The increase of sale in one or two weeks could be caused by other reason like bulk purchase which requires no action. The KPI for when to re-locate the products is set by the sale frequency indicated in Table 3.4. When a product sale continuously increases, for example, from three to nine pieces per week then the supervisors have to re-locate the product.

The measurement of the sales increment has to go by the actual pieces sold not by the percentage increase. This is because, for example, an article has a sale of one piece per week; an additional sale of an extra piece gives 100% sales increase to the product which in fact the product re-location is not necessary. The supervisors also need to
consider the condition of the combination products and family grouping since moving one product affects the others

It is very important that the supervisors maintain the stock allocation plan and ensure that the new products are grouped correctly by family and sales frequency is considered.

On the customer side, monthly surveys have to be conducted to customers receiving combination-pick products or picks of over 15 products to ensure that satisfaction level remains above the set standard. Customer complaints have to be recorded also and have to be traced their root causes. Standards have to be set for each of these key factors and a systematic means of monitoring and tracking be developed.

4.1.5 Communication

As mentioned in Chapter three, there is no signal to notify pickers when new pick lists are generated. Unfortunately, there are no automatic signals that are able to notify pickers, but there is a new agreement between the picker team and the checker team. The checker team agrees to notify the pickers, only when there is no picker at the station, using mobile phone provided by the company.

4.2 Control

Control is the last phase of DMAIC model which is designed to ensure that the improvements made during the previous phase, Improve, remain in place and service levels do not drift from standards over time. The Control phase safeguards that steps in the process are done according to standard so as to ensure that the working process is maintained and documented. After the change of the warehouse storage policy was completed and the in-house order picking training was conducted to improve the in-store delivery service and reduce customers’ waiting time, at the researcher’s request, AAA Company has instituted measures designed to sustain the working process. This
was done with an eye to provide continuous improvement designed to increase customer satisfaction.

Therefore, after the improvements have been put in place and the trial has been completed, the researcher-proposed KPIs are to be closely monitored. Currently, performance records are kept but have not been reviewed to examine the actual performance of the process or the pickers. So, it is recommended that the supervisors use the KPIs as a control mechanism to measure the actual performance of the picking process, individual pickers as well as customers’ satisfaction levels and the number of customers’ complaints made against the in-store delivery service.

The previously existing KPI that supervisor should have been using was set by the company at 7+1 meaning that a picker has seven minutes for the first item then one minute extra for each additional item to be picked. For example, if the items that are to be picked on a pick list are 10 items, this means that the target time to complete this pick list is $7 + 9 = 15$ minutes. Therefore, in weekly audits of process and picker performance, if the picker is unable to complete a specified number (5 percent) of picks within the 7+1 standard, supervisors will collect further information from the picker on the causes of the delay so that the causes are prevented from happening again. Over time, due to the training and the revised warehouse storage policy, actual picking time has to be examined for possible reductions leading to incremental improvement. Family, function and frequency of purchase groupings may allow for reductions in the picking formula, particularly as it relates to combination picks.

Supervisors should not only look at the day to day performance but also should have a record to look at the overview performance as a team. The researcher has suggested that the supervisors have to maintain a monthly performance record to track the total average time used as well as the trends in number of order picking requests and associated pick times. The total average time used for pickers to pick each pick list is calculated by using total time used divided by the total number of picks which allows AAA Company to know customers’ average waiting time. Keeping records can also
help identify the peak times of the month, week or day, special days or seasons and develop strategies to handle picking and checking in these peak periods.

Each tracking process has to be assigned to an “owner” who is charged with the responsibility of making sure that his or her particular KPI is measured, and tracked, and deviation from standard is reported to the proper authority for corrective actions. Deviations from standards for KPIs will have consequences designed to mitigate or eliminate negative variations in the process. These may range from specific training, to process revision to administrative action.

The researcher has not only focused on the pick time results but also how performance has to be monitored. Based upon the findings of this study, the researcher has strongly encouraged the supervisors to conduct scheduled training sessions for all pickers. This training should be based upon the findings of the data collected in the Control measures that have been instituted so as to address specific causes identified in that data.

