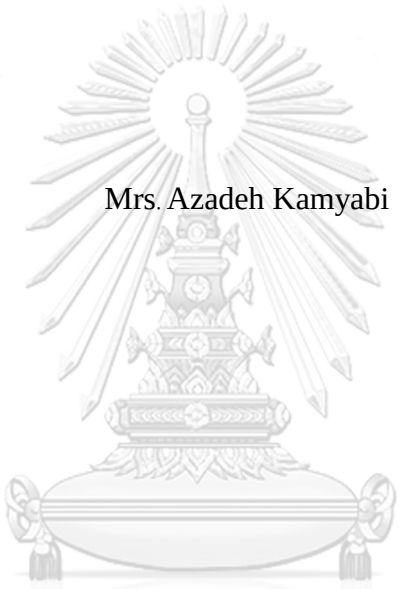
LOGISTICS BUSINESS PROCESS IMPROVEMENT IN A SPORT GEAR COMPANY

Mrs. Azadeh Kamyabi



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การปรับปรุงกระบวนการโลจิสติกส์ในบริษัทเครื่องกีฬา

นางอาซาเด คัมยาบี

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิศวกรรมศาสตรมหาบัณฑิต
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อาซาเด คัมยาบี : การปรับปรุงกระบวนการโลจิสติกส์ในบริษัทเครื่องกีฬา (LOGISTICS BUSINESS PROCESS IMPROVEMENT IN A SPORT GEAR COMPANY) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: โอฬาร กิตติธีรพรชัย, หน้า.

บริษัทจำหน่ายอุปกรณ์กีฬาขนาดเล็กซึ่งเป็นผู้นำด้านอุปกรณ์มวยสากลและมวยไทย ได้รับข้อร้องเรียนจากลูกค้าเกี่ยวกับการส่งสินค้าผิดพลาด ผลกระทบของการส่งสินค้าผิดพลาดก่อให้เกิด ความไม่พอใจของลูกค้า ค่าใช้จ่ายที่เพิ่มขึ้นจากการรับสินค้ากับและจัดส่งสินค้าใหม่ และการสูญเสียทรัพยากรและด้านเวลา ดังนั้นวัตถุประสงค์ของวิทยานิพนธ์ฉบับนี้คือปรับปรุงกระบวนการทำงานและกระบวนการโลจิสติกส์ฝั่งขาเข้าโดยใช้กรอบแนวคิดของ SCOR โมเดล และการจัดการสารสนเทศ หลังจากได้ตววจสอบข้อมูลของการส่งสินค้าผิดพลาดแต่ละรายการแล้ว ทางบริษัทได้กำหนดคณะทำงานเพื่อวิเคราะห์และค้นหาสาเหตุที่เป็นไปได้ทั้งหมดโดยอาศัยเครื่องมือทางการปรับปรุงคุณภาพอาทิเช่น ผังก้างปลาและการวิเคราะห์แบบ why-why จากนั้นจึงระดมความคิดเพื่อหาแนวทางการแก้ไขและจัดลำดับโดยวิเคราะห์ค่าความเสี่ยง (Risk Priority Number: RPN) เพื่อกำหนดแนวทางแก้ปัญหาหลักพร้อมเปรียบเทียบข้อดี-ข้อเสียของแต่ละแนวทางเพื่อนำเสนอผู้บริหารก่อนำไปประยุกต์ต่อไป จากการนำเสนอแนวทางที่บริษัทลือกที่จะประยุกต์ได้แก่ การปรับปรุงรหัสสินค้า การนำระบบคอมพิวเตอร์ช่วยจัดการโลจิสติกส์ฝั่งขาเข้า การฝึกอบรมระหว่างการทำงาน และ การประชุม หลักจากการประยุกต์ใช้แนวทางดังกล่าวตลอดเวลา xxx เดือนไม่ปรากฏว่ามีการส่งสินค้าผิดพลาดได้เกิดขึ้น ในฐานะส่วนหนึ่งของแนวทางการแก้ไข การประชุมรายงานประจำสัปดาห์ยังมีส่วนช่วยสนับสนุนการสื่อสารระหว่างองค์กรและช่วยให้ผู้บริหารจัดการแก้ไขปัญหาอื่นๆที่เกิดขึ้นได้อย่างรวดเร็ว ผลทางอ้อมของการโครงการอีกประการหนึ่งความถูกต้องของสินค้าคงคลังที่เพิ่มขึ้นและปริมาณสินค้าคงคลังที่ลดลง

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A small sports gear company, specialising in boxing and muaythai, is receiving complaints from customers due to incorrect shipments. The consequences of incorrect shipments are: customer dissatisfaction, higher costs due to returns and reshipments, and waste of time and resources. As a result, the objective of this thesis is to reduce incorrect shipments improving the internal logistics processes using framework of SCOR model and information technology management. Having investigated the record of each incorrect shipment, a working group of employees was formed to analyse and determine possible causes using quality improving tools such as fishbone diagram and why-why analysis. Each cause is given different priority using Risk Priority Number (RPN) and is discussed in detail for possible solutions. Advantages and disadvantages were evaluated before presenting the root causes and solutions to executive management for the final approval. This leads to four inter-dependent solutions, particularly a new coding system of all products, information system for inbound logistics process, on-site training, and regular meetings. After six months of implementation, there was no incorrect shipment. As a part of solutions, the weekly meetings and regular reports also promoted inter-organisation communication and allowed the management to identify issues promptly. As a result of improvement implementation time to response to customer order and time to prepare order from stock decreased, monthly sales from stock and total sales increased. Possible intangible benefits of the implementation include higher inventory accuracy and lower inventory level.

Department:	Regional Centre for Manufacturing Systems Engineering	Student's Signature	.....
		Advisor's Signature	.....
Field of Study:	Engineering Management		
Academic Year:	2017		

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CHAPTER 1. INTRODUCTION

This thesis will analyse the incorrect shipment issue, which a small sports gear company is facing and will attempt to resolve the root causes of this problem. This chapter will give a brief introduction to the company, its problem, the objective of the thesis, expected benefits and scope of study.

1.1 Company Profile

Founded in 1999, Company A is a rather small sports gear retailer, specializing in boxing and mauythai with the vision of bringing quality fight gear and equipment to the market. The company offers two different quality levels for products: expensive high quality, affordable lower quality. Upon customer's request, the company customizes the print and design to customer needs as well.

The company's office and warehouse are both located in Bangkok. The production is outsourced to other parts of Thailand, Pakistan and China. Products which are produced in Thailand are shipped directly to the customer. Products which are produced in China and Pakistan may be shipped directly to the customer or may be shipped to the warehouse first.

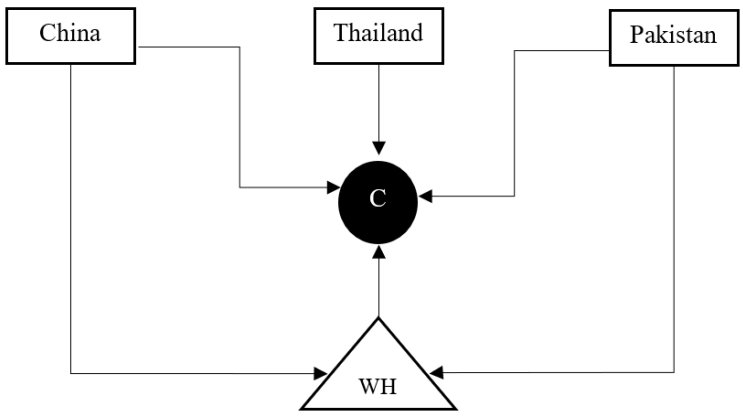


Figure 1-1 Products' journey from suppliers to customers. "C" stands for customer and "WH" stands for warehouse.

1.1.1 Organisational structure

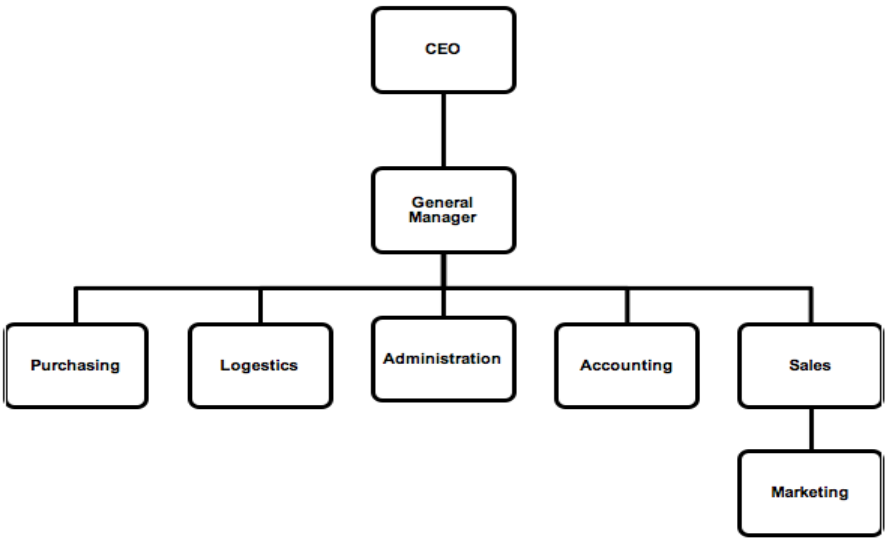


Figure 1-2 Organisation chart of Company A

As shown in Figure 1-2, in company A, the CEO is at the highest level in the company hierarchy and the General Manager works under him. The General Manager has responsibility for the functioning of the other six departments: Administration, Purchasing, Logistics, Accounting, Sales and Marketing.

The roles and responsibilities of the six departments are as following: purchasing finds suppliers, manages purchasing and runs quality control. Logistics manages the inventory and the shipment. Sales conducts the market research and reaches to the customers. Marketing prepares catalogues, art works and advertising for sales. Administration has administrative tasks. Accounting department manages the accounts and controls the payments coming in and going out.

1.1.2 Products

There are more than 150 different products available from Company A in an array of different sizes and colours. Due to this, there are more than 1700 unique products on invoices out of which only 600 unique products are kept in stock. Many businesses are supplied with the equipment falling under the following four product categories:

a) Boxing gear: All equipment which a fighter needs during training and competitions. These proudcts are manufactured in both Thailand and Pakistan. Most of the orders are from international customers and are custom designed, produced in Pakistan and sent to customers directly. Small orders are shipped from the warehouse in Bangkok, depending on availability of product in inventory. Large orders are shipped directly from the supplier in Pakistan to customer. Both domestic and international customers use small freight from Bangkok. Most of the customers for this product category are fitness gyms, boxing and muaythai gyms, national federations.

Figure 1-3 Example of products in boxing gear category

b) Gym Equipment: All equipment which a gym needs for conducting trainings or courses. This product category is only made to order and is never kept in stock. After receiving order from customer, the company places order with the

supplier, which is based in Thailand as well. Most of the customers for this category are fitness gyms, boxing gyms, national federations and sport event organisers.

Figure 1-4 Example of products in gym equipment category

c) Apparel: Anything that can be worn during or outside training and competition. This category of products is produced in Thailand only. The customers are gyms and national federations.

Figure 1-5 Example of products in apparel category

d) Accessories: Anything which can be added or attached to anything else, and does not fall into other categories. Figure 1-6 shows some of the products in this category. This category is produced in Thailand and the customers are gyms and national federations.

Figure 1-6 Example of products in accessories category

A summary of product categories is given in Table 1-1. This table is used later on to generating SKU coding.

Table 1-1 Company A product categories

Boxing gear	**Gym equipment**	**Apparel**	**Accessories**
Gloves Hand wraps Protection gear: Shin guards Knee guards Head guards Mouth guards Training equipment: Kick pads Belly pad Focus mitts ...	Boxing ring Punching bag Wall bag Tray ...	Shorts Singlet T-shirt Polo shirt Uniform Sweat suit	Key chain Car hanger Cap Skipping rope Boxing oil Mongkol Arm rings Sport bag

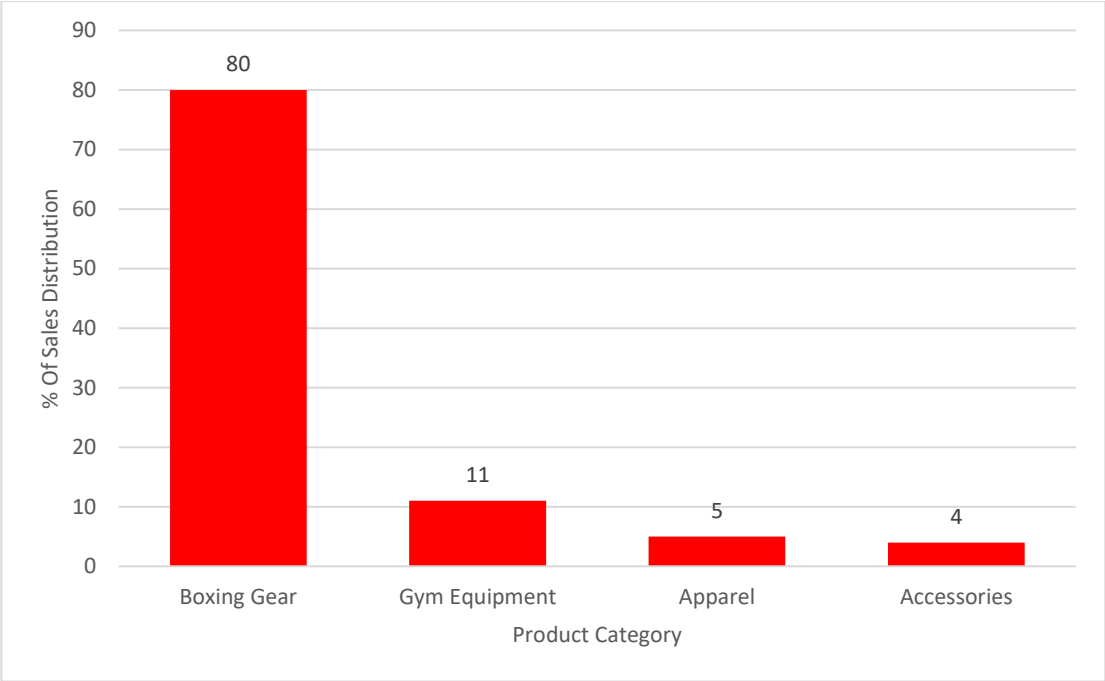


Figure 1-7 Percentage of Sales distribution by product category

The percentage of sales distribution by product category is shown in Figure 1-7. The highest selling product category is boxing gear, which is 80% of the sales distribution, and second highest selling product category is gym equipment, which is 11% of the sales distribution.

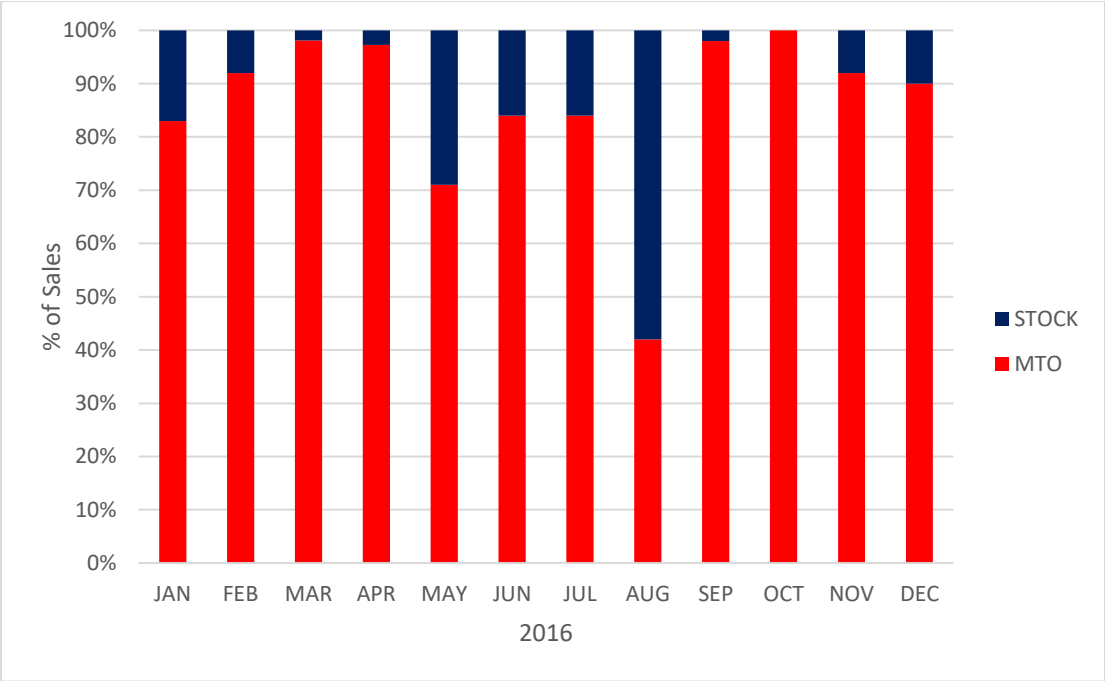


Figure 1-8 Monthly percentage of products which were sold from made to order to products sold from stock in 2016

Figure 1-8 shows the monthly percentage of products sold from made to order (MTO) to products sold from stock. The percentage of products sold from MTO is higher in most of the months. Only in August the percentage of products sold from stock is higher.

