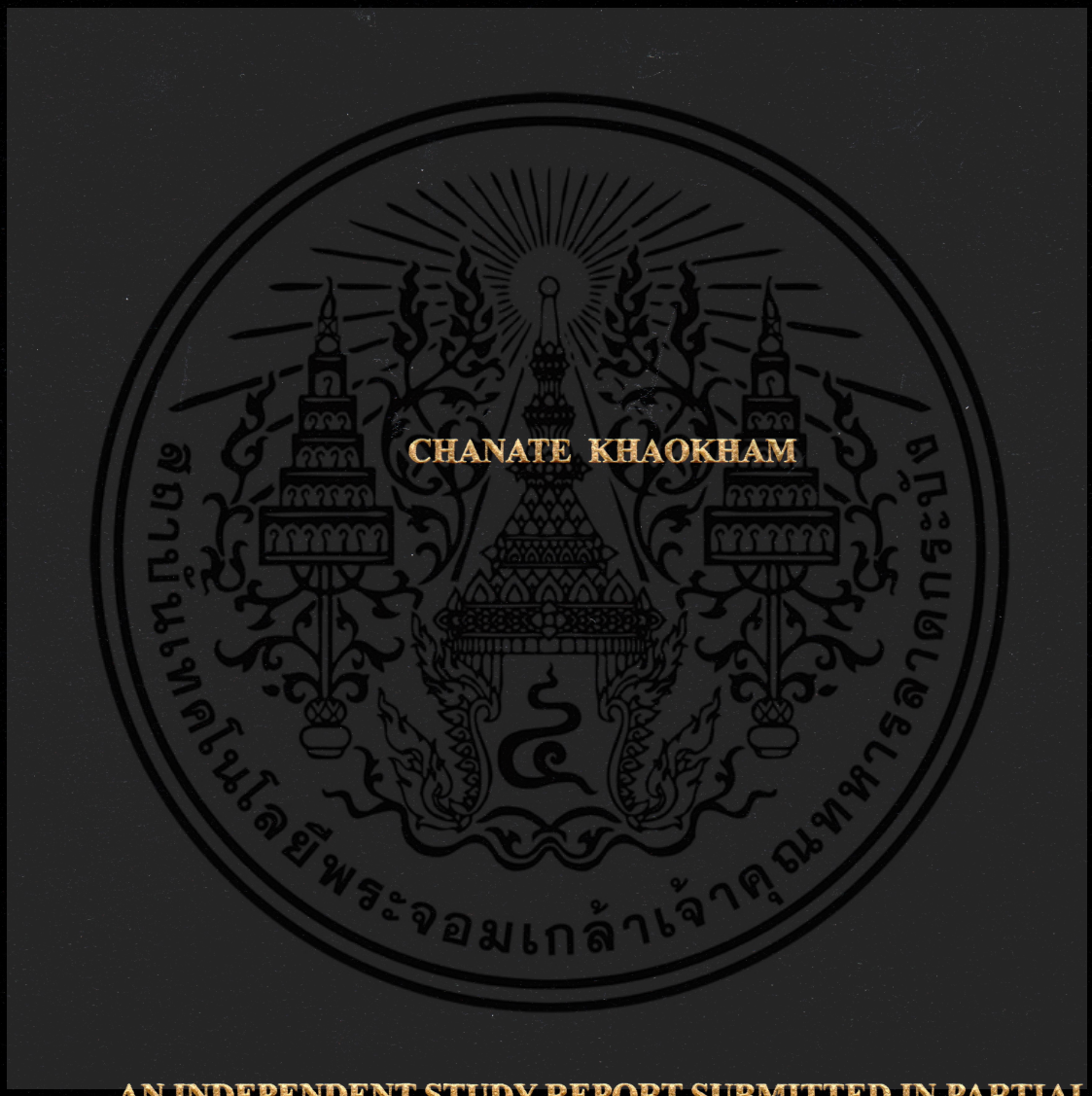
# PRODUCTION CONTROL PROCESS IMPROVEMENT BY USING DATA FLOW DIAGRAM (DFD)



CHANATE KHAOKHAM

AN INDEPENDENT STUDY REPORT SUBMITTED IN PARTIAL FULFILLMENT
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INTERNATIONAL COLLEGE
KING MONGKUT'S INSTITUTE OF TECHNOLOGY LADKRABANG
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**Independent Study Certification**

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| **Independent Study Title** | Production Control Process Improvement by Using Data Flow Diagram (DFD) |
| **Student** | Ms. Chanate Khaokham |
| **Student ID** | 58610026 |
| **Degree** | Master of Science |
| **Program** | Logistics and Supply Chain Management (International Program) |
| **Thesis Advisor** | Asst. Prof. Dr. Phaophak Sirisuk |
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| EXAMINERS | SIGNATURES |
|---|---|
| Asst. Prof. Dr. Wichitsawat Suksawat na Ayudhya<br>Asst. Prof. Dr. Phaophak Sirisuk<br>Dr. Jaruwit Prabnasak | |

**Date**: 9 Sep 2017 **Time** : 09:30 – 11:30 pm.
**Place**: International College, 8th floor, 55th Anniversary Chalermprakiat Building



(Assoc.Prof.Dr. Supat Kittiratsatcha)
Dean of International College
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|---|---|
| **THESIS TITLE** | Production Control Process Improvement by Using Data Flow Diagram (DFD) |
| **STUDENT NAME** | Miss Chanate Khaokham |
| **STUDENT ID** | 58610026 |
| **DEGREE** | Master of Science |
| **PROGRAME** | Logistics and Supply Chain Management |
| **ADVISOR** | Assistant Professor Dr. Phaophak Sirisuk |


**ABSTRACT**

Currently, there are many auto industries in Thailand, and the industry is expanding into the automotive parts export business. The automotive parts industry is one of the key industries which are still attractive to car makers and foreign investors. The industry is very competitive and requires a high quality logistic system, so a good system for the activities and operations between customers and vendors for parts distribution to each factory is required. In this study, the researcher studied the interesting export business of car manufacturing which orders parts from local suppliers and supplies other regions and oversea plants through regional production control, which creates cooperation between suppliers and customers. Therefore, intranet system interface data and communication are formed, but problems always occur during the operation which concern delay issues. Regional production control results in loss of cost and time when suppliers cannot deliver shipments to customers on time, and the fluctuation of orders is the main cause of delay which suppliers cannot control. Thus, a data flow diagram has been used to analyze information flow and to improve the operation between the regional production control and the suppliers. The functions for checking the order and informing suppliers about the order fluctuation before releasing orders on the intranet system have been added. Using Macro excel is a tool which combines data such as firm orders, forecasts, part numbers, supplier codes and customer codes. The output is part numbers which

indicate the fluctuating volume and risk of delayed delivery. This information has been surveyed from suppliers and the feedbacks from negotiating with customers have been kept. After implementing the order management activity to improve the delivery performance to suppliers and to control the orders from customers, delay issues are decreasing, and the regional production control can work with suppliers without delay. However, the experiment took 3 months and was applied for the parts export in Spain only. The overview result shows a little score of delivery performance. Therefore, the researcher will apply this activity to other customers and monitor trends to develop a suitable commination with suppliers.

**ACKNOWLEDGEMENT**

I am deeply thankful for Assistant Professor Dr. Phaophak Sirisuk for his invaluable advice and his patient proofreading towards the completion of this independent study. He always suggests the way that I should improve and keep more the details of this study. Because there are many techniques in the information technology science which I can apply to the production control for export part, I can gain more knowledge to use with my job in future as well.

Furthermore, I would like to thank my colleagues in the company who support and understand me while I am studying for the maser degree. They are team consultants whom I rely on when I have questions about export operation, which is an important part for collecting data and testing the experiment.

Additionally, I would like to thank my parents who support me to pursue my master degree. They never reject my intention to study in an international college even though my English is not so good. I would also like to thank those whose names are not mentioned here but who are part of this research and always assist me in this independent study.

Chanate Khaokham

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## LIST OF DEFINITIONS

| | |
|---|---|
| **RPC** | Regional Production Control |
| **BOM** | Bill Of Material |
| **DFD** | Data Flow Diagram |
| **MRD** | Material Requirement Date |
| **ETA** | Estimate Time Arrival |
| **ETD** | Estimate Time Departure |
| **GCC** | Gulf Countries |

# CHAPTER 1

# INTRODUCTION

## 1.1 Introduction

Currently, auto part industries are growing due to the expansion of car market in Thailand. There are suppliers who produce materials and component parts, and they support import and export auto parts for car manufacturing in domestic and foreign regions. In addition to suppliers' development of product design, production technology and supply chain have been developed in order to meet the customer needs. Some automotive industries are suppliers in their supply chain. They export parts to supply regional plants which bear the purchasing route and capital control in business. Thus, the information systems have been set up for communication and comprehension between them. In Figure 1.1, the business flow of parts export is shown.

As for the supply chain of parts export in the automobile industry, customers are oversea plants, and the regional production control (RPC) is a supplier. They export parts to supply production plants. For the procedure when new models are available, customers have to check lists of parts from the bill of material (BOM) of each model. Then, they confirm with the design center which will confirm the purchasing route with the production plant. After that, customers notify the information to the regional production control via mail. The responsibility of regional production control is project management. They will cooperate with suppliers and internal operations (packaging, logistics, purchasing, transportation, and cost). Parts are exported to plants oversea until the mass production is started.

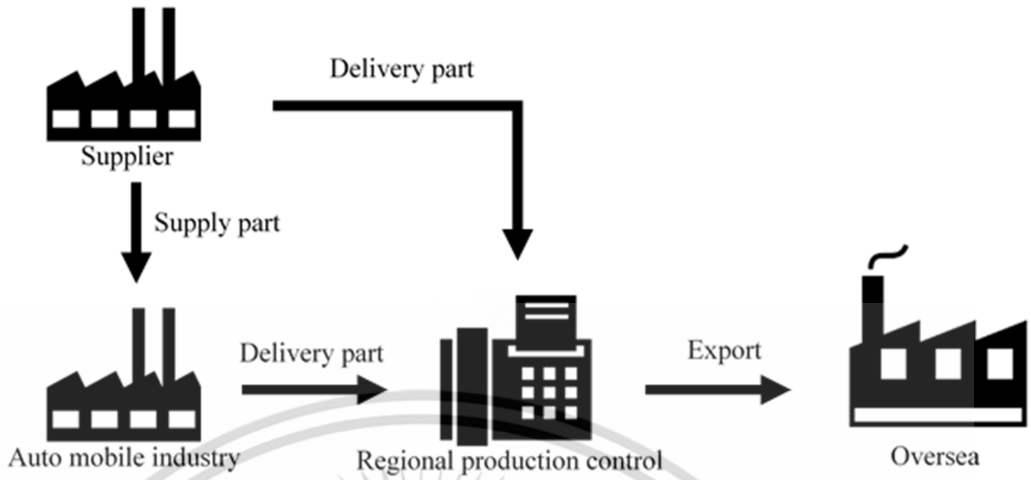



**Figure 1.1** Business Flow for Parts Export

The regional production control transforms information from customers. They submit the production control documents to suppliers, which consist of production and shipment schedules, part list and volume per part number. They construct an operation flow of customers' part orders and the logistic route between suppliers and the regional production control.

When the trial production starts, all operations will be confirmed for readiness, especially quality, standard packaging and part price which have been approved by customers. Suppliers must be prepared before starting the mass production. In this stage, information is controlled by manual operation. The order and forecast are sent to suppliers via mail.

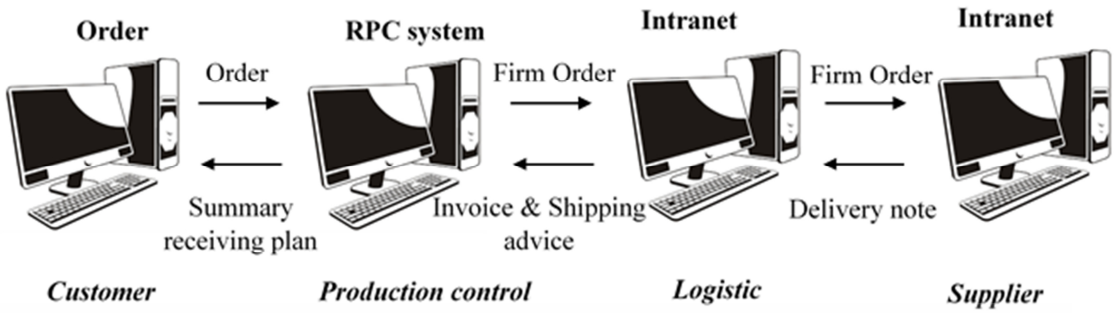



**Figure 1.2** Information flow for export part

Then, the regional production control releases part lists on the internal intranet. They prepare BOM and request for package engineer input standard packing. When the order interface is in the order system, the information will be combined to be used in the internal operation. The logistic team determines material requirement date of delivery to suppliers and plans the container ratio for booking shipment for each customer. Then, the order is released on the internet for suppliers.

Suppliers download orders and forecasts from the intranet. They prepare parts and plan the production to support customers. Suppliers will attach packaging labels on packages and delivery note sheets. Both documents are order lists for the logistic team controlling when receiving parts. Meanwhile, the intranet will update the status when suppliers receive the orders and when the shipments are shipped. All orders will be checked before loading containers and complete vanning. The logistic team confirms shipping advice, issue the invoice and send it to customers when parts depart from Thailand.

The regional production control has to send the feedback of the error list to customers in order to verify and confirm the volume and revise parts status in the system

again. Those parts will be created or abolished from the system after this information is sent to the regional production control. Then, they input the data in the intranet for suppliers. The problem occurs from the step of receiving information from customers since the system filters and receives only the part number and the number of purchase orders only. However, the main problem is the order fluctuation that always occurs with suppliers. In some cases, there are forecast orders, but when it is time to place the real order, the number of orders exceeds the number of forecast orders. In some cases, there is no forecast but the order is confirmed. Therefore, the system between the regional production control and suppliers cannot solve this problem, which is risky if suppliers do not receive the information.

Thus, the information of customers has to be improved after having been combined in the regional production control system. The researcher analyzes how to notice and solve this problem before delay occurs because the order is unstable and the request is in short timing, which results in suppliers having a lot of back orders and lose cost.

There are a few studies concerning information flow by using data flow diagram. Rowziati Ibrahim and Siow Yen Yen [12] studied about formalization of the data flow diagram rules for consistency check. They compared the tools to automate the process of manual consistency check in the data flow diagram. They applied the data flow diagram to simulate and create software. Moreover, they applied the data diagram to develop the process model in Bursary Cash office [10]. They found the problem and improve the documentation system.

