DEAD STOCK REDUCTION BY THE DMAIC CONCEPT: A CASE OF CONSTRUCTION FITTINGS TRADING COMPANY

By

THITA LERTANANTASUK

A Final Report of the Six-Credit Course
SCM 2202 Graduate Project

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

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November 2013

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DEAD STOCK REDUCTION BY THE DMAIC CONCEPT:
A CASE OF CONSTRUCTION FITTINGS TRADING COMPANY

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Date 9-Nov-2013

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Thita Lertanantasuk

Assumption University

November, 2013

ABSTRACT

This case study is about construction fittings of trading company whose warehouse contained both active stock and dead stock. The company's dead stock is currently a cause of profit losses to the company and this research work will propose solutions to reduce the dead stock by applying the DMAIC concept.

The DMAIC approach is recognized as an effective tool to solve the problem at its root cause. In this case study, data between June 2012 and May 2013 had been used. It was found that 12.95% of the total stock is dead, which valued approximate THB1.7 million. Moreover, 79% of dead items by value came from Retail Business and 21% came from Project Business respectively. Therefore, dead items from Retail business were chosen and studied further and Pareto Analysis was applied to Retail Business's dead stock to narrow down the focus. The 80% highest value Retail dead items consisted of 34 items and were selected to analyze further to get the root cause of the problem. A cause and effect diagram was made to understand the root causes of dead stock. The biggest causes to the problem were obsolescence, customer changed their mind, and a sales forecast error. The as-is process of these 3 causes was studied in detail. Creative solutions to eliminate the key root causes are developed in order to fix and prevent a process problem. Controlling the improvement process is also developed to ensure the sustainable reduction of dead stock.

The result indicates that the proposed strategy can help sustain dead stock reduction of the company. Thus, DMAIC is one of most effective problem solving tools to solve the problem at the root cause.

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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

(Asst.Prof.Dr. Sureepong Phothongsunan)

Contact Number / Email address sureepongp@hotmail.com

Date: 25 Oct 2013

CHAPTER I

GENERALITIES OF THE STUDY

According to Bozarth and Handfield (2008), supply chain management is the active management of supply chain activities and relationships among partners in order to maximize customer value and gain a sustainable competitive advantage. The goal of supply chain management is to increase collaboration and trust among supply chain members, thus improving inventory visibility and the speed of products or inventory movement throughout the supply chain (Bozarth & Handfield, 2008). The higher the speed of inventory movement, the fewer inventories the company holds, and the lower the inventory becomes dead. This depends on how effective groups of firms run the supply chain.

Any stock that a firm keeps is called inventory. Inventory is a significant and visible asset in most companies. According to Ballou (2004), companies store inventory for two reasons, which are to improve customer service and to reduce costs. However, firms have to balance the problem of holding too much inventory, which can lead to high costs and holding too little inventory, which can lead to lost sales. The ultimate goal of the companies should be just to have enough inventories to satisfy customer demand (Ballou, 2004).

There are many reasons why companies hold large inventories, which are when potential savings from inventory reductions are far less than economies of scale in production, procurement, transportation cost, and economies of size cause long productions runs which lead to inventory accumulation, seasonal demand, quantity discounts, and bulk shipping discounts (Ballou, 2004). Inventory levels are affected by customer service expectations, demand uncertainties, and the flexibility of the supply chain (Ballou, 2004). However, holding high levels of inventory can be a disadvantage. Managers must decide on an inventory level that balances the risk of running out of products with storage costs and the other negative aspects of holding too much inventory.

This case study is about Door and Window Hardware Trading Company whose warehouse has both moving and dead inventory. Only eliminating dead inventory does not solve the problem in the long term, but preventing future dead inventory to reoccur would be the best way.

1.1 Background of the Research

Inventory is stocks or items used to support operations (raw material and work-in-process items), supporting activities (maintenance, repair, and operating supplies) and customer service (finished goods and spare parts) (Bozarth & Handfield, 2008). The fact is that inventory can be both a valuable resource and a potential source of waste, which depends on how well the company plans. High fluctuation in demand increases the challenge of maintaining inventory to avoid stock outs; however, the inventory should be carefully monitored; otherwise, it can end up being dead inventory.

Dead inventory is the old items or stocks that cannot be used up or sold and are still kept in the warehouse for an extended period of time. Active inventory that once had high sales can lose favor with customers and turn into dead stock. Dead stock is defined as item that has had zero sales in the last 12 months. Most companies are facing the problem with dead inventory. Those can include rejected items, damaged items, out-of-date goods, slow-moving items, and scrap and waste. Dead stock affects the organization's cash flow, consumes valuable warehouse space, and freezes earnings that otherwise should be dedicated to the purchase of revenue-generating products.

Inventory is a dependent variable, which depends on inputs of many factors, such as demand and demand fluctuations, supply lead time and lead time variability, supply chain design, manufacturing capabilities compared with client purchase characteristics, transportation modes, and desired service levels. In order to gain sustainable inventory reduction while maintaining good customer service, the variables that drive inventory must be developed as well. Therefore, this research is based on Lean Six Sigma methodology using the DMAIC tool to understand the current state of the company's inventory, select the crucial area, emphasize critical items that need attention, and recommend solutions to gain sustainable dead stock reduction.

Background of the Company

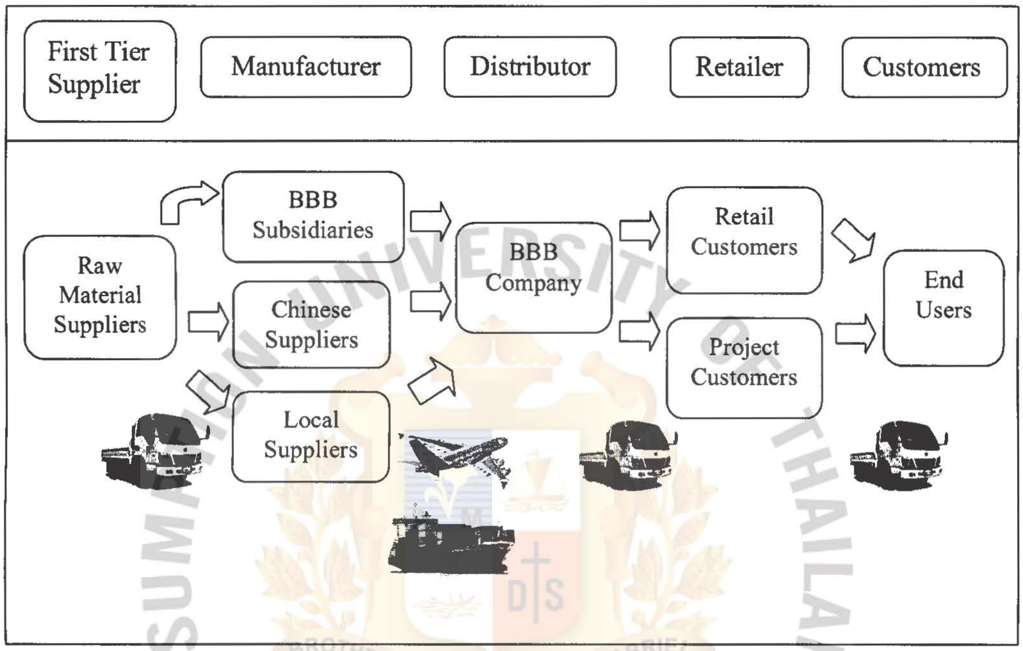
The BBB Group, the corporate group, has been founded for more than 100 years. It consists of more than 50 manufacturing and distribution companies in 35 countries. With the internationally leading brands, the BBB group offers "securing technology for you". Furthermore, BBB-Logistik organizes worldwide shipment of BBB quality products and another IT company is concerned with all IT tasks of the group (Gretsch-Unitas Group, 2013).

Profession of the company is the opening and moving, closing and locking of windows and doors, as well as functional and secured facility management. BBB Group is one of the leading suppliers of door and window technology, automatic entrance systems and building management systems (See Appendix A). The BBB Group manufactures and distributes about 30,000 single items, which are easy to combine. The company uses the major challenges of creating innovative system solutions to break new ground. Together with architects, planners and profile system manufacturers, the company develops individual comprehensive solutions (Gretsch-Unitas Group, 2013).

Moreover, BBB Company is a trading company offering the customers a complete range of construction fittings and security equipment for doors and windows. The Headquarter, BBB Group, one of the largest manufacturers of construction fittings in the world, has been located in Ditzingen near Stuttgart since the 1970s. BBB Company mostly imports products from the headquarters in Germany and in China.

Moreover, some products are manufactured and imported from Canada, Chinese vendors, and Singapore.

Figure 1.1: Supply Chain Mapping



Source: Author

Figure 1.1 shows the supply chain mapping of the company. It starts with suppliers, which deliver raw materials to manufacturers. The manufacturers convert the raw materials into products, which are door and window hardware. Then, BBB Company imports the products from the manufacturers, such as BBB Subsidiaries and Chinese suppliers. However, some items are produced by local suppliers. After receiving the products, BBB Company distributes the goods to our customers, which are Retail customers and Project customers. Then, our customers sell the products to the end users.

In addition, there are total 34 members of staff in BBB Company office and warehouse. For Sales Department in Thailand, this sector is classified into two groups, which are the Retail team and the Project team. The Retail team focuses on the Manufacturer business, which refers to the traditional door and window manufacturer. Customers are typically small enterprises servicing individual home owners or small projects. The market is dominated by small aluminum and timber door manufacturers. Next, the Project team focuses on the Project business, which is the main market of all window and door hardware manufacturers in Asia. In Thailand, the industry is controlled by large property developers, architect firms and contractors. Traditional window and door manufacturers can seldom acquire large projects by themselves due to the lack of product knowledge, cash flow issues, and lack of sales force.

1.2 Statement of the Problem

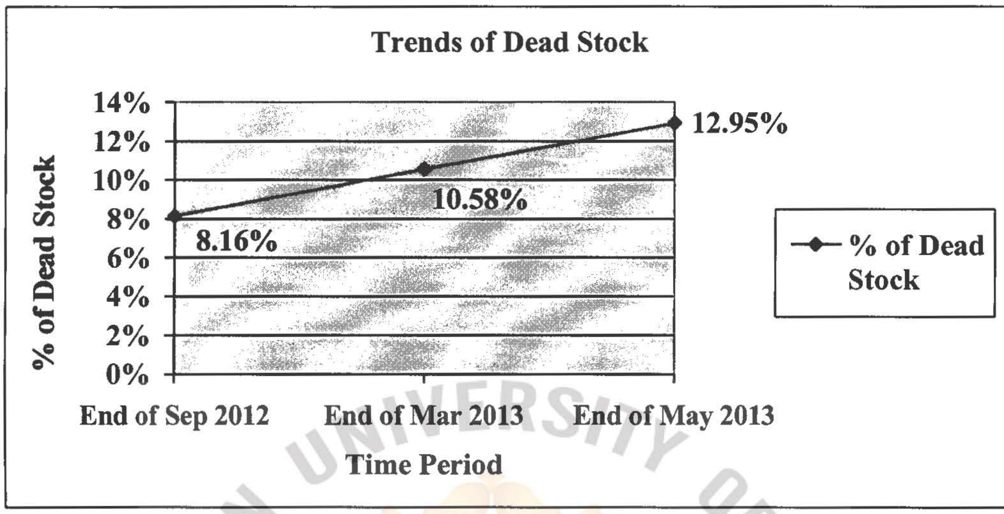
If the demand could be fully predicted, the need for holding inventories throughout the supply chain would disappear. However, given the frequent market changes and unpredictable customers' reactions, the company needs to hold some inventories. Some other numerous benefits are the company will gain greater flexibility and uncertainty will be reduced at some levels. Also, certain costs would arise during holding the inventory.

Inventory must be maintained in the proper level and provided in a timely fashion. The company should have controls in place and regular check-up to avoid the dead inventory. Not only paying close attention to the movement of inventory, but inputs from other departments, such as Sales Manager, Purchasing Manager, Warehouse Manager, and salespeople are also important to decide what items and how many quantities to order.

Trends Analysis of Dead Inventory

The percentage of the dead inventory in the past of different time period was collected and compared. The researcher studied the past data further in order to recognize the stock trends of BBB Company.

Figure 1.2: Trends of Dead Stock at BBB Company

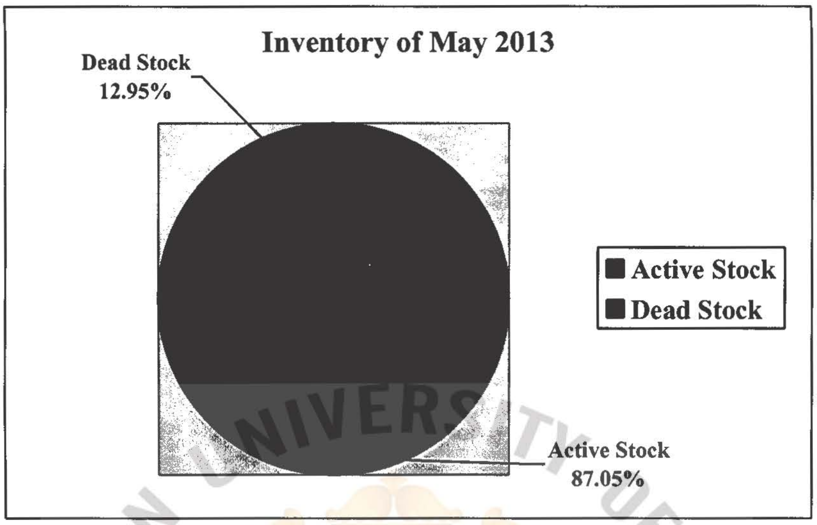


Source: Author

Figure 1.2 shows that the percentage of the dead inventory keeps increasing in each time period, which is not a good signal for the company. It shows the negative trends that more values or items in company's inventory are not moving as the time passed. This issue concerns the management to monitor closely in order to identify the root causes of the dead inventory problem.

Furthermore, from May 2013, the inventory data of BBB Company of the past 12 months was collected.

Figure 1.3: May 2013 Inventory at BBB Company



Source: Author

Figure 1.3 above shows the percentage of dead inventory found in the warehouse of BBB Company during May 2013. It consists of 298 items worth 12.95% of the total stock (approximate 1.7 million THB) without any movement for the past 12 months. This study is aimed to answer the research question: **"Can the Define-Measure-Analyze-Improve-Control (DMAIC) model reduce future dead stock of finished goods?"**

1.3 Research Objectives

The focus of this project is on dead inventory of the Retail team of BBB Company. The inventory of this trading company is imported from other countries. Therefore, the company has to hold stock and the level of stock depends on the lead time and the demand of each item. The study will concentrate on dead inventory non-moving of the Retail team for more than 360 days. The objectives of this research are:

1.3.1 To identify the major problems and possible causes of dead inventory of BBB Company and recommend solutions to reduce dead stock in the long term based on the data and facts.

1.3.2 To provide the problem solving process based on the Define-Measure-Analyze-Improve-Control (DMAIC) model and to recommend the process improvements in the company.

1.4 Scope of the Research

Only BBB Company will be selected as a case study. This case study is about the prevention of dead inventory and focuses on the top 80% value of materials with more than 360 days non-moving of Retail business. Interviews will be held with the head of the Sales Department of the Retail business to collect information regarding causes of dead inventory more than 360 days and for further understanding of the as-is process that caused the problem to occur. Finally, an improved process will be suggested to eliminate future dead inventory.