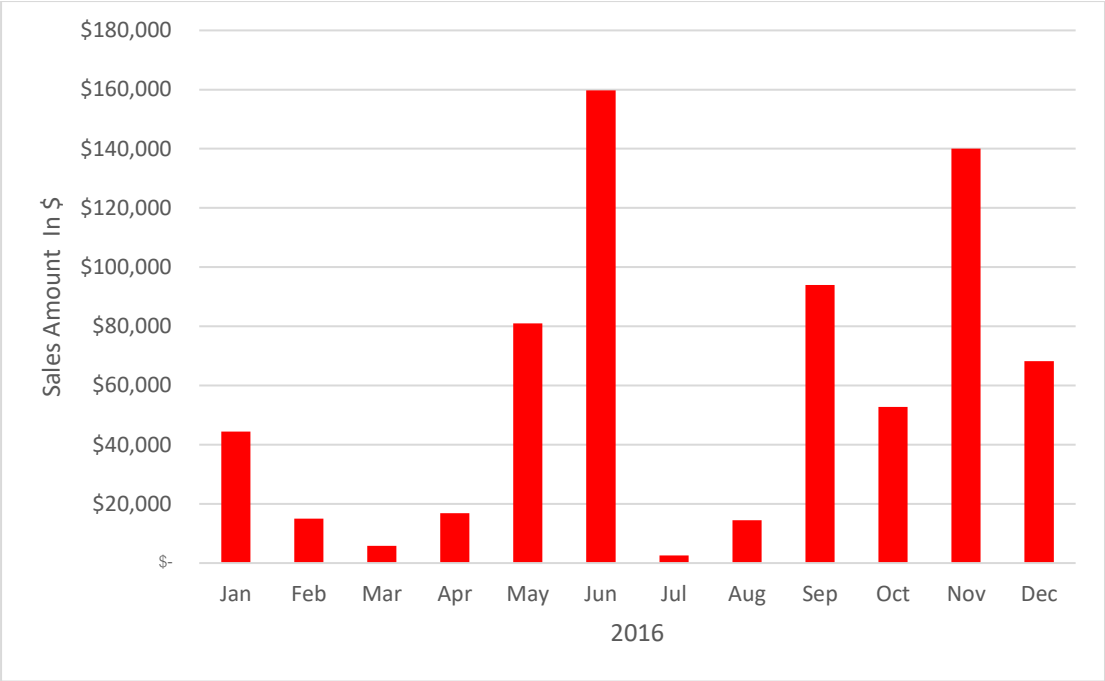


Figure 1-9 Sales of product categories per month in 2016

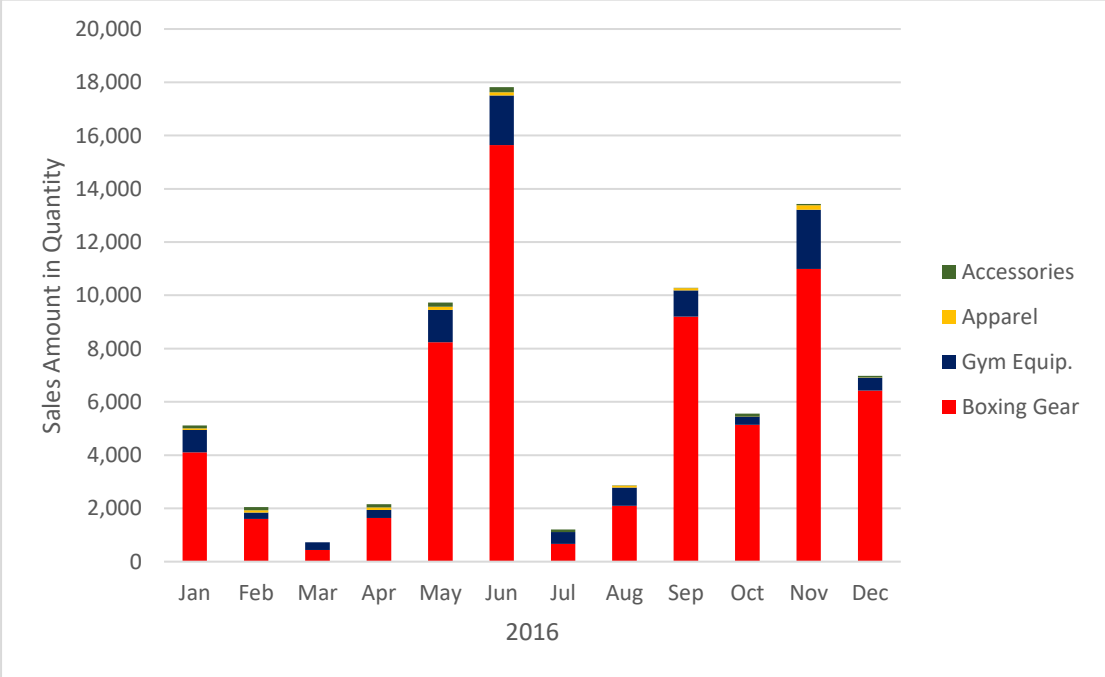


Figure 1-10 Sales per month in US Dollars in 2016

Figure 1-9 illustrates total sales per month in US Dollars in 2016. Figure 1-10 illustrates total quantity of sales of each product category per month in 2016. A clear increase in

sales of all product categories can be observed in the months of June and November, because the biggest customer orders products in those two months. The company does not hold inventory for this case. Large orders are made to order only.

1.1.3 Customers

The company's main customers are professional combat sports gyms, fitness gyms, event organisers and sport federations from various countries. The United States of America, Thailand and Australia are the largest markets.

In Table 1-2, the globally distributed customers of the company and the products they purchase mostly are shown. The customers are distributed domestically and internationally and most of them are private companies.

Table 1-2 Company's global customers

Code	Company	Country	Products	Annual sale
C1001	Private	Monaco	Boxing gear, Gym equipment	$ 4,270
C1002	Private	Italy	Boxing gear	$ 324
C1003	Private	Macau	Boxing gear, Accessories, Apparel	$ 785
C1004	Private	Korea	Boxing gear, Gym equipment	$ 651
C1005	Private	Sweden	Boxing gear, Gym equipment	$ 1,289
C1006	Public	Thailand	Boxing gear	$ 7,170
C1007	Private	England	Boxing gear, Accessories, Apparel	$ 2,745
C1008	Public	Australia	Boxing gear, Accessories, Apparel	$ 11,238
C1009	Private	Australia	Boxing gear	$ 1,080
C1010	Private	Australia	Gym Equipment	$ 450
C1011	Private	New Zealand	Boxing gear	$ 2,292
C1012	Private	Australia	Boxing gear, Accessories, Apparel	$ 4,550
C1013	Private	Switzerland	Apparel, Accessories	$ 320
C1014	Private	Spain	Boxing gear, Accessories, Apparel	$ 567
C1015	Private	Australia	Boxing gear	$ 140

Code	Company	Country	Products	Annual sale
C1016	Public	USA	Boxing gear, Gym equipment, Accessories	$ 525,378
C1017	Private	Australia	Boxing gear	$ 1,442
C1018	Public	Uzbekistan	Boxing gear, Gym equipment	$ 8,990
C1019	Private	USA	Boxing gear, Accessories	$ 1,122
C1020	Private	Korea	Boxing gear, Accessories	$ 330
C1021	Private	Australia	Boxing gear, Accessories	$ 1,568
C1022	Private	Australia	Boxing gear	$ 140
C1023	Private	France	Boxing gear, Gym equipment, Accessories	$ 3,450
C1024	Private	USA	Boxing gear	$ 780
C1025	Private	Korea	Boxing gear, Accessories	$ 1,116
C1026	Private	Australia	Boxing gear	$ 258
C1027	Public	Russia	Boxing gear, Accessories	$ 5,420
C1028	Private	USA	Boxing gear	$ 420
C1029	Private	Australia	Boxing gear, Gym equipment	$ 2,280
C1030	Private	Singapore	Boxing gear	$ 880
C1031	Private	Croatia	Boxing gear	$ 1.100
C1032	Private	USA	Boxing gear	$ 322

1.1.4 Marketing and Distribution

Direct channel is used as distribution method. The company is in direct contact with the customers. Advertisement is done by sponsoring athletes, events and charities. The company, procures a booth at competition venues during large sport events. Personal connections and relationships play an important role in maintaining business relationships with main customers.

1.1.5 Process Flowchart

The work procedure at Company A is as following: sales department receives orders from customers. After preparing the sales order and receiving confirmation from the General Manager, the sales order is sent to the Logistics department to check its

availability in the inventory. Then depending on the order and availability in inventory the General Manager decides whether to instruct the purchase department to make a purchase order or not. The purchase department then places the order with the supplier. Logistics department then manages shipment to the customer and the accounting department sends an invoice to the customer and records all transactions and manages the accounting.

The operation process of the company can be divided into three distinct processes:

- Expo and sponsorship; illustrated in Figure 1-11
- Small customer order; illustrated in Figure 1-12
- Large customer order; illustrated in Figure 1-13

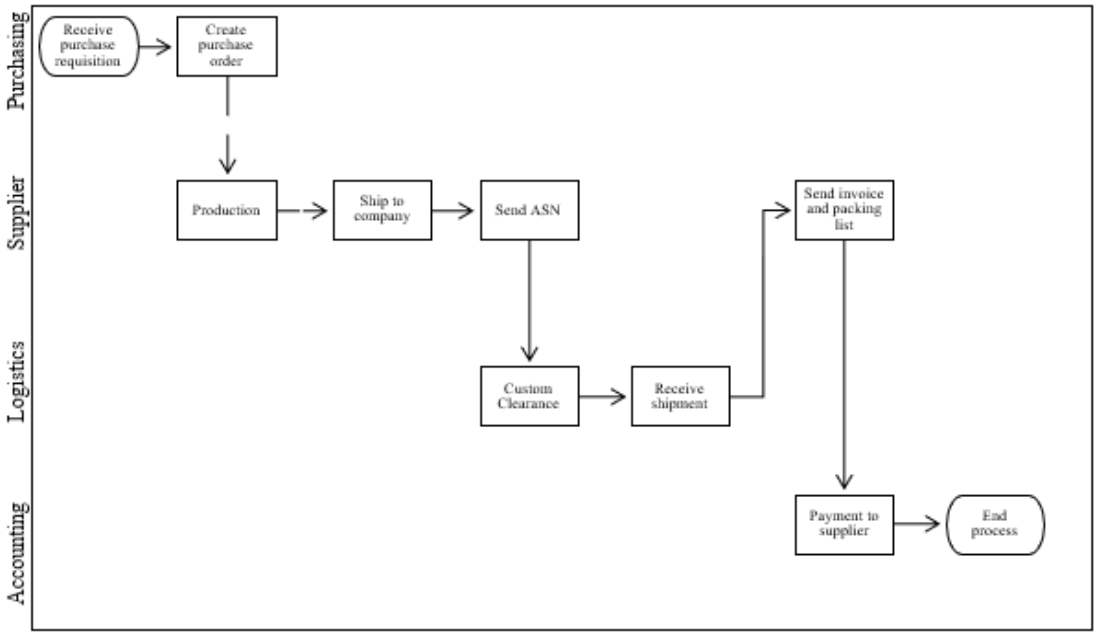


Figure 1-11 Expo or sponsorship

Figure 1-11 shows the operation process where the company orders products from supplier to present in expos or to sponsor events. In this process, the purchase department creates the purchase order and then sends it to the supplier. The supplier starts the production of the order, ships the finished goods to the company and sends the advanced shipping notification. Logistics department receives the shipment after custom clearance. At this stage, the supplier sends invoice to the company. The process ends with payment by the accounting department of the company.

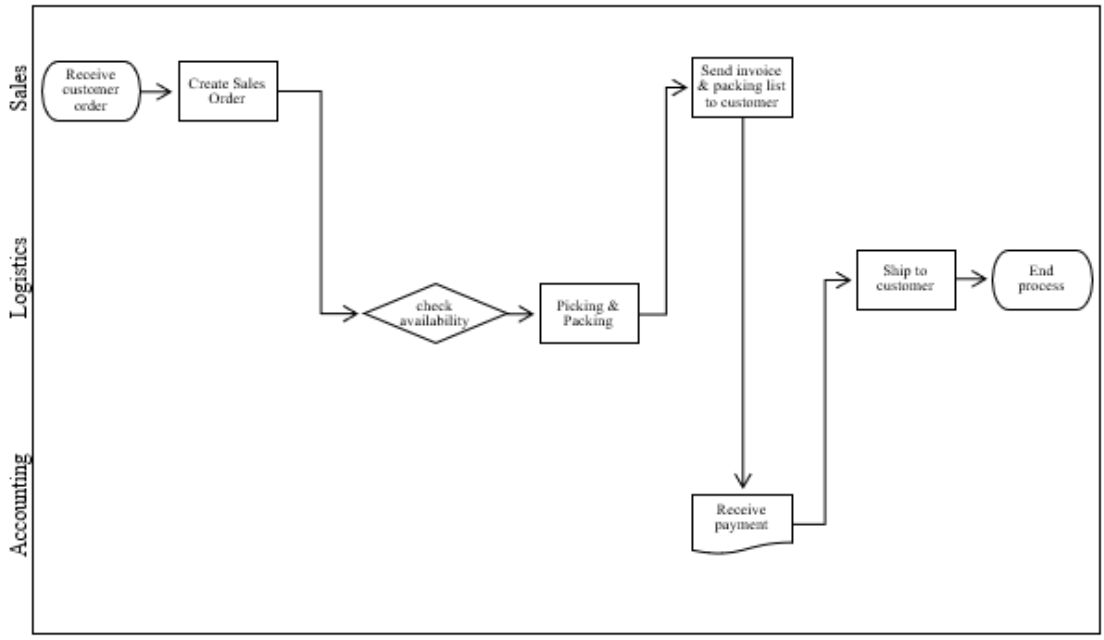


Figure 1-12 Small customer order

Figure 1-12 shows the operation process where the company has a small order from the customer. In this process, after the customer places order, sales department creates sales order. Logistics department will then check if the products are available in the warehouse. If the products are available in company's warehouse, then logistics starts picking and packing and accounting department sends invoice to the customer. Only after accounting department receives the full payment, logistics department ships the products to the customer and the process ends. But if the company does not have the products available in the warehouse, then purchase department has to create a purchase order to the supplier and the process follows the process explained in Figure 1-13, which is usually for large orders.

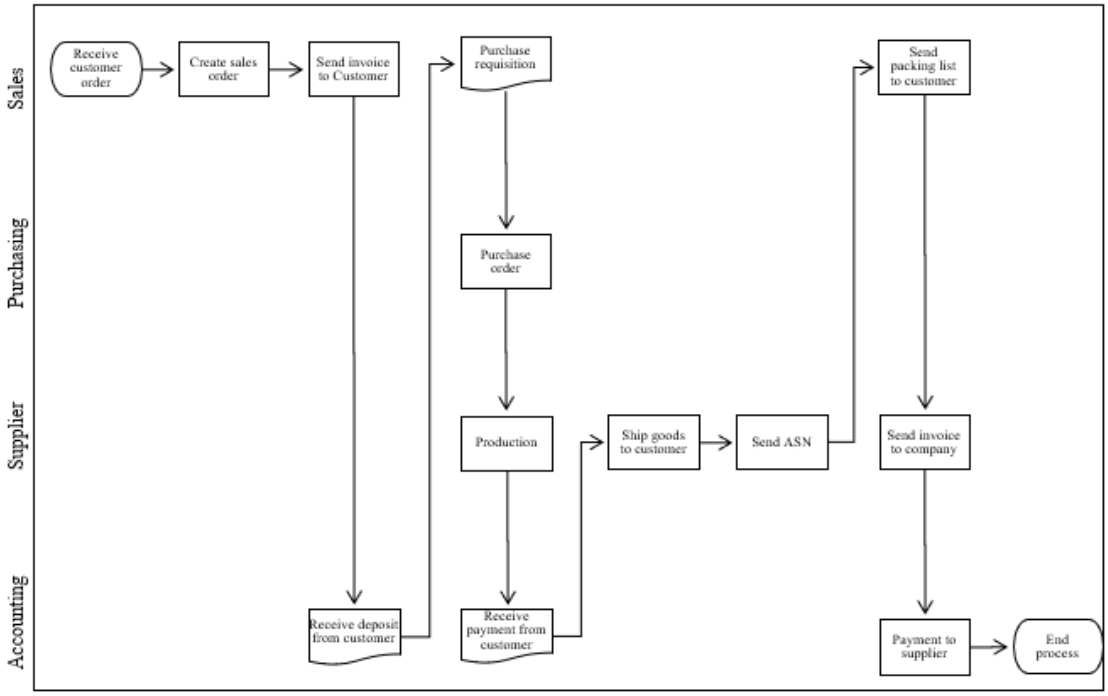


Figure 1-13 Large customer order

Figure 1-13, shows the operation process where the company has a large order from the customer. After sales department receives customer order, sales order is created and invoice is sent to customer to pay a 30 percent deposit. After accounting department receives the deposit, sales department requests the purchase department to make the purchase. Following this, purchasing department creates the purchase order and supplier starts the production. Only after accounting department receives full payment from the customer, supplier can ship the products to the customer and send advanced shipment notification. At this stage, sales department sends the packing list to the customer. Finally, the supplier sends an invoice to company A. Payments to the supplier are cleared every two months.

1.2 Problem Analysis

The company receives frequent complaints from the customers following incorrect shipments. An example of customer complaint can be found in Appendix A. Incorrect shipments are harmful to the company, as they result in dissatisfied customers and the company loses customers consequently. Returning the shipment and reshipment are waste of time, money and resources.

There can be a maximum of five shipments per month. Some of the shipments are partially or completely incorrect. Typical mistakes include wrong logo for custom made products or supplying boxing gloves in an incorrect size.

Table 1-3 Frequency and reason for incorrect shipments in 2016

Month	Freq.	Reason	Quantity	$	% of sale
Jan	1	Incorrect product specification (wrong logo)	920	4,400	10
Feb	-	-	-	-	-
Mar	-	-	-	-	-
Apr	-	-	-	-	-
May	1	Incorrect picking from warehouse	150	4,500	5.6
Jun	2	Incorrect product specification (wrong colour & wrong size)	220	5,220	3.3
Jul	-	-	-	-	-
Aug	1	Incorrect product specification (wrong material)	312	3,320	23
Sep	1	Incorrect product specification (wrong colour)	800	12,200	13
Oct	-	-	-	-	-
Nov	1	Incorrect picking from warehouse	20	600	0.43
Dec	-	-	-	-	-

As shown in Table 1-3, there have been incorrect shipments in the months of January, May, June, August, September and November. In January, wrong logos were printed on the products. In May, wrong items were picked from the warehouse. There were two incorrect shipments in June. One incorrect shipment was because of wrong colour and

the other incorrect shipment was because of wrong size. In August, products with different material were sent to the customer. In September, products with wrong colour were shipped to the customer. In November, wrong items were picked from the warehouse.

Investigation shows that the main problem lies in the purchasing and logistics departments. One main cause for incorrect shipment, is that there is no standard operating procedure. Another cause for incorrect shipments which can also be observed in Table 1-3, is that there is no unique name and ID for the products. Employees use different names on invoices and purchase orders every time, which results in misunderstandings between the company, customers and suppliers.

On the other hand, sales, purchase and inventory reports are not available for the CEO or the general manager to assess or evaluate the company's state. The creation of such reports would have a positive impact on future shipments.

In addition, there appears to be a disconnect between employees and the operation process. Employees seem to treat their job with ignorance and lack of attention. The Management allocates many people to each task and it is not always immediately clear which individual is responsible for which task.

1.3 Problem Statement

The company frequently receives complaints from its customers following incorrect shipments. Incorrect shipments have destructive impact on the company, as they result in dissatisfied customers and loss of customers. Returning shipments and reshipments, both cost the company time, money and resources.

1.4 Thesis Objective

The objective of this thesis is to reduce incorrect shipments, consequently number of customer complaints, by improving operation process and logistics process. In order to do so, SCOR model's KPI and best practice, Information Technology and reports will be adopted.

1.5 Expected Benefits

The main benefit resulting from this thesis is improvement of the business process flow and logistics process by implementing a new system and eliminating incorrect shipments. Additionally, the work efficiency of the employees is expected to increase and the high cost due to reshipment and rework is expected to decrease.

1.6 Scope and Limitations

The focus of this thesis will be on internal processes and people only. A new standard product coding syste,. A new standard product coding system and IT system will be set up using Excel as a primary tool. The new system will link sales, purchasing, logistics and accounting and will create a more logical and intuitive pathway for product sales.

The new system will have the ability to:

- Assign product codes and create product groups
- Store product description, cost and pricing
- Store customers' information
- Store suppliers' information
- Stocktaking
- Create sales, purchase and inventory reports for better decision making

Because of limited time, this study will be conducted only over six months and the system will not be customised to each user. External processes and factors will not be covered. This thesis will not go into changing processes and reorganization of the company.

1.7 Methodology

The following methodology is used to achieve the objectives of this thesis.