Consequently, the researcher considers the parameter and operation flow of regional production control system. The researcher applies the data flow diagram to the improvement method, which is a tool depicting the overview of the information flow in the parts export process and identifying the solution steps. Therefore, this study aims find out the cause of production control for parts export using the data flow diagram.

## 1.2 Statement of Problem

On-time delivery is a target for achieving shipments of parts export, so timing and accurate information are primary for suppliers and the regional production control which requires management before announcement. As customers have order fluctuation, suppliers cannot keep on-time delivery which may result in delayed delivery and shipment.

Figure 1.3 shows data selection from the logistic team in 2016. They receive feedbacks from suppliers regarding the cause of delay. 47.7% of delay issues concerns order fluctuation. When analyzing the cause, the number or orders exceeds the previous forecast. The regional production control has no forecast but firm orders which affects the production plan, supplier capacity and materials. Moreover, suppliers have two-week lead time for preparing part, so it is very tight for managing and recovering plan for all back orders.

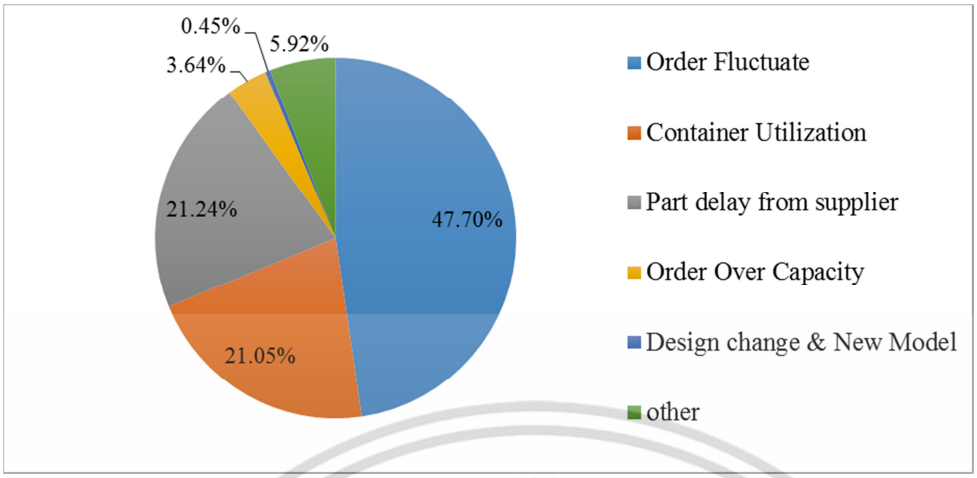



**Figure 1.3** Ratio of Delayed Delivery

When suppliers confirm the delivery date, the regional production control has to negotiate with customers. If suppliers delay, the regional production control has to work with suppliers. They set up a recovery plan and try to keep normal shipments so that it does not stop the production plan. They re-confirm the orders in the system for actual performance. However, this method takes a lot of time for cooperating between suppliers and customers, and the regional production control cannot detect all issues.

The effect of delayed delivery is loss of time and cost. The logistic team cannot arrange shipments and utilize containers with full capacity. The worst case is that the production plant cannot produce vehicles, and end customers are unsatisfied when they do not receive shipments on time.

## 1.3 Objective

The purpose of this study is to use the data flow diagrams (DFD) for analyzing and improving regional production control process which encounters problem from ordering before releasing firm orders to suppliers. Since the information flow and lead time affect delivery performance of suppliers, the data flow diagram can show the

overview operation from upstream to downstream process. Therefore, it is useful for finding the cause and solution. If a solution is advantageous, the researcher will suggest it to other regional production controls in oversea plants.

### 1.4 Scope of study

1. To analyze the information flow of parts export by using Data flow diagram (DFD) after receiving requirements from customers until shipments are completed.
2. To identify the operation which affects delivery and shipment achievement for parts export.
3. To suggest a solution for the ordering process and prevent the order fluctuation.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Modeling system

A part of determination information system in this chapter is a tool to create understanding on how the information is collected and transformed. The graphical tool is the data flow diagram that shows how data flows and operates to change or transform data. The diagram explains the relationship between data and how data are stored at a specific location. Analysts can define the flow of data in the information system which can be physical or logical, manual or computer-based.

A process model is a formal way of representing how a business system operates; it explains a process or activity which is performed and operated during processing. Moreover, the process model can be used to document the current system or computerize with the new system being developed [1].

### 2.1.1 Data Flow Diagram

There are a variety of methods that analysts use to study the information system. They start with a two-step method to translate language modeling and to communicate between designers and users' requirement. First, they work with users to create simple text descriptions of the processes which clarifies with classification of source document, form, report, and anecdotal impressions, and then analysts translate text descriptions into formal models such as the data flow diagram (DFD).

The researcher finds a journal that applies DFD to improve and develop the system. Rosziati Ibrahim and Siow Yen Yen [12] use the context diagram and data flow diagram to formalize the rules for consistency check. There are several benefits from this study. They can prevent the syntax error when users draw DFD and correct DFD to guarantee via the tool.

Moreover, the advantages of DFD are to continue improvement and to design the system. Vijaylaxmi Bittal and Manjula Dyavanur [13] create C program by using DFD to help understand the current system and represent a require system. It is the object model which explains the statistics and use of the object diagram.

Several authors [10] study the process and modeling of the Univesity Bursary system that is perspective of cash office. They use various symbols in the data flow diagram to explain how to develop and eliminate errors during combination requirement.

Therefore, the data flow diagram (DFD) is called a process model, which shows each element of the system transforming data into information and input – output between processes. The data flow diagram shows many of the important relationships between the data / information, procedures, and people components of the system

These diagrams are useful diagramming tools. With four symbols, they can represent both physical and logical information systems. The data flow diagram is not as good as flowcharts to explain the details of physical system; on the other hand, flowcharts are not very beneficial to explain the purely logical information flow [2].

**Purposes of Creating Flow Diagrams**

1. A diagram that summarizes all the information obtained from the analysis in terms of structural form.

2. A common agreement between system analysts and users.
3. A diagram used to further develop the system design process.
4. A reference diagram or development in the future.
5. Know the source of data flow in the process (data and process)

**Element of Data Flow Diagram**

The symbol of data flow diagram includes naming of conventions and syntax rule. There are four symbols in the DFD language (process, data flow, data stores, and external entity), each of which is represented by a different graphic symbol. There are two commonly used styles of symbols. One set is developed by Chris Gane and Trish Sarson and the other by Tom DeMarco and Ed Yourdon as shown in The Table 1.1.

| Data Flow Diagram Element | Typical Computer-Aided Software Engineering Fields | Gane and Saron Symbol | DeMacro and Yourdan Symbol |
|---|---|---|---|
| Every *process* has,<br>- A number<br>- A name<br>- One or more output data<br>- Usually one or more input data flow | Label (name)<br>Type (process)<br>Description (what is it)<br>Process number<br>Process description (Structured English notes) |  |  |
| Every *data flow* has<br>- A name (a noun)<br>- A description<br>- One or more connection to a process | Label (name)<br>Type (flow)<br>Description<br>Alias (another name)<br>Composition<br>(Description of data elements)<br>Notes |  |  |
| Every *data store* has<br>- A number<br>- A name (a noun)<br>- A description<br>- One or more input data<br>- Usually one or more output data flows | Label (name)<br>Type (flow)<br>Description<br>Alias (another name)<br>Composition<br>(Description of data elements)<br>Notes |  |  |
| Every external entity has<br>- A name (a noun)<br>- A description | Label (name)<br>Type (flow)<br>Description<br>Alias (another name)<br>Entity description<br>Notes |  |  |

**Table 2.1** Denotation and Symbol for DFD

Source : Jeffrey A. Hoffer, Joey F. George and Joseph S. Valacich. 2011. Modern Systems Analysis and Design (Sixth Edition). United states of America. Pearson Education, Inc., publishing as Prentice Hall.

**The process** includes collecting, sorting, selecting, summarizing, analyzing, and reporting. Those are procedures operating on data. The description of the process often reflects the level of abstraction in the diagram. The caution about the use of messages is

to avoid explaining the operational process. The process or procedure is a task that performs or responds to input data. An action or reaction of person, an organization, a robot, a machine or a computer to any condition or situation is a verb [3].

**Data Flows** are communication between different processes and external or internal systems which display the information. The processes import and export data to represent data records, deletions, modifications of data. The symbol is a straight line that consists of an arrow at the end to indicate the direction of travel or flow of information [3].

**Data Store** is the source of data storage that describes the details and specifications of what to keep / record. The symbol is one open square. It displays the code of the data store at the left side which may be a sequence number or letter, such as D1, D2, etc., the opposite side displays the name of the data store or file name [3].

### 2.1.2 Context Diagram

Context Diagram is a top-level flow diagram that shows an overview of the system. It interacts with the external environment [2].

The Figure 1.1 shows the context diagram of food ordering system. There are three objects involved in this system such as customer, Kitchen and bank. They transfer information image of data flow between them.

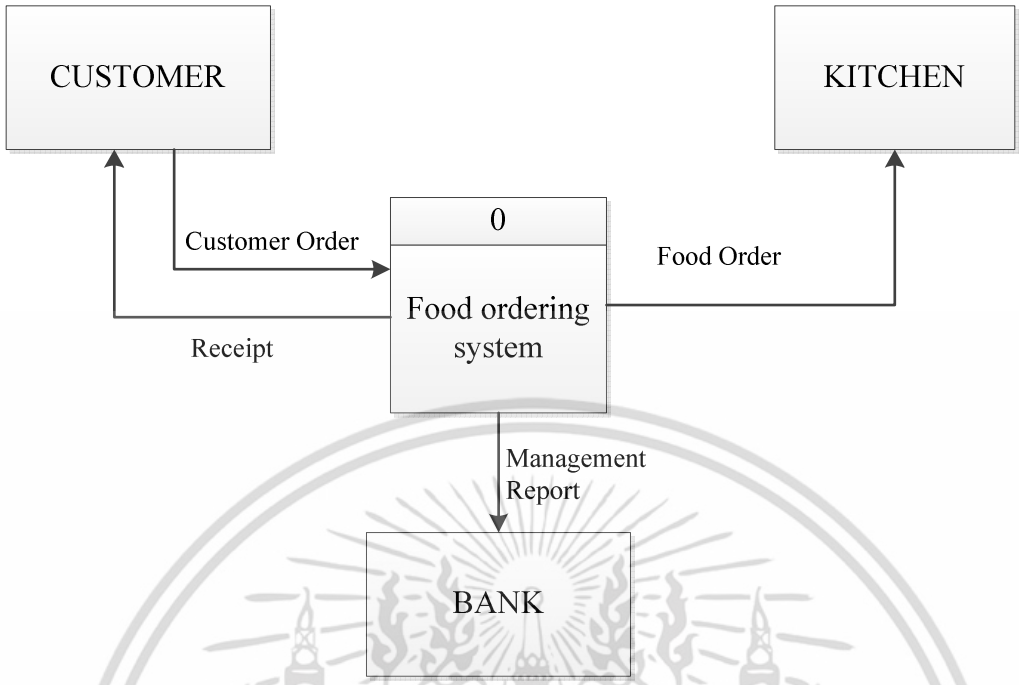



**Figure 2.1** Context Diagram

Source : David Harris. 1999. Systems Analysis and design (A project Approach) . United states of America: Harcourt Brace College Publishers

### 2.1.3 Level 0 Data Flow Diagram

Level 0 data flow diagram is a flow diagram that shows all the main processes of the system, flow direction of the data flow and the details of the data store.

The diagram gives the details of relationship in the Context Diagram and depicts the order of the system steps. The level of the diagram is subdivided and called Level-1, and the diagrams which are subdivided in the next level diagram must have at least 2 processes [2].

The Figure 2.2 shows Level 0 data flow diagram which explains the operation flow in the food ordering system. There are four processes when the system gets the order from customers. This diagram presents information which is input and output from the process. The details are more clarified than those in the context diagram.

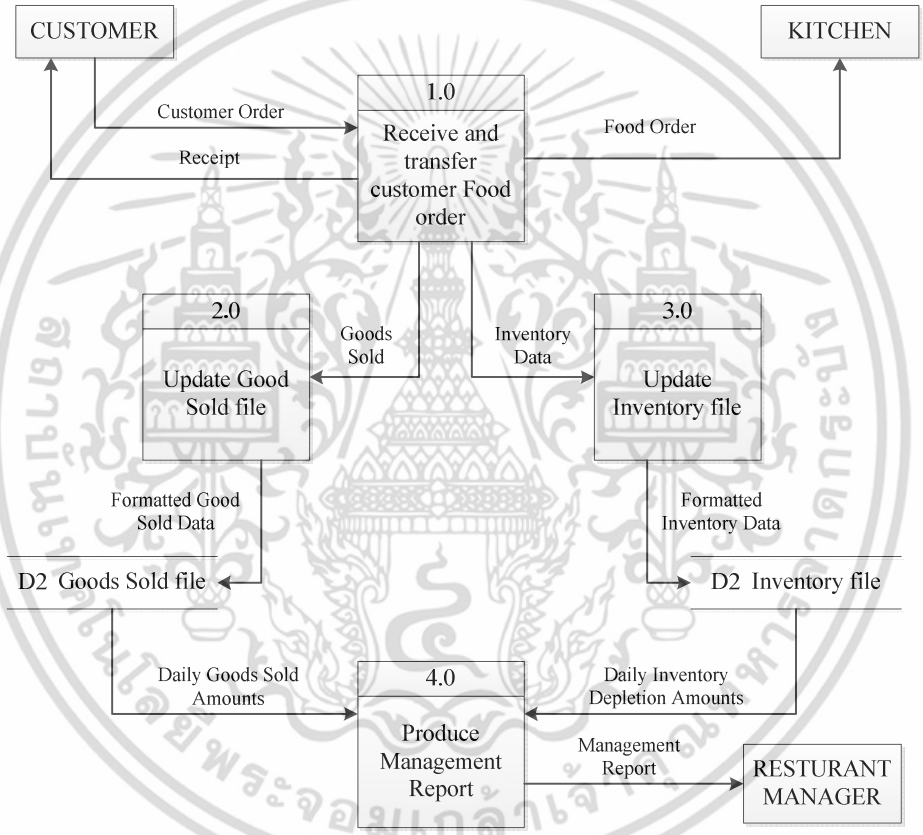



**Figure 2.2** Level 0 Data Flow Diagram

Source: David Harris. 1999. Systems Analysis and design (A project Approach) . United states of America: Harcourt Brace College Publishers

### 2.1.4 Level 1 Data Flow Diagram

If any system has a very complex operation, system analysts will not be able to describe all the work in the Context Diagram. Therefore, system analysts can be classified subsystems and divided into smaller subsystems.