The researcher has recommended that the product knowledge trainings have to be conducted at least twice a year. The training is not only useful for junior pickers but also valuable for senior pickers and supervisors since it incorporates training based upon the actual problems and trends identified in collected data. These training sessions will refresh the information that the senior pickers and supervisors may have forgotten and provide them with new information as trends and problems are identified. The researcher has also suggested that On-the-job training has to be conducted whenever there is a major change regarding storage assignment within the warehouse. This is because normally, the product groupings should not change unless there is a movement of major products.

Moreover, it is also recommended that a buddy system be instituted for all new pickers. This means that when a new picker is recruited, that person should be paired with a senior picker and/or picker with substantial order picking experiences. The
experienced buddy has to be trained on how to mentor the new employee and how to help evaluate the performance of the new picker.

4.3 Summary

This chapter has addressed the major root causes of the delayed in-store delivery service of AAA Company identified in Chapter III. The four key factors: Process, People, Management and Equipment, which directly influence the outcome of the service, were analyzed and improved.

The proposed actions helped to reduce the service time from 65 to 85 minutes with the previous process to 37 to 54 minutes, on average, with the revised process. The picking time was significantly reduced due to shorter picker travel time after the storage assignment policy was implemented. The trainings of the pickers have helped them to improve the in-store delivery service as well. In order to maintain and even further improve the in-store delivery process, appropriate maintenance procedures and continuous improvement in warehouse management standards, measurement schedules and corrective action procedures have been instituted to sustain the positive result after the implementation.
CHAPTER V

SUMMARY FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

This chapter aims to discuss and provide conclusions based upon the findings from the research question “What are the root causes of delays in the in-store delivery service at AAA Company and how can the time used to provide this service to customers be reduced?” This chapter also addresses Theoretical and Managerial implications of the study and discusses the Limitations of the study and Recommendations for future research.

5.1 Summary of the Findings

This research was conducted to identify the root causes and find solutions of the delays encountered by the customers utilizing the in-store delivery service of AAA Company. These delays caused the customer low satisfaction level with this process. The researcher reviewed the related literature and determined that DMAIC was a suitable model for identifying the root causes, solving or mitigating those problems and proposing sustainable solutions to address the problems of AAA Company.

The major causes of in-store delivery delays discovered during the research using DMAIC model were the pickers’ travel time and lack of product knowledge which both contributed to the delays in the service. There were two major areas where corrective actions were devised by the researcher to improve working process and resolve problems. These included the development and implementation of a storage assignment policy and employees training in product knowledge, warehouse layout, proper lifting methods and KPIs.

The resulting reductions in service time required for in-store delivery after implementation of the storage assignment policy and employee training showed an improvement from average of 65 minutes and 85 minutes (weekdays and weekends,
respectively) to 37 minutes and 54 minutes (weekdays and weekends, respectively). The reduction in customers’ waiting of 28 minutes for weekdays and 31 minutes for weekends should have a positive effect on customer satisfaction levels. The time improvements were caused by a reduction in the pickers’ travel time. This was facilitated by the new product storage assignment policy for the warehouse in which the majority of high turnover items were placed closer to the main aisle and products that need to be purchased together were grouped closely to one-another. Therefore, pickers no longer have to walk as far to complete their picks and travel time for picks has been reduced. Also, pickers have gained more product knowledge regarding product dimensions, weights and sizes and are therefore better able to plan which products have to pick in strategic order so as to properly stack the trolley.

Despite the large improvements attained by the implementation of the product storage assignment policy and the employee trainings, the store’s warehouse has to continue to find ways to incrementally improve the in-house process in sustainable ways. This is not only to prevent reoccurrences of the problems but also to be proactive by averting new problems in the future.