1. A theoretical overview of the literature
2. Preliminary analysis of the problem
3. Determination of improvement areas
4. Setting up a working group
5. Performing root cause analysis by combining why-why analysis and fishbone diagram, and FMEA analysis
6. Solution finding and implementation
7. Evaluating the system results using SCOR model KPIs

CHAPTER 2. LITERATURE REVIEW

2.1 Supply Chain Operations Reference model (SCOR model)

Supply Chain Council introduced SCOR model for supply chain management. SCOR model is a reference model for supply chain processes and acts as a communication language among supply chain partners and eases supply chain collaborations. SCOR model enables a framework for supply chain improvements, which covers everything from operational strategy to implementation of new practices. It functions as a roadmap.

Supply chain is processed from supplier's supplier level to customer's customer level by SCOR model. All interactions starting from the customer's order to customer's invoice are covered by this model. SCOR model describes the structure of the processes and makes it understandable. [1]

Figure 2-1 SCOR model framework [1]

This framework connects business process, performance metrics, best practices and technology features together to assist better communication. SCOR model helps to identify, measure, reorganise and improve a supply chain process and contains: processes, performance metrics, best practices and people. [2]

2.1.1 Process modelling and reengineering

SCOR has three levels of process:

- Level 1: This is the highest level of process. It describes the scope and content of the supply chain and focuses on the following five main management areas, which relate to the value adding activities, and define the scope of SCOR model: plan, source, make, deliver, return and enable. [3]These five management areas repeat themselves from the supplier's supplier level to the customer's customer level. [4]

- Level 2: This lower level process is the configuration level. The organisation can determine a configuration for their supply chain in order to implement their strategy. Each process can be described by its type (plan, execution, enable). [3]

  There are 26 processes at this level. Each process can be classified by product type: make to stock, make to order, engineer to order and retail product. For instance, the process "Make" from level 1 contains the following three sub processes:

  - M1: Make to stock, products produced according to a forecast.
  - M2: Make to order, products produced according to a customer order in a just in time manner.
  - M3: Engineer to order, blueprint of product is needed to start making [1]

- Level 3: This level describes the steps and elements required to perform the processes in level 2. At this level, the implementation of best supply chain management practices belonging to each of level 2 (M1.01, M1.02, etc....) can be initiated. This level contains 185 processes. [1] Level 3 contains:

- Definitions for process components
- Inputs and outputs of process components
- Performance metrics
- Best practices
- Required abilities of the system to back up best practices
- System [3]

2.1.2 Performance attributes and metrics

This section of SCOR model consists of performance attributes and metrics. Performance attribute sets strategic direction for the organisation and cannot be measured. Performance attributes are characteristics, which describe the supply chain and allow the analysis and comparison with other supply chains. The five performance attributes are divided into two groups: customer facing and internal facing as shown in Figure 2-2. [5]

Level 1 Metrics	Performance Attributes				
	Customer-Facing			Internal-Facing	
	Reliabilty	Responsiveness	Flexibility	Cost	Assets
Perfect Order Fulfillment	✔				
Order Fulfillment Cycle Time		✔			
Upside Supply Chain Flexibility			✔		
Upside Supply Chain Adaptability			✔		
Downside Supply Chain Adaptability			✔		
Supply Chain Management Cost				✔	
Cost of Goods Sold				✔	
Cash-to-Cash Cycle Time					✔
Return on Supply Chain Fixed Assets					✔
Return on Working Capital					✔

Figure 2-2 Performance attributes and Level 1 Metrics [3]

Metrics on the other hand measure the capability of the organisation to achieve these strategies. The performance of the organisation in their desired market position is measured by metrics. For each level in the process modelling there are specific metrics:

- Level 1: Metrics at this level, as shown in Figure 2-2, are associated with performance attributes and are high level measures. They are used by the top management for the measurement of overall supply chain performance. These are also called KPIs, Key Performance Indicators. [6]

- Level 2: Metrics at this level diagnose the metrics in level 1. They help to identify causes for gaps in performance for level 1.

- Level 3: Metrics at this level diagnose the metrics in level 2.

2.1.3 Best practices

After the performance gaps and problems, in a supply chain are identified and measured, best practices will be selected to create improvement. A best practice may have different results in different industries and supply chains. Best practices are connected to performance metrics and business process. [7]

The managerial operations and software solutions, which produce best outcome and improve performance, must be determined. Best practices must be current, structured, proven and repeatable. [1]

Realignment of supply chain processes and best practices to satisfy business goals can be achieved by different methods, such as:

1. Business process re-engineering (BPR)
2. LEAN manufacturing analysis
3. Six-Sigma analysis [2]

Best practices fall into three distinct groups: SCOR in general, green SCOR and supply chain risk management. Each of these groups have different best practices and different ways to improve a process. [7]

2.1.4 People

People are key assets in supply chain. Positive changes can be achieved in an organisation by people. People and their skills are matched to the organisation's process. Employees have to be trained according to the process, metrics and best practice. In SCOR model each skill is connected to the following key elements:

1. Experience, which is obtained by fulfilling tasks actively.
2. Talent, which is a natural capability.
3. Training, which helps people to obtain skills visa teaching.
4. Competency, which includes five levels: beginner, experienced beginner, competent, proficient and expert. [1]

2.1.5 Benefits

SCOR model helps an organisation to analyse its supply chain in detail. The five areas from level 1 repeat themselves. All five areas are important in order to pass the product successfully to the next level. By going through the levels of process, organisations can determine the problems in their supply chain and make improvements in their processes. [4]

2.2 LEAN

Toyota created Lean manufacturing as a management system which then underwent continuous improvements by other academics. Lean supply management reduces waste and hence increases efficiency, reduces cost of inventory by promoting production of small batches, adds more value for the customer and is customer driven. The main

concept is doing more with less. Skilled employees play an important role. There are six drivers which lead to a lean supply chain:

- Reducing waste in the supply chain
- Continuous improvement in the organisation
- Standardisation of business processes
- Engagement of people in the processes
- Collaborations
- Management of demand [8]

A few LEAN tools are: 5S, Kaizen, KPIs, Root Cause Analysis and Six-Sigma.

2.2.1 Kaizen

Kaizen is a mind-set and means continuous improvement. In this method, each employee has to contribute to take part in the procedure actively. The supply chain process goes through continuous evaluation and improvement. The continuous improvement can be applied to different areas of a supply chain such as time, resources and quality. Following steps have to be taken to form a Kaizen framework:

1. The area of concern has to be identified.
2. A working team consisting of helpful employees is set up.
3. Support and commitment from management is important for making changes.
4. The team should have a blue print of the current process.
5. The team should then be trained in lean manufacturing techniques.
6. The current state is analysed next and a current state value stream map is produced.
7. A proposal, including an action plan is prepared.
8. The new action plan by the team is handed over to the management.

9. Short-term plan is going to be implemented by the team members and the long-term plan is going to be assigned by management.
10. The action plan and the before and after performance are graphically presented.
11. Changes are implemented straightaway.
12. Results and improvements of the short-term action plan is presented to the management.
13. Management should show appreciation to the team members for the accomplished improvements. [9]

2.2.2 Root cause analysis

Root cause analysis is a systematic method which helps to find the real causes of a problem in a process and recommends actions to avoid their reoccurrence. Few different tools are joined together to perform a root cause analysis and a better result is achieved when it is performed by a team. The leaders in the analysis team, who identify the causes, are the ones who are responsible for elimination of the causes. [10]

Root cause analysis includes the following steps:

- Defining the actual problem.
- Identifying the causes and the effects, which cause the actual problem.
- Collecting data, which supports the cause and effect relationship.
- Identifying root causes, which are related to the actual problem.
- Determining and implementing corrective actions and solutions.
- Informing and following up with all employees about the results and lessons learned. [11]

2.2.3 Why-Why Analysis

Why-Why Analysis also known as, 5 Why Analysis, is a simple Root Cause Analysis technique which was introduced by the Toyota Production Team. It helps to identify the root causes by asking repeatedly "why?". This technique can be used individually when there is only a single root cause. When multiple root causes exist, then it is used in combination with Fishbone Diagram. Fishbone Diagram helps to make sure that no root causes are missed and determine relationship between them. [12]

This technique is applied in Kaizen and quality control and it can be visualised by using Fishbone Diagram. It is performed by:

1. Identification of problem.
2. Asking why did the problem happen. Brainstorming all the potential causes.
3. Asking again why did every cause happen.
4. Asking "why" over and over again until steps two and three are done for five times. Root cause should have been found by now.
5. Finding solutions to eliminate the root cause. [13]

2.2.4 Fishbone Diagram

Fishbone diagram (Ishikawa diagram, cause and effect diagram) is a root cause identification tool, which analyses possible causes of a problem in root cause analysis. It's a powerful tool which combines brainstorming and structured analysis. [10]

The Fishbone diagram is a constructive tool for revealing root causes of a problem and was originally developed for quality control in the Japanese automobile company, Toyota. This method is very similar to brainstorming. To assess all the root causes of a problem, all the inputs to a product or service should be considered and analysed.

Fishbone diagram is a simple, complete and structured method, which helps to find root causes to a problem in a short time by asking "why?" over and over. [14]

To implement this method, firstly, the problem has to be clearly described and written at the right end of the large arrow, as illustrated in Figure 2-3. The main categories of causes are identified and written on the arrows emerging from the large arrow. All possible primary and secondary causes in each category are brainstormed, written on the corresponding arrows and analysed to identify the root causes. [10]

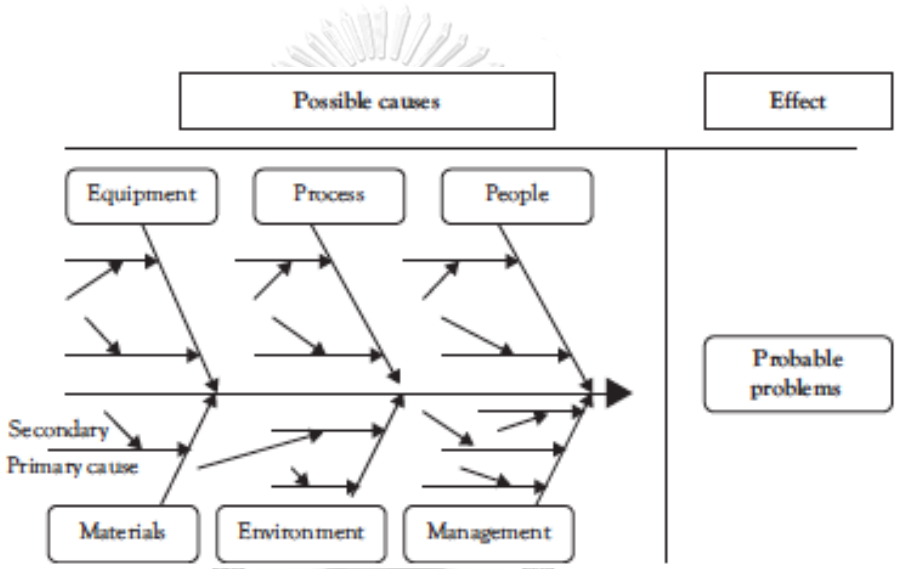


Figure 2-3 Fishbone diagram [14]

People using this method should be able to perform analysis objectively. All internal and external causes and various possibilities which have an influence on the problem must be considered during brainstorming. As shown in Figure 2-4, depending on the industry this method is being used in, there are different elements which have to be analysed. This method has shown positive results in identifying key performance areas. [14]

Manufacturing	• Machine (technology) • Method (process) • Material (includes raw material, consumables, and information) • Man power (physical work) • Mind power (brain work) • Measurement (inspection) • Milieu or Mother nature (environment) And more recently have added: • Management and money power • Maintenance
Marketing	• Product, service, or both • Price • Place • Promotion • People and or personnel • Positioning • Packaging

Figure 2-4 Popular cause categories in fishbone diagram [14]

2.2.5 Failure Mode and Effect Analysis (FMEA)

Failure Mode and Effect Analysis (FMEA), an engineering field technique, is applied to define, recognise and eliminate failure modes from the process [15].

The primary purpose of FMEA is to recognise the failure modes, assess the effects and the root causes of the failure modes and identify actions which can be taken towards reduction of occurrence of high risk failures. [16]

After identifying the failure modes, critical analysis is performed. The risk factor ratings for Occurrence, Severity, Detection are determined. FMEA allows the prioritisation of failure modes. So that the items with highest risk receive less resources. The Risk Priority Number (RPN) is calculated to prioritise failure modes. It is calculated by multiplying risk factors O, S and D. The three risk factors are chosen from a range of numbers between 1 to 10. A high RPN of a failure mode shows that failure mode is a high risk to the process. The failure modes can be ranked according to their RPN. Action can be taken against failure modes with higher RPNs. RPNs will be calculated again to see if the risks have been reduced by the actions taken [17].

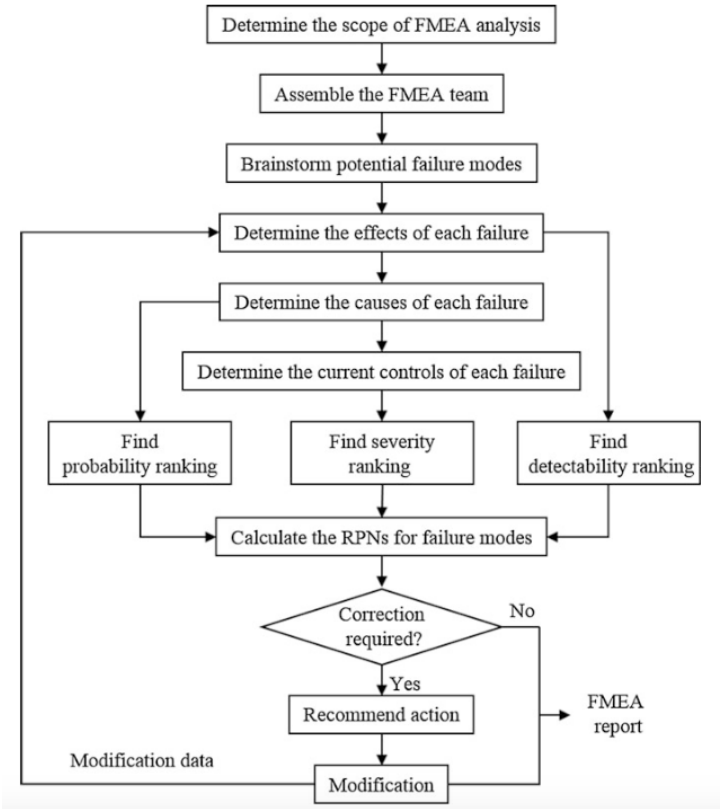


Figure 2-5 Steps of FMEA [17]

Figure 2-5 explains FMEA in a step by step manner. Firstly, the scope of FMEA has to be defined, in order to have clear boundaries to establish issues of the process and approaches.

Second step is to set up a team, because FMEA is a team work. The team must consist of people from different disciplines. They must be able to work in a group, and must have some knowledge about the task and the problems. The leader of the team must be well trained.

Third step is to understand the system to be analysed. This step is very important. The system must be divided into subsystems to identify components and their relations. For process FMEAs flowcharts and flow diagram worksheet can be used.

Fourth step is to have all failure modes and their effects brainstormed in sessions. Each component may have more than one failure mode and each failure mode may have one or more effects.

Fifth step is to determine the three risk factors (O, S and D) for all the failure modes which range between 1 to 10. 1 is the lowest and 10 is the highest. The description in the scoring system for each point must be clear so that everyone has the same understanding.

Sixth step is to calculate RPN of each failure mode by multiplying the three risk factors. By adding up RPNs of all failure modes before the recommended actions are taken and adding up the RPNs of failure modes after the recommended actions are taken, a comparison can be made. [17]

2.3 Business Process Reengineering

Business Process reengineering (BPR) is to rethink and redesign a process radically so that performance improvements in important areas, such as cost, profit, quality, service and speed can be achieved.

In order to create an entirely new process, the current process must be approached with a clear mind by the reengineering team. [18]

Due to the high competition which appeared in the 1990's in the market, BPR became a popular method to help organisations make performance improvements and reduce costs. After the 1990's, the organisations preferred to use other terms describing their reengineering process, such as business process improvement, business process redesign, business process innovation or business process transformation. [19]

2.3.1 Business Process

Business process consists of interrelated, controllable operations which are conducted by people and lead to a value adding product or service for customers. [20]

The efficiency of the business process matters as a whole, not that of individual departments. Every organization has many business processes. Business process reengineering is to change and redesign the existing business process to achieve higher efficiency and dramatic improvements. [18] BPR tends to change the orientation of a business from vertical management to horizontal. [21]

Built on Adam Smith's insight about fragmenting work into its components, businesses were originally divided into different departments, with each having certain responsibilities and tasks. His idea was that specialists performing single simple tasks have more efficiency than generalists engaged in performing the whole task. But this theory has its disadvantages. This type of business divides the employees into small groups and tells them to focus on their own task only. Therefore, the employees are not aware of their input step and objective of the whole business process. This develops bad customer service, because the employee is only focused on his/her own task and is not aware of the whole process, therefore is not able to offer solutions to problems a customer is having. Each department responses to customer in its own way. Too much time and resources is wasted on non-value adding tasks.

2.3.2 Process Mapping

Process mapping suggests mapping the current As-Is process and To-Be Process after reengineering and comparing them. The process, which is functioning the worst, is most essential for customer satisfaction and will most likely undergo a successful reengineering, needs to be identified.

2.3.3 BPR Structure

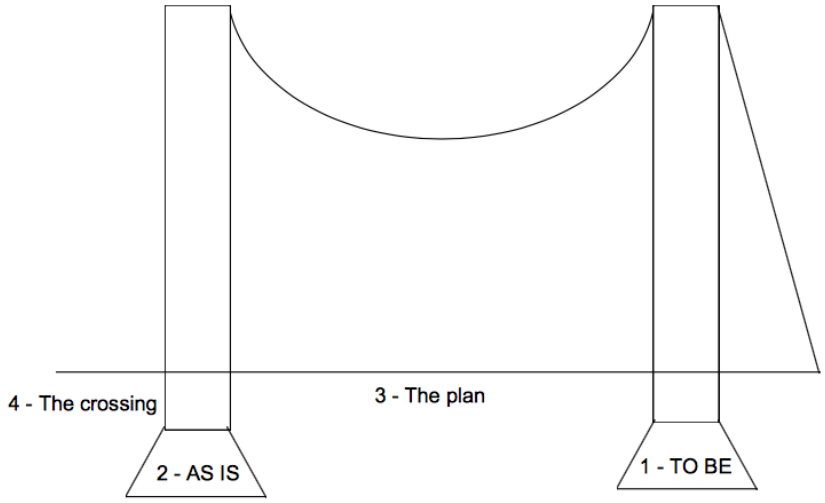


Figure 2-6 The four phases of BPR [22]

Figure 2-6 illustrates a structure for BPR projects consisting of four phases, which was proposed by Evans:

- Phase 1: To Be

  This phase describes the position, which the company wants to be, and therefore what the company needs from its business processes.

- Phase 2: As Is

  The running business processes of the company is described in this phase.

- Phase 3: The Plan

  In this phase, plans are made to make the transformation from the 'as is' phase to the 'to be' phase.