This research is based on Lean Six Sigma methodology, using the Define-Measure-Analyze-Improve-Control (DMAIC) model to eliminate the future dead inventory of the company. Literature reviews offer supporting literature on the research area, which contains the critical points that help to get to the root causes of the problem and provide the solution process that is appropriate to solve dead inventory and prevent it from happening again in the future.

1.5 Significance of the Research

This research is to use the DMAIC concept to adapt in order to solve dead inventory problem. This study helps the company identify the proportion of active inventory and dead inventory and focuses on the elimination of dead inventory by finding the root causes of the problem. It also gives the company a better understanding of the underlying causes related to dead inventory and the disadvantages of holding dead inventory, which will result in inventory levels reduction, lower inventory holding cost, and increased company's productivity and profitability.

1.6 Limitations of the Research

This research mainly focuses on the dead inventory of the Retail business at BBB Company, the Construction Fittings Trading Company during May 2013, and does not include the dead inventory of other business sectors of the company. Moreover, the data of dead stock may vary in each time period, but this research mainly relies on the historical data of the last 12 months concerning the May 2013 time period.

1.7 Definition of Terms

Cause and Effect Diagram	It shows the relationship of all factors (causes) that lead to the given situation (effect). It identifies major causes and breaks them down into sub-causes and further sub-divisions (if any) (Bozarth & Handfield, 2008).
Customer Deposits	It refers to the money received by a company before providing the product or service to the customer.
DMAIC	It is the five-step approach, which are Define, Measure, Analyze, Improve, and Control that refers to a data driven improvement cycle used for improving, optimizing, and stabilizing business processes. Moreover, DMAIC delivers sustained defect-free performance and highly competitive quality costs over the long run (Goldsby & Martichenko, 2005).

Pareto Analysis	It refers to a statistical technique used for decision making based on the Pareto Principle, known as the 80/20 rule, which is the idea that 20% of causes generate 80% of results (Pyzdek & Keller 2010).
Pull Strategy	It is an inventory system in which minimum stock is kept on hand. This approach depends on the actual demand to drive purchasing products. Inventory replenishment relies on end user purchases (Christopher, 2011).
Ramp-up/Ramp-down Approach	It is the process of introducing new parts and products into the inventory system while recognizing that some old certain parts and products are also going to be replaced and must be reduced by putting someone in charge of this process and keeps them actively involved with salespeople (Pay, 2010).

CHAPTER II

REVIEW OF RELATED LITERATURE

This chapter reviews related literature of the research that considers the critical points of the current study and knowledge. The chapter starts with the broad term, which is the definition of Inventory Management, followed by the combination of two popular methods, which is Lean Six Sigma. Next, the report mentions the Six Sigma tool, which is DMAIC with the two important supporting models including Pareto Analysis and the cause and effect diagram. Lastly, it mentions powerful process improvement methodologies, which are the Pull Strategy and the Ramp-up/Ramp-down Approach.

2.1 Inventory Management

Inventory is such a critical resource in many organizations. It helps the company to shorten the delivery lead times and provide better customer service. The company must hold some stock in order to sell anything. The promise to serve customers cannot be made unless the firm has the products on hand or can be made available when customers demand it. The challenge comes when customers need the product now and the company has to estimate what they will want, in what quantities, and where to locate it (Goldsby & Martichenko, 2005). Delivering the right product to the right time at the right place in the right quantity and condition and at the right cost is what every organization wants. Having the right inventory on hand and near customers is the simplest way to ensure on time delivery and the satisfaction of customers (Goldsby & Martichenko, 2005).

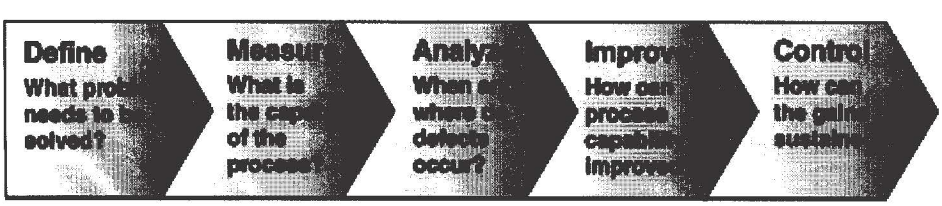
Inventory management is the process of efficiently managing the constant flow of units into and out of an existing inventory. It is not limit to the movement of finished products into the company, but it also involves with the effective delivery of the finished goods until they are delivered to the customers. This process usually involves controlling the transfer in of units in order to prevent the inventory from becoming too high and seeks to control the costs associated with the inventory. In general, using cheaper and slower transportation modes will cause stock levels within the supply chain to increase while using more expensive and faster transport modes will enable firms to lower stock levels (Christopher, 2011). The lower inventory levels are offset by higher transportation costs.

However, companies cannot hold more inventory than necessary; otherwise, it will tie up space and capital. There are many drivers of inventory; however, if the organizations can manage and control drivers of inventories, the organizations can reduce the supply chain's need for inventory (Christopher, 2011). Therefore, the fewer inventories the companies hold, the less dead stock the companies tend to have.

2.2 DMAIC (Define-Measure-Analyze-Improve-Control)

The improvement process and tool associated with Six Sigma is DMAIC. Define-Measure-Analyze-Improve-Control (DMAIC) is an approach to problem-solving defined by Motorola as part of the Six Sigma management philosophy, which is a tool for improving an existing process (George, 2002). Many refer to DMAIC as the roadmap for Six Sigma. It is the backbone methodology applied in Six Sigma improvement efforts (Goldsby & Martichenko, 2005). The vision for a DMAIC effort is developed using the voice of the customer and voice of the business tools. The outcome of these strategic analyses should recognize the opportunities for improvement that the DMAIC method is employed (Goldsby & Martichenko, 2005).

Figure 2.1 the DMAIC Method



Source: Goldsby and Martichenko (2005)

The stages of the DMAIC process are shown in Figure 2.1 above. All of the DMAIC process steps are required and always proceed in this order.

Define: The 'define' stage of DMAIC is to define the problem, select the project, and scope the project. First, the problem must be stated clearly with the project's purpose, scope, team members, resource requirements, and potential constraints. It should be clear to members involved about the project mission needed to be achieved and who is responsible for each action. The critical inputs for this stage are voice of customer, voice of business, and value stream mapping (Goldsby & Martichenko, 2005).

Measure: Measurement refers to assessment of the current state and it also has to be focused on the accuracy in measurement. Multiple measures might be necessary to assess a particular area of performance. Furthermore, all measures should be reviewed with the same considerations and be prioritized which measures are the most important. Cost, time, and quality are common areas of measurement. The best measures will prove to be those that are quantifiable, easily measured, robust, reliable, and valid. The DMAIC process provides the perfect opportunity to correct errors in measurement (Goldsby & Martichenko, 2005).

Analyze: The 'Analyze' step is to find the true underlying causes of the problem that is leading to unsatisfied result. Also, it is to identify the relationships and factors that cause the process to perform the way it does (Bozarth & Handfield, 2008).

Improve: This stage is to identify ways to eliminate the gap between the current performance level and the performance target established (Bozarth & Handfield, 2008). It offers a firm an opportunity for competitive advantage if the firms can deal with the problem rapidly and most effectively that achieves valued differentiation (Goldsby & Martichenko, 2005). Making effective change is not an easy thing for any organizations. An organization with individual not only is interested in, but also gives an effort in the success of the whole, which is far more likely to make change with favor than those who force change. The approach involves open communication of what is the current situation, how the improvement will be managed, and what is expected of all team members (Goldsby & Martichenko, 2005). Moreover, communication of change and expected contribution of team members is a critical measure used to judge the effort success and to assess the contribution of each individual. Improvement efforts are sought to get rid of waste and distractions that increase the meaningful productivity. One key point to the Improve stage is that Six Sigma does not provide the actual solution of the problem, but a problem solving method (Goldsby & Martichenko, 2005).

Control: It is a final stage of the DMAIC process, which is to sustain the effort. It generates a detailed solution monitoring plan, observe implemented improvements for success, update plan records on a regular basis, and maintain a workable employee training routine (Bozarth & Handfield, 2008). Furthermore, it focuses on taking corrective actions when a problem occurs or environment changes in order to maintain expected performance. The company must also have robust and flexible processes to be ready to adapt with the change situation (Goldsby & Martichenko, 2005).

2.3 Pareto Analysis

According to Summers (2006), Pareto Analysis is a statistical technique in decision making that is used for selecting a limited number of tasks that produce a significant overall effect. It is an idea that a large majority of problems (80%) are produced by a few key causes (20%). It is also a creative way of looking at causes of problems as it helps to identify the top portion of causes that needed to be addressed to resolve the majority of problems. Pareto Analysis can also be referred as 80/20 rule under the assumption that, in all situations, 20% of causes determine 80% of problems (Summers, 2006).

The company can apply Pareto analysis into 2 cases, which are inventory management and finding the root cause of dead inventory. For inventory management, Pareto Analysis can help the company determine the importance of items. For the trading company, it can use sales data as the Pareto input; the results tell the firm its top selling and bottom-selling materials. After knowing the importance of each item, a firm can design the correct inventory control procedures to manage inventory at each level. Not all items require the same type of management. Moreover, Pareto Analysis can help improve service levels. When executed correctly, Pareto Analysis forms a complete inventory management. It gives the company an idea what to have in stock, when to have it in stock and how many to have in stock. Companies that understand and manage well can decrease the number of out-of-stock items, back orders and unfilled orders. These reductions lead to increased fill rates and improved customer service levels.

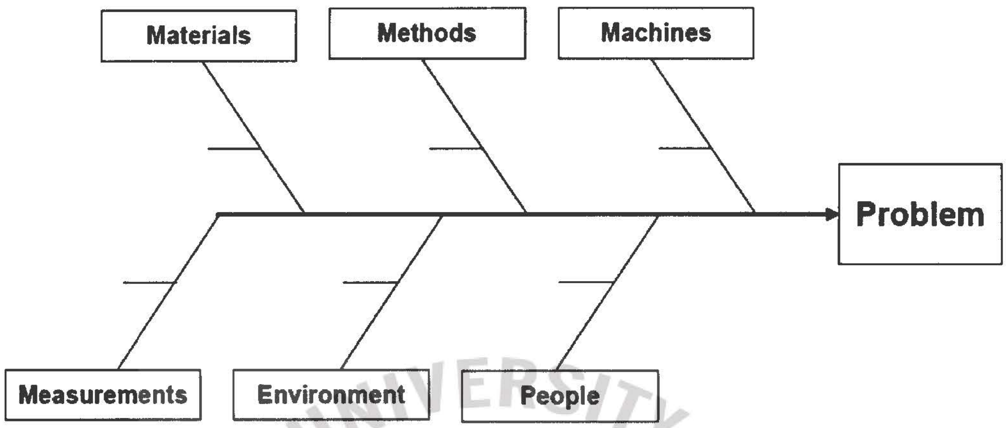
Next is the case of dead inventory. The company can use Pareto Analysis to pinpoint problems that yield maximum result by identifying all the root causes of dead inventory problems and group them together. The company should focus on the group that has the maximum score ranks top on priority and resolving such problems can help achieve the maximum cost benefits and results (Summers, 2006).

2.4 Cause and Effect Diagram

The cause and effect diagram is also known as Ishikawa diagrams, Fishbone diagrams, and Herringbone diagrams, which were created by Kaoru Ishikawa in the year 1968 to determine the causes of a specific event (Summers, 2006).

The cause and effect diagram is a tool that helps identify and categorize possible causes of a specific problem. It explains the relationship between a given outcome and all the factors that influence the outcome (Bozarth & Handfield, 2008). This tool is able to help the firm to identify the possible root causes, the basic reasons for a specific effect problem or condition, to relate some relationships among the factors affecting a particular process, and to analyze the problems so that corrective action can be implemented (Bozarth & Handfield, 2008).

Figure 2.2: Example of Cause and Effect Diagram



Source: Bozarth & Handfield, (2008)

Figure 2.2 shows how the cause and effect diagram works and how it looks like. According to Bozarth and Handfield (2008), it states that possible causes of problem can be divided into six major categories, which are

People – This category comprises the people involved in a process. People might not have the right skills, authority, or responsibility (Bozarth & Handfield, 2008).

Methods – This category consists of the policies and procedures followed in a process, such as poor business practices process or poor product or service designs (Bozarth & Handfield, 2008).

Machines – This category contains the tools and equipment that are put to do the job, but might not be capable (Bozarth & Handfield, 2008).

Materials – It is about the raw materials, which are utilized for creating the final product, but the quality of inputs might be poor (Bozarth & Handfield, 2008).

Environment – The conditions in which a process takes place is what this category deals with (Bozarth & Handfield, 2008).

Measurements – This category includes performance measurement that helps in determining the product quality; however, it might not gear towards eliminating the problem (Bozarth & Handfield, 2008).

In case of non-moving inventory, the firm can use the cause and effect diagram to discover the root causes of a dead inventory problem, to reveal the bottlenecks in the process, and to identify the point where and why the process is not working by identifying the major factors involved of the dead inventory problem and recognize the possible causes. Then, the firm analyzes the diagram.

2.5 Pull Strategy

With this strategy, companies only purchase just enough products to provide what customers want where there will be no excess of inventory that needs to be stored in the warehouse; therefore, reducing inventory levels and the cost of carrying and storing products (Christopher, 2011). Pull strategy relies on placing smaller and more frequent orders to meet the demand and the process would be started with a customer's order first.

Pull strategy controls the flow of products by automatically adjusting inventory levels according to actual consumption from customers. It simply only responds to what customers place an order or purchase. The major advantage of a pull strategy is that the company should be able to comfortably meet customer demand without having to store any large inventory (Christopher, 2011). If a particular product suddenly increases or drops in high amount, the company can adjust accordingly to customer's order.

In case of preventing dead stock, pull strategy is one of the most effective strategies that can help the company reduce the stock to the lowest possible level. A company not only can free up warehouse space, but also can free up the workforce to focus on primary duty, rather than stocking dead inventory.

2.6 Ramp-up/Ramp-down Approach

According to Pay (2013), Ramp-up/Ramp-down Approach is the introduction of new parts and items stage into the stock system while at the same time getting rid of the old models, and it also protects the company from oversupply in forecasting of a sudden increase in sales. During the ramp-up period, purchasers should carefully monitor results to determine if the sales target is achieved and communicate frequently and closely with the suppliers to set appropriate replenishment levels and update plans. Even before the sales process begins, the purchasers can collaborate with design engineering to advise common parts that will help the company narrow down the quantity of part numbers, which can potentially lead to over stock (Pay, 2013).

Ramp-down is the process of systematically realizing that some parts and products are going to be replaced, resulting in an attempt to decrease the quantity of those products and parts. Companies are often hesitant to discontinue the old models because they often think that there might still be some clients who still need them or during the time of introducing a new product, the firms might fail to plan the slowdown of the old models. Moreover, buyers should adjust their replenishment plans with suppliers. In case of implementation of ramp-down approach, a purchaser must be in charge to control the process and remain actively involved with salespeople and new product development (Pay, 2010).