Divide / split / sub-system and workflow into sub-sections in each step. Subsystems will show more details of the operation. The subdivision can be continuously until that cannot be divided.

Figure 1.3 shows the Level 1 Data Flow Diagram that produce management report processing, and Figure 1.4 presents how to a prepare management report in Level 2 Data Flow Diagram. Both are the example to create and divide the process which is interesting.

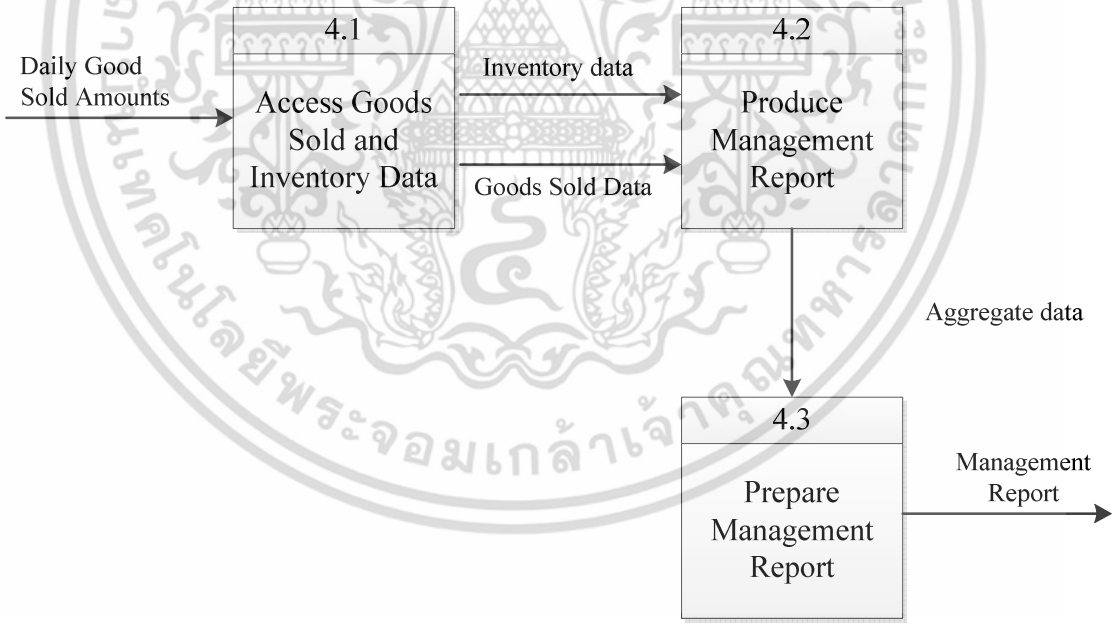



**Figure 2.3** Level 1 Data Flow Diagram

Source: David Harris. 1999. Systems Analysis and design (A project Approach) . United states of America: Harcourt Brace College Publishers

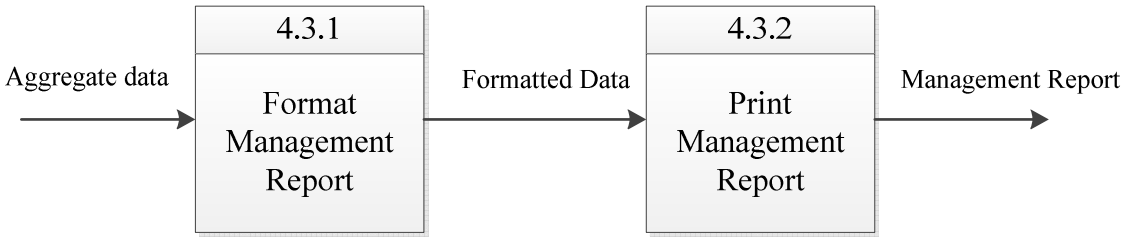



**Figure 2.4** Level 2 Data Flow Diagram

Source: David Harris. 1999. Systems Analysis and design (A project Approach). United States of America: Harcourt Brace College Publishers

### 2.1.5 Data Flow Diagram Rules

**Rules of the Process**

1. There is no input data without sending output data from the process. This type of error is referred to as "black hole" because the received data is lost.
2. There is no output data without input data into the process.
3. Naming Process requires verb such as Prepare, Management, Report, and Calculate.

**Rules of Data Flow**

1. Data flow has only one direction of flow between symbols.
2. If the data go from a common location to two or more different processes, Data Store or External Agent can use a fork in data flow.
3. If the data come from two or more different processes, Data Store or External Agent to common location can join Data flow.
4. Data flow cannot run back to the same process it leaves.
5. Data flow to Data Store means update.
6. Data flow from Data Store means retrieve or use.

7. Naming Data Flow must use nouns such as Inventory Data, Goods Sold Data, etc.

**Rules of External Agent**

1. The data from the External Agent cannot directly flow to another External Agent, which must go through the process for processing the data and get the information to another External Agent.
2. Naming the External Agent requires a noun such as Customer, Bank etc.

**Rules of Data Store**

1. Data cannot run directly from Data Store to another Data Store. That must be moved from Process.
2. Data from External Agent cannot run directly to Data Store.
3. Data from Data Store cannot run directly to External Agent.
4. Naming a Data Store requires a noun such as a Customer File, an Inventory, or an Employee File.

### 2.1.6 How to Create Data Flow Diagram [14]

1. First, start writing Context Diagram to determine the main information whether it is input or output and interact in the system. This step is very important because it will make you aware of the scope of the system.
2. Using the information from Step 1 to create a different DFD.
3. Repeat the four sub-items until the desirable DFD is obtained.

    3.1 Determine the process and data input and output from the process in the first DFD.

    3.2 Divide the next DFD from the process needed to realize the information flow.

3.3 Find out and detail the error in DFD

3.4 Write each diagram step by step. The DFD will be used in the design process and involved in the project team.

4. Investigate the error with users and system analysts
5. Produce all final diagrams and develop them in the next step.

## 2.2 Flowchart

Flowchart is picture of whole process flow that shows the sequence or actions are explain by the symbols. The chart has a relationship among steps and what is starting and ending in the basic process.

The chart shows a step-by-step tool or work process by using the same standard. In the symbol, there is a short text describing the data that needs to be processed and the result or instruction of that process, linking those steps in lines with directional arrows from start to finish.

**Purposes of Flowchart**

1. Create same understanding of operation flow, which is important for studying and working with another
2. Develop the process as the chart is an advanced analysis which shows how the process works and can identify the impact of each other's activities
3. Improve when the problem occur and see defective and what actually works in the process
4. Standardize the process, acknowledge with operators to make an agreement on what improvement and development to work for

However, the flowchart has some limitations because it represents the problem, but it cannot explain the process in depth or specify the information or effect from such process. In addition, it cannot identify the cause of the problem. So, the flowchart is a material which supports investigation or information [9].

**The flowchart is divided into 2 types.**

1. System Flowchart is a flowchart of the system, a flowchart that shows the process of the system. It represents the device for receiving and transmitting media information, processing, methods, displaying results and operating sequences [8].
2. Program Flowchart is a flowchart showing how the program works. A flowchart that shows the steps of a work order to plan or compile a programming idea. The program displays a sequence of steps. Step By Step Programming the program flowchart reduces programming errors, making programming easier and more accurate. It also analyzes the defects that occur, such as bottlenecks caused by programming [8].

The content in the boxes shows the major process or significance in each step which should be easily understood and primary outlined for the process. The symbols have different types and shapes which represent different activities. The table below shows denotations and symbols.

| Symbol | Description |
|---|---|
|  | **Start** and **end steps** are easier to locate if they are drawn as **ovals.** |
|  | **Actions** are shown in **retangles** |
|  | **Decisionare** shown as diamans. Each **diamonds** should have more than onc exit- for example, one path for steps takenif the decision is yes; another path if it is no. |
|  | **The sequence ofsteps** is shonws by flowlincs with thc **arrows** that lcad into thc next flowchart symbol |
|  | When flowlines cross, a **bridge** helps avoidconfusion by showing where each line goes |

**Table 2.2** Denotation and Symbol for Flowchart

Source: Lynda Finn, Casey Garhart, Flowcharts: Plain & simple. United State: Oriel Incorporated. 2002.

**Advantage of Flow Chart**

- Helps to sequence the program and can be programmed without any confusion
- Helps to detect and fix the program when errors occur easily

- Allows quick and easy modification
- Helps people learn the program more easily and quickly

A user analysis is needed when using Data Flow Diagram. By writing a symbol, the processor only writes the thread for processing. No detailed description is written. Detailed explanations can be added by writing a Process Description or Process Specification.

The purpose of writing process specification is to be used as a media between system programmer users and system analysts for clear understanding of the processing. Programmers will understand the processing for programming purposes, especially in case of presence of many programmers in programming to convey the message. The system users will see if the analysis is correct understanding or not [4].

**How to Write a Good Flowchart**

1. Use the symbols as prescribed
2. Use the arrows to indicate the flow direction of the information from top to bottom or left to right
3. The description in the image should be short, compact and easy to understand**.**
4. All diagrams must have arrows showing direction in and out.
5. It should not be linked to a very distant workflow. The point symbol should be used instead.
6. The flowchart should be tested for correctness of operation before programming.

## 2.3 Problem Solving and Identification of Cause

Taran Kanti explained the application of fish bone analysis for evaluating supply chain and business process which is a case study on St James Hospital. He used the fish bone diagram to incorporate in the business with lack of proper equipment, faulty process, misdirected people, poorly materials management, improper environment and inefficient management in the problem area.

As manufacturing has a complicated system and there are many people involved in solving the problem, they should be participants in the investigation. When the group gets together, suggestions and opinions affecting the quality can be extracted [4].

The fishbone diagram helps to find many factors involved in the problem and gather information to find the right solution. However, mapping or mind mapping is organizing ideas that scatter the relevant concepts into a single mess. It is a brainstorming tool designed to mimic brain function. In case the cause of the problem needs to be analyzed, using Fish-Bone Diagram or the cause and effective diagram is most suitable.

The cause and effect diagram was developed by Kaoru Ishikawa in 1943. This diagram is used to identify and systematically list various causes which can be attributed to a problem (or an effect). Thus, the cause and affective diagram determines which of several causes has the greatest effect. The cause and effect diagram can aid in identifying the reasons why a process goes out of control. Figure 1.5 shows the structure of the cause and affect diagram [5]

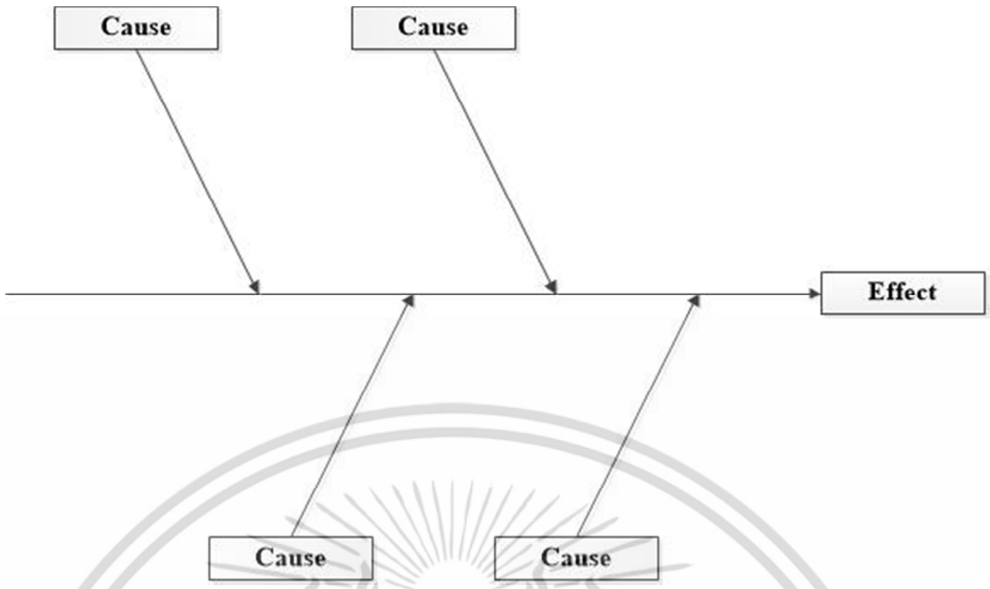



**Figure 2.5** Structure of Cause and Effect diagram

Source : Amitava Mitra.2008. Fundamentals of quality control and improvement Third Edition. United states of America: A John Wiley & Sons, INC., Publication.

The problem or effect is displayed at the fish head.

Causes can be further subdivided as follows:

- Factors that affect the problem are written on the main fish.
- The main reason is written down in each key.
- The sub-cause is written down in the main stem. There may be several sub-clauses.

The cause of the problem is written in each fishbone. The pulp is the cause of the pulp, and the pulp is the root of the pulp.

**Benefits of Fishbone Diagram**

1. Used as a brainstorming tool from all members of the quality group as a category which works best

2. Shows the causes of the problem of the consequences that have come on continuously until the key to the pledge to improve.
3. This map can be used to analyze many problems, including social functions, even daily life.

**Constructing Cause and Effect Diagram**

An essential feature of the cause and effect diagram is brainstorming, which is used to bring ideas on cause out into the open. A group of people freely exchanging ideas bring originality and enthusiasm to problem solving. [6]

**Step 1 Identify the Effect**

It is vital that the effect of problem is state in clear, concise terminology. This will help to avoid the situation where the 'cause' are identified and eliminated,

**Step 2 Establish Goal**

A goal should be stated in some terms of measurement relate to the problem and this must include a time limit.

**Step 3 Construct the Diagram Framework**

Cause enumeration is usually developed through a brainstorming session in which all possible types of causes are list to show their influence on the problems (or effect) in question.

Any manufacturing process can basically be divided into four major categories (causes), which have an impact on a quality characteristic (effect) that is monitored to control the line, that are usually employed in conjunction with these diagrams are man, machine, method, and material. These are traditionally call the 4m's in the manufacturing process

**Step 4 Incubation and Analysis of Diagram**

**Dispersion analysis** - analysis caused by investigating the sub causes: this process is repeated for each major prioritize order.

**Process analysis**: the emphasis is on listing the cause in the sequence in which the operations are actually conducted.