- Phase 4: The Crossing

  The plan is implemented in this phase. [22]

2.3.4 BPR Failure and Success Factors

Very often business process reengineering is assumed to be beneficial for all organisations. Therefore, as a result, there has not been enough information on its failures, where the failure rate is quite high. [23] But some organisations have successfully implemented Business Process Reengineering, such as Caterpillar Inc., which has been able to reduce costs by $10 to $20 million over five years. [24] Caterpillar has a structured problem-solving method. Its organisational structure enables an easy cross functional teamwork. [25]

The process of reengineering requires the support and commitment from top management, as the success of reengineering process depends strongly on the management.

A reengineering team is required to run the business reengineering process. The team is selected by the top management and reports to the head of the team or the top management. The team might consist of consultants from outside the organisation. The reengineering team identifies, rethinks and redesigns the process or processes which need improvement. The employees of the organisation are involved in the plan implementation stage. Due to possible occurrence of resistance from employees, it is essential that the reengineering team has strong communication skills. The team must be able to convince and motivate the employees to implement the new plan. The employees must be clarified that the new process is not going to replace them.

2.3.5 Role of IT in BPR

A successful business process reengineering includes redesign of information systems and information technologies. [19] Information systems supported by Information Technology systems have been used to assist the enhancement of business processes. Information Technology helps to reduce turnaround time, automatize or increase the

speed of present manual processes and reduce possibility of cheating and corruption. By proper application of Information Technology systems, organisations can benefit from increased precision, more work and reports in less time, increased quality of outcomes, improvement of products and services, faster communication within the team and with customers and higher efficiency. [26, 27]

After the reengineering process is over, the new process is ready to be implemented. In order to get the best out of combining Information Technology and Business Process Reengineering, it is important to train the team and the employees, who are the end users of the new IT system used to implement the new designed process. [27]

2.4 Summary of Literature

Ideas from SCOR model KPI and documents relating to internal logistics operation are applied in this thesis. All processes, elements and parties are related in a supply chain. The back draw of SCOR model is the need to use IT.

LEAN is an ideal framework for internal continuous improvement and changes organisation's top down culture. Kaizen aims for waste reduction and continuous improvement by team work. Properly selected KPIs motivate the team by measuring the performance improvement. Root Cause Analysis (fishbone diagram and why-why analysis) aims for a fundamental problem solving by elimination of root causes. All employees will contribute with clear tasks. LEAN is used as a method to align supply chain processes and best practices to satisfy business strategies.

Business Process Reengineering indicates the important role of standard information system and IT in the process of change and improvement and how information system can integrate all parties. BPR is also used as a method to align supply chain processes and best practices to satisfy business strategies.

CHAPTER 3. METHODOLOGY

In this chapter, the methods used to achieve thesis objectives are explained. Figure 3-1 illustrates the improvement framework. The preliminary problem analysis and determination of improvement areas were done in chapter one. In this chapter, after setting up a working group, the root cause analysis combining fishbone diagram and why-why analysis is performed to find the root causes of the problem. Next, FMEA analysis is performed to rank the root causes. Then, the actions to eliminate the high-risk root causes are determined and implemented.

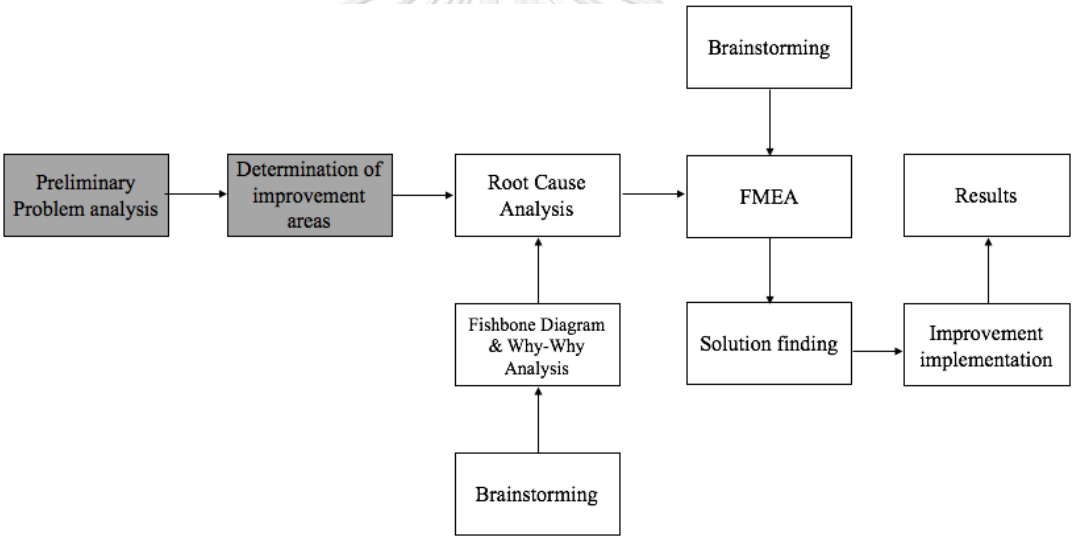


Figure 3-1 Improvement Framework

3.1 Working Group

A working group consisting of employees from every department was set up with the following duties:

- Discuss the problem in detail
- Perform root cause analysis (RCA) using fishbone diagram and why-why analysis

- Perform failure mode and effect analysis (FMEA)
- Find possible solutions to reduce or eliminate root causes based on SCOR model KPIs

In a meeting, where all staff attended, the CEO explained the purpose and duties of the working group and announced the decision to have all departments represented in the working group. Having people from different departments as a part of working group gives access to a large variety of ideas. Therefore, General Manager, administration, purchase, sales, logistics and accounting departments were all selected to be part of the working group.

3.2 Root Cause Analysis

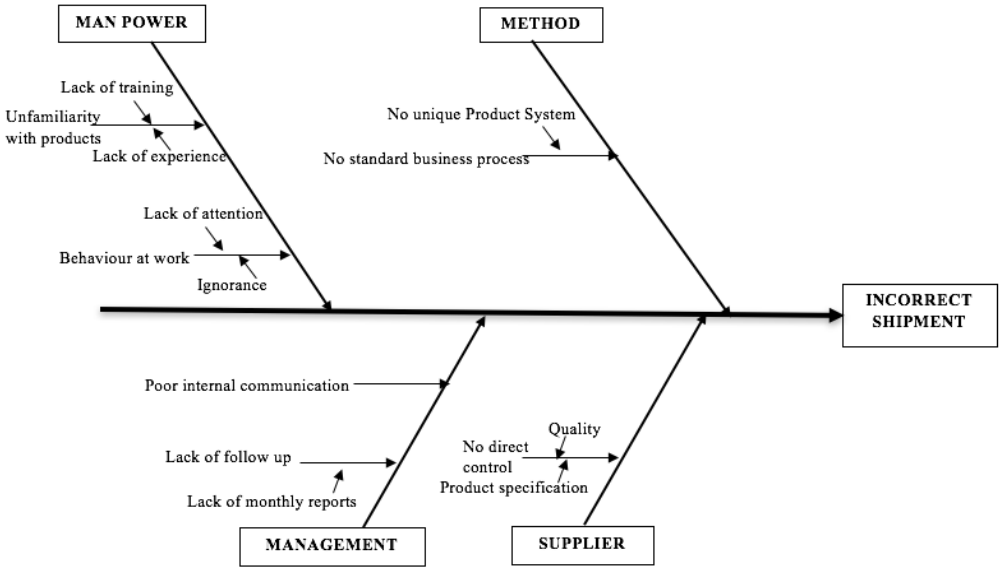


Figure 3-2 Fishbone Diagram for Company A

Root Cause Analysis is problem solving technique, which helps to find root causes of the problem before the solutions can be discussed. Fishbone diagram, is a root cause identification tool, which is used to determine root causes of the problem.

The root cause analysis was implemented by the working group, using the fishbone diagram tool in combination with why-why analysis tool. The problem was clearly described and written at the right end of the large arrow and the categories of causes were identified and written on the arrows emerging from the large arrow. Primary and secondary causes in each category were then brainstormed and written on the corresponding arrows. The resulting fishbone diagram is illustrated in Figure 3-2. The root causes of the problem "incorrect shipment" are categorised into four main areas, which are explained below:

- Manpower: One primary cause, which falls under this category, is unfamiliarity of the employees with products. And this is because the employees are not properly trained and do not have enough experience. There have been many incidents where sales or purchase department have used wrong name or specifications when communicating with customer or supplier and this was as a result of untrained and inexperienced employees. Another primary cause is employee's behaviour at work. The employees work with lack of attention and ignorance. Very often the employees seem not to care about their task results and the mistakes they make can be tracked back to their ignorance towards their work.
- Management: One primary cause falling under this category is poor internal communication. Many times, it has been observed that the employees are not aware of other departments' tasks and work status. The poor communication is not only between employees but also upwards with the CEO. Another primary cause is lack of follow up, because there is a lack of monthly reports. There have been many incidents where lack of weekly or monthly reports and hence follow ups by the management has resulted in incorrect shipment.
- Method: The primary cause under this category is lack of standard business process with unique product system as the secondary cause. The employees do

not follow a standard wok procedure and they assign different names and specifications to products every time. This causes mistakes and confusion for the customers, employees and suppliers and information is not stored properly.

- Supplier: Primary cause under this category is lack of direct control on the suppliers. The secondary causes are lack of direct control on product quality and product specification when shipping a new batch. Most of the suppliers are located outside Thailand, therefore the company rarely visits the supplier.

Table 3-1 shows a summary of the root causes from the fishbone diagram is shown in.

Table 3-1 Summary of the root causes for incorrect shipment

Root causes	
Man Power	
1	Lack of training and experience
2	Lack of attention and ignorance
Method	
3	Lack of unique product system
4	Lack of standard business process
Management	
5	Poor internal communication
6	Lack of follow up and monthly reports
Supplier	
7	Lack of direct control

3.3 Failure Mode and Effect Analysis (FMEA)

FMEA helps to determine where the priority should be given. FMEA was explained to the working group to make sure everyone understands the concept and purpose of it.

FMEA scoring system for severity, occurrence and detection is shown in Table 3-2. Severity is the seriousness of the effect to the customer and is rated between 1 to 5. 1 is

insignificant and 5 is catastrophic. Occurrence is the frequency of failure occurring because of that woot cause. It is rated between 1 to 5. 1 is unlikely and 5 is very likely. Detection is the probability of the problem being detected and acted upon before it has occurred. Detection rating is between 1 to 5, where 1 stands for high detectability and 5 stands for very low detectability. When no control exists, 5 is given as a score.

Table 3-2 FMEA scoring system

Risk Factors	Score	Definition of Risk
Severity	1	No direct effect on customer
	2	Minor effect on customer
	3	Definite effect on customer
	4	Major effect on customer
	5	Catastrophic effect on customer
Occurrence	1	Probability of one out of five shipments
	2	Probability of two out of five shipments
	3	Probability of three out of five shipments
	4	Probability of four out of five shipments
	5	Probability of five out of five shipments
Detection	1	Failure is 100% detectable
	2	Failure is detectable
	3	Failure is somehow detectable
	4	Failure is almost not detectable
	5	Not detectable at all

To perform FMEA analysis, which is illustrated in Table 3-3, the working group went through the following process:

1. The scope of FMEA is defined. The focus of the analysis is determined to be the shipment process.

2. FMEA is a teamwork. Therefore, FMEA team is set up, which is the same as the working group, who performed the root cause analysis. The working group consists of people from different departments.
3. The function shipment is identified as the system to be analysed.
4. The potential failure mode for shipment is determined to be incorrect shipment.
5. The potential failure effect is identified to be dissatisfied customers.
6. The potential failure causes, which are brainstormed in the root cause analysis section by the working group, are added to the FMEA form.
7. The current controls to prevent each failure cause is added to the form.
8. The three risk factors (O, S and D), which range between 1 to 5, are determined. 1 is the lowest and 5 is the highest. The description of each score is explained in Table 3-2, so that all working group members have the same understanding of the scoring system.
9. Finally, RPN is calculated by multiplying the risk factors S, O and D (RPN=S*O*D) to prioritise the root causes according to their RPN.

In the next section, possible solutions to the failure causes are brainstormed by the working group to lower severity or occurrence.

Table 3-3 FMEA carried out by the working group

Function	Failure Mode	Failure Effect	Severity	Failure Causes	Occurrence	Current Controls	Detection	RPN
Shipment	Incorrect shipment	Dissatisfied customers	4	Lack of training and experience	3	On the job training	3	36
				Lack of attention and ignorance	3	Double checking before shipping	3	36
				Lack of unique product system	4	None	5	80
				Lack of standard business process	4	Manual unstructured system	4	64
				Poor internal communication	1	Irregular meetings	2	8
				Lack of follow up and monthly reports	2	Infrequent verbal follow ups	3	24
				Lack of direct control	1	occasional visits to the supplier	2	8

3.4 Possible Solutions

The failure causes from FMEA form in Section 3.3 are arranged in the left column of Table 3-4 by descending RPN. The corresponding solutions to each root cause are brainstormed by the working group in a meeting session and listed in Table 3-4.

Table 3-4 Summary of Root Causes and solutions

Root causes		Solutions	
		Likely	**Unlikely**
1	Lack of unique product system	SKU coding	UPC
2	Lack of standard business process	Information system	-
3	Lack of training and experience	Training	-
4	Lack of attention and ignorance	Meetings	Control by penalty
5	Lack of follow up and monthly reports	Information system, Meetings	-
6	Poor internal communication	Information system, Training	-
7	Lack of direct control	-	

As shown in Table 3-4, the solutions are divided into two groups of likely and unlikely by the working group. Likely solutions, are the solutions that will be implemented and unlikely solutions are solutions which won't be implemented. The solutions and the reason why they were chosen to be implemented or not is explained in the next section.

3.4.1 SKU Coding

It is unanimously agreed that product IDs are lacking from the current system. This root cause has the highest RPN, implying its significant contribution to incorrect shipments. Creating unique product IDs will have highest impact on reduction of mistakes causing incorrect shipments. All departments will use same SKUs during their work procedure, which facilitates the process of checking product availability and prices, controlling inventory, monitoring transactions based on product and controlling purchase and sales. On the whole, it will increase efficiency and allow future growth. Due to the high impact this solution has, the working group decided to implement it and Microsoft Excel is selected as the tool to help with the product ID generation. A summary of pros and cons analysis of this solution is shown in Table 3-5.

Table 3-5 Pros and Cons Analysis for Coding as a solution

SKU Coding	
Pros	**Cons**
Employees will be able to follow a unique product system	Employees have to invest time in learning about the new product IDs
facilitates the process of checking product availability and prices, controlling inventory, monitoring transactions based on product and controlling purchase and sales	Confusion during transition
Increases efficiency	
Allows future growth	

3.4.2 Information System

Information system is a high impact solution as it is proposed to be a solution to more than one root cause. Lack of standard business process, lack of monthly reports for the manager to overlook the company's status and poor internal communication are the root causes for incorrect shipments. Additionally, lack of standard business process has the second highest RPN, implying its high contribution to incorrect shipments. Information system creates a standard and clear business process for the employees to follow.

Information system and SKU coding will be combined in the same Microsoft Excel file, as it is the simplest and least time-consuming tool to create, learn and implement. Microsoft Excel is already being utilized by the employees to carry out various tasks.

Although implementation of a new system and procedure using Excel would lead to confusion in the initial stages of the changeover, as it requires employees to learn and utilize it, it will have very high impact on the desired work procedure improvement.

Microsoft Excel will have the ability to:

- Generate unique product IDs,

- Keep record of all purchases and sales,
- Keep record of inventory on hand,
- Generate documents such as; inventory summery, purchase order and sales invoice.

This solution addresses more than one root cause and has high impact on improvement framework, therefore the working group decided to implement it despite the drawbacks. Table 3-6 shows a summary of the pros and cons analysis for this solution.

Table 3-6 Pros and Cons Analysis for information system as a solution

Information system	
Pros	**Cons**
Creates standard business process	May cause confusion at first
Excel is cheap, easy to learn and use	Requires employees to make effort
Improves internal communication	The implementation requires training
Keeps record of purchase, sales and inventory	Requires employees to take time off work to be trained
Creates inventory summary, purchase order and sales invoice	Employees may resist the change
Creates monthly reports and enables follow up for the manager	

3.4.3 Training

Training the employees is a possible solution to avoid or reduce mistakes caused by inexperienced employees who are, unfamiliar with the products. Training will help the employees to learn about the products, understand the business process and have better internal communication, and therefore avoid mistakes.

Training will have financial and time costs for the company and the employees must dedicate time and effort to the training. Additionally, the employees will most likely feel unhappy about being presented with new work instructions and resist the change. But lack of training and experience has the third highest RPN in the FMEA Analysis.

The working group decided that a full day training and a one month on the job training are necessary for successful implementation of the new system. Therefore, they decided to implement this solution. Table 3-7 illustrates a summary of the pros and cons analysis of training as a solution.

Table 3-7 Pros and Cons Analysis for Training as a solution

Training	
Pros	**Cons**
Employees will become familiar to the products	Financial and time cost for the company
Employees will understand and learn the business process and their role	Employees have to take time off work
Employees will learn how to communicate internally	Employees might feel unhappy about being thought new work instructions and having to change
Reduced mistakes	

3.4.4 Meeting

Having regular weekly meetings is a solution that can be implemented to avoid or reduce incorrect shipments. Ignorance and lack of attention of the employees and lack of monthly reports and follow ups, which respectively have the third and fourth highest RPNs, can both be addressed by this solution. Regular weekly meetings will oblige the employees to report back on their tasks from previous week and discuss upcoming weeks' target. Having to give individual reports on their work process at the weekly meetings, will make the employees feel more responsible and alert for their task results and will force them to make more effort towards better results. Reports help the management to stay informed of company's status and issues, to follow up and take actions accordingly. Therefore, the working group decided to implement this solution. The whole team, including the CEO and manager take time off work to attend the weekly meetings. Table 3-8 illustrates a summary of the pros and cons analysis of regular weekly meetings as a solution.

Table 3-8 Pros and Cons Analysis for Meeting as a solution

Meetings	
Pros	**Cons**
Employees are obliged to report back individually on their tasks	Costs time
Employees are more alert and feel more responsible for their task results	
Weekly and monthly reports help the management to stay informed of issues and take actions	

3.4.5 Universal Product Code (UPC)

Using standard UPCs is a possible solution to lack of unique product system which has the highest RPN in the FMEA Analysis, but UPC is mainly used for price reading and it is time consuming to implement. Hence, the working team decided not to implement this solution. Table 3-9 illustrates a summary of pros and cons analysis for UPC as a solution.

Table 3-9 Pros and Cons Analysis for UPC as a solution

UPC	
Pros	**Cons**
Helps to create unique product system	Time consuming
track the number of units sold during a specified time period	Tracks only basic information

3.4.6 Control by penalty

Controlling by penalty is another solution to lack of attention and ignorance of the employees which has the third highest RPN in FMEA Analysis. A penalty in cash will force the employees to be more alert and disciplined about their tasks and take their job serious. However, it is difficult to implement in a small organisation and may cause anger and negative work atmosphere. It requires clear job descriptions and a panel to make fair judgments according to approved KPIs. Hence, the working group decided

not to implement this solution. A summary of the pros and cons analysis for control by penalty is illustrated in Table 3-10.