2.7 Summary

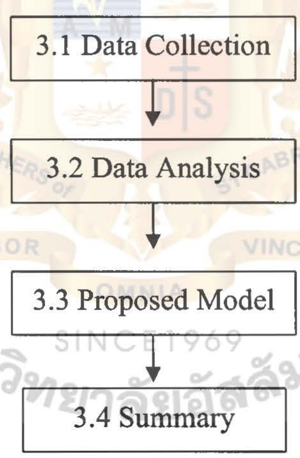
All related literatures are reviewed in this chapter. The researcher has discussed relevant concepts in dead stock reduction by using DMAIC model. Pareto Analysis and the cause and effect diagram focus on finding major root causes of dead stock problem. Moreover, Pull strategy and Ramp up/Ramp down Approach are the models that help eliminate the excess stock.

CHAPTER III

RESEARCH METHODOLOGY

This research is a case study of BBB Company, which is a construction fittings trading company. The company purchases and imports the construction fittings from BBB subsidiaries and other OEM suppliers, such as Chinese suppliers and local suppliers. The study focuses on the inventory at BBB Company. The research is conducted to study the movement of dead inventory items and to reduce the dead stock in the future based on Lean Six Sigma methodology using the DMAIC model. Regarding Figure 3.1 below, it shows the steps of the research process.

Figure 3.1: Research Process



This chapter comprises of four sections, which are data collection, data analysis, proposed model, and summary. The actual study begins with the collection of data. The collection of data is a critical step in providing the information needed to realize the current situation and to define the inventory problem. Last 12-month inventory items have been collected in order to analyze the inventory condition and to study the amount of dead inventory. Once the data are collected, the researcher is ready to move on to the next step of the process, which is the data analysis. In section 3.2 Data analysis, the data collected had revealed the movement of each item and were separated into each category based on the number of non-moving days. After that, the data or items with more than 360 days staying in the warehouse without any consumption will be focused on. These data have also been separated into two divisions according to sales business, which are the Retail business and the Project business and the Retail business was chosen to focus on. Then, Pareto Analysis was used to prioritize Retail business items providing problems according to the value. The next section is the Proposed Model. It states how the company implements DMAIC (Define-Measure-Analyze-Improve-Control) to help solve the dead inventory problem in the long term. The last Section 3.4 Summary concludes the chapter.

3.1 Data Collection

This section explains how the data have been collected step by step. First of all, the data have been directly exported from SAP, a company database into an excel spreadsheet. SAP is an Enterprise Resource Planning solution and Data Management Program, which consolidate information from various functions or departments of an organization. These data are up-to-date and will be the real-time information of the date the data was run, which was 1st May 2013. The key figure of this report is slow moving items. The data were collected based on the number of non-moving days of each item and were divided into the time period to analyze.

The consumption values were examined for the number of days entered, starting from today's date. For materials with no consumption in this period, the input value displayed in the results list will be the number of days of non-movement. These data will show only materials kept in stock.

Initial data collected is the slow moving item report, consisting of material numbers with stock value, and the number of non-moving days (for no consumption, it will show no consumption). The data have been filtered from the largest number of non-moving days to the smallest number of non-moving days.

3.2 Data Analysis

After the data collection process, those data were used to analyze further to identify the problem. It is a process of inspecting, cleaning, and transforming data with the goal to discover the useful information and supporting decision making.

3.2.1 Inventory Analysis

Data of inventory at the date of running report were collected. Every item with stock value was shown. Inventory data show the total stock value, which is THB13,408,471.83 and the total material numbers are 1,035 items. The data have been grouped according to the number of non-moving days.

Table 3.1: Inventory Aging Report

Number of Non-Moving Days	Value	Quantity (SKUs)	Percentage
>360 days non-movement	1,736,246.79	302	12.95%
301-360 days non-movement	123,224.62	38	0.92%
241-300 days non-movement	443,218.61	51	3.31%
181-240 days non-movement	889,274.65	70	6.63%
121-180 days non-movement	275,121.35	40	2.05%
61-120 days non-movement	3,540,043.67	202	26.40%
<60 days non-movement	6,401,342.14	332	47.74%
Total	13,408,471.83	1,035	100.00%

Source: Company Inventory Aging Report

From the table, you can see that more than half of the inventory is not moved more than 60 days. Furthermore, around 26.40 percent of total stock stays in the warehouse around 61 to 120 days since the last consumption, and so on. As observed from the table, the value of items not moved more than 360 days is THB1,736,246.79, which is calculated to be 12.95 percent of the overall stock value.

The items staying in the warehouse with more than 360 day non-movement are considered as dead inventory and have been selected to do further research. The reasons are those items have never been used or sold and have been in inventory for an extended period of time. If the company holds too much dead inventory in the warehouse, the company will run the higher risk of high cost, obsolescence, and getting stuck with inventory that cannot be sold. Moreover, the value of this dead inventory is considered high when compared with other time periods. Therefore, these items with more than 360 day non-movement will be studied further item by item.

3.2.2 Dead Inventory Material Analysis

Based on the data from Table 3.1, items that stay in the warehouse more than 360 days since consumption have been focused on as those items had no consumption more than 360 days and the company still has it in stock. The total numbers of materials with no consumption more than 360 days are 302 items.

After analyzing the data, those items are separated into two groups, which are items from the Retail business and items from the Project business. However, there are some gift items as the company never sells them and is giving them out for free. Therefore, those items are not considered as dead inventory. Filtering out these gift items finally reveals the actual dead inventory with different sales teams.

Table 3.2: Dead Inventory Status per Sales Team

Sales Team	Items	Value (THB)	% by Item	% by Value
Retail	252	1,365,803.75	84.56%	79.15%
Project	46	359,839.99	15.44%	20.85%
Total	298	1,725,643.74	100.00%	100.00%

Source: Author

Table 3.2: Dead Inventory Status per Sales Team shows that most dead items are derived from the Retail business resulting in 252 items or 84.56 percent of the total dead inventory, worth nearly THB1,365,803.75 or 79.15 percent of total THB1,725,643.74 of total dead inventory (more than 360 day non-movement). While only 46 items or 15.44 percent of total dead items come from the Project business with the value of THB359,839.99 or 20.85 percent of total dead inventory. Table 3.2 proves that dead inventory from the Retail business needs more attention as it contains much more value in dead stock.

3.2.3 Pareto Analysis on Dead Inventory from Retail Business

George (2002) states that Pareto Analysis is a technique which helps to identify the top portion of causes that need to be addressed to resolve the majority of problems. This makes the company able to focus on the key items with the major causes of the problem. Furthermore, the solution can be developed to solve the highly affecting causes of problems resulting in reducing or eliminating the problem.

Table 3.3: Pareto Analysis on Dead Items from Retail Business

Total Non-Moving Stock		Pareto	80% of Total Non-Moving Stock	
Total Non-Moving Items	Value in THB		Top 80% Items	Value in THB
252	1,365,803.75	**80%**	34	1,095,417.82

Source: Author

From the list of dead inventory of Retail business (see Appendix B); there are 252 items with the total value of THB 1,365,803.75. The data were filtered from the highest value to the lowest value and the percentage of each item is also calculated in term of total value of the Retail business dead inventory. Besides this percentage, the accumulative percentage is also calculated and the top 80% value of items is selected as these items contain the biggest amount of capital. As seen in Table 3.3, there are 34 items falling in the top 80% value of the Retail business dead inventory, and these items will be focused on for further study and research.

After finishing analyzing data, it can be concluded that dead inventory from the Retail business consists of higher value when comparing with that of the Project business, which can be calculated to be around 80% of total dead inventory. Therefore, dead inventory from the Retail business will be selected and focused on. The next step is to find out the causes of this dead inventory of the Retail business and find the way to eliminate it in the future.

3.3 Proposed Model

The use of Six Sigma tools and processes has allowed the organization to eliminate any events that result in a failure to meet customer expectations. The real power of DMAIC (Define-Measure-Analyze-Improve-Control) emphasizes permanently solving recurring problems by fixing underlying processes and achieving lasting results. However, this paper uses a Lean Six Sigma based methodology for developing the process to eliminate a dead inventory problem in the future by using the DMAIC approach. The DMAIC will be applied in this research paper as the steps below.

3.3.1 Define: The researcher collected the data of slow moving items reported from the company's database and exported them into the Excel format and categorized them into ranges according to the number of non-moving days. The range with more than 360 non-moving days with the amount THB1,736,246.79 was selected as it was the dead stock in the warehouse. Next, the dead items were classified into 2 categories, which were items from the Retail business and the Project business by Retail Sales Manager and Purchasing Manager. It was found that 79% of dead items by value came from the Retail business and 21% came from the Project business respectively. Therefore, dead items from the Retail business were selected and needed more attention as justified above in 3.2.2 due to its higher value as not all areas can be corrected. In this case, this defines the scope of the project.

3.3.2 Measure: To verify the current process and to measure the extent of the problem, more detailed data of dead items with more than 360 non-moving days of the Retail business were collected further by interviewing the Retail Sales Manager together with documents and a system review. The data were sorted from the highest value to the lowest value. After that, the Pareto Analysis was applied to the Retail business's dead inventory to narrow down the focus of the project. The high impact dead items within the 80% highest value consisted of 34 items and were selected as the focus of the study. This unproductive inventory should not only be eliminated, but preventing it from happening again was also very important. Therefore, items with high impact should be analyzed further to get to the root cause of the problem.

3.3.3 Analyze: This is to find and understand the root causes of the problem and to isolate the top causes behind the dead inventory. The further steps were implemented as follows:

a. The researcher interviewed the Retail business's head of Sales Department together with reviewing the related documents in order to understand the reasons that cause dead inventory of items with the 80% highest impact value. The historical data of each item was also collected and studied based on facts.

b. The cause and effect diagram was made to clearly explain the causes of dead inventory. Potential causes of problem were listed and prioritized and the researcher found that there were 7 causes of the company's dead stock, which are obsolescence, customer changed their mind, sales forecast error, excess item, poor sample order practice, item defects, and price competition. Then, Pareto Analysis was used to find the causes with the 80% highest value as they revealed the biggest causes of the problem, which included obsolescence, customer changed their mind, and sales forecast error.

c. The three important causes with 85% value were selected to study in detail by creating the detailed process map to help understand the as-is process that caused the problem and to pinpoint where the critical areas in the process of the root causes, were what might be contributing to the occurrence. The first cause is obsolescence. The problem occurred because the items and parts were bought into stock and didn't sell. When the time passed, it had been replaced by the new model. The second cause is customer changed their mind. The problem occurred because the customers refused to accept the goods they ordered, so the goods were stored in the warehouse for a long time. The last cause of dead inventory is sales forecast error. The Sales Manager used their ideas and feeling for stock planning, which resulted in no demand for those items.

3.3.4 Improve: the researcher will identify an innovative solution in order to decrease or if possible to remove these key root causes of the dead inventory problem by working through with related people from different departments to identify the improvement areas to create a detailed implementation plan in order to get the to-be process. Creative solutions to eliminate the key root causes will be developed in order to fix and prevent the process problem. It is expected that the products the company bought have to be sold out before obsolescence to ensure that the items customers placed the orders should be delivered and accepted by customers as soon as possible, and the company should have an effective forecasting method to ensure the demand in the market.

3.3.5 Control: the researcher will propose the control plan to ensure the sustainability of inventory reduction and the benefits made by changes. The Stock Aging Report will be generated on a monthly basis to ensure that the dead inventory does not accumulate. Employees' training on a regular basis is also important in preparing the reports and analyzing the documents. Feedback will also be provided by related employees as a result back to the process for continuous improvement.

Table 3.4: DMAIC Model Action Research Approach Framework

Model	Action	Plan	Result	Tools
Define	Collect the data of slow moving items reported and categorized them into range.	Get Aging Inventory Report to see the current inventory situation. To see whether the problem exists and select the items that need attention.	Define the scope of the project	Sort data
Measure	Collect the detailed data of dead inventory from Retail team by interviewing and a system review.	Get all dead items from Retail team and analyze available data.	Narrow down the focus of the project by focusing on the 80% highest impact dead items.	Pareto Analysis
Analyze	Understand the root cause of the dead inventory problem by interviewing the Retail Sales Manager and reviewing documents.	Use Pareto Analysis to prioritize the causes to the problem and to understand the as-is process of the major causes.	Clearly get the overall picture of the root causes of the problem and realize the areas that need process improvement.	Cause and Effect Diagram Pareto Analysis
Improve	Identify solutions for causes that most need process improvement.	Work through with cross functional team to create the solution plan.	Develop solutions in order to get the to-be process and to eliminate the problem from recurring.	Pull Strategy Ramp-up/Ramp-down
Control	Monitor the improvement process to ensure success. Offer employees training program.	Require employees to follow specific requirement and update documents.	Prevent the problem from future recurrence.	Control Plan

Table 3.4: DMAIC Model Action Research Approach Framework summarizes the activities and plans in each step of the DMAIC approach. It also shows the expected result after implementation and tools to be used in each process.

3.4 Summary

This chapter gives a full explanation of research methodology starting with collecting data, analyzing the data in order to see the current inventory situation, using the DMAIC approach to define the problem, measuring the scope of the problem, and understanding the major root causes of the problem in order to find the solutions to improve the process. The data and facts are based on documents and a system review together with Sales Department's Head of Retail Business interview.

CHAPTER IV

PRESENTATION AND CRITICAL DISCUSSION OF RESULTS

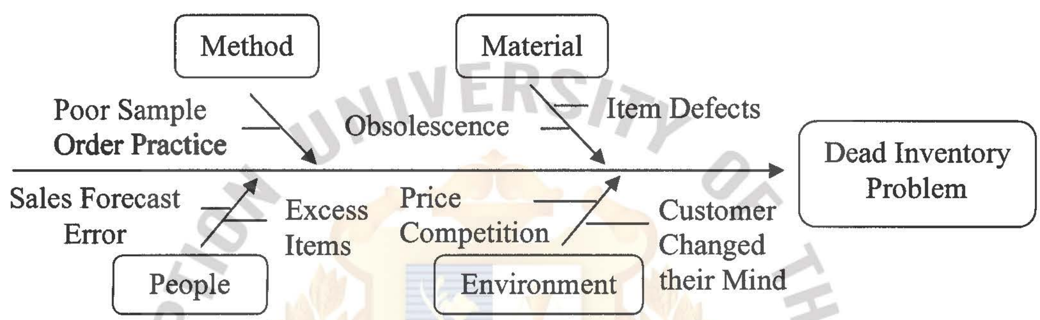
Following the DMAIC model, the Define step and the Measure step are already finished in the previous chapter. This chapter presents and discusses the current processes causing the dead stock. The objective of this analysis is to study the as-is processes of each cause and to find the best alternative for each major cause in order to reduce dead stock to the minimum. It also shows an analysis of those critical items with an in-depth study of each of the 34 items selected. To find the root causes of the problem, the cause and effect diagram is used. After that, Pareto Analysis was brought to implement in order to find the major causes of the problem. Next is the Improve step, which is to suggest to-be processes for causes that need process improvement most. Last is the Control step, which is to monitor and to control the improvement process to ensure the sustainable reduction of dead stock. The implementation and result of the investigation is as follows:

4.1 Define: The researcher collected the data of slow moving items reported from the company's database in order to understand the trends and the overall picture of company's inventory situation. This step helped define the problem of stock with the specific items that need more attention, which are dead items that stay in the warehouse more than 360 days from the Retail business.