5.2 Conclusion

This research has utilized the DMAIC (Define, Model, Analyze, Improve and Control) process improvement model to improve AAA Company’s in-store delivery service and order picking process by reducing pickers’ travel time and the total time required to serve customers. The DMAIC model has helped the researcher to define problems, measure the current performance, analyze the root causes of delays and find ways to improve and control the outcome of the in-store delivery service process. The waiting time requirements of the in-store delivery service have now been improved from around 65.5 to 73.5 minutes to 37.5 to 47 minutes on weekdays and from 75 to 85 minutes to 42.25 to 54 minutes on weekends, on average.
5.3 Theoretical Implication

This research applied the DMAIC process (Define, Measure, Analyze, Improve and Control) to improve AAA Company’s in-store delivery service. Several analytical tools and techniques were utilized within each step to improve AAA Company’s in-store delivery service.

This study found that DMAIC was a useful set of procedure when applied to identify and address the unknown or unclear underlying causes of customer dissatisfaction resulting from delays encountered when using the in-store delivery service (Mehrjerdi, 2011).

DMAIC is a phased process that can be modified through the selection of analysis tools and procedures from the myriad of those available to specifically target conditions in the process(es) targeted for improvement. The Cause-and-Effect Analysis allowed the researcher to see the relationship between causes and effects (Synder, 2012) while the Pareto Chart was used to state the relative important information and prioritize causes of the problems (Finn 1995). In this case, the tools used in the DMAIC stages led to improvements in the storage assignment policy and training designed to improve the pickers' picking and lifting skills and product knowledge. The improved storage assignment policy and improved pickers’ skill and knowledge helped to reduce the picker travel time which consumed 50% of order picking time (Tompson, 2003). This supports that the model can improve the process quality when appropriately and systematically applied.

5.4 Managerial Implication

This research used DMAIC model to improve a delayed in-store delivery service due to long travel times incurred by pickers in picking the products. Reductions in picker travel time are directly related to customer waiting time. Longer waiting time reduces customer satisfaction. Therefore, reductions in picking travel distances and the time to make picks reduce in-store delivery time and thereby directly affect customers’
satisfaction levels. The use of DMAIC’s various tools and techniques has helped the company to improve warehouse layout, reduction in time required for picks, reduction in employee injuries due to improper lifting techniques and improve customer satisfaction. Control procedure has been instituted to keep both the improvements to the process in place and services to incrementally improve the process further over time. All of these improvements should lead to positive outcomes like reductions in costs, improved customer satisfaction and reduced employee turnover.

The improved process has the additional benefit of increasing the positive reputation of AAA Company. This leads to gain more loyal customers, get repeat purchases and attract new customers by word of mouth.

5.5 Limitations and Recommendations for Future Research

The research was designed to improve the in-store delivery service for AAA Company’s Bangkok store in Thailand. The problems identified and proposed solutions apply to Bangkok store only. Furthermore, due to the changes in the self-serve and staff-pick areas of the warehouse, some of the recommendations made in this study may not apply in the future. Additionally, the research only focused on in-store delivery factors that influenced the quality of the service which had negative impact on customers. The improvement of the order picking time of junior and senior pickers depends upon to the turnover rate of the pickers. The turnover rate of the junior picker is the major factor in the time different between senior and junior pickers.

AAA Company has recently instituted a picking service where pickers help customers to pick goods within the self-service area at flat rate of 200 Thai Baht. The service applies only for customer who use home delivery service (extra charges). However, from September 2016, customers will have a choice of using either the home delivery service or waiting for the goods to be picked and delivered to the customers waiting areas as in the past.
It is recommended that future research be conducted to study the pickers routing and storage assignment policy within the self-service area. During the planning stage of the area expansion, the warehouse manager and supervisor must thoughtfully plan the final outcome of the expansion and the routing that pickers will use in order to minimize customers’ waiting time. AAA Company must also modify the training by extending its course beyond the staff pick area in order to better help the customers with this new customer/picker picking system. Research needs to address the content of this additional training. Future research should also address the development of additional or modified KPIs that would serve to further improve all picking systems. In particular, KPIs designed to provide for continuous incremental improvement would be valuable.
BIBLIOGRAPHY


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Appendix A: Enlarge Current Product Assortment within Staff Pick Area at Level 00
Appendix B: Enlarge Current Product Assortment within Staff Pick Area at Level 10
Appendix C: Enlarge Final Storage Assortment at Level 00
Appendix D: Enlarge Final Storage Assortment at Level 10

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