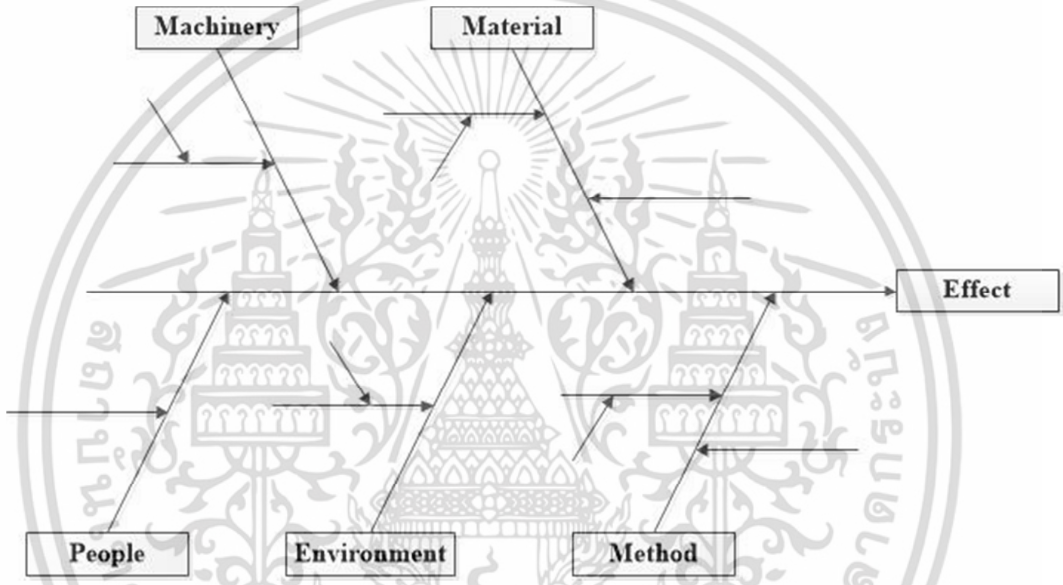



**Figure 2.6** Analysis of Main Cause of Problem

Source: Amitava Mitra.2008. Fundamentals of Quality Control and Improvement, Third Edition. United States of America: A John Wiley & Sons, INC., Publication.

In the investigation, each possible cause is recorded on this diagram. The next step is to establish the validity of the assertions and the relative importance of the various possible causes. They cannot all be investigated at once, so they must be put in order. For this scheme of weighted voting to be helpful, each participant gives a weight to each cause and the cause with the greatest total weights as studied first.[7]

Alternatively, if the process is stable, these diagrams can help the management team decide which causes to investigate for process improvement.

# CHAPTER 3

# PROBLEM ANALYSIS

## 3.1 Operation Analysis for Export Part

The parts export business has the operation for controlling ordering and shipment to overseas plants. They have the system to communicate among customers, regional production controls and suppliers. The system transfers information to operate and interface to users, but the regional production control encounters a problem from suppliers when they cannot achieve the delivery. There are many reasons to find a solution and prevention.

The main problem is order fluctuation where firm orders are higher than forecasts, and sometimes there is no forecast but firm order. Therefore, suppliers have short lead time for recovery requirement. The regional production control receives orders from customers, and they have to check or notice information for suppliers and customers.

Thus, this chapter will explain the operation flow and organization that concerns the export operation. Using the cause and fish bone diagram to find out the cause and realize the current information flow by using data flow diagram, the researcher designs the improvement method and applies it to customers.

**Organization Chart**

Firstly, studying of the job description is primary in order to see what the responsibility of each department is. This section is part of the supply chain management department as shown in Figure 3.1. Figure 3.2 shows five sections operating for parts export to overseas plant.

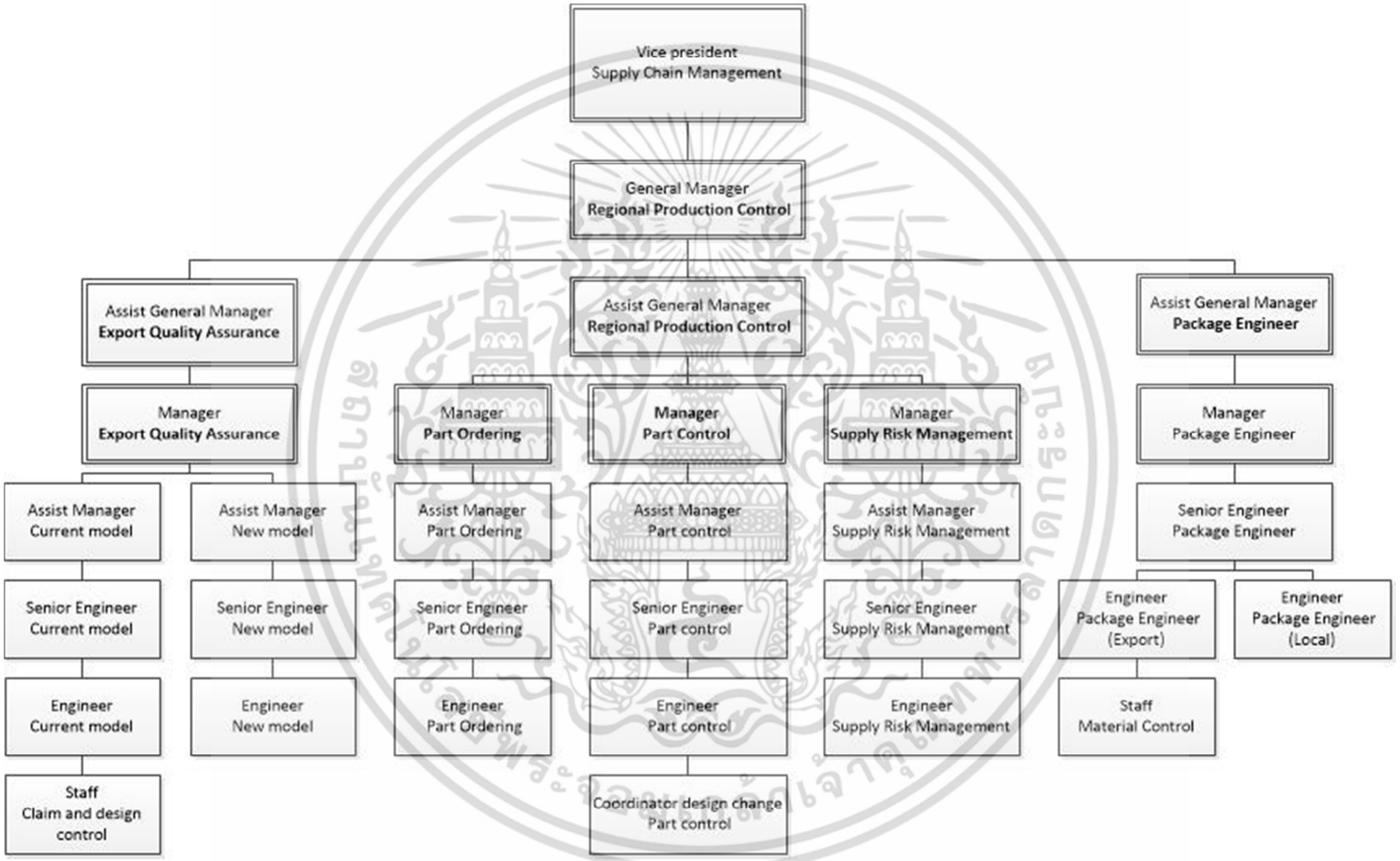



**Figure 3.1** Organization chart of Supply chain management

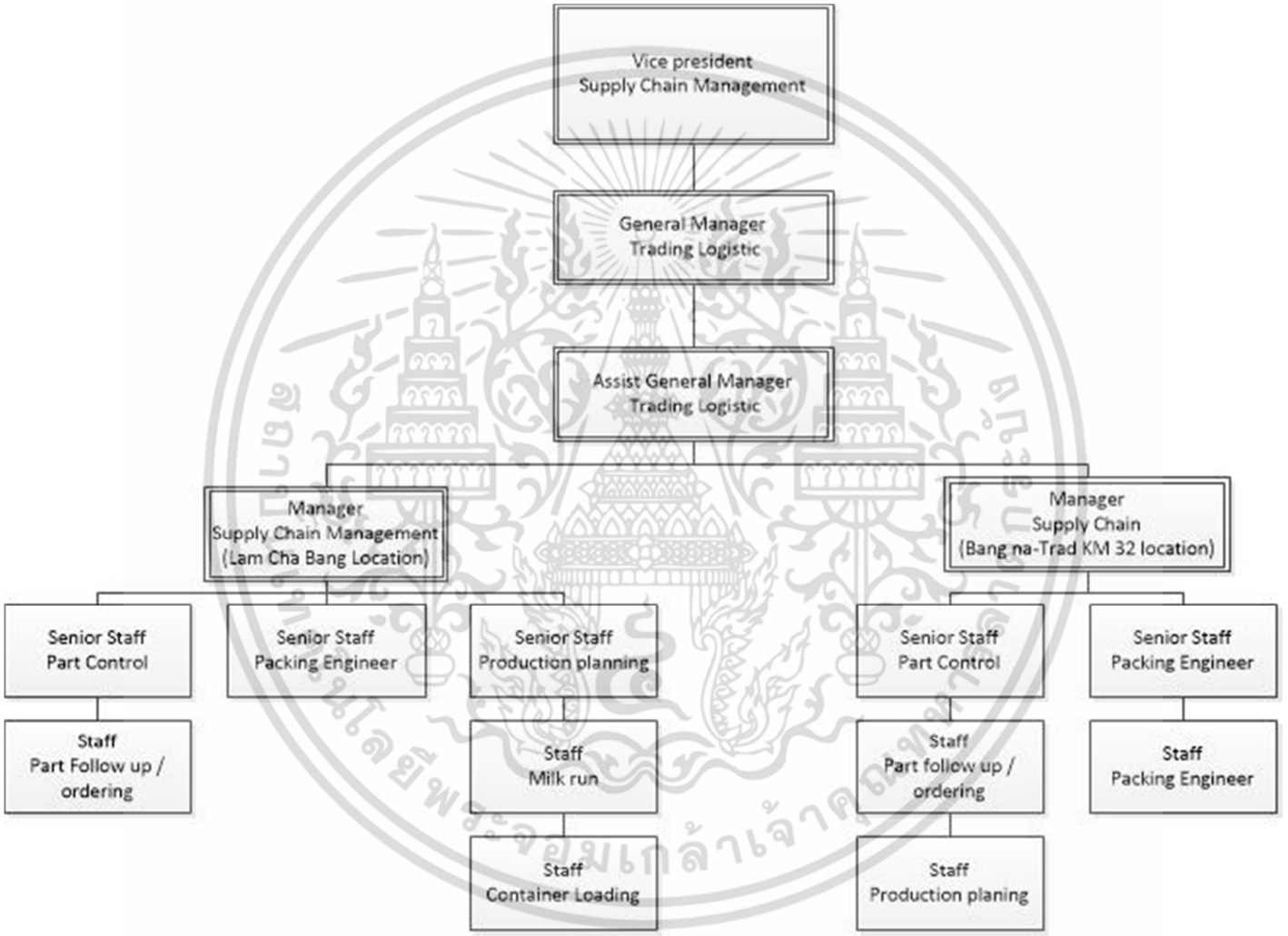



**Figure 3.2** Organization chart of Trading Logistic

## 3.2 Description and Sequence of the Process

Customers are overseas plants, and they have requirements to order components and parts from the regional production control due to parts familiarity in Thailand and low capital for control cost. The procurement department will find suppliers to order parts or materials for the production. There are customers in Asia Oceania, Europe, North America and South Africa, and 20 countries more which import parts to their production. Customers provide information about part number, volume, delivery date, and design control.

**3.2.1 The regional production control** manages requirements from customer sand transfer them to suppliers. They set up the operation for new models and how to order them for suppliers. The information is forecast and firm order. Moreover, they control design issues from designs and customers.

**3.2.1.1 Part Arrangement** sets BOM in The internal system. Vehicle models consist of many parts which are supplied by various suppliers. Some parts are ordered from local suppliers or exported from another region. Therefore, Part Arrangement must check which parts should be provided from their side. In Thailand, Part Arrangement has around 200 suppliers to export parts to customers. They verify part list, volume, master schedule and control design of each part. After customers and designers release the BOM in global system, Part Arrangement will explain and notify details to suppliers and relevant internal export organizations.

They control design change and proceed with trial production to be smoothly launched.

**3.2.1.2 Part Ordering** makes the contract on how to order, pay and incoterm. They receive orders weekly via the ordering system when customers place orders to the ordering system. Information is computed with BOM which Part Arrangement sets up in the ordering system. Part Ordering will check the volume of each part number and then send this information to the logistic team to release orders to suppliers, Furthermore, they arrange special orders such as emergency order or order for replacement when customers or suppliers have a claim. If suppliers cannot provide parts on time, Part Ordering will feedback customers and work with the supply risk management team. They solve the problem and instruct a recovery plan with suppliers to avoid the production line halt.

**3.2.1.3 Supply risk management** controls the capacity of supplier. They can support the volume from customers and observe the risk of suppliers failing to keep parts delivery on time. In case of new part numbers or new suppliers, the supply risk management will co-check the readiness of suppliers with the quality assurance team. If the capacity is not enough, they improve and request purchasing to investigate new tooling or machine to support requirements from customers.

**3.2.2 Export Quality Assurance (EQA)** controls the parts quality before exporting to customer. They audit and improve the quality with suppliers, designers and customers. This team monitors suppliers when designers have design change issues or new parts. Suppliers should follow the specifications and adopt the time target for each issue. After EQA approves documentation, the warrantee will be issued before shipment to customers.

**3.2.3 Packaging Engineer** works together with suppliers to design packaging standards for each part number. They plan for utilization of container loading, empty boxes, proper packaging, and capacity maximization. They design packages while keep the quality from suppliers to customers. In addition, this study concerns container planning and milk run verification to pick up parts from suppliers. The logistic team uses this information to arrange shipments and parts delivery, and customers must order parts at the minimum volume based on standard packaging which is useful for ordering and planning.

**3.2.4 Logistic Team** is a trading logistic company and manages orders for suppliers. The operations cover receiving and shipping parts to customers. They release orders on the intranet which is the ordering system of suppliers. The intranet interfaces information between part ordering and suppliers. They manage orders by sea shipments for normal orders and air shipments for special orders (dangerous parts, parts with controlled temperature such as labels or engine assemblies). There are three sections of this team as follows:

**3.2.4.1 Production planning** arranges orders that should be completed in containers and follow shipment schedules. Then, they release orders to supplier 2 weeks before the delivery date,

**3.2.4.2 Logistics and transportation** books milk run to pick up parts from suppliers.

**3.2.4.3 Part follow up** confirms the delivery date with suppliers after orders are released in order and checks the actual receiving plan. They summarize and proceed with shipment booking.

The logistic team consists of 2 sections which control normal orders which are arranged by sea freight. Their responsibility concerns mass production and standard operation ordering. The warehouse location is in Laem Chabang. They have the logistic team who manages special orders, which are for the trial production, emergency order and special parts which are part with controlled temperature. The orders can be shipped by air and sea freight depending on ETA requirements from customers,

## 3.3 Business Flow

According to Section 2, the flow chart technique has been applied. In this section, the researcher uses the technique to represent the business flow of the department.