4.2 Measure: Detailed data of dead items that stay in the stock more than 360 days of the Retail business were collected further by interviewing the Retail Sales Manager together with documents and a system review. Moreover, Pareto Analysis was used to apply to the Retail business's dead stock in order to emphasize the top 80% value items. These consisted of 34 items and were selected as the focus of the study. Therefore, items with high impact should be analyzed further to get to the root cause of the problem in order not only to eliminate, but also prevent it from recurring, which will be explained in the next step, which is Analyze.

4.3 Analyze: Cause and effect diagram helps capture problem's possible causes, which begins with a problem, then identifies possible causes by separate categories, such as materials, methods, machine, measurement, environment, and people. Based on information from the Head of Retail Sales Department interview and the historical data report, the causes of dead inventory are shown below (Figure 4.1).

Figure 4.1: Cause and Effect Diagram of the Dead Inventory Problem



Source: Author

The cause and effect diagram shows seven causes of the dead inventory problem. This research analysis is based on 34 dead inventory items from the Retail business. After listing all possible causes of dead inventory, Pareto Analysis has been used to implement further in order to find the top priority 80% value by cause. Not only does it help to separate the few major causes from many possible causes, which make us able to narrow the focus on improvement efforts, but also it allows significant problems to be focused and corrected first.

Table 4.1: Pareto Analysis by Causes of Dead Stock

NO.	Causes of Dead Stock [a]	Number of SKUs [b]	Dead Stock Value (THB) [c]	Dead Stock Value in Percentage (%) [d]	Accumulative Dead Stock Value in Percentage (%) [e]
1	Obsolescence	12	348,392.59	31.80%	31.80%
2	Customer Changed their Mind	3	330,611.00	30.18%	61.99%
3	Sales Forecast Error	9	255,208.64	23.30%	85.28%
4	Excess Item	4	71,663.12	6.54%	91.83%
5	Poor Sample Order Practice	4	71,051.51	6.49%	98.31%
6	Item Defects	1	10,180.55	0.93%	99.24%
7	Price Competition	1	8,310.41	0.76%	100.00%
	Total	34	1,095,417.82	100%	

Source: Author

Remarks: [a] The causes of dead stock was gathered from Figure 4.1: Cause and Effect Diagram of the Dead Inventory Problem

[b] The number of SKUs was gathered from Company's database
[c] The dead stock value in THB was gathered from Company's database
[d] The dead stock value in percentage is calculated by (c)/Total Value (THB)
[e] Accumulative dead stock value in percentage is calculated by d1=e1, e1+d2 = e2, e2+d3= e3, e3+d4 = e4, e4+d5 = e5, e5+d6 =e6, e6+d7 = e7

Table 4.1 shows seven causes of dead stock; however, according to Pareto Analysis, the researcher will focus only three major causes of the dead inventory problem consisting of obsolescence, customer changed their mind, and sales forecast error, which fall into approximately 85% of the total value. Next, the as-is process of each cause will be studied further in order to understand the root problem of each process. The first cause, which is obsolescence, will be analyzed first.

4.3.1 Obsolescence: After studying 12 SKUs in detail (See Appendix C) by interviewing the Retail Sales Manager and a system review, the researcher found that there are 2 major problems that cause obsolescence, which are missing model parts and purchasing items without customer order confirmations. The first problem is that these items are old part models that have to be used together with other model parts, but other parts have already been sold to some of the customers. Therefore, these old part models cannot be sold to other customers as they are not in full set, and the company has no longer bought these parts from the suppliers. The second problem is these items are old models that were used to request for purchase by salespeople, but until now there are still no purchase orders from customers. Also, these unused old items have been replaced by the new models and they are no longer promoted; therefore, these unused old items are still kept in the warehouse.

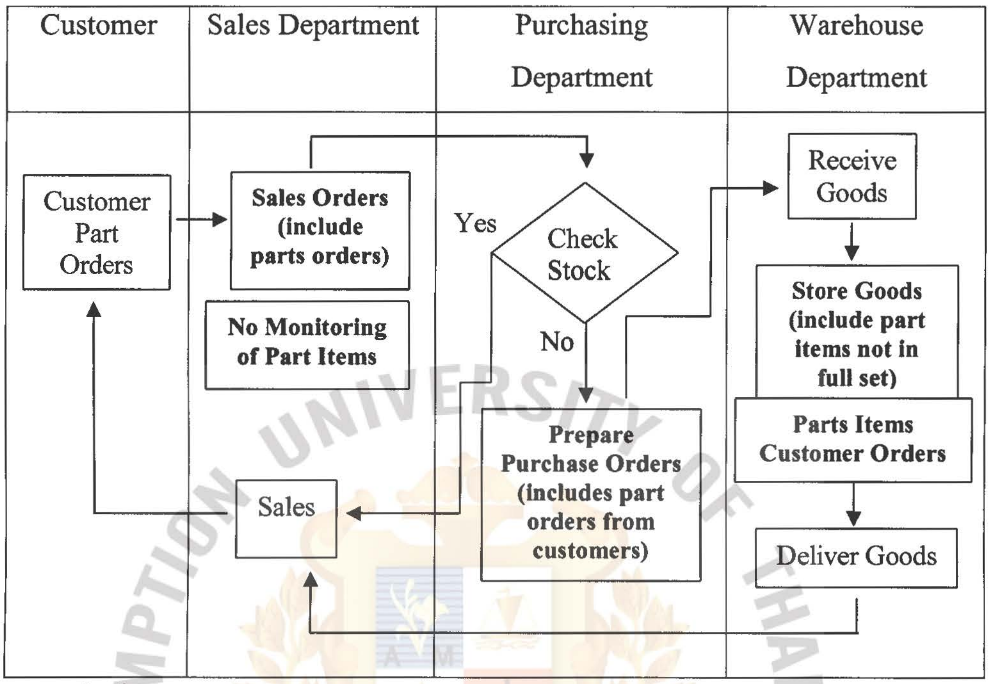
Table 4.2: Problems that Cause Obsolescence

No.	Problems that cause to Obsolescence	Quantity (SKUs)	Value (Baht)
1	Missing model parts	5	207,489.16
2	Purchasing items without customer order confirmations	7	140,903.23
	Total	12	348,392.39

Source: Author

Table 4.2 helps summarize the 2 major problems that cause obsolescence. The missing model parts problem consists of 5 SKUs and the purchasing items without customer order confirmations problem consists of 7 SKUs. Next, the as-is process of each problem will be explained further in detail in order to understand each problem of obsolescence. The as-is process that shows the missing model parts problem is presented next.

Figure 4.2: As-Is Process Showing the Missing Model Parts Problem

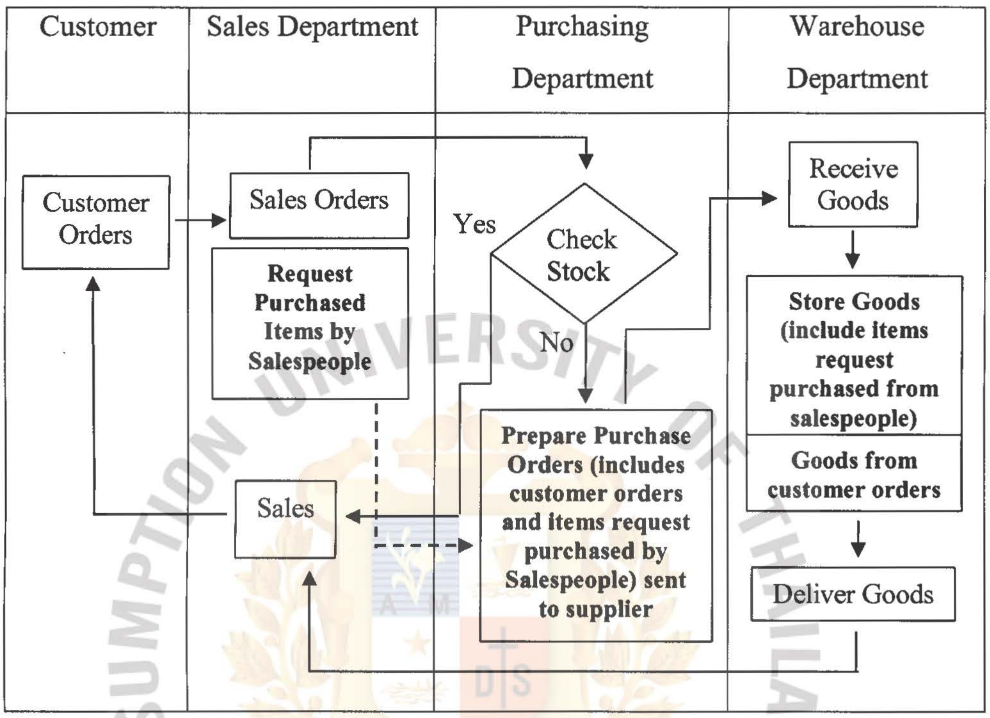


Source: Author

Figure 4.2 is the as-is process that shows the missing model part problem. Some customers placed the orders of parts and accessories with the indoor sales teams. They didn't purchase it in sets. The indoor sales teams normally process the orders; therefore, some parts of the product set were missing without monitoring. When the time passed, the company checked the slow moving items reported and assigned the salespeople to present and sell, but they cannot sell because of some parts were missing. However, it shouldn't be a problem if a purchaser can buy the parts from the suppliers, but the problem is some parts are no longer available from original suppliers.

This cause frequently occurs when a replacement has become available with more advantages than the previous products, which is related to repurchasing the replacement. Next is the process flow of purchasing items without customer order confirmations.

Figure 4.3: As-Is Process Shows Problem of Purchasing Items without Customer Order Confirmations



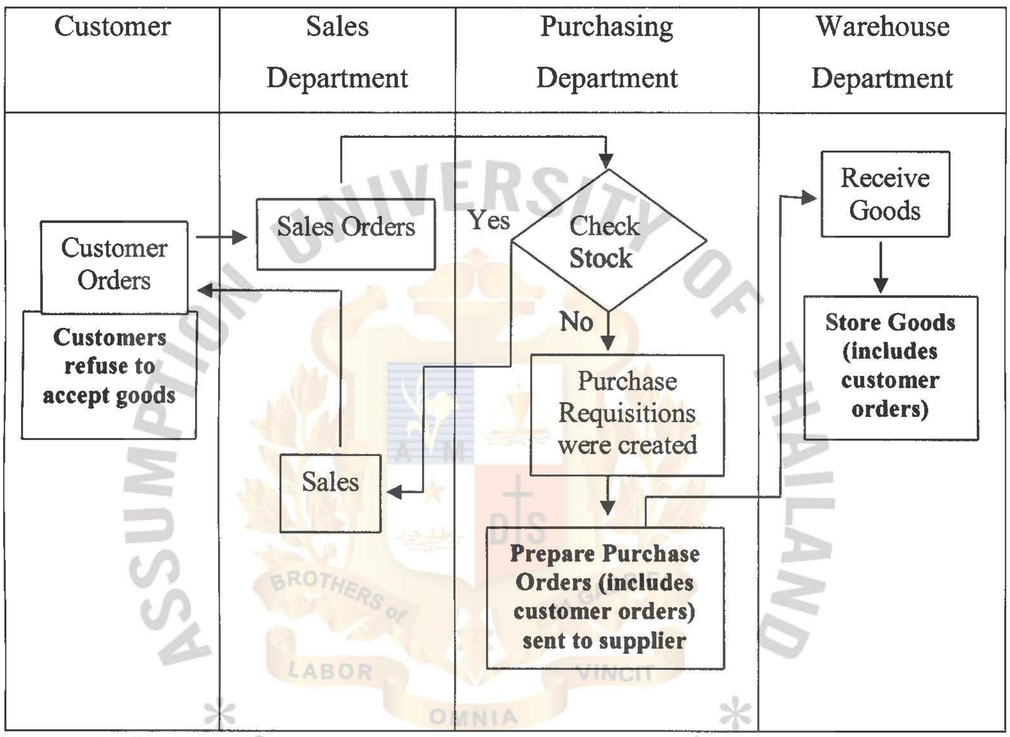
Source: Author

Figure 4.3 is the as-is process that shows the problem of purchasing items without customer order confirmations. These dead items had previously been requested for purchase by Salespeople without any customers' order confirmations as they thought that they can sell to the customers in the future. However, after the time passed, the company found out that these items were still in the warehouse and obsolete.

Therefore, it can be concluded that obsolescence is one of the major causes of dead stock that comes from two main root causes which are missing model parts and purchasing items without customer order confirmations that lead to dead stock in terms of obsolescence.

4.3.2 Customer Changed their Mind: According to the Retail Sales Manager interview and the documents review, the researcher found that this cause of dead stock directly comes from customers as the customers refused to accept what they have ordered. Furthermore, the goods that customer ordered are customized. As the items are not standard, they cannot easily be sold to other customers. Therefore, the goods were still left in the warehouse.

Figure 4.4: As-Is Process Showing Customer Changed their Mind



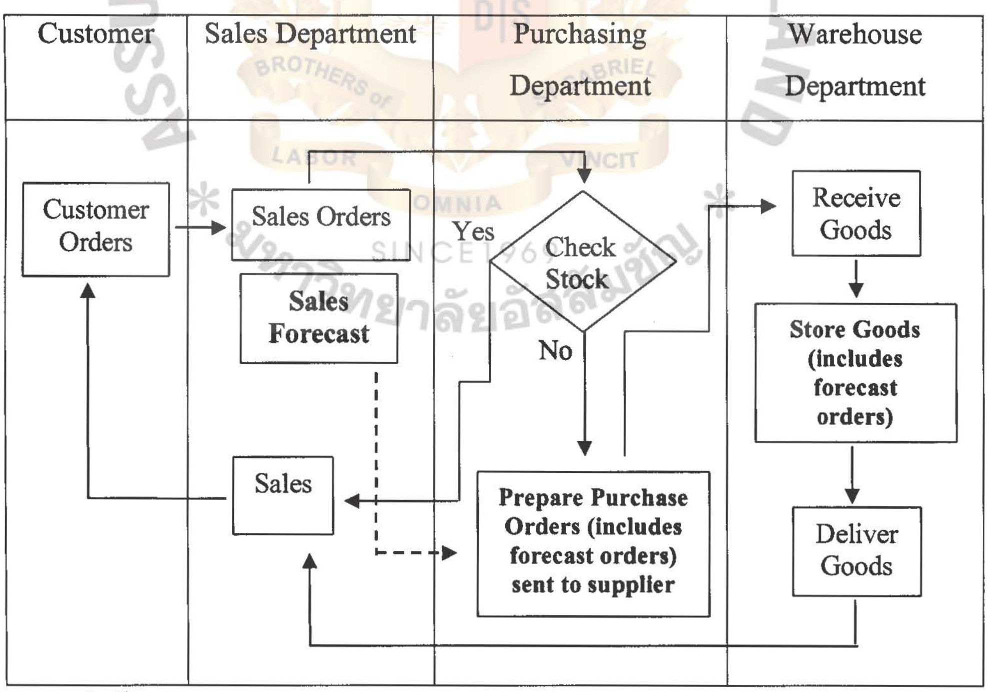
Source: Author

Figure 4.4 is the as-is process showing customer changed their mind. The process starts with customers issuing the purchase orders to the company. The indoor sales team of the Sales Department creates the sale orders in the system. Then, the system creates the purchase requisitions and sends it to the Purchasing Department. The purchasers check the purchase requisitions and place the orders with the suppliers. After that, the suppliers deliver the goods to the company and those goods are kept in the warehouse. Next, indoor sales team has to confirm with the customers first about the delivery date and place. Then, the goods are delivered to the customers. However, customers refuse to accept the goods. Therefore, goods that customers rejected are normally kept in the company's warehouse.