Table 3-10 Pros and Cons Analysis for control by penalty as a solution

Control by penalty	
Pros	**Cons**
Employees will feel more disciplined	Employees might feel unhappy, pressured and therefore resist
Helps to reduce number of mistakes	May create a negative work atmosphere

3.4.7 Summary of solutions

The working group made the decision to implement the following four solutions: SKU coding, information system, training and meetings. These four solutions were selected, because all the root causes with high RPN are addressed by them. The solutions, including the solutions which are not going to be implemented, and their corresponding root causes are mapped out in table 3-11.

Table 3-11Cross checking root causes and the solutions

Solutions		SKU Coding	Information Sys.	Training	Meetings	UPC	Control by penalty
1	Lack of unique product system	√				√	
2	Lack of standard business process		√				
3	Lack of training and experience			√			
4	Lack of attention and ignorance				√		√
5	Lack of follow up and monthly reports		√		√		
6	Poor internal communication		√	√			

CHAPTER 4. IMPROVEMENT IMPLEMENTATION

The improvement implementation starts with coding of SKU and design of the information system. Before starting to implement them, a training and meeting is conducted. Table 4-1 shows the improvement implementation schedule in 2017.

Table 4-1 Improvement implementation schedule in 2017

Solutions	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Coding	Design							
Information sys.	Design		Implement					
Training		Implement						
Meetings		Implement						

4.1 SKU Coding

Stock Keeping Units (SKUs) are unique product identification codes, which are used to set up the information system, manage inventory and ensure that the correct products are shipped to the customer. All variations and types of products should have their own unique SKU. SKU is an abbreviation of the product specifications and should be easy to read, recognise and understand. Numbers and letters are both used as abbreviated attributes to generate a logical SKU.

The product goes through different processes. Therefore, SKUs will be used in different stages:

1. Adding new products
2. Checking product availability and prices
3. Customer orders and returns
4. Purchase and sales orders
5. Monitoring transactions and shipments based on product
6. Stock taking

A well-structured SKU makes it easy to recognise product, add new products and product groupings. It is best to have less than 14 characters and a combination of letters and numbers. The first step was to agree on product attributes, which were of highest importance and were most commonly mistaken by the employees. These attributes would then have to be included in the coding. The following attributes, in order of decreasing importance, were decided to be part of SKU:

- Category: As explained in previous sections, there are four distinct categories of products:

    a. Boxing gear: Equipment, which is required by athletes during training and competitions.
    b. Gym equipment: Equipment, which is used in the gyms for trainings and classes.
    c. Apparel: Anything, that is wearable on and off training and competition.
    d. Accessories: Anything, which can be added to something else for different purposes.

As shown in Table 4-2, the working group decided to allocate a one-digit number, between one and four to each product category, as the company is unlikely to have more product categories in the next five years.

Table 4-2 Coding of product categories

Category	**Code**
Boxing Gear	1
Gym equipment	2
Apparel	3
Accessories	4

- Brand: Currently there are eight different product brands. As shown in Table 4-3, a two-letter code was decided to be allocated to each brand name. The two letters were selected from the brand name itself to make it easy for the employees to recognise. The letters XX is assigned to products with no specific brand name.

Table 4-3 Coding of product brands

Name	**Code**
Contender	CT
MTG	MT
Chok	CH
Fight Life	FL
IFMA	FM
Custom	CC
EPIC	EP
UFC	UF
-	XX

- Product name: There are 23 different type of products. As shown in Table 4-4 a two-digit number was assigned to each product, because it is most likely that the company will have more products in each category in the next five years. Numbers between 10 and 22 were assigned to product names, which belonged to the boxing gear category. Numbers 40 and 41 were assigned to product names, which belonged to gym equipment category. Numbers between 60 and 64 were assigned to products, which belonged to apparel category. Numbers 80, 81 and 82 were assigned to products, which belonged to accessories category. There are numbers reserved for each category, as the quantity of the product names may grow.

Table 4-4 Coding for product names

Category	**Product Name**	**Code**
Boxing Gear	Gloves	10
Boxing Gear	Hand Wrap	11
Boxing Gear	Shin Guard	12
Boxing Gear	Knee Guard	13
Boxing Gear	Head Guard	14
Boxing Gear	Mouth Guard	15
Boxing Gear	Groin Guard	16
Boxing Gear	Breast Guard	17
Boxing Gear	Kick Pad	18
Boxing Gear	Belly Pad	19
Boxing Gear	Focus Mitt	20
Boxing Gear	Oil	21
Boxing Gear	Full Body Protector	22
Gym equipment	Boxing Ring	40
Gym equipment	Punching Bag	41
Apparel	Short	60
Apparel	T-shirt	61
Apparel	Polo Shirt	62
Apparel	Uniform	63
Apparel	Sweat Suit	64
Accessories	Key Chain	80
Accessories	Car Hanger	81
Accessories	Cap	82

- Material: There are four different materials, which the products are made from: leather, synthetic, DX and cotton. As shown in table 4-5, a single letter code is assigned to each material type. The selected letter is the first letter of each material type, to make it easier for the employees to recognise. The letter X is assigned to products with no material specification.

Table 4-5 Coding for product material

Material	**Code**
Leather	L
Synthetic	S
DX	D
Cotton	C
-	X

- Model: There are 27 different models. As shown in Table 4-6, a two-digit number is allocated to each model, and because it is likely that the company will have more models for each product in the next five years, there are more numbers reserved for each product. For example, gloves have seven different models, which numbers from 10 to 16 are allocated to. The numbers from 17 to 39 are reserved for gloves' number of models' future growth, therefore coding for head guards starts from 40. A two-digit number, 00 is allocated to products with no specific model.

Table 4-6 Coding of product model

Product	**Model**	**Code**
Gloves	Deluxe Velcro	10
Gloves	Deluxe Lace Up	11
Gloves	Antique	12
Gloves	Bag Gloves	13
Gloves	Double Wrist Band	14
Gloves	MMA	15
Gloves	ADIDA	16
Head guard	Half Face	40
Head guard	Full Face	41
Groin guard	Female	50
Groin guard	Male	51
Groin guard	Male with kidney	52
Kick pad	Curved	60
Kick pad	Straight	61
Punching bag	Hanging bag	70
Punching bag	Standing bag	71
Punching bag	Wall bag	72
Punching bag	Tear drop bag	73
Punching bag	Speed bag	74
Punching bag	Upper cut bag	75
Punching bag	Double end bag	76
Sweat suit	Thick	80
Sweat suit	Thin	81
T-shirt	Buakaw	90
T-shirt	SIYG	91
T-shirt	Muaythai	92
-	-	00

- Size: As shown in Table 4-7, a two-letter code is assigned to each product size. The two letter code was selected in a way to make it easy for the employees to recognise. Some products, such as: some gloves, shin guards, groin guards, kick pads, full body protection, apparel, etc. come in sizes ranging from XXXS to XXXL. Hand wraps appear in two sizes, three meters and five meters. Most of the boxing gloves come in six different sizes ranging from 6 Oz to 16 Oz. Muaythai oil comes in 120 cc and 250 cc. The two-digit number 00 is allocated to products with no size specification.

Table 4-7 Coding of product size

Size	**Code**
-	00
XXXS	4S
XXS	3S
XS	2S
S	1S
M	1M
L	1L
XL	2L
XXL	3L
XXXL	4L
Assorted Sizes	XX
3m	3M
5m	5M
06 oz	1Z
08 oz	2Z
10 oz	3Z
12 oz	4Z
14 oz	5Z
16 oz	6Z

Size	Code
120 cc	1C
250 cc	2C

- Colour: A three-digit number is assigned to each product colour, because very often the company adds new colours of products to its collection. The three-digit colour code, appears as the last value in the SKU and it is separated with a dash from the rest to make it easier to read. The three-digit number, 000, will be allocated to products without a colour specification.

Table 4-8 Colour coding

Colour	Code
-	000
Assorted Colours	999
Black	100
Black tire	101
Black/blue	102
Black/red	103
Black/white	104
Blue	130
Blue/red	131
Blue/white	132
Blue/yellow	133
Brown	160
Camo	190
Carbon black	105
Carbon blue	134
Carbon red	404
Dark brown	161
Glossy black	106

Colour	Code
Glossy white	461
Gold	220
Grey	250
Green	280
Hot pink	342
Neon blue	135
Neon yellow	491
Orange	310
Pink	340
Pink leopard	341
Purple	370
Red	400
Red/black	401
Red/blue	402
Red/white	403
Silver	430
White	460
White leopard	462
White tire	463
Yellow	490

Figure 4-1 illustrates a breakdown of the SKU "1MT10L106Z-130" as an example, showing what each variable stands for.

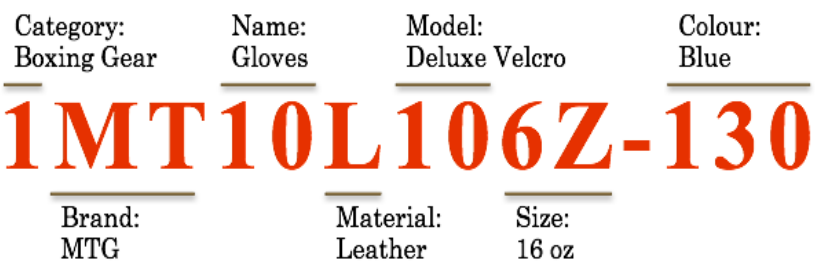


Figure 4-1 Breakdown of the product ID 1MT10L106Z-130

The SKU generation was integrated on to SKU master sheet on the information system. A table was created with the seven product specifications, categories, brands, products, materials, models, sizes and colours represented in the first seven columns with drop down lists reading data from the seven separate sheets created beforehand. The user can easily select the specifications of a product from the drop-down lists and the SKU will be generated automatically in the last column. A section of the SKU Master sheet from the information system is illustrated in Figure 4-2.

Catagory	Brand	Name	Material	Model	Size	colour	SKU	Product Name
Boxing_Gear	Contender	HandWrap	cotton	-	5m	AssortedColours	1CT11C005M-999	Contender - HandWrap - AssortedColours - 5m
Boxing_Gear	MTG	Gloves	leather	DeluxeVelcro	06 oz	Green	1MT10L101Z-280	MTG DeluxeVelcro Gloves - Green - 06 oz
Boxing_Gear	MTG	Gloves	leather	DeluxeVelcro	06 oz	Orange	1MT10L101Z-310	MTG DeluxeVelcro Gloves - Orange - 06 oz
Boxing_Gear	MTG	Gloves	leather	DeluxeVelcro	06 oz	Pink	1MT10L101Z-340	MTG DeluxeVelcro Gloves - Pink - 06 oz
Boxing_Gear	MTG	Gloves	leather	DeluxeVelcro	16 oz	Black	1MT10L106Z-100	MTG DeluxeVelcro Gloves - Black - 16 oz

Figure 4-2 Generating SKU using Excel

It is decided by the working group that only the Admin should have access to the SKU coding area. The Admin will be trained to add products to the system in the future whenever necessary.

4.2 Information System

The purpose is to create a standard and clear business process using Microsoft Excel, which will have the following abilities:

- Generate SKUs and product names, which is explained in section 4.1
- Add new products
- Store cost and sales price
- Store customer and vendor information
- Stocktaking
- Keep record of all purchases, sales and inventory
- Generate documents, such as; sales delivery, purchase delivery and inventory summary reports, purchase order and sales invoice

The idea is to create different excel sheets, which are linked together to carry out different required functions. The following nine sheets are created:

1. SKU master sheet: part of this sheet was created in previous section for SKU coding
2. Vendor master sheet
3. Customer master sheet
4. Opening stock
5. Purchase delivery sheet
6. Sales delivery sheet
7. Inventory summary sheet
8. Purchase order sheet
9. Sales invoice sheet

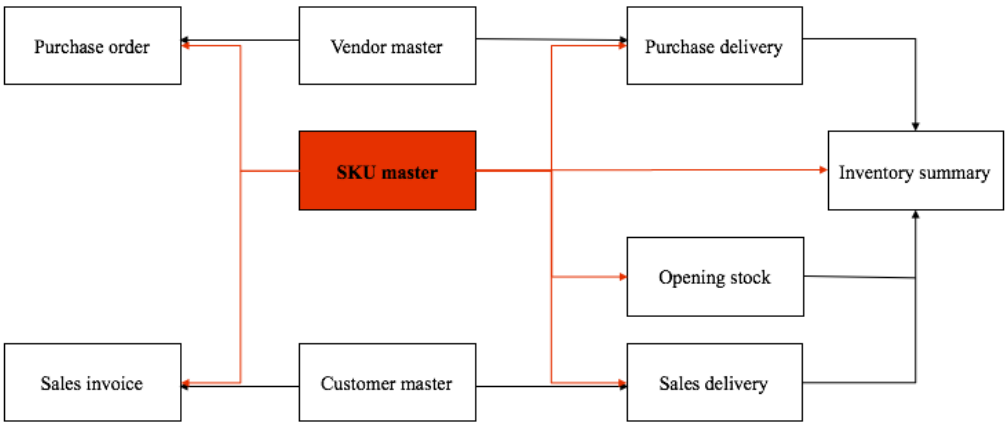


Figure 4-3 Information system structure

Figure 4-3 shows how all the excel sheets are linked together. The arrows in the figure indicate inputs and outputs to each sheet. SKU master sheet is the heart of the system, because almost all of the sheets require information input from the SKU master sheet to be able to carry out a function. A screen shot of the system can be found in Appendix B.

The first necessary step towards creating the information system is to gather detailed information from all the departments and build the database of the system. Detailed information on products' specifications, products' sales prices and customers' names and addresses is gathered from sales department. Information on products' purchase prices, cost prices and vendors' names and addresses is gathered from purchase department. Information on inventory on hand is gathered from logistics department. The gathered information is then used to build the database, which includes SKU master sheet, Vendor master sheet, Customer master sheet and opening stock.

4.2.1 SKU Master Sheet

This excel sheet is the heart of the information system and includes information on SKUs, names, purchase prices and sales prices of any product which has ever been purchased and sold by the company. Figure 4-4 illustrates a section of the SKU master sheet. This sheet allows the user to add products. This is done by selecting product category, brand, name, material, model, size and colour from the drop-down lists, which retrieve information from the coding sheets explained in section 4.1. The corresponding SKU and product name are generated automatically in the next two columns. The cost and sales price is entered by the user into the last two columns.

Catagory	Brand	Name	Material	Model	Size	colour	SKU	Product Name	Cost Price	Sales Price
Boxing_Gear	Contender	HandWrap	cotton	-	5m	AssortedColours	1CT11C005M-999	Contender - HandWrap - AssortedColours - 5m	$1.20	$4.00
Boxing_Gear	MTG	Gloves	leather	DeluxeVelcro	06 oz	Green	1MT10L101Z-280	MTG DeluxeVelcro Gloves - Green - 06 oz	$18.00	$36.00
Boxing_Gear	MTG	Gloves	leather	DeluxeVelcro	06 oz	Orange	1MT10L101Z-310	MTG DeluxeVelcro Gloves - Orange - 06 oz	$18.00	$36.00
Boxing_Gear	MTG	Gloves	leather	DeluxeVelcro	06 oz	Pink	1MT10L101Z-340	MTG DeluxeVelcro Gloves - Pink - 06 oz	$18.00	$36.00
Boxing_Gear	MTG	Gloves	leather	DeluxeVelcro	16 oz	Black	1MT10L106Z-100	MTG DeluxeVelcro Gloves - Black - 16 oz	$20.00	$40.00

Figure 4-4 SKU master sheet

4.2.2 Vendor Master Sheet and Customer Master Sheet:

These two sheets contain information on the vendors and customers and are shown in Figures 4-5 and 4-6. In the first column, a code is allocated to each vendor and customer. The next columns contain name, country, address and telephone information of vendor

and customer. The user is able to add more vendors and customers to these two sheets in the future.

Code	Name	Country	Address	Tel
V1001	MTG Co.	Thailand		
V2001	WMA	Pakistan	Adalat Gharah Road, Bhabrianwala,, sialkot - 51310 - P	+92 300 8613925
V2002	DOVTEL MANUFACTURING CORPORATION	Pakistan	MANUFACTURING CORPORATION Paris Road, Street No	9252-4592891
V2003	Pak Asian Manufacturing Co	Pakistan	Ahmad Pura, Khan Mahal Road, Sialkot - 51310	0092 - 52 - 4588896
V2004	SIALKOT TRADE	Pakistan	786 Kashmir Road.. Pacca Garha. Sialkot	

Figure 4-5 Vendor Master sheet

Code	Name	Country	Address	Tel
C1001	CPMC Claude Pouget Monte-Carlo	Monaco	No 7, rue Suffren Reymond,98 000 Monaco -Principaute de Monaco	+377 (0)6 07 93 31 36
C1002	Davide Carlot	Italy	Via Marcha 14, 20811 Cesabi Maderno, Milano	
C1003	Hong Tat Logistics Co., Ltd	Macau	Estrada Marginal Da Areia Preta No.45,Fase 1,Edif.Centro Industrial Polyte	853 28336710
C1004	Hyun Dong Lee	Korea	13,1 sunhwan-ro 1656 beongil, Sangdang-gu, Cheongju-si, Chungcheongbuk-do	
C1005	Klavio Invest AB	Sweden	c/o Rumble of the Kings Promotion, Box 11094, SE-100 61 Stockholm	46707447000

Figure 4-6 Customer Master sheet

4.2.3 Opening Stock Sheet

This sheet contains information on the quantity and cost price of each product on the day the system starts being implemented. Figure 4-7 shows a section of the opening stock sheet. The user is able to select a SKU in the first column from the drop-down list, where the product name appears automatically in the next column. The user can then enter the quantity and the cost price per unit is retrieved from the SKU master sheet, which appears in the next column. The total price of the product in the stock is calculated in the last column.

SKU	Product Name	Qty	Cost Price/unit	Total price
1CT11C005M-999	Contender - HandWrap - AssortedColours - 5m	0	$ 1.20	$ -
1MT10L101Z-280	MTG DeluxeVelcro Gloves - Green - 06 oz	4	$ 18.00	$ 72.00
1MT10L101Z-310	MTG DeluxeVelcro Gloves - Orange - 06 oz	4	$ 18.00	$ 72.00
1MT10L101Z-340	MTG DeluxeVelcro Gloves - Pink - 06 oz	4	$ 18.00	$ 72.00
1MT10L106Z-100	MTG DeluxeVelcro Gloves - Black - 16 oz	0	$ 20.00	$ -

Figure 4-7 Opening stock

The above mentioned four sheets will serve as database for the main sheets and functions of the system explained below.