### 3.3.1 Study of Operation Flow for Parts Export

The operation flow shows activities and sequences for all operations from upstream to downstream of ordering process as shown in Figure 3.3.

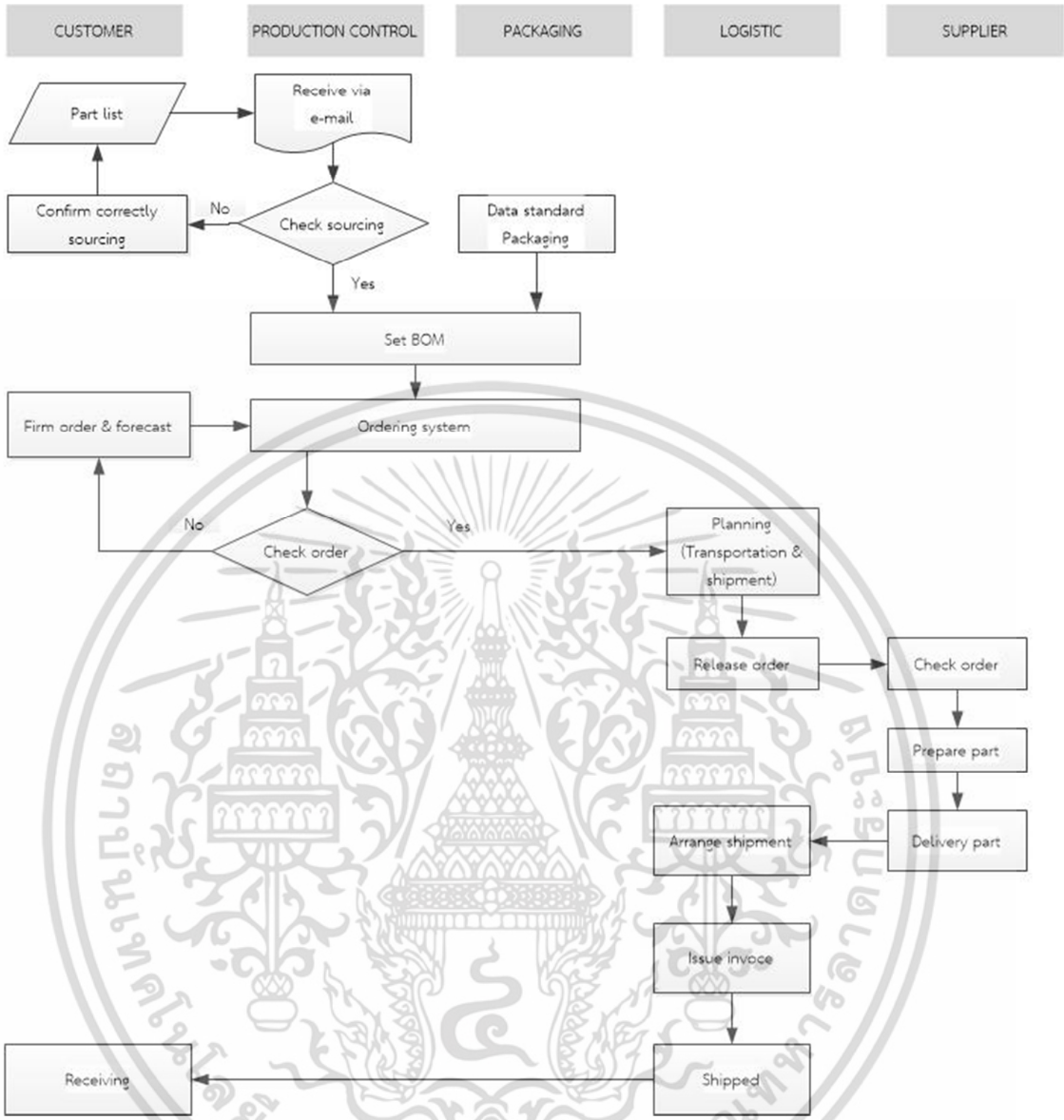



**Figure 3.3** Operation Flow of Parts Exports

At the beginning of the operation, customers communicate with the regional production control concerning new models. They send the parts list and volume which they want to import for their production. After that, the regional production control verifies the information and send announcement via email to suppliers.

**Firm orders** are part orders from customer per week. Regional production control receive this requirement via order system and separate to supplier. Customer will create RAN No. for control their ordering system. But regional production control generates order to supplier by issue no. because that supports transportation planning and shipment plan.

**Forecast** is the volume that customer predict to order from regional production control. Those include 3 month forecast and weekly forecast.

Supplier must check the parts list and parts status

1) Design / specification
2) Capacity of production
3) Logistic route for information and transportation
4) Schedule for trial and mass production
5) Part price confirmation

After supplier confirms their readiness, the regional production control sets up the BOM in the ordering system, which supports order transmission from customers. There are 4 parameters which the regional production control release in the ordering system such as

1) Part number and part name
2) Supplier code and depot code
3) Customer code
4) Standard packaging and quantity per package

In terms of packing data, the package engineer inputs the information after the BOM is released. This is completed in the ordering system for each vehicle model. When customers place an order, the part ordering team will check for correction of part number, quantity and order number before sending it to the logistic team.

Table 3.1 shows an order example from customers where part ordering can be downloaded from the ordering system in Microsoft Excel format. They check and proceed with the trial operation before the order is transferred.

| Week no. | Buyer code | Order no | Issue no. | Part number | Part name | Due date | Q'ty |
|---|---|---|---|---|---|---|---|
| 35 | 5SPA05 | DSFCU4X | D24KDF | 111015AD0A | BRKT ASS'Y-HEAT INSUL | 161025 | 33 |
| 35 | 5SPA05 | DSFCU4X | D24KDG | 222025AD0A | BRKT ASS'Y-HEAT INSUL | 161026 | 33 |
| 35 | 5SPA05 | DSFCU4X | D24KDH | 333035AD0A | BRKT ASS'Y-HEAT INSUL | 161026 | 33 |
| 35 | 5SPA05 | DSFCU4X | D24KDJ | 444045AD0A | BRKT ASS'Y-HEAT INSUL | 161027 | 33 |

**Table 3.1** Order Sheet from Customers

The logistic team manages the orders to suppliers and booking milk run after checking the shipment requirements from customers. Suppliers download the orders from the intranet and prepare parts for delivery. The logistic team receives parts and confirms booking and vanning within that week.

After setting the estimate time delivery (ETD), the logistic team will issue the invoice and send it to the accounting team. They will update the shipment status plan in the ordering system where customers can check for the estimate time arrival (ETA).

## 3.4 Cause of Delayed delivery

In this section, the knowledge of effective diagram in Chapter 2 has been used to analyze the problem. The researcher needs to brainstorm with the logistic team and suppliers as their ideas can prove and identify the cause of delay. The researcher needs the data of supplier performance, trend volume from customers and number of delay issues in 2016.

### 3.4.1 Process Flow Analysis

The problem is suppliers' parts delayed delivery which makes customers lose time and cost. As reported by the logistic team, the main cause is that suppliers receive high volumes in each week which makes suppliers have short lead time for planning and production to supply parts. Thus, the Supply Risk Management team will work with suppliers to solve this problem and set an action plan to avoid production halt.

However, the part ordering team which receives orders from customers will transmit orders weekly. They have the process to check firm orders before sending them to the logistic team and suppliers. The part ordering team spends 2 days checking correction of part number and volume. Therefore, if the order fluctuation is detected, the part ordering team can solve the problem and improve this process.

**Current Problem in Export Operation**

According to the statistical number of order issues from customers during Weeks 14-52 in 2016, the data shows delay issues where suppliers cannot achieve target shipment to customers.

Figure 3.4 shows the data of orders for parts export during Weeks 14-52 when the regional production control has 496,042 issues concerning the export volume. The

highest volume is in Week 16 with 17,895 issues, and the lowest volume is in Week 49 with 6,993 issues. The average on-time delivery in 2015 is 12,720 issues. Therefore, it has been found that the volume in 2016 is higher than that in 2015. However, the interesting point in this figure is 2,361 of delay issues in Week 20 which is highest when the regional production control has a huge volume.

In addition, Figure 3.5 shows the consequences when suppliers cannot keep delivery on time. There are 2,096 issues of back order in Week 16, 1,008 issues of cancelled order in Week 1, and 610 issues of air freight in Week 19. Those are the highest range of delayed delivery. The volume is small compared to the actual delivery, but a lot of expense incurs in order to improve shipment schedules when changing the shipment from sea to air. The full capacity of containers cannot be achieved which means some shipments are empty containers for normal shipments.

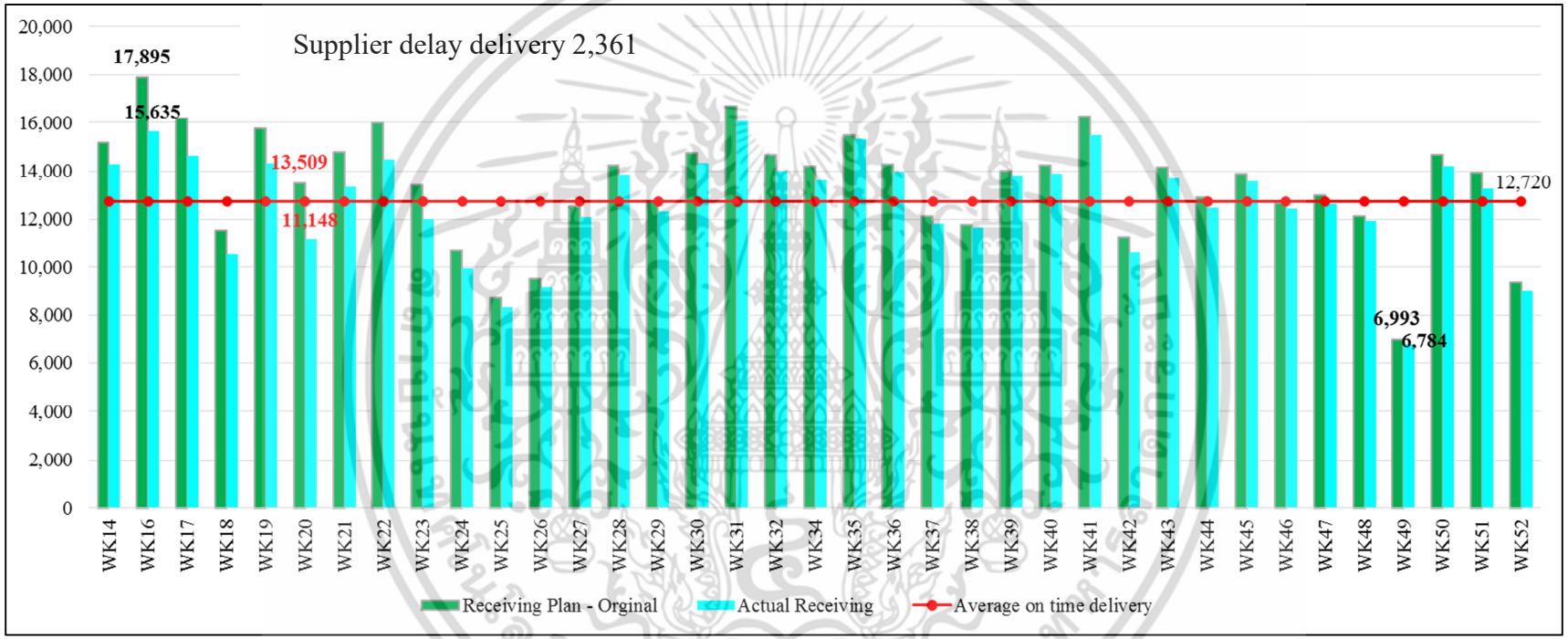



**Figure 3.4** Delivery performances week 14-52 in 2016

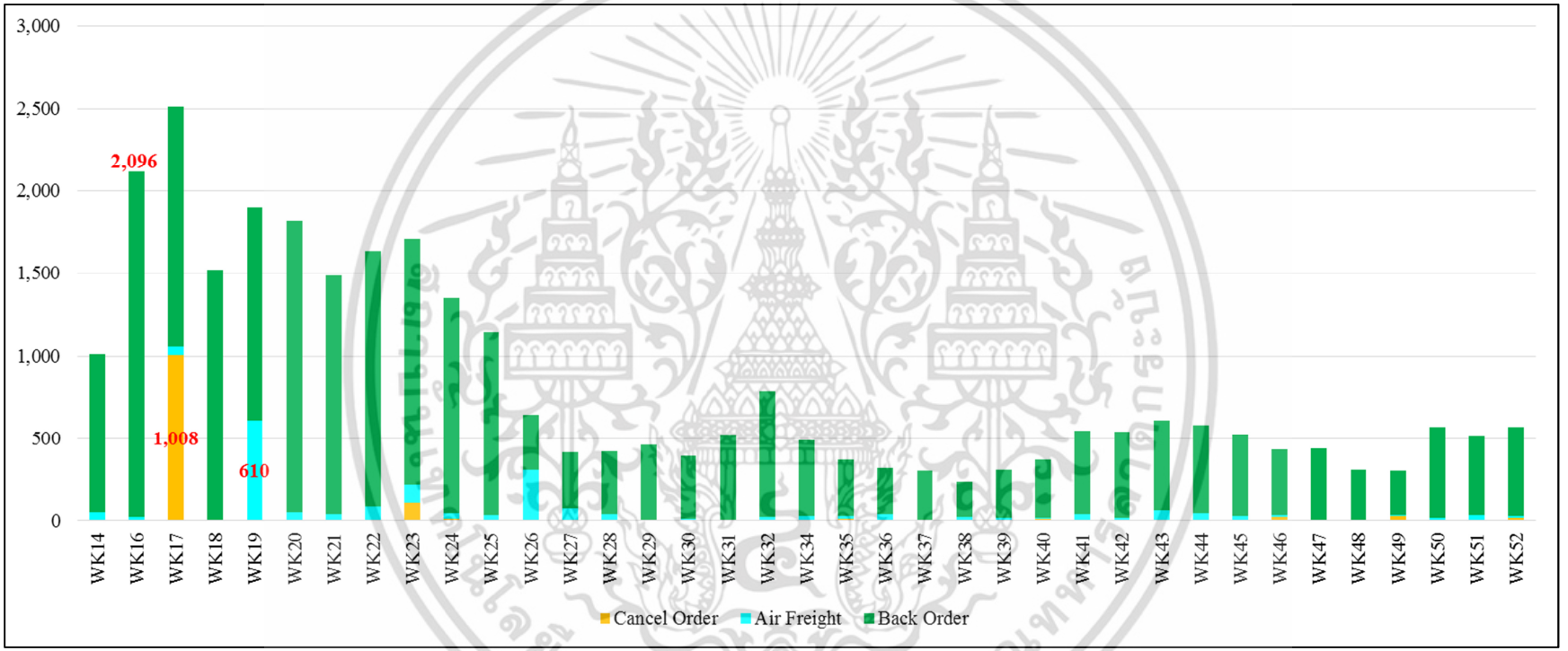



**Figure 3.5** Affective from delay issues week 01-52 in 2016

Hence, the logistic team surveys suppliers after orders are released in the ordering system. They request suppliers to confirm the delivery date for each order. This method can prevent delay shipments and is used to make container plans. The benefit is for avoiding loss of cost if suppliers cannot meet the delivery date.