After reviewing documents, the researcher confirmed that customer issued the purchase order to the company. Moreover, from the Retail Sales Manager interview, he said that the reason the customer rejected the goods is because they wanted to change the specification of the goods even though they had issued the purchase order to the company. When the times passed, the customer did not accept the goods as they said that they still did not need the goods as the project was postponed. As a result, this can be concluded that the customer changed their mind can also cause the dead stock in the company.

4.3.3 Sales Forecast Error: This process studied shows the sales forecast orders of products placed without confirmed sale orders from customers. These forecast items may or may not interest customers. If the customers are not using them, then they will finally become dead items in stock.

Figure 4.5: As-Is Process Showing the Sales Forecast Error



Source: Author

Figure 4.5 is the as-is process that shows the sales forecast error. First of all, the purchase planning begins with the Sales Managers and the management discussing the monthly sales turnover with the target. In order to reach the target, the companies should have the supplies to support the sales team. Therefore, they make a forecast of what items, in what quantity should have in stock. This sales forecast from the Sales team is the most important input for setting safety stock, and purchasing products to keep in stock. They place the orders based on their ideas that the market would probably demand these items. The management approved. Then, the Retail Sales Department informs the Purchasing Department to prepare the orders based on the sales forecast. The Purchasing Department prepares and places an order according to the sales request as they already got approval from the Management.

After interviewing the Retail Sales Department and the Purchasing Department including studying the historical data of the items, it was learnt that dead items were purchased based on the sales forecast. By reviewing the system item by item, there are no requisitions created from customer orders. The products are arrived without any order confirmations from customers. When the time passed, the firm expected that those forecast items will get used, but those items were still not ordered and are still in the stock for more than 12 months. Moreover, the Retail Sales Manager said that one of the root causes of the sales forecast error is items ordered are the new items, which they haven't sold it before. Also, they didn't have much knowledge on product and the market demand. They bought it because they just had an idea that they could sell it.

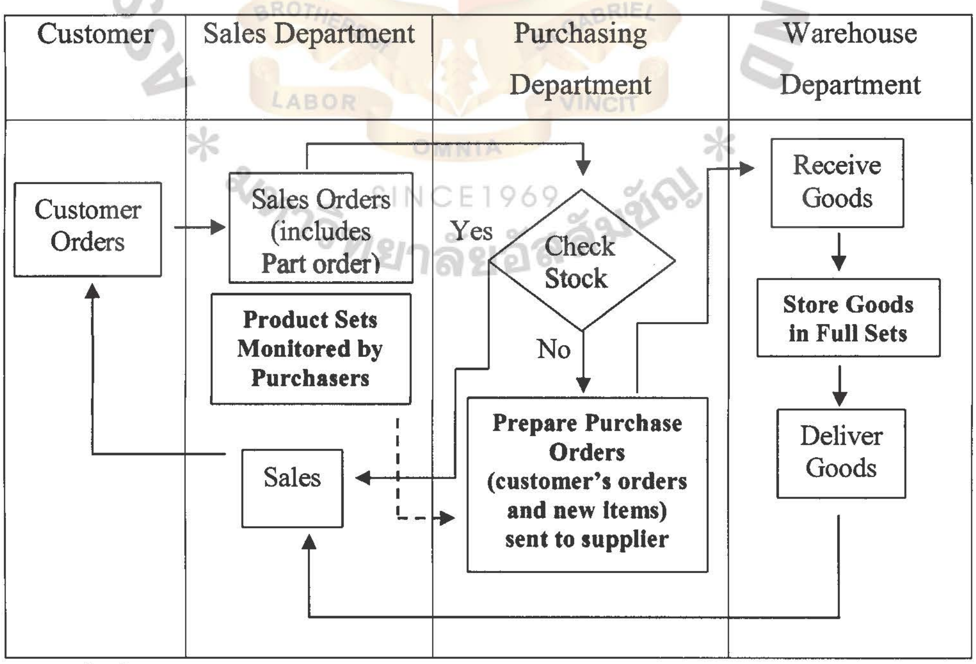
As the problems of each process were studied and understood, the next paragraph will be about finding the solutions using the DMAIC model to improve the process in order to eliminate the problem and to control the process to ensure that the problem will not happen again in the future and that the company gets most benefits in making the changes.

4.4 Improve: This stage is to identify ways to reduce dead stock in the long run. Three causes have been studied further in depth, and potential solutions to improve each as-is process have been developed as follows:

4.4.1 Obsolescence: After understanding the as-is processes of two major problems that cause obsolescence, which are the missing model parts problem and the purchasing items without customer order confirmations problem. To-be processes will be developed to eliminate both problems.

4.4.1.1 Missing Model Parts Problem: After studying the as-is process, this cause happened because some parts were missing without monitoring. When the time passed, those unused parts become obsolete and cannot be bought from the original suppliers.

Figure 4.6: To-be Process Showing the Prevention of the Missing Model Parts Problem

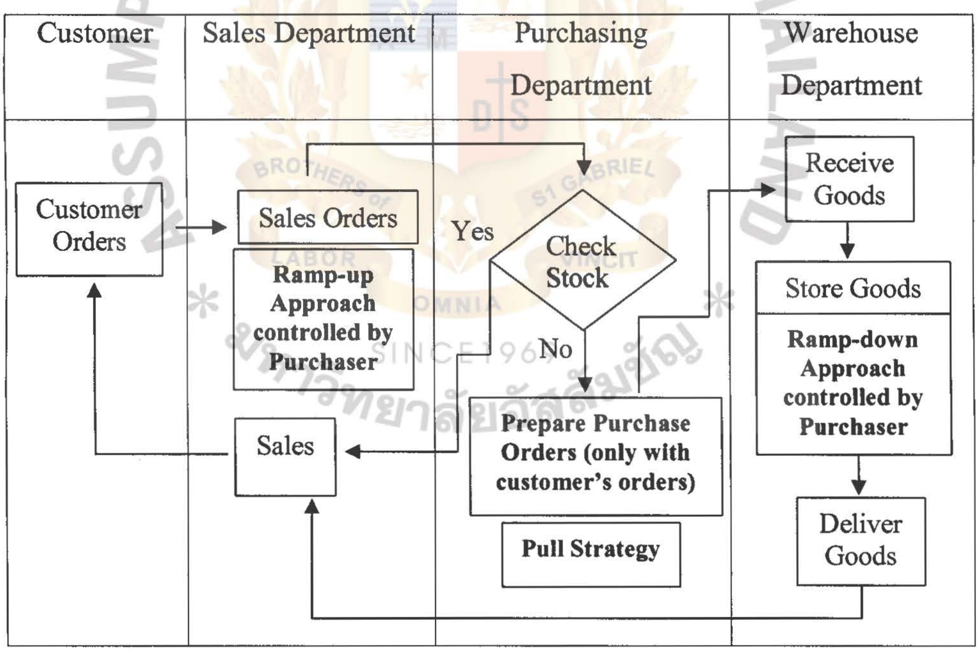


Source: Author

Figure 4.6 is the to-be process that shows the prevention of the missing model parts problem. Product sets should be monitored by purchasers and purchasers have to check frequently to ensure that all parts are in complete set and are available for sale to customers in set before those parts become obsolete. If some parts are missing, purchasers have to quickly place the parts order and send them to the suppliers.

4.4.1.2 Purchasing Items without Customer Order Confirmations Problem: To improve the process and prevent these items to turn into dead stock, it is suggested that most items that have been brought to stock have the purchase orders or order confirmations from customers in order to make sure that they will be used.

Figure 4.7: To-be Process Showing the Prevention of Purchasing Items without Customer Order Confirmations Problem



Source: Author

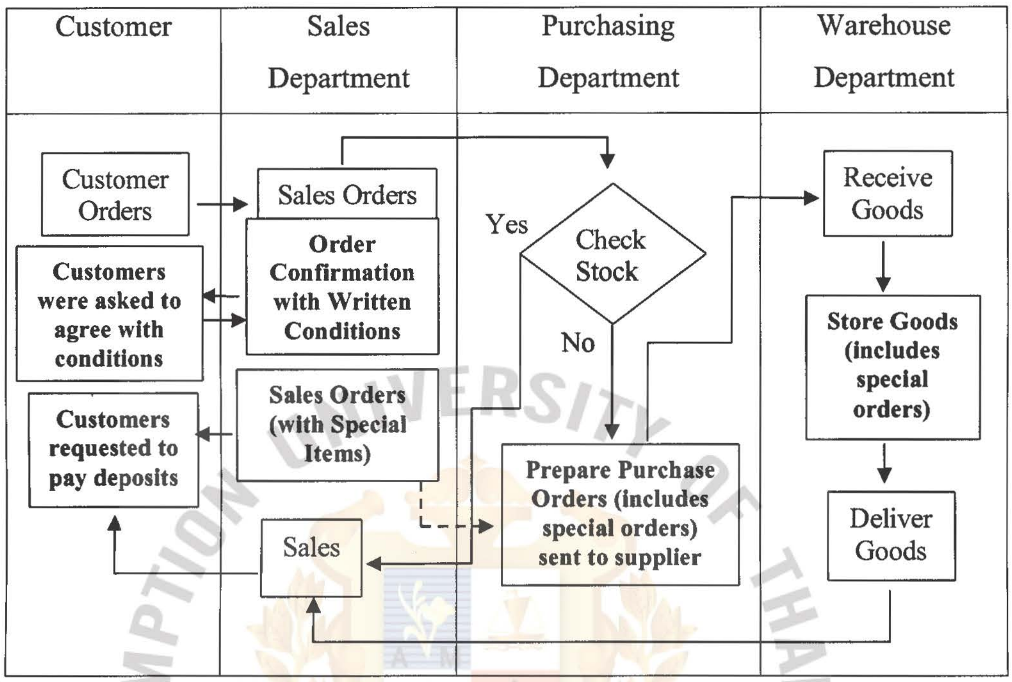
Figure 4.7 is the to-be process that shows the prevention of purchasing items without customer order confirmations. It is normal that company forecasts the stock; however, by eliminating the sales forecast from the current as-is process and implement the pull inventory control system, it can help reduce dead stock by some certain degree. The process should start with a customer's order. With this strategy, a company will only purchase enough products to fulfill customer's orders. Therefore, there will be no excess inventory. Once the company receives the goods, it will all be sent out according to the customers' order.

The company will also implement the Ramp-up/Ramp-down strategy in the workflow. The technique is to put purchasers in charge of this process and keep them actively involved with salespeople. The process begins when the salespeople request to buy new models. Purchasers should check first whether the old models have already run out; otherwise, purchasers have to push salespeople to sell old models first. After the old model has run out, now the company is ready to sell new models. This process is to balance between new models and old models in order not to make the company oversupply.

4.4.2 Customer Changed their Mind: This cause occurs because customers changed their mind about the specification of the goods even though they had already sent the company the purchase orders. Therefore, when the goods arrived, they refused to accept the goods. However, the company might establish the procedure. For example, if customers order products that are not the standard items, the company might request customers to pay some amount of money first as a deposit.

In addition, the researcher has checked the company's order confirmation (See Appendix D) and found that the company has no written evidence of order cancellation and didn't mention the delivery conditions to the customers. Thus, the company might change the commitment on the paper by adding one statement that the purchase order cannot be cancelled and might also add some delivery conditions and mention them in the order confirmation contract indicating that after the company receives the goods, customers must take out the goods within 60days.

Figure 4.8: To-be Process Showing the Prevention of Customer Changed their Mind

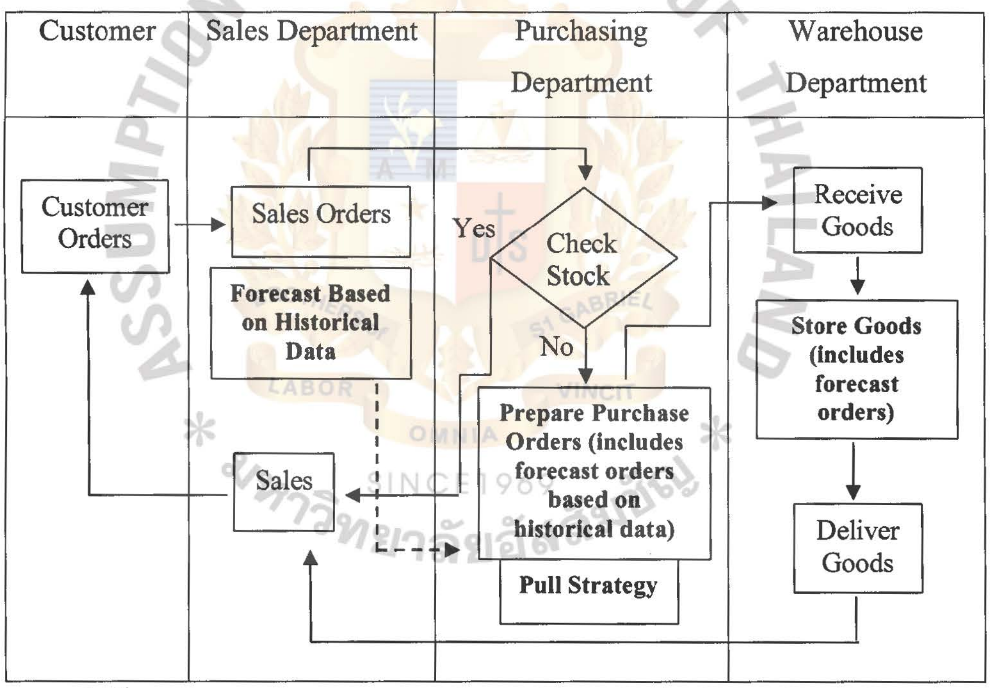


Source: Author

Figure 4.8 shows the to-be process that shows the prevention of customer changed their mind and it recommends the company to request deposits from customers in case they order special items. The reason why company may want customer deposits is the product ordered is customized and the deposited amount stands as an assurance for the company that the customer will buy and accept the product once completed. In this case, customer can also help the company to finance a part of the cost. Moreover, when customers place the orders, indoor sales teams should send the order confirmation contract with the written statement of no cancellation and delivery conditions to customers. This should be agreed by both parties; otherwise, the company cannot continue to process the orders.

4.4.3 Sales Forecast Error: After studying 9 SKUs (See Appendix E), the researcher found that all dead items are from the forecast orders of the salespeople and all items have no sales turnover history, which means that company has never sold them before, but they were purchased it anyhow. To reduce the company's dead stock, the sales forecast orders of products from the salespeople should be eliminated as the company cannot rely on salespeople to plan the stock based on their ideas or their feelings. It should be calculated based on historical data. Continued inaccurate assumptions could lead to the increase of dead stock. Moreover, the Retail Sales Manager said that one of the root causes of the sales forecast error is that items ordered are the new items, which they haven't sold before. Also, they didn't have much knowledge of the product and the market demand. They bought them because they just have an idea that they could sell it.