4.2.4 Purchase Delivery Sheet and Sales Delivery Sheet

Purchase delivery sheet creates a report on quantity and cost of purchased products giving information on the vendor code and name and date of purchase. Sales delivery sheet creates a report on quantity and sales price of products giving information on the customer code and name and date of sales. Figure 4-8 and 4-9 show sections of the purchase and sales delivery sheets. The user can select the vendor code or the customer code, respectively from the drop-down lists. The vendor name or customer name will then appear in the next column. The date of purchase or sales and the delivery number can be entered into the next two columns. The SKU of the product which has been purchased or sold, can then be selected from a drop-down list, where the corresponding product name appears in the next columns. The quantity can be entered into next column and the cost price per unit or sales price per unit are retrieved from the SKU master sheet which appear in the next columns. And the total price is calculated in the last column

Vendor Code	Vendor Name	Date	SKU	Product Name	Qty	Cost price/unit	Total Cost
V2001	WMA	12/04/2017	1UF10D145Z-100	UFC DoubleWristBand Gloves - Black - 14 oz	200	$ 11.30	$ 2,260.00
V2001	WMA	12/04/2017	1UF10D145Z-400	UFC DoubleWristBand Gloves - Red - 14 oz	200	$ 11.30	$ 2,260.00
V2001	WMA	12/04/2017	1UF10D145Z-460	UFC DoubleWristBand Gloves - White - 14 oz	200	$ 11.30	$ 2,260.00
V2001	WMA	12/04/2017	1UF10D146Z-100	UFC DoubleWristBand Gloves - Black - 16 oz	300	$ 11.30	$ 3,390.00
V2001	WMA	12/04/2017	1UF10D146Z-400	UFC DoubleWristBand Gloves - Red - 16 oz	300	$ 11.30	$ 3,390.00

Figure 4-8 Purchase delivery sheet

Customer Code	Customer Name	Date	SKU	Product Name	Qty	Sales price/unit	Total Price
C1016	UFC Gym Franchise Corporation	12/04/2017	1CT11C005M-999	Contender - HandWrap - AssortedColours - 5m	200	$ 4.00	$ 800.00
C1016	UFC Gym Franchise Corporation	12/04/2017	1UF10D145Z-100	UFC DoubleWristBand Gloves - Black - 14 oz	200	$ 24.00	$ 4,800.00
C1016	UFC Gym Franchise Corporation	12/04/2017	1UF10D145Z-400	UFC DoubleWristBand Gloves - Red - 14 oz	200	$ 24.00	$ 4,800.00
C1016	UFC Gym Franchise Corporation	12/04/2017	1UF10D145Z-460	UFC DoubleWristBand Gloves - White - 14 oz	300	$ 24.00	$ 7,200.00
C1016	UFC Gym Franchise Corporation	12/04/2017	1UF10D146Z-100	UFC DoubleWristBand Gloves - Black - 16 oz	300	$ 24.00	$ 7,200.00

Figure 4-9 Sales Delivery sheet

4.2.5 Inventory Summary Sheet

The inventory summary sheet provides the following information on every product: cost and sales price, quantity in opening stock, quantity of sales, purchase and loss, quantity in inventory on hand and total price. Figure 4-10 shows the inventory summary sheet. The product ID can be selected from a drop-down list in the first column and the

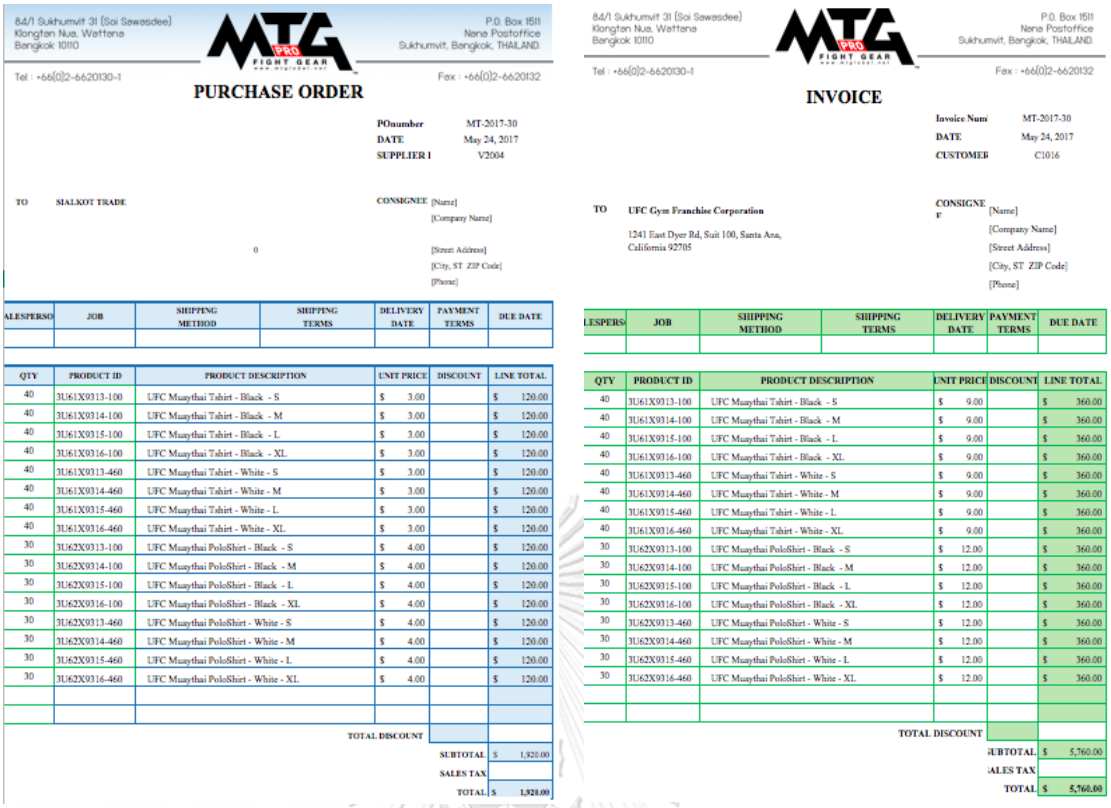
corresponding product name appears in the next column. The vendor code can be selected from drop-down list. The cost price per unit and sales price per unit are retrieved from the SKU master sheet which appear in the next columns. The initial quantity of the product in opening stock and the quantities sold and purchased will come up in the corresponding columns. This information is retrieved from opening stock, sales delivery and purchase delivery sheets, respectively. The current inventory on hand and the total price is calculated in the last column.

SKU	Product Name	Cost price/unit	Sales price/unit	Opening stock	Sales	Purchase	Losses	Inventory on hand	Total price
1CH10S162Z-460	Chok ADIDA Gloves - White - 08 oz	$ 8.50	$ 23.00	11	3	0	0	8	$ 68.00
1CH10S163Z-100	Chok ADIDA Gloves - Black - 10 oz	$ 8.50	$ 23.00	8	3	0	0	5	$ 42.50
1CH10S163Z-135	Chok ADIDA Gloves - Neon blue - 10 oz	$ 8.50	$ 23.00	15	0	0	0	15	$ 127.50
1CH10S163Z-134	Chok ADIDA Gloves - Carbon blue - 10 oz	$ 8.50	$ 23.00	14	3	0	0	11	$ 93.50
1CH10S163Z-280	Chok ADIDA Gloves - Green - 10 oz	$ 8.50	$ 23.00	33	0	0	0	33	$ 280.50

Figure 4-10 Inventory summary

4.2.6 Purchase order and sales invoice sheets

Figure 4-11 shows the purchase order and sales invoice which can be generated using the system. The recipient can be selected from a drop-down list which retrieves information from vendor and customer master sheets. The user can enter the information on the consignee, enter the quantity of product and select the SKU from the drop-down list. The name and the price of the product will then appear in the next columns. These sheets can be saved as pdf file on the server to keep digital record of all transactions.



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PURCHASE ORDER

POnumber	MT-2017-30
DATE	May 24, 2017
SUPPLIER I	V2004

TO SIALKOT TRADE

CONSIGNEE [Name]
[Company Name]
[Street Address]
[City, ST ZIP Code]
[Phone]

ALESPERSO	JOB	SHIPPING METHOD	SHIPPING TERMS	DELIVERY DATE	PAYMENT TERMS	DUE DATE

QTY	PRODUCT ID	PRODUCT DESCRIPTION	UNIT PRICE	DISCOUNT	LINE TOTAL
40	3U61X9313-100	UFC Muaythai Tshirt - Black - S	$ 3.00		$ 120.00
40	3U61X9314-100	UFC Muaythai Tshirt - Black - M	$ 3.00		$ 120.00
40	3U61X9315-100	UFC Muaythai Tshirt - Black - L	$ 3.00		$ 120.00
40	3U61X9316-100	UFC Muaythai Tshirt - Black - XL	$ 3.00		$ 120.00
40	3U61X9313-460	UFC Muaythai Tshirt - White - S	$ 3.00		$ 120.00
40	3U61X9314-460	UFC Muaythai Tshirt - White - M	$ 3.00		$ 120.00
40	3U61X9315-460	UFC Muaythai Tshirt - White - L	$ 3.00		$ 120.00
40	3U61X9316-460	UFC Muaythai Tshirt - White - XL	$ 3.00		$ 120.00
30	3U62X9313-100	UFC Muaythai PoloShirt - Black - S	$ 4.00		$ 120.00
30	3U62X9314-100	UFC Muaythai PoloShirt - Black - M	$ 4.00		$ 120.00
30	3U62X9315-100	UFC Muaythai PoloShirt - Black - L	$ 4.00		$ 120.00
30	3U62X9316-100	UFC Muaythai PoloShirt - Black - XL	$ 4.00		$ 120.00
30	3U62X9313-460	UFC Muaythai PoloShirt - White - S	$ 4.00		$ 120.00
30	3U62X9314-460	UFC Muaythai PoloShirt - White - M	$ 4.00		$ 120.00
30	3U62X9315-460	UFC Muaythai PoloShirt - White - L	$ 4.00		$ 120.00
30	3U62X9316-460	UFC Muaythai PoloShirt - White - XL	$ 4.00		$ 120.00
				TOTAL DISCOUNT	
				SUBTOTAL	$ 1,920.00
				SALES TAX	
				TOTAL	$ 1,920.00

84/1 Sukhumvit 31 (Soi Sawasdee)
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Nana Postoffice
Sukhumvit, Bangkok, THAILAND.

Tel : +66(0)2-6620130-1

Fax : +66(0)2-6620132

INVOICE

Invoice Num	MT-2017-30
DATE	May 24, 2017
CUSTOMER	C1016

TO UFC Gym Franchise Corporation

1241 East Dyer Rd, Suit 100, Santa Ana,
California 92705

CONSIGNE E [Name]
[Company Name]
[Street Address]
[City, ST ZIP Code]
[Phone]

LESPERS	JOB	SHIPPING METHOD	SHIPPING TERMS	DELIVERY DATE	PAYMENT TERMS	DUE DATE

QTY	PRODUCT ID	PRODUCT DESCRIPTION	UNIT PRICE	DISCOUNT	LINE TOTAL
40	3U61X9313-100	UFC Muaythai Tshirt - Black - S	$ 9.00		$ 360.00
40	3U61X9314-100	UFC Muaythai Tshirt - Black - M	$ 9.00		$ 360.00
40	3U61X9315-100	UFC Muaythai Tshirt - Black - L	$ 9.00		$ 360.00
40	3U61X9316-100	UFC Muaythai Tshirt - Black - XL	$ 9.00		$ 360.00
40	3U61X9313-460	UFC Muaythai Tshirt - White - S	$ 9.00		$ 360.00
40	3U61X9314-460	UFC Muaythai Tshirt - White - M	$ 9.00		$ 360.00
40	3U61X9315-460	UFC Muaythai Tshirt - White - L	$ 9.00		$ 360.00
40	3U61X9316-460	UFC Muaythai Tshirt - White - XL	$ 9.00		$ 360.00
30	3U62X9313-100	UFC Muaythai PoloShirt - Black - S	$ 12.00		$ 360.00
30	3U62X9314-100	UFC Muaythai PoloShirt - Black - M	$ 12.00		$ 360.00
30	3U62X9315-100	UFC Muaythai PoloShirt - Black - L	$ 12.00		$ 360.00
30	3U62X9316-100	UFC Muaythai PoloShirt - Black - XL	$ 12.00		$ 360.00
30	3U62X9313-460	UFC Muaythai PoloShirt - White - S	$ 12.00		$ 360.00
30	3U62X9314-460	UFC Muaythai PoloShirt - White - M	$ 12.00		$ 360.00
30	3U62X9315-460	UFC Muaythai PoloShirt - White - L	$ 12.00		$ 360.00
30	3U62X9316-460	UFC Muaythai PoloShirt - White - XL	$ 12.00		$ 360.00
				TOTAL DISCOUNT	
				UBTOTAL	$ 5,760.00
				ALES TAX	
				TOTAL	$ 5,760.00

Figure 4-11 Purchase Order and Sales Invoice

4.2.7 Access Authorisation

It was decided by the working group that each department obtains access only to their related area. Admin has access to SKU Master, Vendor Master and Customer Master sheets, new products, vendors and customers can be added to the system. Purchase department has access to purchase delivery and purchase order sheets. Sales department has access to the sales delivery and sales invoice sheets. Logistics has access to the opening stock and inventory summary sheet. Accounting has access to purchase delivery and sales delivery sheets. Figure 4-12 shows the interaction between the users and the system. The Excel file will be saved on the server for everyone to access. The file will be password protected, this means that every department will have the password to their own area only.

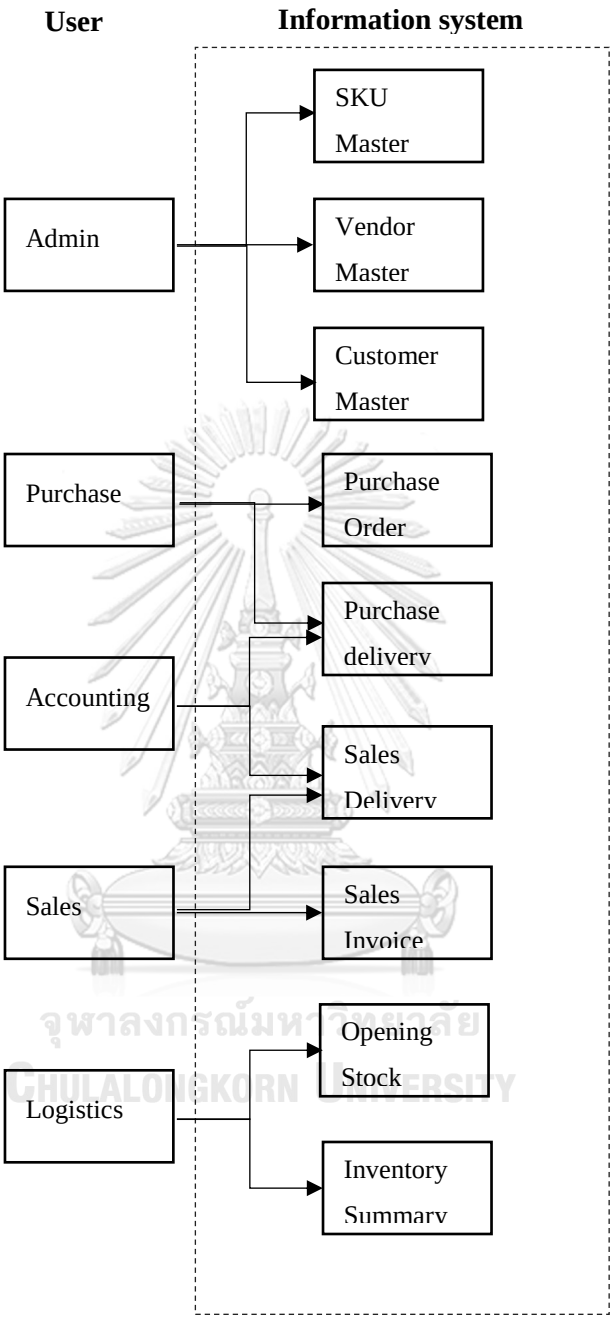

Figure 4-12 Interaction between the users and information system

4.3 Training

After the coding and the information system are created, training is the next necessary step towards improvement implementation and preparation and instruction of the employees for the desired changes.

It was decided by the working group to allocate one full day to training, and additionally have on the job training for a month. It is necessary to have the whole team trained to make sure all departments understand the new system and work procedure. Therefore, the training has to be attended by the manager, sales, purchasing, logistics and admin department. The manager and the person who created the system will be the speakers.

Table 4-9 Company A's training day agenda

Time	**Subject**
10:00-13:00	Products and business process
14:00-18:00	New system

Table 4-9 shows the agenda for the training day. The three-hour session in the morning has the objective of making the employees familiar to the products and business process and is conducted by the manager. There is a one hour lunch break and then the afternoon session has the objective of making the employees familiar to the new system, teaching them how to utilize it and is conducted by the person who creates the new system. There will be an on-going on the job training during the first month to make sure everyone understands how the system runs. Figure 4-13, shows one of the employees getting on the job training.

At the end of the training, in order to evaluate the employees' understanding of the system, each person will be requested to utilize the system to generate a report.

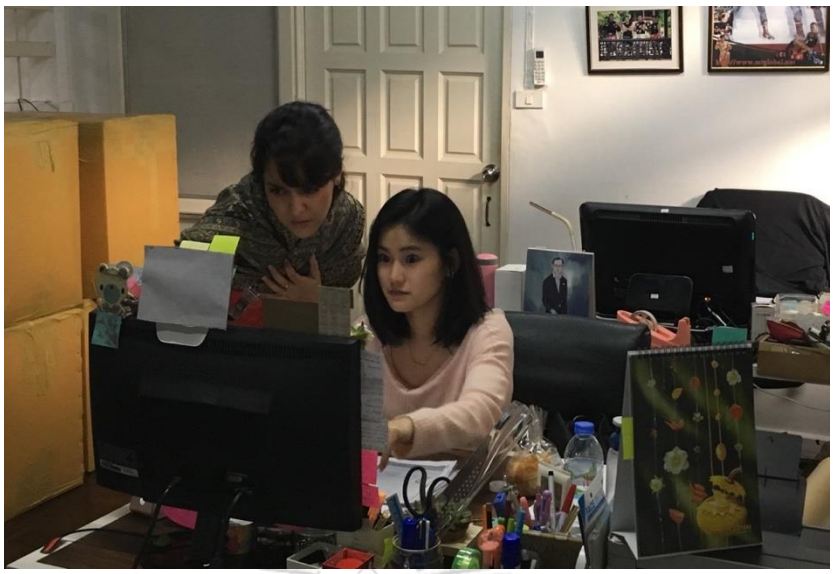

Figure 4-13 On the job training

4.4 Meeting

The working group decided to hold regular meetings as one of the solutions to be implemented. It is important to hold the meetings regularly, so that the employees take the meetings serious and feel more responsible and obligated every week to satisfy the management with better work results. Therefore, the working team decided to hold the meetings regularly every Friday after lunch at the meeting room for an hour. Figure 4-14 shows employees attending one of the weekly held meetings.

Figure 4-14 Weekly meetings

To discuss work results, obtain and share updates and reports from every department, discuss everyone's tasks for the upcoming week, and avoid misunderstandings due to poor internal communication it was decided that the meetings must be attended by the manager, sales, purchasing, logistics and admin departments.

The employees are obliged to give individual reports to the manager and the team on their work results from previous week and set targets for the upcoming week. The weekly meetings will make the employees feel responsible and alert about their work results.