This is part of the logistic team when following up suppliers 2 weeks before the delivery date. They ask what the cause is if suppliers cannot keep up with the original delivery plan. Suppliers check and confirm how they can manage orders. The content of survey consists of:

1) Customer
2) Parts list
3) Quantity
4) Order issue number
5) Confirmed delivery date
6) Reason of delay
7) Recovery plan

Currently, there are 273 suppliers and 23 customers in total. The logistic team will send the notification via email and require a reply from suppliers within 2 days after order release. Then, the information is summarized and shared to the parts ordering team. They have to report delay issues to customer.

Figure 3.6 shows the acceptance from suppliers when acquiring order. Most suppliers can confirm the delivery, except in April and May when the target is lower than 98.00%, and the logistic team will track and give credit marks to suppliers when they get the actual delivery. When suppliers cannot keep their commitment, the logistic team

cooperates with suppliers to explain the reason of delay and ask for a recovery plan for back order.

| Detail | Average FY 15 | APR-16 | MAY-16 | JUN-16 | JUL-16 | AUG-16 | SEP-16 | OCT-16 | NOV-16 | DEC-16 | Average FY16 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Average | 97.84% | 97.03% | 97.60% | 98.17% | 98.16% | 99.13% | 98.98% | 98.15% | 98.68% | 99.09% | 98.37% |
| Target | 98.00% | 98.00% | 98.00% | 98.00% | 98.00% | 98.00% | 98.00% | 98.00% | 98.00% | 98.00% | 98.00% |

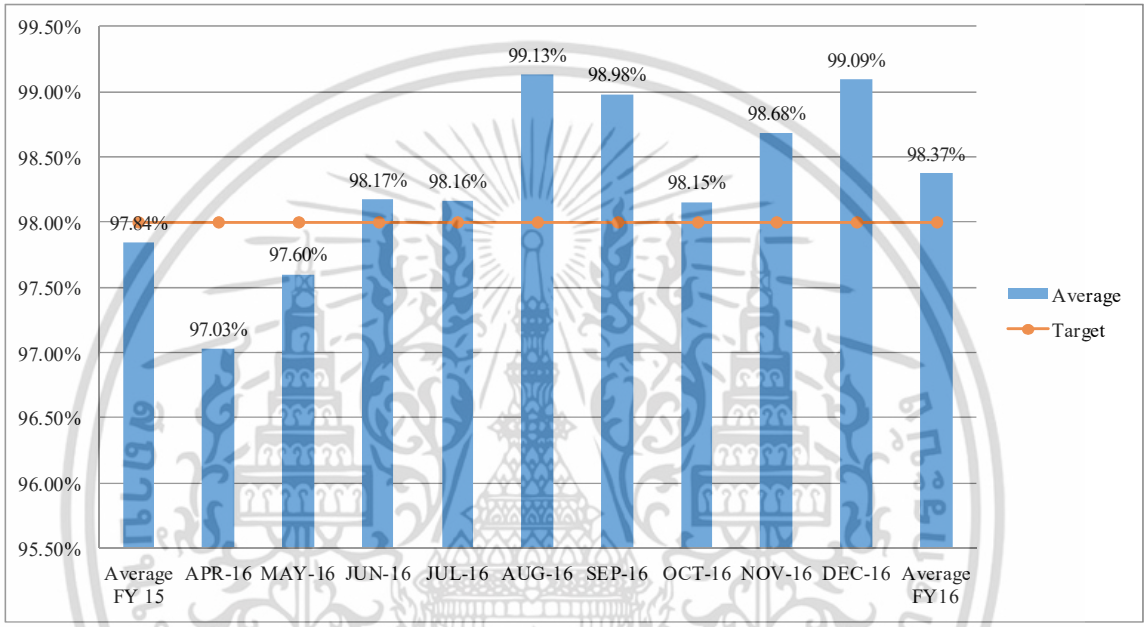



**Figure 3.6** Acceptance of Delivery from Supplier

Nevertheless, this method does not improve suppliers' delivery, because the main cause is variation of orders and inaccurate forecast. Suppliers cannot manage the delivery on time, and the regional production control cannot detect the problem before having the firm order in the system. Then, suppliers have a lot of back orders and more demand than their capacity. Even though suppliers have a recovery plan, but in some cases, the plan cannot be used with the production plan at overseas plants. So, this study aims to detect order fluctuation before orders are transmitted to suppliers.

### 3.4.2 Use of Cause and Effective Diagram for Analysis the Cause

This is a brain storming method for finding the problem. Every section concerning the export operation has to discuss what the affective delivery performance of suppliers is, especially suppliers who are the key persons for this operation.

There are four major cause and effect diagrams which are the main causes of any problems in the business process. Those are men, machines, methods and measurements.

**Men** are those who work in the parts export operation such as customers, regional production controls, logistic teams and suppliers.

**Machines or Equipment**

a) Intranet system: information technology and information flow between customers and suppliers, which may encounter errors and be shut down.

b) Machines have enough capacity to support volumes and requirements from customers or to maintain the system to prevent mechanic break-down during the production

**Material**s are inputs in the export operation.

a) Firm order and forecast

b) Materials for the production under suppliers' management are based on forecast from customers.

c) Machines for the production

**Environment** which is unpredicted such broken packaging from accidents.

**Management**: suppliers can arrange and prepare parts when they have orders and a recovery plan.

a) Production plan

b) Material purchasing

c) Inventory management

**Process** is a sequence of the parts export operation.

a) BOM set up for new parts / change part numbers / abolish parts and adopt timing

b) Process design

c) Transport and logistic

The regional production control has to invite and meet those who are involved in the ordering operation in order to find, vote which problem is the main cause of delay in parts delivery, and suggest a method to improve the operation and detect this problem in the next order.

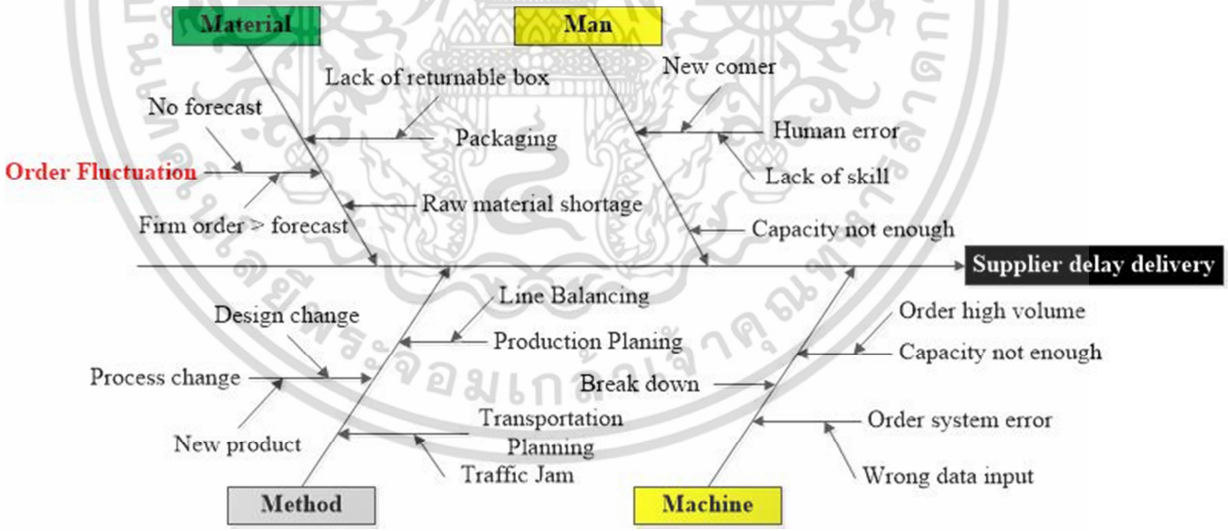



**Figure 3.7** Cause-Effect Diagram for Analyzing Cause of Delay in Delivery

According to the cause-affect diagram in Figure 3.7, after brainstorming with colleagues, they analyze from 4 main factors that affect supplier delay delivery. The first is Machine which is tooling for ordering and production such as order system error. Their machines break down and capacity not enough. Supplier cannot supply part on time if they has limited capacity that less than customer requirement

The second is Man, the cause come from human error when supplier has new comer and they lack of skill for working. Therefore supplier has problem when starting production that is lost time in our process.

The third is Method, that concern about planning of transportation and production. Logistic team and supplier have to work together for control delivery planning. Some case they found design change issue during production which supplier has to improve and create new process for supporting.

The last is Material, that cover information which regional production control provide to supplier and raw material for producing. Especially the firm order and forecast which are shared to supplier, they found the firm orders over forecast and no forecast in previously. Most suppliers use 3-month forecast to prepare the production and order materials. If the firm order is unstable and not balanced in that week, it is likely that delay in delivery will occur in that week.

Figure 3.8 shows the reasons why suppliers encounter delay. The data are collected from suppliers when the logistic team finds that parts are not received. The cause of firm order which customers send to supplier is 8,318 issues or 37.68%, and the effect of order fluctuation pose 6,285 issues or 10.26% to the production plan, which makes suppliers unable to manage orders and the production plan such as ordering

materials, man power, machines, capacity and inventory on the suppliers' side. When order fluctuation exceeds 100%, suppliers have to use their safety stock to supply and set a recovery plan in the next production. In some cases, suppliers incur addition cost for importing components. They manage the inventory in the warehouse for finishing goods and raw materials.

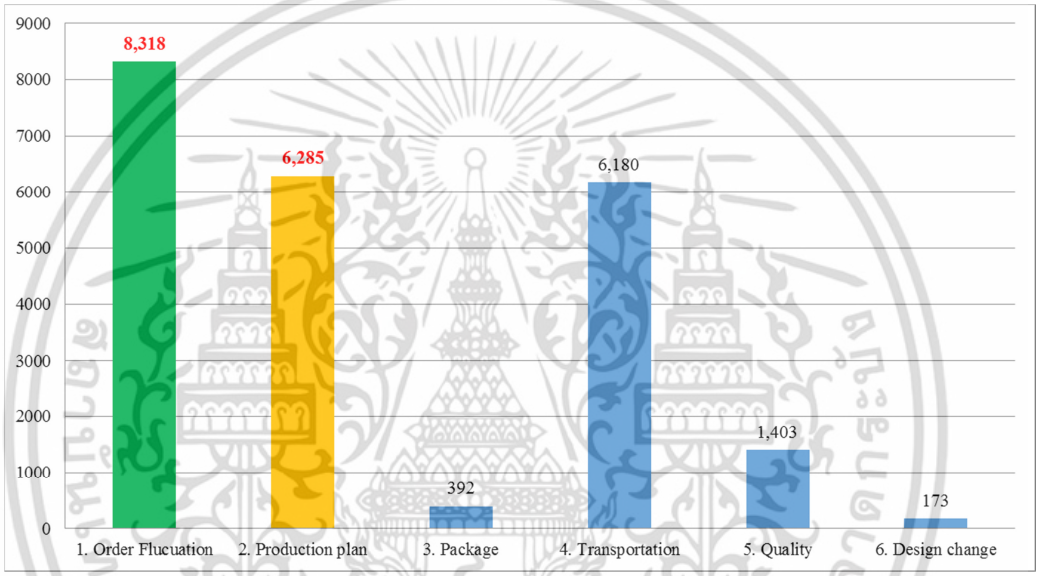



**Figure 3.8** Cause of Delay in Delivery from Weeks 14 – 52 in 2016 (number of order issues)

Figure 3.9 shows that suppliers always encounter delay in delivery when orders exceeds forecast for more than 20% which is 46% of order fluctuation. The logistic team should set a plan for the increasing demand which concerns milk run and container booking. This means if suppliers encounter delay in delivery, there will be loss of cost and time for that shipment.

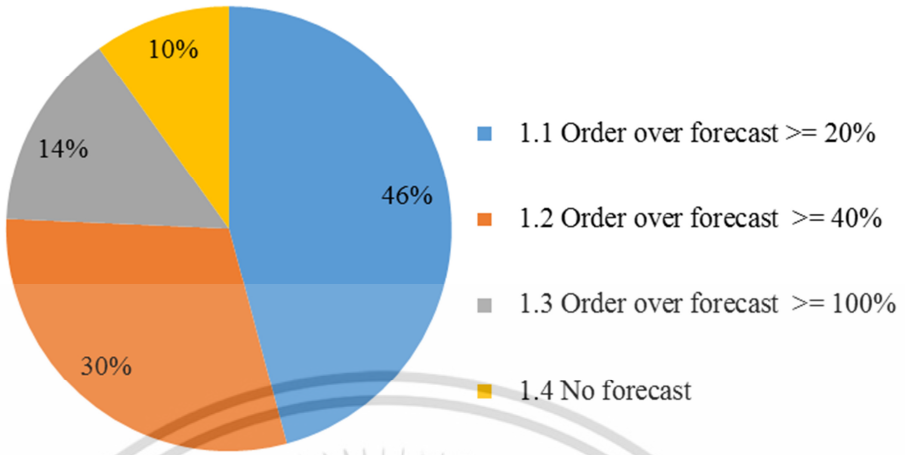



**Figure 3.8** Cause of Delay in Delivery from Weeks 14 – 52 in 2016

## 3.5 Information Flow

The data flow diagram in Chapter 2 is applied to depict the information flow of parts exports which supports the analysis of what information should be improved and developed. Therefore, in this section, the current ordering operation will be described and examples of document control from the system will be displayed.

### 3.5.1 Overview of Information Flow

The information starts when BOM from customers is received. It will identify what region will supply parts to production plants. The regional production control will set up BOM with parameters in their systems. The customers' order will be interfaced in the ordering system, except the orders for trial production which customers need to place during the manual operation via mail. However, the orders will be sent to suppliers and released in the intranet. Figure 3.10 shows the context diagram which is the overview of the ordering operation. There are four sections which connect information for parts export.