Figure 4.9: To-be Process Showing the Prevention of Sales Forecast Error



Source: Author

Figure 4.9 shows the to-be process that prevents the sales forecast error and suggests that the company change the sales forecasting method from salespeople-oriented ideas to be based on historical data. Changing the inventory forecasting system from uncertainty to accuracy with proper planning can decrease products becoming dead stock. Basically, the products that arrived should have order confirmations from customers. Moreover, the company will purchase only items that have sales turnover history; otherwise, the company will not purchase those items. The company will only purchase a few quantities in case customers need the sample. In contrast, one major disadvantage is that it contains a high chance to run into delay shipments for non-stock items. This can leave the company to be unable to fulfill the order and contributes to customer dissatisfaction; however, the researcher had compared the sales turnover of each item and found that the cost to serve these non-standard items is not reasonable. As a result, the company should not keep stock of these items.

4.5 Control: The last step of DMAIC is the 'control' step. This step is to ensure that the proposed method of improvement is sustainable. It is an essential step to control the new processes to make sure that changes made are reducing dead stock in the long run and not to happen again. Performance measures of the improved process can also ensure success of changes implementation. In this case, the researcher has focused on three major causes and control methods of each to-be process of each cause will be explained as follows:

4.5.1 Obsolescence: There are two to-be processes that prevent obsolescence as there are two problems that cause obsolescence, which are the missing model parts problem and the purchasing items without customer order confirmations problem.

4.5.1.1 Missing Model Parts Problem: The company must negotiate with the suppliers that any replacement of the new models should be informed in advance in order for the purchasers to inform the salespeople to clear the stock of the old model first. Moreover, purchaser training on a regular basis about product knowledge is also important as they can know more about products and common parts that will help the company narrow down the quantity of part numbers.

4.5.1.2 Purchasing Items without Customer Order Confirmations Problem: Purchaser training on a regular basis about purchasing procedures, and analyzing stock movement are essential. For example, purchasers should buy only products to fulfill customer orders and purchasers should know which items should be purchased, set appropriate replenishment levels, and frequently update plans. Moreover, purchasers should carefully monitor the sales request to purchase items. The objective is to ensure that all items requested for purchase by salespeople are in use. Moreover, for the sales team side, salespeople should be well informed and have knowledge and information about causes of dead stock and the disadvantages of dead stock which can make salespeople collaborate for making changes for improvement and encourage salesperson to draw attention and put more concerns on getting confirmation from customers for every transaction.

4.5.2 Customer Changed their Mind: As mentioned earlier in the to be process, Figure 4.8, the company is recommended to request the customer to pay for deposits and state clearly in order confirmation in the part of terms of payment to prevent any changes. Moreover, the company should modify the software to automatically pop up in the system. The objective is to warn the indoor sales team in advance that the customer orders confirmations with the available goods should be delivered to customers within 60 days from the posting date of the goods arriving in the warehouse mentioned in the order confirmation contract. This could automatically help indoor sales team to ensure that all orders have been delivered to customers within 60 days after the goods arrived.

Figure 4.10: Delivery Schedule Monitor Report

Date: dd/mm/yy

Delivery Schedule Monitor Report

Order Date	Customer Name	Order Confirmation Number	Order Confirmation Value	Goods Received Date	No. of Days after Goods Arrived

Source: Author

Figure 4.10 shows the Delivery Schedule Monitor Report. This report must be generated by indoor sales team on a weekly or monthly basis. In the report, it should mention the order date, the customer's name, the order confirmation number and value, goods received date, and the number of days after goods arrived.

4.5.3 Sales Forecast Error: After the company changes the way to forecast, which is based on historical data. The company might make the forecast manually by one responsible person, which is Purchasing Manager while this responsible person has to work and coordinate with Salespeople accordingly to plan and adjust the sales forecast and stock. Moreover, Purchasing Manager has to monitor and control the sales forecast closely in order to make sure that the dead stock is not increased.

4.5.4 Overall Dead Stock Control

What gets measured gets managed; the report that essentially requires to be generated by the Warehouse Department is the Stock Aging Report. The company should also establish key performance measures for dead inventory, set a level of acceptable dead stock, and monitor slow-moving inventory through turn and earn reports to help ensure levels do not go up unintentionki8ally. The objective of generating the Inventory Aging Report is to make sure that the level of dead stock is still in an acceptable level.

Figure 4.11: Inventory Aging Report

Date: dd/mm/yy

Inventory Aging Report

Number of Non-Moving Days	**Value**	**Quantity (SKUs)**	**Value in Percentage (%)**	**Items Classification**
>360 day non-movement				
301-360 day non-movement				
Total				

Source: Author

Figure 4.11 shows the Inventory Aging Report. This report will be generated on a monthly basis by the Warehouse Manager and sent to the Purchasing Department and the Sales Department. Purchasing Departments must be responsible for monitoring those items with more than 360 day non-movement where the values of those dead items should be in an acceptable level. At the same time, the Sales Department must try to sell and promote both dead stock as well as slow-moving items to ensure that dead stock is not accumulated. Furthermore, the company can use the "ABC" classification to rename obsolete or slow-moving items as "D" stock to help them stand out in reports.

4.6 Summary

In conclusion, this chapter discusses the identification of the causes of dead stock by using the cause and effect diagram, pinpointing only the major causes using Pareto Analysis, and aims to understand the causes of dead stock by studying the as-is processes of each cause. After the researcher knows the areas that need improvement, to-be processes have been developed in order to solve each cause of dead stock. The control plan is also implemented to monitor to new processes to ensure success.

CHAPTER V

SUMMARY FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

In this chapter, the researcher provides the summary the findings followed by the conclusion of the research result, theoretical implications, managerial implication and the recommendations to clearly see the picture and guide for further research. The details will be discussed as follows.

5.1 Summary of the Findings

According to the main research question mentioned in the first chapter **"Can the Define-Measure-Analyze-Improve-Control (DMAIC) model reduce future dead stock of finished goods?"**, the explanation in the findings helps answer this research question. The previous findings showed in the Define step that the BBB Company held some amount of dead stock. Data between June 2012 and May 2013 had been collected and analyzed and it was found that 12.95% of the total stock is dead stock, which valued approximately THB1.7m. This study also found that dead items are from the Retail business, which contains the highest value in the Measure step. Therefore, the focus of this study was dead stock from the Retail business.

After that, Pareto Analysis was applied to the Retail Business's dead stock. The high impact dead items within the 80% highest value consisted of 34 items and were selected to analyze further to get to the root cause of the problem. Next, the cause and effect diagram was made to clearly explain the causes of dead stock in the Analyze step and it was found that there were 7 causes of the company's Retail business dead stock. Then, Pareto Analysis again was used to find the causes with the 80% highest value as they revealed the biggest causes to the problem, which were obsolescence, customer changed their mind, and sales forecast error. These 3 major causes had been studied further by analyzing the as-is processes. Next, the researcher identified areas of improvement in order to get the to-be processes in the Improve step. These will result in sustainable dead stock reduction. Lastly, in the Control step, the researcher proposed the control plan to ensure benefits made by changes.

The key benefits of using the DMAIC concept to reduce the dead stock are summarized as follows:

5.1.1 A reduction of dead stock can be made by implementing an improved ordering product process. Order to stock should be made only for fast moving items, not new items and slow-moving items.
5.1.2 A reduction of dead stock can be made further by mentioning the delivery conditions into the company order confirmation contract in which customers must take the goods within 60 days after the company received the goods.
5.1.3 Controlling the purchase of new items together with recognizing that certain old products/parts must be replaced and reduced can also help reduce the dead stock.

5.2 Conclusions

The purpose of this research is to reduce the future dead stock by using the DMAIC concept in order to improve the current inventory situation of BBB Company. Based on the data and information analysis, the researcher recommends the DMAIC model.

In this research, the DMAIC approach helps not only define the problem and the extent of the problem, but also helps the researcher to understand the underlying root causes of the dead stock. Then, it helps the researcher to further study the as-is process of each root cause and come up with the areas that need improvement. Then, to-be processes were developed in order to solve each cause of the problem and the control step has also been implemented to ensure the sustainable dead stock reduction.

5.3 Theoretical Implications

This case study used the problem solving approach by applying the Define-Measure-Analyze-Improve-Control (DMAIC) model. It focused primarily on solving recurring problems by fixing underlying processes and achieving lasting results. It is an effective tool for improving processes in inventory management. The DMAIC process is to define the problem, measure the extent of the problem, find the true underlying causes of the problem that leads to an unsatisfied result, identify ways to improve the current as-is process, and sustain the improvement effort.

5.4 Managerial Implications

This research can be a guideline for BBB Company to implement the proposed model to sustain dead stock reduction using the DMAIC model. The company can reduce dead stock not only in the short term by just selling dead stock in discounted price, but the company can also solve the dead stock problem in its root causes and can prevent it from recurring, which results in inventory reduction, cost-cut, improved profitability, and increased customer satisfaction.

5.5 Limitations and Recommendations for Future Research

This case study was conducted to identify the root causes of retail dead stock and sustain dead stock reduction of the Retail business by using the DMAIC concept only. Also, the conceptual framework may not correspond to other business processes due to different environments and timeframes. Limitations to this research are shown as follows:

5.5.1 This research mainly focuses on the Retail business's dead stock at BBB Company, the Construction Fittings Trading Company, not including the dead stock of other business sectors of the company.

5.5.2 The data of dead stock may vary in each time period, but this research mainly relies on the historical data of the last 12 months from the June 2012 - May 2013 time period.

According to the study, the focus is on dead stock reduction under the DMAIC concept of the Retail business. It is highly recommended that the study be applied to other business sectors of BBB Company to understand the root causes of dead stock in other business sectors. Furthermore, the company can use the DMAIC concept to apply to solve the problem in the other areas of business processes not only the dead stock problem.

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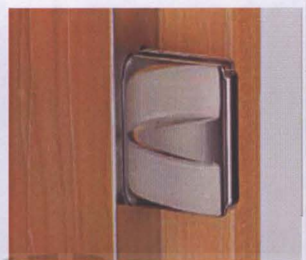
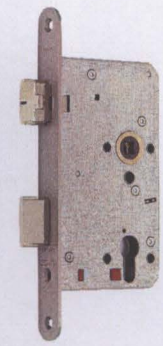
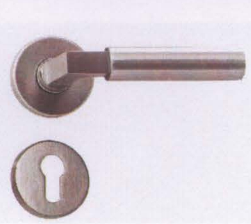
APPENDICES

APPENDIX A: BBB Company Products

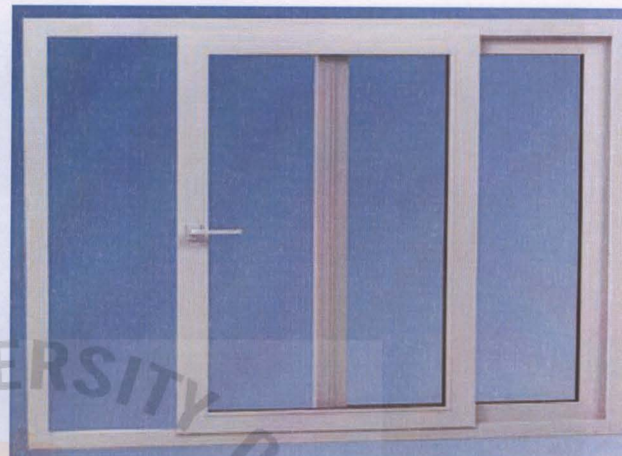
Door Technology





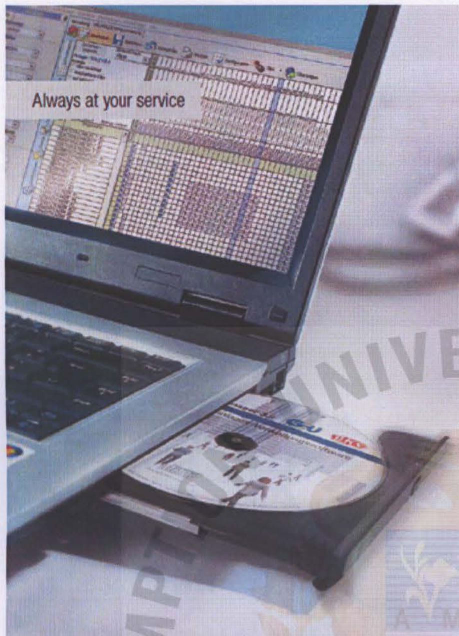


Window Technology



Automatic Entrance System

Management Systems – Software and Service



APPENDIX B: Retail Business Dead Inventory

No.	Material	Short text	Stock Value		Number of Non-moving Days	
1	L-15-0012	Double Facelock; w/o Key; Left&Right	158,886.00	THB	400	(no consumption)
2	L-15018-003-20L	Rhenocryl DSL 88 Futur Base C 20L Pail	110,324.20	THB	394	(no consumption)
3	L-15-0011	Double Facelock; Lockable; w/o Hook	101,325.00	THB	395	
4	L-1540591-0101	DORMA Floor Spring BTS84; EN4 HO; AL Acc	76,821.56	THB	400	(no consumption)
5	L-15-0049	Short Hook for Double Facelock	70,400.00	THB	365	
6	L-1575340-1011	HAUTAU SLIDING GEAR - BS17MM	70,351.60	THB	400	(no consumption)
7	L-1540591-0100	DORMA Floor Spring BTS84; EN4 HO; SS Pla	57,995.33	THB	400	(no consumption)
8	5345	SE electronic double knob cylinder	30,530.98	THB	400	(no consumption)
9	L-1575340-1007	HAUTAU SLIDING GEAR - BS17MM	27,348.06	THB	400	(no consumption)
10	9-09547-50-0-1	RUNNING RAIL P432 EVI	23,468.32	THB	400	(no consumption)
11	L-15018-004-5L	Rhenoplast KP1+ CCN Structure BaseA 5L	22,780.20	THB	395	
12	L-15018-005-20L	Rhenoplast KP1+ CCN Structure BaseB 201	21,956.84	THB	393	(no consumption)
13	6-30021-19-0-1	LIFT LOCKING GEAR 37.5 X 1235-1865 EV1	21,849.23	THB	365	
14	W751048-00-0-1	GASKET DV P 1483 LIGHT GREY 100M ROLL	21,323.25	THB	365	
15	6-35030-67-0-1	GU-timberstep 164	20,864.12	THB	400	(no consumption)
16	L-15014-026	Fric. Hinge18" SS201, 4bar; 14.5mm Side	19,872.00	THB	386	(no consumption)
17	L-1540214-0582	VBH FLOOR SPRING BTS 582- EN 3	19,325.93	THB	400	(no consumption)
18	L-1575352-00902	VBH ECO FRIC. HINGE 12'- TOPH	18,564.60	THB	400	(no consumption)
19	L-15018-030	Set of nozzles 2,0 mm for SATAjet 3000 R	17,912.50	THB	392	(no consumption)
20	L-1575000-0101	HOPPE WINDOW HANDLE- F1 SILVER	17,597.40	THB	400	(no consumption)
21	6-29890-33-0-7	Handle ADAGIO F/KD	16,330.05	THB	400	(no consumption)
22	L-1575200-0104	VBH PROFILE SET FS	16,221.18	THB	400	(no consumption)
23	L-15014-017	Fric. Hinge14" SS201, 4bar; 13mm Top Hun	15,726.00	THB	386	(no consumption)
24	L-15018-003-5L	Rhenocryl DSL 88 Futur Base C 5L Pail	15,209.10	THB	394	(no consumption)
25	K-16616-00-0-1	BAG ACCESSORIES 934/937 SCHEME C	15,000.40	THB	400	(no consumption)
26	G-22346-40-0-1	Gear, Variable 40	12,596.80	THB	400	(no consumption)
27	K-17017-00-0-8	L&S FORTE int/ext handle 180°/PC-hole/ss	12,166.84	THB	400	(no consumption)
28	L-1575412-2325	WINKHAUS GEAR GRM 2300/2 SL	10,652.54	THB	400	(no consumption)
29	C-90606-40-L-7	Casement handle with locking button	10,180.55	THB	365	
30	L-1540560-05002	DORMA Floor Pivot 8551 set; H:57mm	9,665.86	THB	400	(no consumption)
31	K-13204-00-0-1	BASIC BOX G.U-922, SILVER	8,852.92	THB	400	(no consumption)
32	6-30268-33-0-7	Handle DIRIGENT-F/KD, white	8,310.41	THB	400	(no consumption)
33	C-90507-02-P-8	Friction hinge ,HC	7,518.48	THB	400	(no consumption)
34	B-55600-23-4-8	Fingerprint for door assembly	7,489.57	THB	400	(no consumption)
35	G-22187-00-0-1	REBATE SHOOT BOLT ZH 2101>2350	7,129.80	THB	395	
36	6-30021-11-0-1	LIFT LOCKING GEAR 37.5 X 865-1285 EV1	6,720.50	THB	400	(no consumption)