Purchasing department can print out the purchase delivery sheet, sales department can print out the sales delivery sheet and the admin can print out the inventory summary sheet from the information system and distribute at the meeting to everyone. The manager will be able to oversee the current state of the company, understand the issues, inform the CEO and take actions accordingly.

CHAPTER 5. RESULTS AND ISSUES DURING IMPLEMENTATION

5.1 Results

5.1.1 Incorrect Shipments and Customer Complaints

Before the improvement implementation, the company received complaints from the customers, as a result of incorrect shipments. From January 2016 to December 2016, the company had a total of seven incorrect shipments. Hence, the company received complaints from the customers and there was a high risk of losing customers. Additionally, returning the shipments and reshipments costed the company time, money and resources.

Figure 5-1 Comparison of number of incorrect shipments between months of April to September in 2016 and 2017

The improvement framework was implemented starting from April 2017 onwards. As shown in Figure 5-1, there hasn't been any record of incorrect shipments and customer

complaints, from April 2017 to September 2017. By running the old system and new system at the same time, every single shipment has been double checked.

5.1.2 KPI: Time to response to order

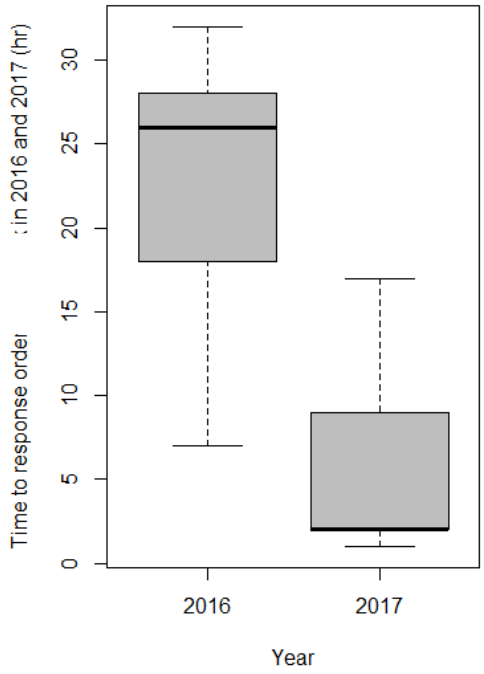

Figure 5-2 Comparison of time to response to customer order between 2016 and 2017

Time to response to an order in 2017 has decreased in compare to 2016, as illustrated in Figure 5-2. The data is taken from small samples and the means are clearly different.

Table 5-1 Average time to response to order, before and after the implementation framework

	Order 1	Order 2	Order 3	Order 4	Order 5	Average
2016	28	18	7	32	26	22.2
2017	2	9	1	2	17	6.2

Before implementing SKU coding as a solution, too many emails were sent back and forth between customer and sales department to finally confirm an order, because they could not communicate well by just using the product specifications and not using unique product IDs. Therefore, in 2016, it took an average of 22.2 hours to response to an order, as shown in Table 5-1. After implementing of SKU coding, customers and sales department were both using the unique product SKUs, which made communication much easier and the process much faster. Therefore, less emails were sent back and forth and the time to response to an order after SKU coding implementation in 2017, decreased to an average of 6.2 hours.

Table 5-2 t-Test: Time to response to customer, Two-Sample Assuming Equal Variances

	2016	**2017**
Mean	22.2	6.2
Variance	98.2	46.7
Observations	5	5
Pooled Variance	72.45	
Hypothesized Mean Difference	0	
df	8	
t Stat	2.972150467	
P(T<=t) one-tail	0.00890628	
t Critical one-tail	1.859548038	
P(T<=t) two-tail	0.017812561	
t Critical two-tail	2.306004135	

As t-Test in Table 5-2 illustrates, the means are different and has decreased in 2017. P two-tail value is less than 0.05, therefore the examples are different from each other.

5.1.3 KPI: Time to prepare order from stock

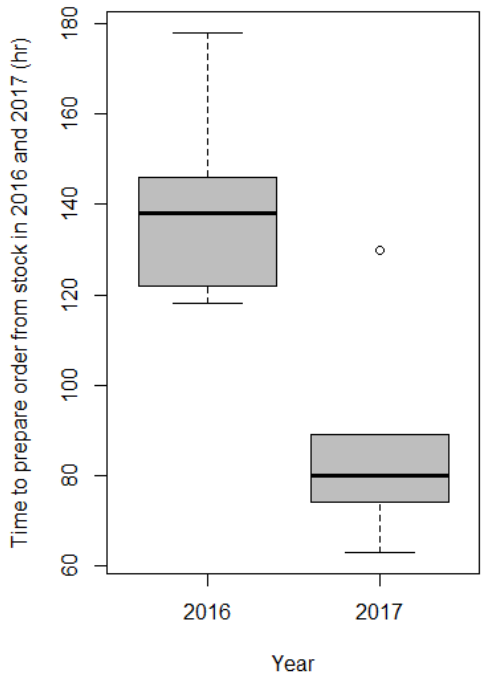

Figure 5-3 Comparison of time to prepare order from stock, between 2016 and 2017

Average time to prepare order from stock in 2017 has decreased in comparison to 2016, as illustrated in Figure 5-3. The data is taken from small samples and the means are clearly different.

Table 5-3 Average time to prepare order from stock, before and after the implementation framework

	Order 1	Order 2	Order 3	Order 4	Order 5	Average
2016	138	146	122	118	178	140.4
2017	63	74	89	80	130	87.2

Logistics department has done the stock taking according to the newly created SKU coding and has used the computer system for stock taking. As a result, the exact stock number and stock value were available, up to date and easy to look up on the system.

As shown in Table 5-3, the average time needed to prepare the order has decreased. Before SKU coding, preparing orders from stock took 140.4 minutes on average. After implementation of SKU coding and the information system the preparation of orders from stock took 87.2 minutes on average.

Table 5-4 t-Test: Time to prepare order from stock, Two-Sample Assuming Equal Variances

	2016	**2017**
Mean	140.4	87.2
Variance	572.8	661.7
Observations	5	5
Pooled Variance	617.25	
Hypothesized Mean Difference	0	
df	8	
t Stat	3.385720377	
P(T<=t) one-tail	0.004780164	
t Critical one-tail	1.859548038	
P(T<=t) two-tail	0.009560329	
t Critical two-tail	2.306004135	

As t-Test in Table 5-4 illustrates, the means are different and has decreased in 2017. P two-tail value is less than 0.05, therefore the examples are different from each other.

5.1.4 Monthly sales from stock

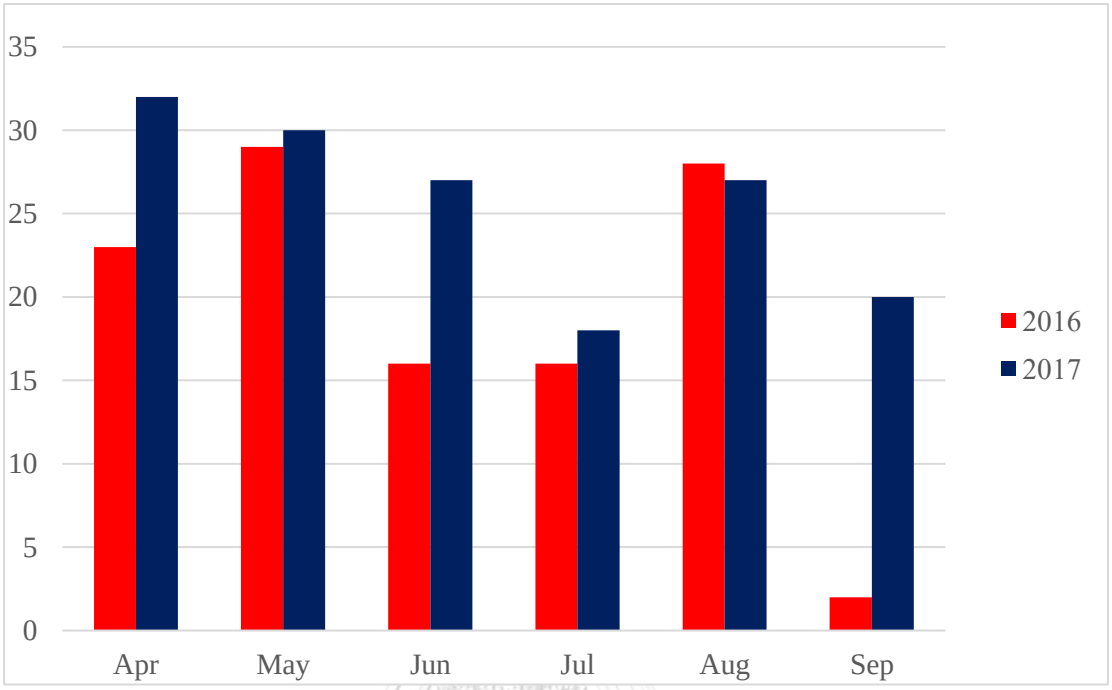

Figure 5-4 Comparison of percentage of sales from stock between 2016 and 2017

Table 5-5 Percentage change of sales from stock between 2016 and 2017

Months	% of sales from stock in 2016	% of sales from stock in2017	% Change
Apr	23	32	9
May	29	30	1
Jun	16	27	11
Jul	16	18	2
Aug	28	27	-1
Sep	2	20	18

Up to date inventory information and availability of inventory reports from the information system allowed more sales from the stock and less loss due to expiration. As before the improvement implementation, when receiving sales order, logistics department was not able to provide an up to date inventory report and check availability

of products in stock. Hence, purchase department would create purchase order, even if the products might have been available in the stock. As illustrated in Figure 5-4 and Table 5-3, an increase in percentage of sales from stock can be observed by comparison of percentage of sales from stock between April to September 2016 and April to September 2017. In August, a decrease in percentage of sales from stock can be observed, which is because of low availability of products in stock.

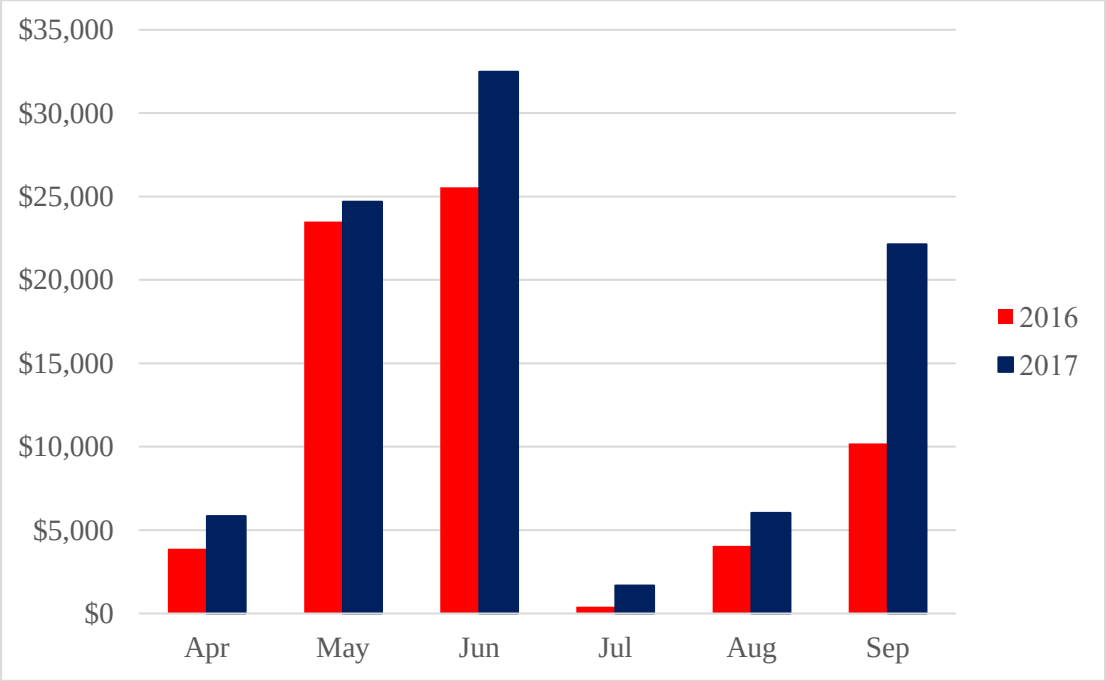

Figure 5-5 Comparison of sales from stock ($) between 2016 and 2017

A comparison of amount of sales from stock in US dollars between 2016 and 2017 in Figure 5-5, shows that the amount of sales in US dollars per month from the sock has increased.

5.1.5 Monthly total sales

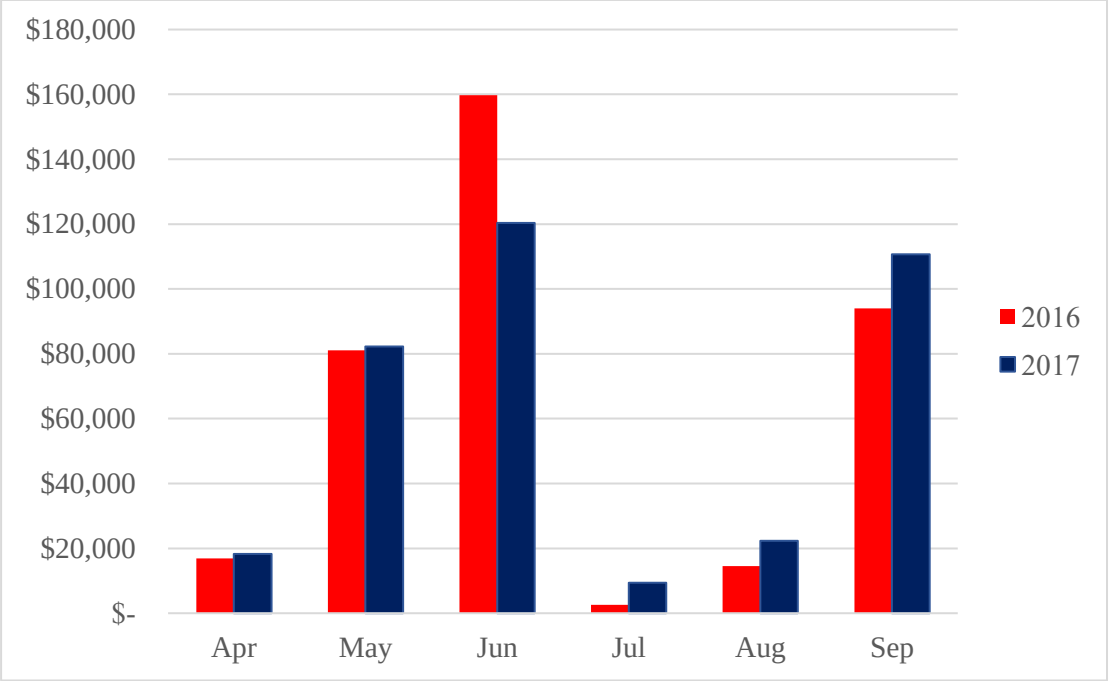

Figure 5-6 Comparison of total sales per month ($) between 2016 and 2017

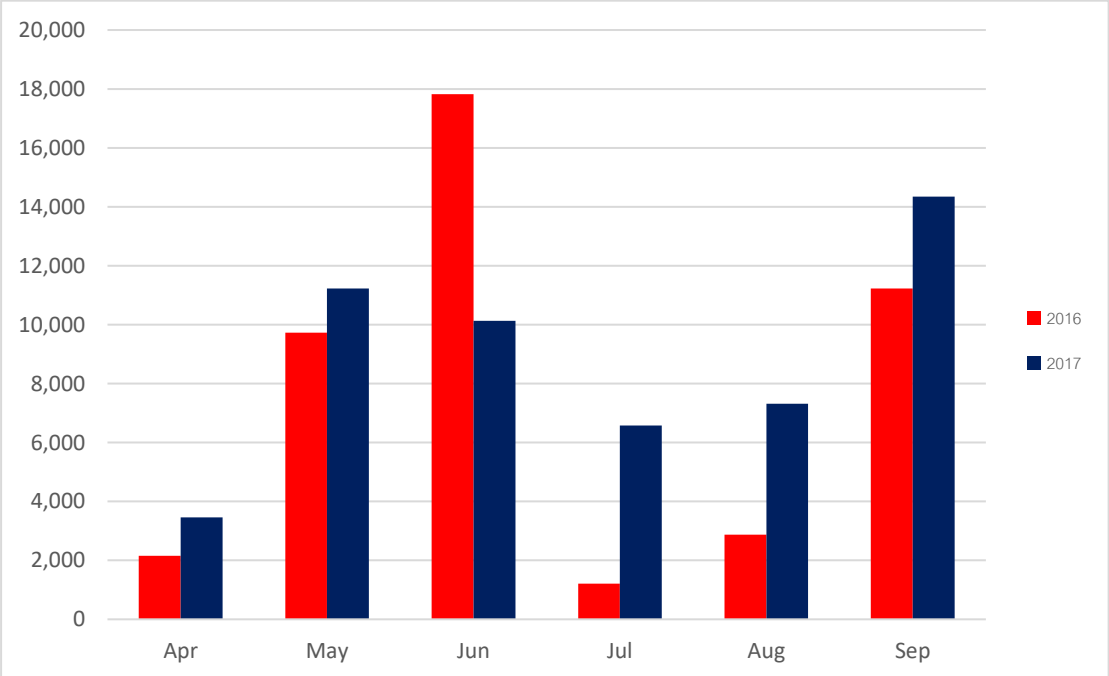

Figure 5-7 Comparison of total sales per month (quantity) between 2016 and 2017

Figures 5-6 and 5-7 show comparisons of total sales per month between 2016 and 2017 during months of April to September, which is a clear increase in sales.

As a result of regular weekly team meetings, the employees performed with increased productivity and efficiency. They were more engaged at work and cared more about the quality of their work. The employees developed an increased sense of responsibility towards their role, therefore they put in more effort and performed better. The meetings allowed better internal communication and information sharing among the team.

Sales reports created based on customers, helped the marketing section, which is under sales department, to create promotional packages for customers based on amount of purchase. Sales reports created based on products, helped to identify the products which sold more, stock them up, and therefore increase margin.

Purchase reports created by the new system, helped purchase department to identify the suppliers who received the most purchase orders.

Suppliers used the SKU coding of the company when communicating with the purchase department, which contributed to the betterment of communication and avoidance of mistakes.

During the weekly meetings, the management received and analysed the purchase, sales and inventory reports and was able to identify issues easier and faster and address them immediately. By analysing the sales reports, they could place a better order for stock. Higher sales from stock is equal to higher margin.

5.2 Issues during implementation

During the implementation period, the company encountered a few issues:

1. Resistance of the employees to change: In the initial stage, when the changes were introduced, employees showed resistance and were unhappy. They found it uncomfortable and confusing to learn and utilize a new system. After the one day training and the one month ongoing on the job training and utilizing the system the employees felt confident and comfortable.
2. Required adjustments to the system: During the first month a few problems regarding link between sheets, which disrupted function, were reported by the employees. After investigation, some adjustments were made to one of the formulas in the information system, which solved the problems immediately.
3. Data collection: It was difficult for the employees to provide data, as part of the data was not stored, therefore was not available. And the data which was available, was scattered and stored in a manual unorganised manner.
4. Commitment of employees: In a few instances, inadequate commitment and effort was observed.