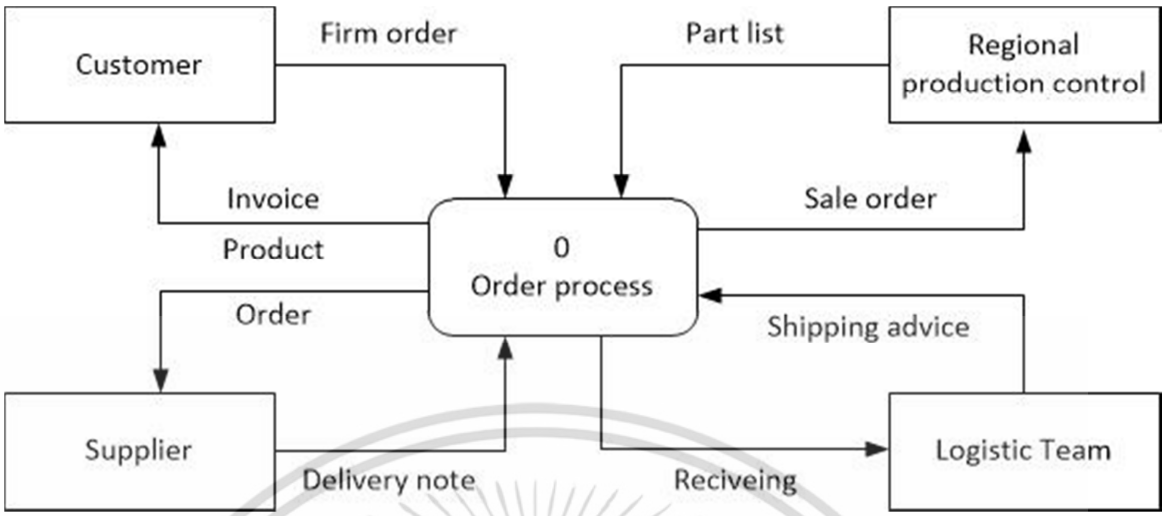



**Figure 3.9** Context Diagram for Ordering Operation

Inputs are requirements from customers in a form of part number, quantity and requirement date. The information is forecasted, and firm orders are transmitted in the ordering system of regional production control.

The information will be computed with the master data which are BOM and volume per standard packaging. The system generate parts error list such as:

1) Forecast and firm order before the adoption date
2) Incorrect part number
3) Incorrect stand packing number
4) No part in the ordering system

The parts ordering team will check the error list and feedback the parts arrangement team and the packaging engineer team concerning each issue. After checking, orders will be sent to the logistic team, and they will upload the orders in the logistic system. This system generates a delivery date for each order and manage milk

run to pick up parts from supplier. Moreover, the logistic team uses these data to simulate containers and book a shipment plan because they have schedules for vanning every day for suppling parts to each customer, vanning time table depending on the contract shipment and forwarders who treat exported parts by sea freight and air freight.

Then, suppliers can download the firm orders from the intranet 2 weeks before the delivery date, which also includes weekly forecast, except 3-month forecast which will be by monthly. The following information will be available on the intranet.

1) Firm order and forecast
2) Packing label
3) Master package label (For large module packing)
4) Delivery note
5) Shipment status

The information which suppliers download is in Excel format. They use this data for preparation and production planning. Suppliers download package labels and attach them on returnable boxes. The intranet uses the barcode system to input delivery data when supplier scans packing labels which creates a delivery note of control list to milk run and recipients. Intranet is linked with the logistic system. Thus, the logistic team can check order status from suppliers and plan loading containers.

Table 3.2 and Table 3.3 show the firm orders and 3-month forecasts which suppliers can download from the intranet system.

| Ordering plan | Issue no | Delivery order date (Year : YYYY) | Delivery order date (Moth : MM) | Delivery order date (date : DD) | Delivery order date (Hour : hh) | Delivery order date (Minute : mm) | Supplier | Depot | Delivery place | Unloading Unit | Part number | process code | Part name | Delivery Q'ty | SNEP (Package) | Number of boxes | Production controller | In/OUT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | TEM0456 | 2016 | 5 | 11 | 10 | 0 | A024 | 3L | EEK | | 333035AD0A | 22FVB | SEN UNIT-DISTANCE | 90 | 18 | 5 | SP | B |
| 2 | TEM0457 | 2016 | 5 | 12 | 10 | 0 | A024 | 3L | EEK | | 333035AD0A | 22FVB | SEN UNIT-DISTANCE | 108 | 18 | 6 | SP | B |
| 2 | TEM0458 | 2016 | 5 | 13 | 10 | 0 | A024 | 3L | EEK | | 333035AD0A | 22FVB | SEN UNIT-DISTANCE | 72 | 18 | 4 | JP | B |

**Table 3.2** Firm Order from the Ordering System

| Ordering plant | Supplier | Depot | IN/OUT | Parts No | Process code | Production controller | Parts abolish mark | Parts name | SNEP(Package) | N Month-Total volume | N+1 Month-Total volume | N+2 Month-Total volume | Target date-From(Year:YY) | Target date-From(Month:MM) | Target date-To(Year:YY) | Target date-To(Month:MM) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | A024 | 3L | B | 231000HZ1AJB | 221JK | JP | | ALTNTR ASSY | 2 | 1632 | 2688 | 2304 | 17 | 4 | 17 | 6 |
| 2 | A024 | 3L | B | 231000TU1BJB | 22LJK | JP | | ALTNTR ASSY | 2 | 288 | 384 | 384 | 17 | 4 | 17 | 6 |
| 2 | A024 | 3L | B | 233000KV0AW3 | 22HMK | MM | | MOTOR ASSY-STARTER | 88 | 792 | 1936 | 968 | 17 | 4 | 17 | 6 |

**Table 3.3** Monthly Forecast from the Ordering System

After the logistic team receives parts at the warehouse, they scan packing labels to collect data. This information needs to match with container planning before confirming the booking shipment. They issue invoices after forwarders inform the estimate time departure (ETD) and input invoice number, ETA (Estimate Time Arrival), Estimate Time Departure) in the logistic system. The invoices are then sent to the accounting team for making bills to customers.

### 3.5.2 Information Transform

There are 23 customers who place purchase orders via the ordering system. The system have to calculate the data and classify orders for supplier by parts number. Therefore, correct parts number, supplier code and customer code are important parameters for interfacing the data. The process is matching data between customers and the regional production control, and the orders are placed to suppliers as shown in Figure 3.11.

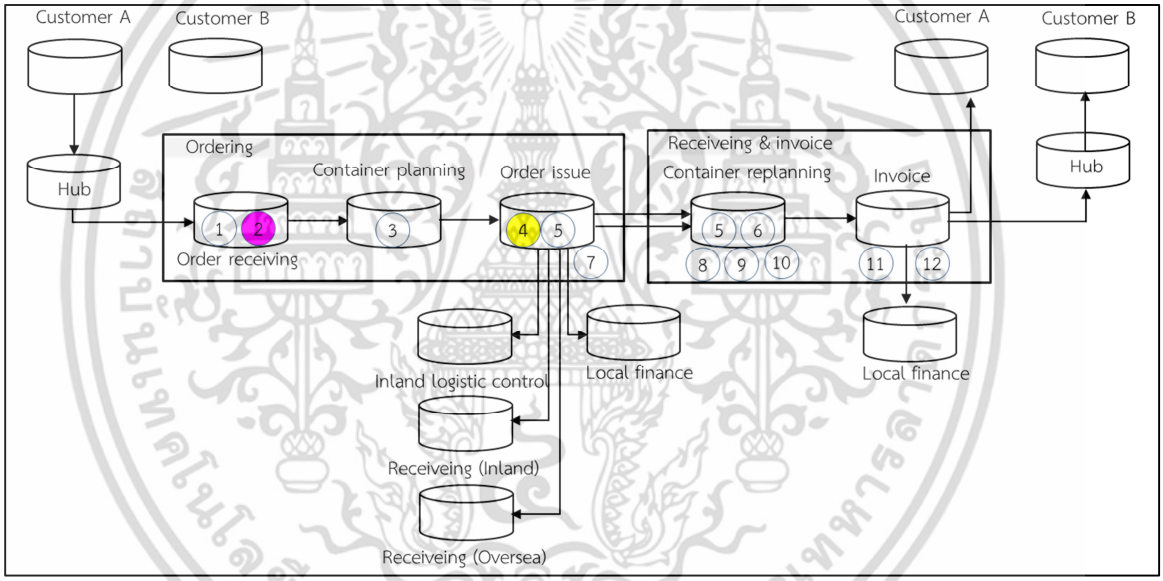



**Figure 3.10** Operation and Data Flow for Parts Export

**12 Operations for Part Ordering**

1. Receiving order from customers and inputting
2. Order checking
3. Container planning

4. Releasing orders to suppliers
5. Delivery status
6. Container, packing re-planning
7. Parts receiving
8. Packing and vanning checking
9. booking containers
10. booking vessels
11. Issuing invoices and shipping documents
12. ASN (advance shipping notice) sent to customers

### 3.5.3 Input and Output of Data

The data flow diagram in Chapter 2 has been applied to find the information flow as shown in Figure 3.12. Upstream process comes from requirements of customers as customers place orders via the ordering system of the regional production control. The data are calculated before being transferred to the logistic team and suppliers who use the internal system for controlling and operating the orders.

The output is the order which is computed and managed for delivery from suppliers and shipment to customer. So, each system has different output data to use and collect. In case of parts ordering, data are used to monitor trend volume from customers which are inputted into the ordering system. The parts ordering team can notice suppliers and internal when they find a variation of ordering and end of production. Moreover, they also refer these data to their management mean for sale volume each month.

Figure 3.12 shows the data flow diagram which starts from receiving orders from customers to confirming invoices for shipment from the regional production control to overseas plants.

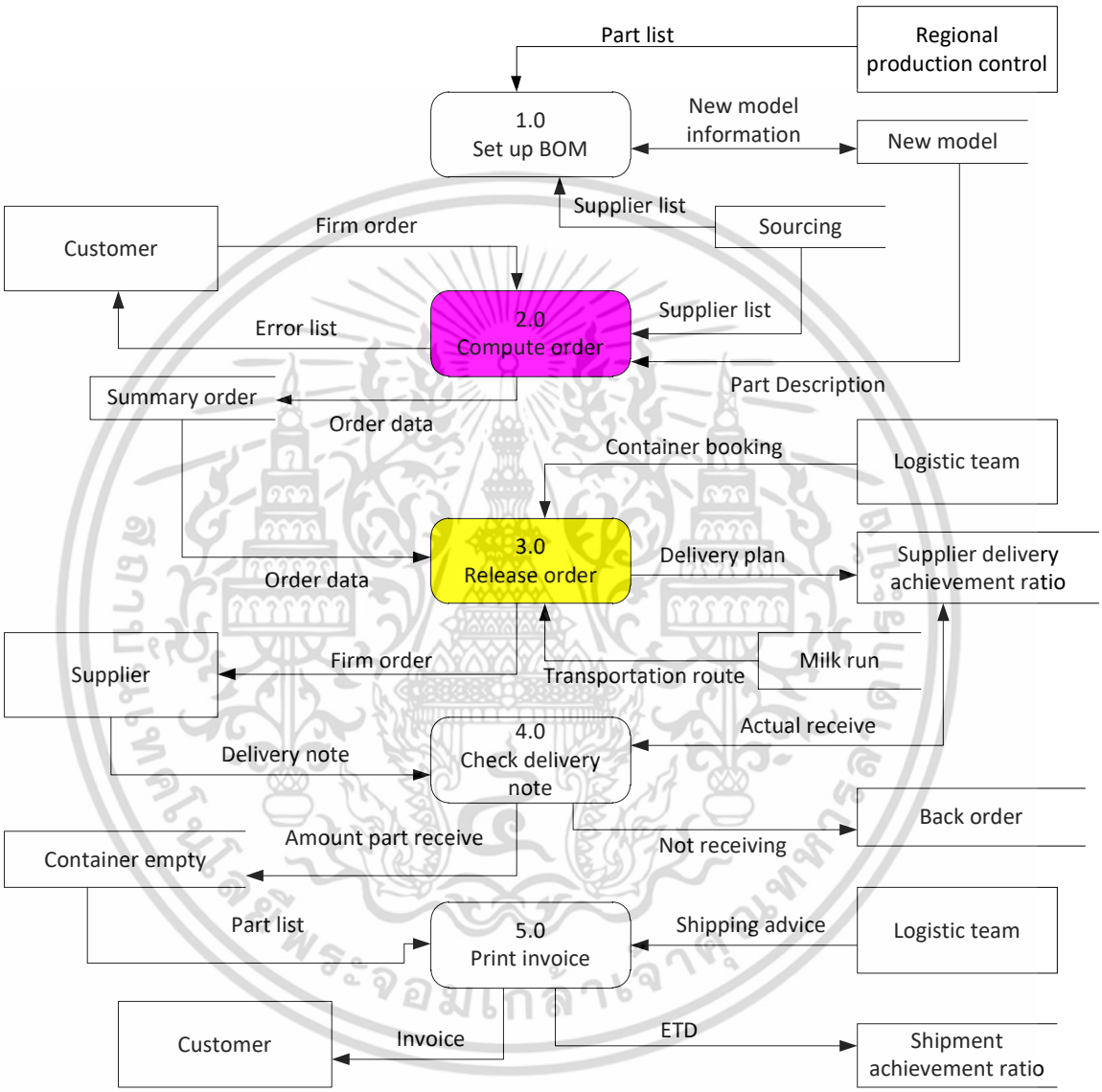



**Figure 3.11** Data flow diagram level 0 for ordering (export part)

The logistic team needs the order summary from the part ordering team in order to use the data to manage the delivery with suppliers and the transport system. Therefore,

the output which is information concerning transportation management and shipment is sent to suppliers.

When suppliers download the orders from the intranet, they get the delivery plan from their customers. They use the data to arrange their production. The logistic team also controls the orders via intranet, because the logistic intranet system interfaces data when suppliers download and scan package labels from the intranet.

After the shipment is completed in each month, the logistic team will collect data concerning the export plans from Thailand to customers and evaluate the suppliers' delivery to see if there is any defect or damage on the deliver, which forces suppliers to improve and develop their performance and keep history for checking when customers or the quality team have a claim or ask to recheck the parts in the future.

### 3.5.4 Identifying Problem in Data Flow Diagram Level 2.0

After receiving orders from customers, the regional production control system computes the orders with the parameter set up in that system. Therefore, this process should be improved before sending the orders to the logistic team. Figure 3.13 shows the data flow diagram level 2.0. The parts ordering team is a coordinator between suppliers and customers. They check the volume of each part number. If the volume is not accurate compared to the previous forecast, the parts ordering team should know and feedback suppliers to check their readiness.