No.	Material	Short text	Stock Value		Number of Non-moving Days	
37	UK-70097-00-0-1	Handle, Polished Silver L	6,488.70	THB	400	(no consumption)
38	C-92650-02-0-8	Floor Spring UTS650,150kg	6,431.25	THB	380	(no consumption)
39	L-1581000-10071	Rhenoplast HR1; 5L; Profil Cleaner	6,381.24	THB	400	(no consumption)
40	6-32991-14-0-8	SECURY AUTOMATIC 35/92/9/16/1050 PANIC	5,935.54	THB	400	(no consumption)
41	C-90506-02-P-8	Friction hinge ,HC	5,824.29	THB	395	
42	6-25370-00-0-9	JIG BI-FOLD GU-922/925	5,612.95	THB	400	(no consumption)
43	K-13269-00-0-5	BASIC BOX GU 925 BROWN	5,511.97	THB	400	(no consumption)
44	L-15018-020	Integral Tinting Paste TR11-01 tomato re	5,323.35	THB	392	(no consumption)
45	K-15166-25-L-7	Bag stay arm F 200, white	5,087.48	THB	400	(no consumption)
46	L-1575200-0101	VBH PROFILE SET FS	4,809.00	THB	400	(no consumption)
47	K-15800-00-0-6	Bag JET AK8,hinge side 14X18	4,649.10	THB	400	(no consumption)
48	K-15013-00-0-7	Bag stay arm F 200, white	4,589.40	THB	400	(no consumption)
49	L-15012-050	Camlock Handle, Left, NA1	4,577.00	THB	386	(no consumption)
50	C-90524-02-P-8	Friction hinge,LC	4,542.25	THB	400	(no consumption)
51	K-15800-00-0-7	Bag JET AK8,hinge side 14X18	4,382.70	THB	400	(no consumption)
52	9-33444-33-0-5	Cover profile F 200, 3050 mm, UC 5	4,265.59	THB	400	(no consumption)
53	L-15018-024	Integral Tinting Paste SG15-01 sulphur y	4,114.08	THB	392	(no consumption)
54	G-22171-00-0-1	Bolt, UniJet Rebate Shoot	4,064.10	THB	400	(no consumption)
55	L-1575415-2335	WINKHAUS GEAR GRMA 2300/2 SL	3,919.08	THB	365	
56	6-28012-20-R-1	Stay arm 751-1200mm	3,912.48	THB	400	(no consumption)
57	L-15018-019	Integral Tinting Paste VR10-01 traffic r	3,667.30	THB	392	(no consumption)
58	K-17375-00-0-1	Box accessories GU-934 schemes E/L SC28	3,599.40	THB	400	(no consumption)
59	K-17015-00-0-8	Handle FORTE w/o CB, with flush pull	3,530.43	THB	400	(no consumption)
60	6-28122-20-0-1	Stay arm JET T 20	3,527.92	THB	400	(no consumption)
61	6-31692-20-L-1	Stay Arm, Uni-Jet 751-1200	3,524.76	THB	400	(no consumption)
62	9-39311-67-0-1	Running rail 15 P 1635, EV 1	3,513.84	THB	400	(no consumption)
63	B 5490 0300	Connec.cable 10m for EK lock	3,497.80	THB	400	(no consumption)
64	H-00014-00-0-0	GU-PLAST ALUMINIUM CLEANER	3,429.00	THB	400	(no consumption)
65	G-19795-05-0-6	ROLL-LINE 50 Kg, FIXED	3,401.40	THB	400	(no consumption)
66	H-00909-16-0-5	Br2 6M roller case/vert./160cm, brown	3,304.79	THB	400	(no consumption)
67	L-15018-013	Integral Tinting Paste ZG04-01 zink yell	3,211.96	THB	392	(no consumption)
68	6-31692-20-R-1	Stay Arm, Uni-Jet 751-1200	3,029.78	THB	400	(no consumption)
69	6-25371-00-0-9	Jig, Handle Stop 922/925	2,926.08	THB	400	(no consumption)
70	L-1510790-1000	DORMA Panic Hardware; PHA2101	2,887.00	THB	365	
71	L-15012-030	Sliding Pull Handle, NA1	2,819.00	THB	391	(no consumption)
72	K-15166-25-L-1	Bag stay arm F 200, EV 1	2,692.08	THB	400	(no consumption)
73	6-31512-10-0-1	UNIJET STAY FOREND 1040 0951>1200	2,632.32	THB	395	
74	L-1575350-00625	ATRIUM HS 300;lift&slide Guide Track 550	2,568.32	THB	398	(no consumption)
75	L-15018-011	Integral Tinting Paste PV02-01 purpur Vi	2,474.80	THB	392	(no consumption)

No.	Material	Short text	Stock Value		Number of Non-moving Days	
76	6-24913-00-0-7	Rosette/F, white	2,446.20	THB	400	(no consumption)
77	L-1575452-0500	Winkhaus Keeper for GZMR SL WSK 21 Z SL	2,438.80	THB	400	(no consumption)
78	L-1545068-0011	VBH A60/A80 PROFILE- 2M	2,389.20	THB	400	(no consumption)
79	K-15169-00-L-1	Bag stay arm F 200, EV 1	2,247.08	THB	400	(no consumption)
80	K-14788-00-0-0	Drilling jig set for EURO-SOLID	2,085.14	THB	400	(no consumption)
81	L-1530097-6630	VBH Glass-Wall Shower Hin	2,068.64	THB	400	(no consumption)
82	9-33444-18-0-1	COVER PROFILE F2000 1800MM EV1	1,994.13	THB	400	(no consumption)
83	L-1575350-00331	ATRIUM HS 300- LIFT & SLIDE	1,992.76	THB	400	(no consumption)
84	6-31512-12-0-1	UNI-JET STAY ARM CONNECT PLATE 1201>1451	1,891.60	THB	400	(no consumption)
85	G-22124-00-0-1	GEAR, FIXED 15 GK 851>1100	1,769.00	THB	400	(no consumption)
86	8-00668-01-0-1	Locking plate	1,732.80	THB	400	(no consumption)
87	6-30427-60-0-7	DUCOSTRIP 24	1,714.78	THB	400	(no consumption)
88	L-15018-017	Integral Tinting Paste TS-08-01 deep bla	1,675.12	THB	392	(no consumption)
89	6-25575-00-0-9	JIG, FOLDING CATCH	1,599.33	THB	400	(no consumption)
90	9-39311-50-0-1	Running rail 15 P 1635, EV 1	1,535.18	THB	400	(no consumption)
91	6-32075-05-0-1	UNI-JET MIDDLE LOCK 530 721>1100	1,534.20	THB	400	(no consumption)
92	6-31852-20-0-1	TURN-ONLY HINGE 9/20 UNI-JET	1,532.60	THB	400	(no consumption)
93	K-14088-00-0-1	BAG PACKERS 922 925 HINGE SILVER	1,525.72	THB	400	(no consumption)
94	G-22790-25-0-1	UNI-JET GEAR F25 SRH 850-1100 L 940	1,507.35	THB	400	(no consumption)
95	K-15810-00-0-1	Bag of locking parts IS JET AK 8	1,491.25	THB	400	(no consumption)
96	L-1530097-6620	Glass-Glass Shower Hinge 90Deg.; 8/12mm	1,473.58	THB	400	(no consumption)
97	G-22791-25-0-1	GEAR JET F25 FIXED HANDLE SRH 1150-1530	1,457.60	THB	400	(no consumption)
98	L-1510090-6900	Knob Set; Entrance Fnct. BS 60mm; SS	1,417.23	THB	395	
99	B-72030-04-0-8	ROG RR Belc- H2.1 PZGL FS XM OV	1,370.89	THB	400	(no consumption)
100	6-32890-01-0-1	Drilling/milling jig mZ/oZ timber GR 8/9	1,336.44	THB	400	(no consumption)
101	6-32890-02-0-1	Drill/mill jig mZ/oZ PVC 9/13 timber 13	1,336.44	THB	400	(no consumption)
102	G-19638-00-0-7T	EURIS LOCK CF STANDARD WHITE 9010	1,297.44	THB	400	(no consumption)
103	9-39616-67-0-1	THERMOSTEP drip rail 126 P 1640	1,292.19	THB	400	(no consumption)
104	K-17016-00-0-8	Int. handle FORTE w CB 180°, flush pull	1,275.76	THB	400	(no consumption)
105	6-32100-50-0-7	Hand lever VENTUS F200, lockable	1,235.32	THB	400	(no consumption)
106	6-31245-00-0-1	Overload safety device	1,232.64	THB	400	(no consumption)
107	6-31674-20-L-1	Stay Arm, UniJet D 751-1200	1,180.60	THB	400	(no consumption)
108	6-31674-20-R-1	Stay Arm, UniJet D 751-1200	1,180.60	THB	400	(no consumption)
109	L-1575170-69081	VBH Turn Restrictor; 8 in	1,178.38	THB	400	(no consumption)
110	9-32230-50-0-7	Crank rod, 5000 mm, white	1,139.39	THB	400	(no consumption)
111	K-14194-00-0-7	Bag T angle F 200, white	1,129.24	THB	400	(no consumption)
112	K-14194-00-0-1	Bag T angle F 200, EV 1	1,086.20	THB	400	(no consumption)
113	6-28013-20-L-1	Stay arm M20/12 tilt-turn SRW 1201-1600	1,076.90	THB	400	(no consumption)
114	6-28013-20-R-1	Stay arm M20/12 tilt-turn SRW 1201-1600	1,039.00	THB	400	(no consumption)

No.	Material	Short text	Stock Value		Number of Non-moving Days	
115	K-13785-00-0-1	Bag handle inside 933/936, EV 1	999.93	THB	400	(no consumption)
116	K-15209-00-0-7	Bag additional locking F 200, white	974.74	THB	400	(no consumption)
117	6-28012-20-L-1	Tilt Turn Stay Arm L/H 751-1200	964.40	THB	400	(no consumption)
118	6-28011-20-L-1	stay arm	949.40	THB	400	(no consumption)
119	K-12608-00-0-7	Swivelling lever handle F 200, white	930.14	THB	400	(no consumption)
120	L-1575002-3011	Cockspur Handle; Type3 Side; Left; White	911.81	THB	400	(no consumption)
121	6-29495-10-0-7	Flexible transmission, white	897.86	THB	400	(no consumption)
122	K-12608-00-0-1	Swivelling lever handle F 200, EV 1	854.82	THB	400	(no consumption)
123	C-90610-00-R-1	Casement handle,Cockspur	814.20	THB	395	
124	6-29495-07-0-1	Flexible transmission, EV 1	812.54	THB	400	(no consumption)
125	C-90132-00-0-7	Inline passive lock	785.91	THB	365	
126	K-13334-00-0-1	BAG FOLDING CATCH 922 925 SILVER	757.83	THB	400	(no consumption)
127	6-31853-20-0-1	TURN-ONLY HINGE UNI-JET 13/20	751.32	THB	400	(no consumption)
128	G-46730-00-0-1	AXIAL HINGE 2-PART 84mm EV1	751.00	THB	400	(no consumption)
129	K-15224-01-0-7	Box of sash braket VENTUS F 200, low	745.11	THB	400	(no consumption)
130	K-16718-02-0-7	JET-Middle lock, EV 1	744.88	THB	400	(no consumption)
131	6-25917-25-0-1	Gear 180°	709.52	THB	400	(no consumption)
132	L-1575428-0775	WINKHAUS TOP ROD OR1025/1 SL	689.20	THB	400	(no consumption)
133	L-1575425-0010	WINKHAUS CORNER DRIVE	681.60	THB	400	(no consumption)
134	K-15012-00-0-7	Basic box F 200 w/o lever handle, white	671.10	THB	400	(no consumption)
135	K-15012-00-0-1	Basic box F 200 w/o lever handle, EV 1	586.54	THB	400	(no consumption)
136	L-1575432-0006	WINKHAUS SHEAR SW22-20/9 RS SL	581.28	THB	400	(no consumption)
137	6-25918-25-0-1	Middle lock	554.24	THB	400	(no consumption)
138	K-16718-02-0-1	JET-Middle lock, EV 1	537.34	THB	400	(no consumption)
139	L-1575204-0110	SIEGENIA COVER CUP FS	495.66	THB	400	(no consumption)
140	6-35175-00-R-1	CORNER BEARING UNI-JET CC	473.28	THB	400	(no consumption)
141	6-23796-00-0-1	Corner hinge	461.24	THB	400	(no consumption)
142	K-15803-00-0-1	Bag of rebate shoot bolt IS, JET AK 8	457.38	THB	400	(no consumption)
143	6-28072-33-0-7	Handle DIRIGENT F 33mm - White/White	427.00	THB	365	
144	L-1575425-0015	WINKHAUS CORNER DRIVE	415.52	THB	400	(no consumption)
145	6-27782-25-0-7	Fl¨¹gelst¨¹tze F 200 f.Klapp ausw?rts	400.50	THB	400	(no consumption)
146	L-1577202-8000	Double Facelock; DIN R&L lockable; Black	376.97	THB	395	
147	9-33787-00-0-7	Fixing plate, white	375.14	THB	400	(no consumption)
148	L-1575486-1001	WINKHAUS CENTRE LOCKS	374.52	THB	400	(no consumption)
149	6-29313-00-0-1	Chain with rod clamps F 200	370.53	THB	400	(no consumption)
150	6-27782-75-0-7	Sash bracket	368.98	THB	400	(no consumption)
151	L-1575433-0001	WINKHAUS SHEAR HINGE SWS 3-6	367.22	THB	400	(no consumption)
152	K-13162-00-0-7	Bag hinged crank, white	354.38	THB	400	(no consumption)
153	6-32076-05-0-1	Lock, Middle 530 TT Bottom	352.02	THB	400	(no consumption)
154	K-15013-00-0-1	BAG STAY ARM F200 SILVER	342.08	THB	400	(no consumption)