CHAPTER 6. CONCLUSION AND FUTURE RESEARCH

This chapter provides a short summary of the study. It describes the methods and processes used to fulfil the objectives of the thesis. Limitations of the study and future work possibilities are discussed as well.

6.1 Conclusion

The objective of this thesis was to decrease or eliminate incorrect shipments in a rather small sport gear company by improving operation process and logistics process adopting SCOR model's best practice, Information Technology and reports. The company struggled with customer complaints due to incorrect shipments.

The initial analysis showed that the company frequently received complaints from the customers due to incorrect shipments. This resulted in dissatisfied and unhappy customers, thus increased risk of losing customers. Returning shipments and reshipments had costed the company time and money. From the data collected, it was observed that the most important reasons for incorrect shipments were lack of unique product IDs and lack of standard work procedure. Further investigation showed that lack of monthly purchase, sales and inventory reports was a back draw, as the management did not have an overlook of the company's state and possible issues. Additionally, the employee carried out their tasks with ignorance and lack of attention.

A working group was set up to discuss the problem further in detail, perform Root Cause Analysis and FMEA and brainstorm for solutions. General Manager, Admin, Purchase, Sales and Logistics deprtments were all selected to be part of the working group.

Once the improvement area was identified, the Root Cause Analysis was performed. Fishbone diagram and Why-Why Analysis were the tools used to analyse the root causes of the company's problem. As a result, seven root causes were identified:

1. Lack of training and experience
2. Lack of attention and ignorance
3. Lack of unique product system
4. Lack of standard business process
5. Poor internal communication
6. Lack of follow up and monthly reports
7. Lack of direct control

After the root causes were determined, FMEA was performed. FMEA allowed the prioritization of the failure causes using RPN. The failure causes were ranked according to their RPN.

The possible solutions to each failure cause were brainstormed by the working group. The pros and cons analysis for each solution was performed as well. The working group decided to select the following four solutions out of six:

1. SKU coding
2. Information system
3. Training
4. Meetings

After selecting the four solutions which were intended to be implemented, an improvement implementation schedule was created. Excel was selected by the working group, as the software to generate the SKU coding and create the information system. First the SKU coding was done. And then the information system was created. The SKU coding was then integrated into the information system and the system was saved on

the server for every department to access. The sheets of the excel file were password protected, so that each department could only access the corresponding sheet or sheets.

Subsequently, a full day training was conducted. After the main training, a one month on the job training was conducted. Weekly meetings were held to report on individual tasks, purchase, sales and inventory to the manager and whole team.

After six months of improvement implementations, the incorrect shipments, hence the customer complaints disappeared. Purchase, Sales and Logistics departments, and also the customers and suppliers used the same unique SKU coding. This helped to avoid any miscommunication during the work procedures.

As unexpected results, time to response to customer orders and time to prepare order decreased. Sales from stock and sales in to total increased.

Meetings were held every week, which helped to increase the sense of responsibility of the employees. Everyone attended the meetings with high commitment and gave report on their individual tasks. The system produced sales, purchase and inventory report, which helped the management to make decisions and take proper action. The reports also helped with identifying highest selling products, customers who purchase most and suppliers who supply most.

Stock taking was improved. The inventory with correct value and number was up to date on the information system using the new SKU coding. Therefore, it was easier to check availability of products. This allowed higher sales from the inventory and decrease loss due to expiration.

A perfect order is an order which, contains correct products, in correct quantity, delivered on time to the correct customer at the correct location in great condition and

quality with complete documents. The most important objective of this thesis, reducing incorrect shipments, was achieved effectively by improving the process. Excel and SKU coding helped to deliver correct products (size, colour and model) to the customers. Time to response to customer orders and time to prepare customer orders from stock were identified as important KPIs. Improving these two KPIs introduced awareness of efficiency into the current system. Therefore, the efficiency of the system improved.

SKU coding and information system (Excel), as a part of BPR, can improve the internal and external communication. They contain a lot of detail and information. It takes a lot of time to do the coding and create the information system. The coding and the information system are both flexible for future changes. The results of this thesis proved that Excel can be used to improve a business process and using shared drive is sufficient for a small company.

6.2 Future Research

Many different ideas and possibilities for future work are provided by this thesis, which can be implemented in the future, such as:

- Improving the information system by:
    - Barcode system: As an upgrade, barcodes can be created for the products. With the help of a barcode reader the information on the products can easily be looked up on the system.
    - Expand the scope of the computer program to cover more functions.
    - Replacing Microsoft Excel with an ERP system: An ERP system such as Microsoft dynamics, will be a good upgrade for this system. However, certain skills and experiences will be required, as the program is more time consuming and complicated to create and learn in compare to Excel.

- Suppliers: The company can evaluate the current suppliers and help them to improve.
- Kaizen: Setting up kaizen framework and TQM for further continuous improvement.

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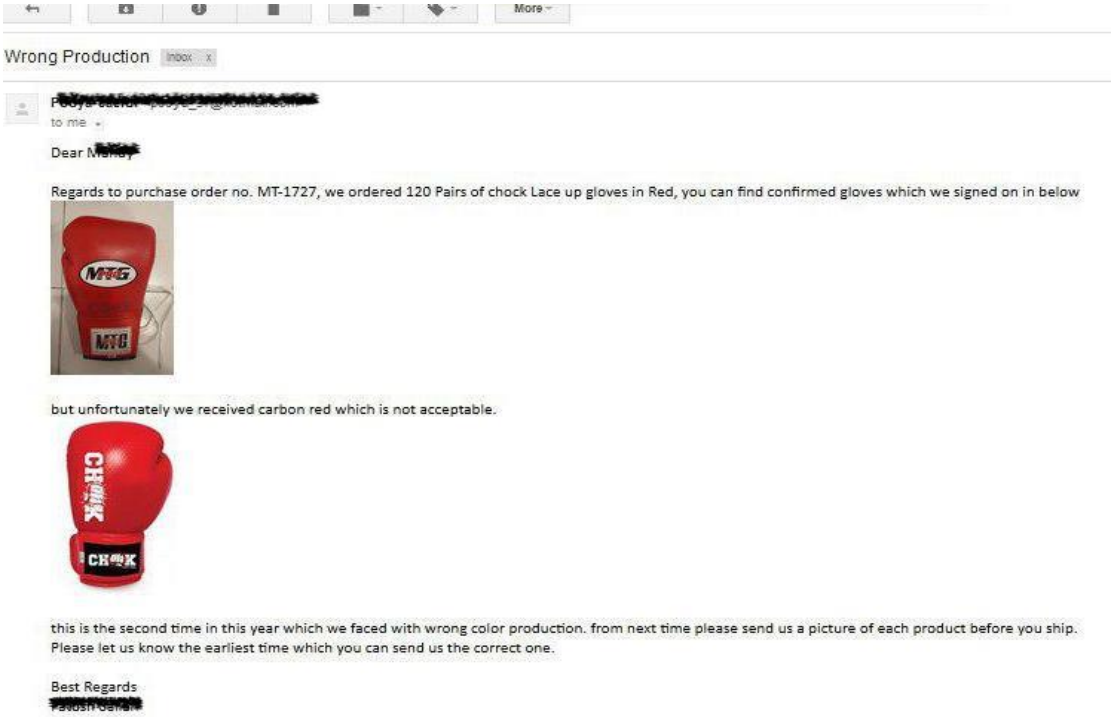
APPENDIX

APPENDIX A CUSTOMER COMPLAINT



Wrong Production Inbox x

[redacted]
to me

Dear [redacted]

Regards to purchase order no. MT-1727, we ordered 120 Pairs of chock Lace up gloves in Red, you can find confirmed gloves which we signed on in below

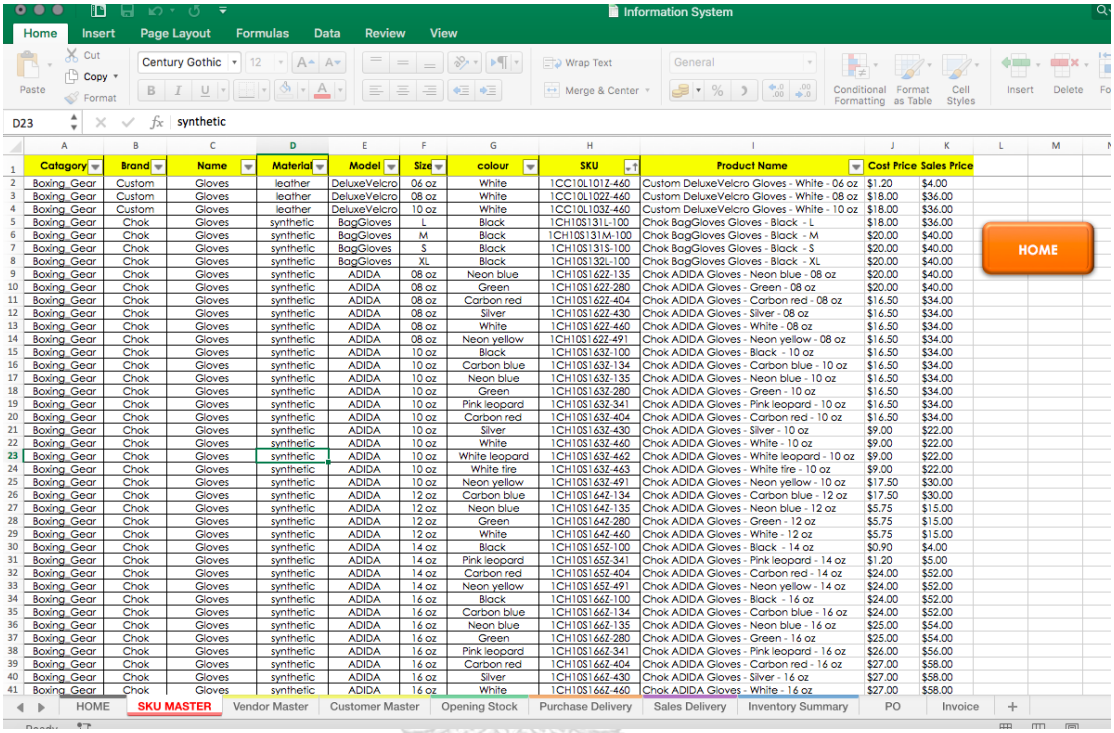
but unfortunately we received carbon red which is not acceptable.

this is the second time in this year which we faced with wrong color production. from next time please send us a picture of each product before you ship. Please let us know the earliest time which you can send us the correct one.

Best Regards
[redacted]

Figure A-1 An example of customer complaint

APPENDIX B INFORMATION SYSTEM



Catagory	Brand	Name	Material	Model	Size	colour	SKU	Product Name	Cost Price	Sales Price
Boxing_Gear	Custom	Gloves	leather	DeluxeVelcro	06 oz	White	1CC10L101Z-460	Custom DeluxeVelcro Gloves - White - 06 oz	$1.20	$4.00
Boxing_Gear	Custom	Gloves	leather	DeluxeVelcro	08 oz	White	1CC10L102Z-460	Custom DeluxeVelcro Gloves - White - 08 oz	$18.00	$36.00
Boxing_Gear	Custom	Gloves	leather	DeluxeVelcro	10 oz	White	1CC10L103Z-460	Custom DeluxeVelcro Gloves - White - 10 oz	$18.00	$36.00
Boxing_Gear	Chok	Gloves	synthetic	BagGloves	L	Black	1CH10S131L-100	Chok BagGloves Gloves - Black - L	$18.00	$36.00
Boxing_Gear	Chok	Gloves	synthetic	BagGloves	M	Black	1CH10S131M-100	Chok BagGloves Gloves - Black - M	$20.00	$40.00
Boxing_Gear	Chok	Gloves	synthetic	BagGloves	S	Black	1CH10S131S-100	Chok BagGloves Gloves - Black - S	$20.00	$40.00
Boxing_Gear	Chok	Gloves	synthetic	BagGloves	XL	Black	1CH10S132L-100	Chok BagGloves Gloves - Black - XL	$20.00	$40.00
Boxing_Gear	Chok	Gloves	synthetic	ADIDA	08 oz	Neon blue	1CH10S162Z-135	Chok ADIDA Gloves - Neon blue - 08 oz	$20.00	$40.00
Boxing_Gear	Chok	Gloves	synthetic	ADIDA	08 oz	Green	1CH10S162Z-280	Chok ADIDA Gloves - Green - 08 oz	$20.00	$40.00
Boxing_Gear	Chok	Gloves	synthetic	ADIDA	08 oz	Carbon red	1CH10S162Z-404	Chok ADIDA Gloves - Carbon red - 08 oz	$16.50	$34.00
Boxing_Gear	Chok	Gloves	synthetic	ADIDA	08 oz	Silver	1CH10S162Z-430	Chok ADIDA Gloves - Silver - 08 oz	$16.50	$34.00
Boxing_Gear	Chok	Gloves	synthetic	ADIDA	08 oz	White	1CH10S162Z-460	Chok ADIDA Gloves - White - 08 oz	$16.50	$34.00
Boxing_Gear	Chok	Gloves	synthetic	ADIDA	08 oz	Neon yellow	1CH10S162Z-491	Chok ADIDA Gloves - Neon yellow - 08 oz	$16.50	$34.00
Boxing_Gear	Chok	Gloves	synthetic	ADIDA	10 oz	Black	1CH10S163Z-100	Chok ADIDA Gloves - Black - 10 oz	$16.50	$34.00
Boxing_Gear	Chok	Gloves	synthetic	ADIDA	10 oz	Carbon blue	1CH10S163Z-134	Chok ADIDA Gloves - Carbon blue - 10 oz	$16.50	$34.00
Boxing_Gear	Chok	Gloves	synthetic	ADIDA	10 oz	Neon blue	1CH10S163Z-135	Chok ADIDA Gloves - Neon blue - 10 oz	$16.50	$34.00
Boxing_Gear	Chok	Gloves	synthetic	ADIDA	10 oz	Green	1CH10S163Z-280	Chok ADIDA Gloves - Green - 10 oz	$16.50	$34.00
Boxing_Gear	Chok	Gloves	synthetic	ADIDA	10 oz	Pink leopard	1CH10S163Z-341	Chok ADIDA Gloves - Pink leopard - 10 oz	$16.50	$34.00
Boxing_Gear	Chok	Gloves	synthetic	ADIDA	10 oz	Carbon red	1CH10S163Z-404	Chok ADIDA Gloves - Carbon red - 10 oz	$16.50	$34.00
Boxing_Gear	Chok	Gloves	synthetic	ADIDA	10 oz	Silver	1CH10S163Z-430	Chok ADIDA Gloves - Silver - 10 oz	$9.00	$22.00
Boxing_Gear	Chok	Gloves	synthetic	ADIDA	10 oz	White	1CH10S163Z-460	Chok ADIDA Gloves - White - 10 oz	$9.00	$22.00
Boxing_Gear	Chok	Gloves	synthetic	ADIDA	10 oz	White leopard	1CH10S163Z-462	Chok ADIDA Gloves - White leopard - 10 oz	$9.00	$22.00
Boxing_Gear	Chok	Gloves	synthetic	ADIDA	10 oz	White tire	1CH10S163Z-463	Chok ADIDA Gloves - White tire - 10 oz	$9.00	$22.00
Boxing_Gear	Chok	Gloves	synthetic	ADIDA	10 oz	Neon yellow	1CH10S163Z-491	Chok ADIDA Gloves - Neon yellow - 10 oz	$17.50	$30.00
Boxing_Gear	Chok	Gloves	synthetic	ADIDA	12 oz	Carbon blue	1CH10S164Z-134	Chok ADIDA Gloves - Carbon blue - 12 oz	$17.50	$30.00
Boxing_Gear	Chok	Gloves	synthetic	ADIDA	12 oz	Neon blue	1CH10S164Z-135	Chok ADIDA Gloves - Neon blue - 12 oz	$5.75	$15.00
Boxing_Gear	Chok	Gloves	synthetic	ADIDA	12 oz	Green	1CH10S164Z-280	Chok ADIDA Gloves - Green - 12 oz	$5.75	$15.00
Boxing_Gear	Chok	Gloves	synthetic	ADIDA	12 oz	White	1CH10S164Z-460	Chok ADIDA Gloves - White - 12 oz	$5.75	$15.00
Boxing_Gear	Chok	Gloves	synthetic	ADIDA	14 oz	Black	1CH10S165Z-100	Chok ADIDA Gloves - Black - 14 oz	$0.90	$4.00
Boxing_Gear	Chok	Gloves	synthetic	ADIDA	14 oz	Pink leopard	1CH10S165Z-341	Chok ADIDA Gloves - Pink leopard - 14 oz	$1.20	$5.00
Boxing_Gear	Chok	Gloves	synthetic	ADIDA	14 oz	Carbon red	1CH10S165Z-404	Chok ADIDA Gloves - Carbon red - 14 oz	$24.00	$52.00
Boxing_Gear	Chok	Gloves	synthetic	ADIDA	14 oz	Neon yellow	1CH10S165Z-491	Chok ADIDA Gloves - Neon yellow - 14 oz	$24.00	$52.00
Boxing_Gear	Chok	Gloves	synthetic	ADIDA	16 oz	Black	1CH10S166Z-100	Chok ADIDA Gloves - Black - 16 oz	$24.00	$52.00
Boxing_Gear	Chok	Gloves	synthetic	ADIDA	16 oz	Carbon blue	1CH10S166Z-134	Chok ADIDA Gloves - Carbon blue - 16 oz	$24.00	$52.00
Boxing_Gear	Chok	Gloves	synthetic	ADIDA	16 oz	Neon blue	1CH10S166Z-135	Chok ADIDA Gloves - Neon blue - 16 oz	$25.00	$54.00
Boxing_Gear	Chok	Gloves	synthetic	ADIDA	16 oz	Green	1CH10S166Z-280	Chok ADIDA Gloves - Green - 16 oz	$25.00	$54.00
Boxing_Gear	Chok	Gloves	synthetic	ADIDA	16 oz	Pink leopard	1CH10S166Z-341	Chok ADIDA Gloves - Pink leopard - 16 oz	$26.00	$56.00
Boxing_Gear	Chok	Gloves	synthetic	ADIDA	16 oz	Carbon red	1CH10S166Z-404	Chok ADIDA Gloves - Carbon red - 16 oz	$27.00	$58.00
Boxing_Gear	Chok	Gloves	synthetic	ADIDA	16 oz	Silver	1CH10S166Z-430	Chok ADIDA Gloves - Silver - 16 oz	$27.00	$58.00
Boxing_Gear	Chok	Gloves	synthetic	ADIDA	16 oz	White	1CH10S166Z-460	Chok ADIDA Gloves - White - 16 oz	$27.00	$58.00

Figure B-1 A screen shot of the information system

VITA

Azadeh Kamyabi, was born on April 23, 1986 in Tehran, Iran. She grew up moving with her parents from country to country in the diplomatic corps. Hence, she went to school in various countries and became accustomed to living in different cultures. In April 2014, she obtained her bachelor's degree in Mechatronics Engineering from Assumption University of Thailand. She then enrolled in a dual degree program run by Chulalongkorn University and University of Warwick, where she obtained her Master's degrees in Engineering Management from Chulalongkorn University and Supply Chain and Logistics Management from University of Warwick.