No.	Material	Short text	Stock Value		Number of Non-moving Days	
155	L-1575489-0003	WINKHAUS SASH HINGE	324.38	THB	400	(no consumption)
156	6-35258-09-R-1	STAY ARM SIDE HUNG UNI-JET CC 9mm	321.92	THB	400	(no consumption)
157	6-35258-13-R-1	STAY ARM SIDE HUNG UNI-JET CC 13mm	321.92	THB	400	(no consumption)
158	L-1575432-0005	WINKHAUS SHEAR SW22-20/9 LS SL	288.33	THB	400	(no consumption)
159	L-1575486-0801	WINKHAUS CENTRE LOCKS	278.04	THB	400	(no consumption)
160	6-32076-07-0-1	Lock, Mid DK Bottom 951-1200	274.28	THB	395	
161	9-32740-00-L-5	End cap, UC 5	270.57	THB	400	(no consumption)
162	6-27782-50-0-1	Sash bracket	257.52	THB	400	(no consumption)
163	L-1575414-1601	WINKHAUS GEAR GRM 1600/1 SL	251.56	THB	400	(no consumption)
164	K-17726-00-0-0	HOLD OPEN DEVICE MECHANICAL OTS 633/634	231.80	THB	400	(no consumption)
165	9-33787-00-0-1	Fixing plate, EV 1	230.62	THB	400	(no consumption)
166	6-27995-04-0-1	Security stay EURO-SOLID	229.85	THB	400	(no consumption)
167	K-13165-00-0-1	Bag coupling horn	226.78	THB	400	(no consumption)
168	L-1577210-0041	VBH Sliding Door Roller No.2 bearing For	219.84	THB	397	(no consumption)
169	9-43605-02-0-1	Rosette outside PZ conered	203.70	THB	400	(no consumption)
170	K-17138-25-0-1	BAG OF LIMITING STAY W/FRICTION SLIDER	199.10	THB	400	(no consumption)
171	6-33278-00-0-1	locking plate	196.00	THB	400	(no consumption)
172	L-1575492-0001	WINKHAUS BOTTOM FRAME	195.72	THB	400	(no consumption)
173	G-18412-01-0-7	Bag of catcher	182.20	THB	400	(no consumption)
174	C-90254-35-0-8	Mill-in gear 90° F35, C groove 15/20	171.78	THB	397	(no consumption)
175	9-32740-00-R-7	cap right	165.06	THB	400	(no consumption)
176	6-32628-00-0-1	LOCKING PLATE UNI-ALU 2mm	161.40	THB	400	(no consumption)
177	L-1575452-0302	WINKHAUS T/T KEEPER	160.85	THB	400	(no consumption)
178	K-17138-15-0-1	Bag of limiting stay JET AK 8	159.90	THB	400	(no consumption)
179	6-22842-00-0-1	Muffe 8, silberfarbig	159.12	THB	400	(no consumption)
180	9-38261-00-0-0	Corner transmission F 200	147.06	THB	400	(no consumption)
181	9-33668-00-0-9	Protective cap	140.50	THB	400	(no consumption)
182	9-29526-00-0-1	L/S FLUSH PULL OUTSIDE 933/936 EV1	139.20	THB	400	(no consumption)
183	9-40467-00-0-1	Wedge plate	136.62	THB	400	(no consumption)
184	6-32075-15-0-1	UNI-JET MIDDLE LOCK 1450 1851>2100	133.04	THB	400	(no consumption)
185	8-00680-00-0-1	Reversing gear	132.22	THB	400	(no consumption)
186	L-1575452-0202	WINKHAUS SECURITY KEEPER	122.52	THB	400	(no consumption)
187	K-17205-02-0-5	Bag of Rosette inside PZ cornered	122.22	THB	400	(no consumption)
188	6-30534-00-0-1	GEAR REBATED F15_SECURITY LOCK	121.46	THB	400	(no consumption)
189	6-33585-00-0-1	Locking plate Se 20x8	119.52	THB	400	(no consumption)
190	9-43605-02-0-5	Rosette outside PZ conered	117.22	THB	400	(no consumption)
191	6-34096-13-R-1	CORNER HINGE UNI-JET SC GR 13	112.94	THB	400	(no consumption)
192	6-27674-48-0-1	LOCKING PLATE MUSHROOM	111.50	THB	400	(no consumption)
193	L-1575432-0011	WINKHAUS SHEAR SW40-20/9 LS SL	110.66	THB	400	(no consumption)

No.	Material	Short text	Stock Value		Number of Non-moving Days	
194	G-11071-00-0-1	Locking plate, 14/18	109.55	THB	400	(no consumption)
195	9-40444-00-0-1	Wedge plate	107.95	THB	400	(no consumption)
196	6-35648-09-R-1	SASH HINGE UNI-JET CC UNDERCUT FIT.GROOV	102.96	THB	400	(no consumption)
197	6-35648-13-R-1	SASH HINGE UNI-JET CC UNDERCUT FIT.GROOV	102.96	THB	400	(no consumption)
198	9-33807-00-0-1	Positioning plate	95.60	THB	400	(no consumption)
199	L-1575426-0060	Winkhaus Extension AZE SL	94.07	THB	400	(no consumption)
200	6-28023-00-L-1	Corner hinge UNI-JET M20/12, bottom	84.60	THB	400	(no consumption)
201	L-1575002-4030	Cockspur Handle; Type4 Right; Grey	80.43	THB	400	(no consumption)
202	6-30961-00-0-1	LOCKING PLATE FOR SHOOT BOLT ADJUST.	76.85	THB	400	(no consumption)
203	6-22916-00-0-1	Shoot bolt bottom	74.58	THB	400	(no consumption)
204	6-22917-00-0-1	Shoot bolt top	74.58	THB	400	(no consumption)
205	9-28888-00-0-1	GUIDING PROFILE	74.58	THB	400	(no consumption)
206	G-21099-18-0-1	SHOOTBOLT 18 x 8 x 120	74.58	THB	400	(no consumption)
207	9-40404-00-0-1	Alignment wedge for sash	71.60	THB	400	(no consumption)
208	9-33443-00-0-7	Cover profile, white	69.96	THB	400	(no consumption)
209	K-17205-02-0-1	Bag of Rosette inside PZ cornered	69.68	THB	400	(no consumption)
210	6-31657-13-R-1	WRONG OP.SAFETY DEVICE GROOVE 13 UNI-JET	66.77	THB	400	(no consumption)
211	L-1575452-0301	WINKHAUS T/T KEEPER	64.34	THB	400	(no consumption)
212	6-31657-13-L-1	Sash positioner w. WOSD + stop clip	63.69	THB	400	(no consumption)
213	6-27831-52-0-1	Locking plate for mushroom-shapeg pin	59.60	THB	400	(no consumption)
214	9-41479-40-0-1	SHOOT BOLTS D/K 400 mm	53.04	THB	400	(no consumption)
215	K-15224-01-0-1	Box of sash braket VENTUS F 200, low	44.59	THB	400	(no consumption)
216	K-15225-01-0-1	Box of angular sash braket VENTUS F 200	44.59	THB	400	(no consumption)
217	6-32155-02-0-1	Extension piece, bottom	43.82	THB	400	(no consumption)
218	5-21021-20-0-1	Rebate stay 24/200	41.51	THB	400	(no consumption)
219	K-15224-00-0-7	Box sash bracket F 200, white	41.13	THB	400	(no consumption)
220	5-21021-15-0-1	Rebate stay 24/150	37.67	THB	400	(no consumption)
221	A-02823-00-0-0	LOCKING BOLT 6,5MM PIN	33.82	THB	400	(no consumption)
222	6-28022-00-L-1	Cup-shaped corner bearing JET T 20	31.51	THB	400	(no consumption)
223	K-14837-00-0-1	Bag accessories EURO-SOLID	28.83	THB	400	(no consumption)
224	6-28020-00-L-1	Stay arm bearing JET T 20	27.40	THB	400	(no consumption)
225	9-34220-00-0-7	Angular cover F 200, white	27.05	THB	400	(no consumption)
226	G-14694-00-0-0	ENTRAINEUR PRISONNIER	25.38	THB	400	(no consumption)
227	9-34412-00-0-6	End cap, black	25.00	THB	400	(no consumption)
228	9-34412-00-0-7	End cap, white	25.00	THB	400	(no consumption)
229	K-14682-00-0-1	Bag accessories EURO-SOLID	24.60	THB	400	(no consumption)
230	K-14683-00-0-1	Bag accessories EURO-SOLID	24.60	THB	400	(no consumption)
231	9-32230-98-0-1	Crank rod F200, 980mm EV1	24.21	THB	400	(no consumption)
232	L-1575432-1001	WINKHAUS SHEAR COVER	24.15	THB	400	(no consumption)

No.	Material	Short text	Stock Value		Number of Non-moving Days	
233	L-1575433-0101	WINKHAUS SHEAR HINGE CAP	24.15	THB	400	(no consumption)
234	9-29525-00-0-0	1/2" SHOOT BOLT SLEEVE BRASS	23.04	THB	400	(no consumption)
235	K-14681-00-0-1	BAG OF ACCESSORIES EURO-SOLID	19.22	THB	400	(no consumption)
236	L-1575493-1601	WINKHAUS BOTTOM FRAME CAP	18.83	THB	400	(no consumption)
237	K-15816-00-0-1	Bag of slide IS JET AK 8	17.68	THB	400	(no consumption)
238	9-42796-00-0-1	Cover for corner hinges	12.44	THB	400	(no consumption)
239	9-42302-20-0-1	locking plate	11.62	THB	400	(no consumption)
240	9-36560-00-L-5	Cover, UC 5	8.71	THB	400	(no consumption)
241	9-36560-00-L-7	Cover, white	8.71	THB	400	(no consumption)
242	9-36561-00-L-5	Cover, UC 5	8.71	THB	400	(no consumption)
243	9-36561-00-L-7	Cover, white	8.71	THB	400	(no consumption)
244	9-36560-00-R-7	Cover, white	7.88	THB	400	(no consumption)
245	9-36561-00-R-7	Cover, white	7.88	THB	400	(no consumption)
246	9-34220-00-0-6	Angular cover F 200, black	7.70	THB	400	(no consumption)
247	9-36558-00-0-7	Cover, white	7.00	THB	400	(no consumption)
248	9-36559-00-L-5	Cover, UC 5	3.79	THB	400	(no consumption)
249	9-36559-00-L-7	Cover, white	3.79	THB	400	(no consumption)
250	9-36559-00-R-7	Cover, white	3.32	THB	400	(no consumption)
251	UK-00811-00-0-1	White Outer Hinge Packer	0.66	THB	400	(no consumption)
252	UK-00811-00-0-2	White 1mm Hinge Packer	0.66	THB	400	(no consumption)
			1,365,803.75	THB		

APPENDIX C: Retail Dead Items Caused by Obsolescence

No.	Material	Short Text	Stock Value		Non-Moving Days	Problems that cause to Obsolescence
1	L-1540591-0101	DORMA Floor Spring BTS84; EN4 HO; AL Acc	76,821.56	THB	400	Purchasing items without customer order confirmations
2	L-1575340-1011	HAUTAU SLIDING GEAR - BS17MM	70,351.60	THB	400	Missing model parts
3	L-1540591-0100	DORMA Floor Spring BTS84; EN4 HO; SS Pla	57,995.33	THB	400	Purchasing items without customer order confirmations
4	L-1575340-1007	HAUTAU SLIDING GEAR - BS17MM	27,348.06	THB	400	Missing model parts
5	L-1540214-0582	VBH FLOOR SPRING BTS 582- EN 3	19,325.93	THB	400	Purchasing items without customer order confirmations
6	L-1575352-00902	VBH ECO FRIC. HINGE 12'- TOPH	18,564.60	THB	400	Purchasing items without customer order confirmations
7	L-1575000-0101	HOPPE WINDOW HANDLE- F1 SILVER	17,597.40	THB	400	Purchasing items without customer order confirmations
8	6-29890-33-0-7	Handle ADAGIO F/KD	16,330.05	THB	400	Missing model parts
9	L-1575200-0104	VBH PROFILE SET FS	16,221.18	THB	400	Missing model parts
10	L-1575412-2325	WINKHAUS GEAR GRM 2300/2 SL	10,652.54	THB	400	Missing model parts
11	L-1540560-05002	DORMA Floor Pivot 8551 set; H:57mm	9,665.86	THB	400	Purchasing items without customer order confirmations
12	C-90507-02-P-8	Friction hinge ,HC	7,518.48	THB	400	Purchasing items without customer order confirmations
			348,392.59	THB		

APPENDIX D: Example of Order Confirmation

Order confirmation
215005687
Date: 07.10.2013 Page: 1 / 1

No.of customer	Salesperson
150041	Jarinya Pimpurch

Your Fax order No. PO-13V08246 dated 07.10.2013 by Pattama Boonnark
Indoor Sales: Makaporn Krancharoen E-Mail:
Created by: Pattama Boonnark

We thank you for order. We exclusively deliver on the basis of our General Delivery and Payment Terms and Conditions which can be ordered or inspected with our services or looked up on our internet page www.g-u.co.th.

Item	Quantity Date of delivery	Unit	Description of article	PU	Net Price in THB	Totalprice in THB
0010	14 11.04.2014	EA	L-15023-012 Connecting Bar	1	390.00	5,460.00
0020	30 11.04.2014	EA	L-15023-013 Connecting Wall	1	300.00	9,000.00
0030	48 11.04.2014	EA	L-15023-014 Connecting Glass	1	300.00	14,400.00
0040	15 11.04.2014	EA	L-15023-007 Glass-wall Fixing Bracket SS304, Satin	1	259.00	3,885.00
0050	14 12.11.2013	EA	L-15023-017 Bar 19mm 2.30m SS304 satin	1	460.00	6,440.00

Item Totals	39,185.00
Amount subject to VAT	39,185.00
VAT 7.00 %	2,742.95
Total	41,927.95

Terms of payment: within 60 days Due net
Terms of delivery: DAP,delivered at place

Authorized by ____________________

APPENDIX E: Retail Dead Items Caused by Sales Forecast Error

Material	Short Text	Stock Value		Date		Days since Consumption
L-15018-003-20L	Rhenocryl DSL 88 Futur Base C 20L Pail	110,324.20	THB	02.04.2012	394	(no consumption)
L-15018-004-5L	Rhenoplast KP1+ CCN Structure BaseA 5L	22,780.20	THB	01.04.2012	395	
L-15018-005-20L	Rhenoplast KP1+ CCN Structure BaseB 20l	21,956.84	THB	03.04.2012	393	(no consumption)
6-30021-19-0-1	LIFT LOCKING GEAR 37.5 X 1235-1865 EV1	21,849.23	THB	01.05.2012	365	
W751048-00-0-1	GASKET DV P 1483 LIGHT GREY 100M ROLL	21,323.25	THB	01.05.2012	365	
L-15018-030	Set of nozzles 2,0 mm for SATAjet 3000 R	17,912.50	THB	04.04.2012	392	(no consumption)
L-15018-003-5L	Rhenocryl DSL 88 Futur Base C 5L Pail	15,209.10	THB	02.04.2012	394	(no consumption)
K-16616-00-0-1	BAG ACCESSORIES 934/937 SCHEME C	15,000.40	THB	27.03.2012	400	(no consumption)
K-13204-00-0-1	BASIC BOX G.U-922, SILVER	8,852.92	THB	27.03.2012	400	(no consumption)