However, the operation is to confirm the requirements from customers. Hence suppliers have to set a recovery plan to re-plan the delivery and shipment in the orders by manual.

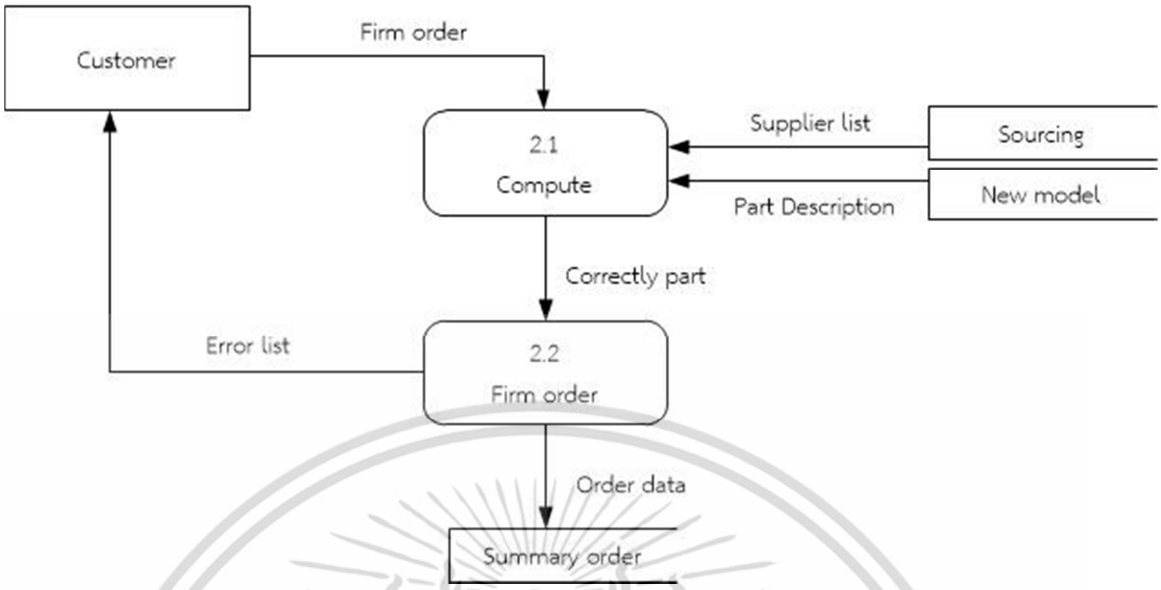



**Figure 3.12** Data Flow Diagram Level 2.0 of (current) Order Operation

## 3.6 Finding Solution

After analyzing the context diagram and data flow diagram, the problem in information flow can be identified. The next step is finding the solution to improve and detect order fluctuation.

### 3.6.1 Improving Data Flow Diagram Level 2

The problem is the information which the regional production controls provide to suppliers which includes weekly firm orders, weekly forecast and 3-month forecast. The forecast has a variation and changes every week, so good information should be accurate and cause less order fluctuation.

Now, abnormal orders cannot be deducted in the orders which suppliers receive in the normal operation, which means some orders have 200% fluctuation without indication before the orders are released. Moreover, suppliers cannot supply parts when

their capacity or materials are not sufficient to the production. Therefore, this is a result of lack of accurate information to suppliers.

Table 3.4 shows an example of the firm order checking result and forecast after summarizing the total order. The part ordering team will know that the number of orders exceeds the number provided by customers when suppliers confirm the orders which cannot be edited.

| Buyer code | Part no | Standard packing | Order week 09'17 | | | |
|---|---|---|---|---|---|---|
| | | | Firm order | Previous forecast | Fluctuation | |
| | | | | | Diff Q'ty | Diff % |
| 6SPA01 | 111015AD0A | 100 | 1200 | 200 | 1000 | 500% |
| 6SPA01 | 222025AD0A | 192 | 576 | 0 | 576 | 300% |
| 6SPA01 | 333035AD0A | 135 | 405 | 0 | 405 | 300% |

**Table 3.4** Data of Order Fluctuation

After identifying the problem in the data flow diagram level 2, the regional production control adds the checking process after receiving orders from customers.

1. The ordering system generates orders with BOM and summarizes orders and error lists as follows:
    a. Feedback total firm order and error list
    b. Summarize the order after customers' confirmation
2. Check order fluctuation of firm order over forecast without forecast in the previous week as follows:
    a. Survey supplier delivery
    b. Share trend volume to suppliers (3-month forecast)
3. Release orders in the ordering system for suppliers

Figure 3.14 shows the operation of data flow when the regional production control adds checking order fluctuation. The key persons are suppliers who can prepare parts and keep up with the delivery plan from the logistic team. Beside the information had illuminated the trend volume and evaluate supplier capacity.

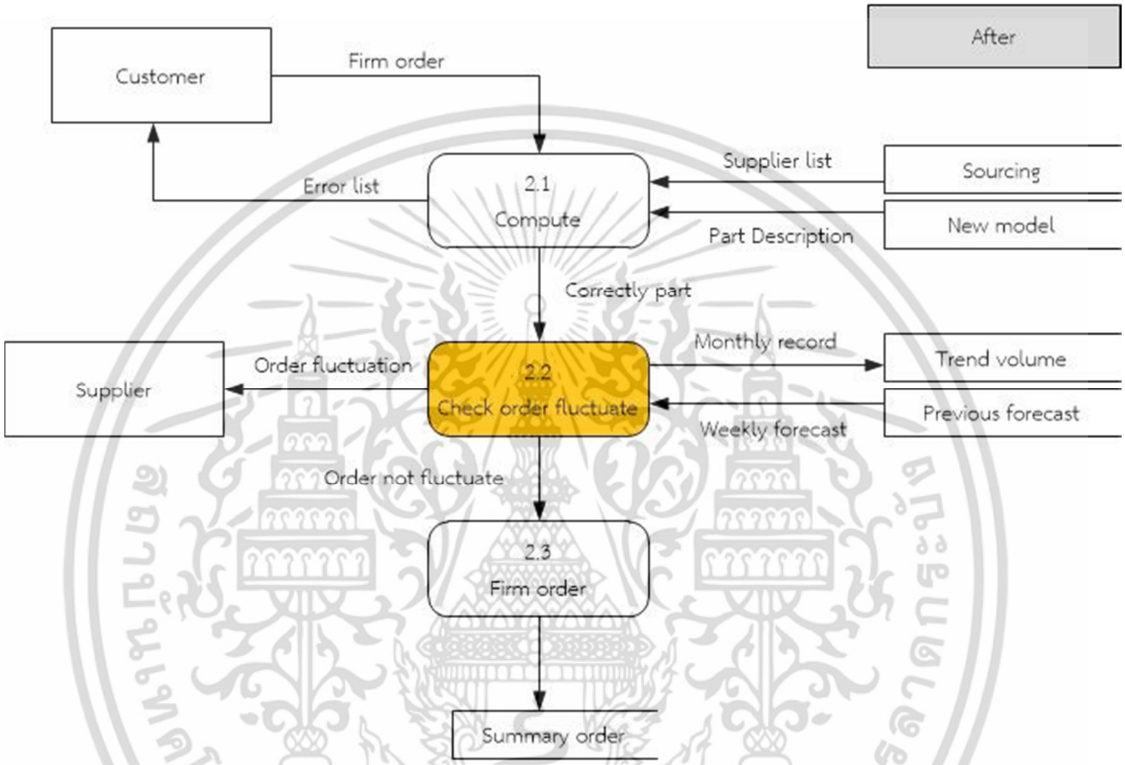



**Figure 3.13** Data Flow Diagram Level 2.0 of Order Operation after Improvement

However, the supply risk management team is a supporting team who helps suppliers if the volume is higher than their capacity in long term, and it causes supplies to have accumulated back orders in each week. The ordering team has to report the trend volume and compromise with customers. Figure 3.15 shows the activity which supports management of order fluctuation.

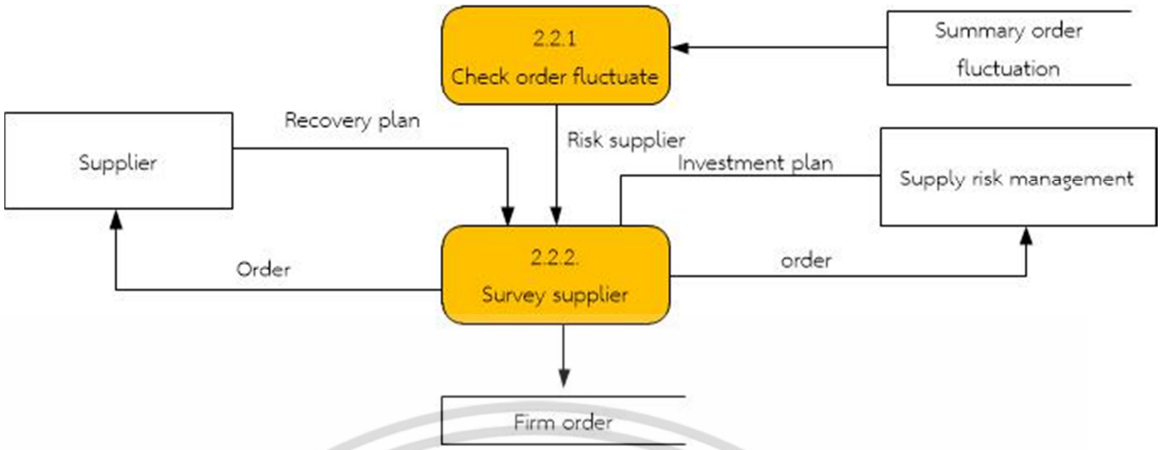



**Figure 3.14** Data Flow Diagram Level 3.0 of Order Operation after Improvement

### 3.6.2 Simulation for Solving Method

After studying about the operation and data flow for the ordering process which shows how the information is transferred to the regional production control and what they use for ordering parts to suppliers, the regional production control should add an operation for checking the forecast and firm order before sending them to the logistic team. This will support ordering checking and inform the part ordering team when order fluctuation occurs.

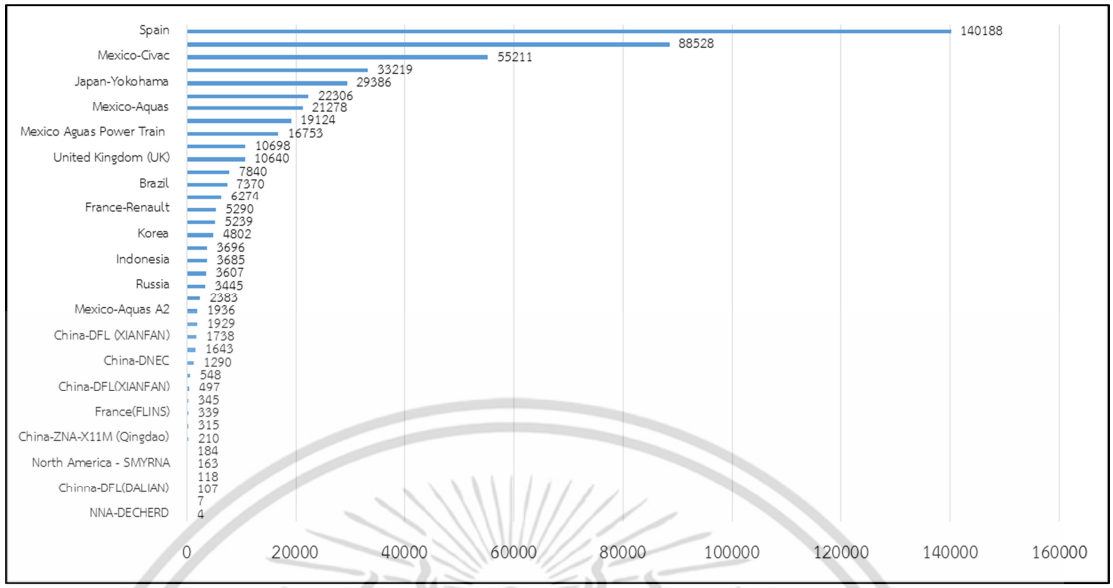
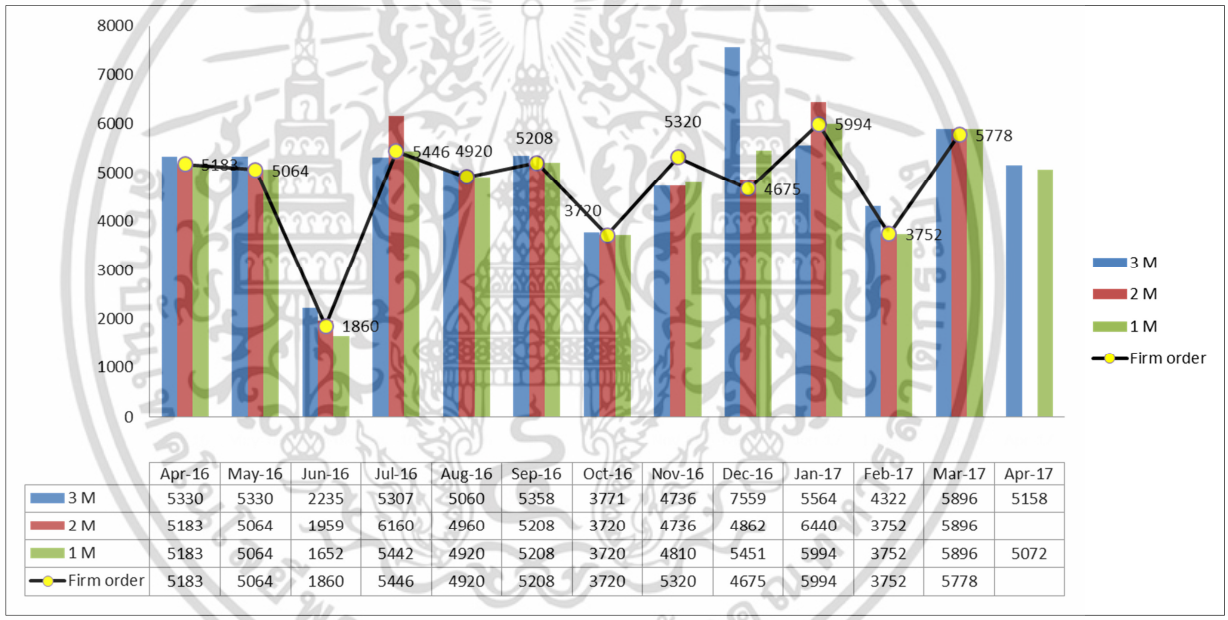



**Figure 3.15** Total Orders for Parts Export during Weeks 14-52 in 2016

Firstly, customers who can participate in this experiment are chosen. The priority is big volume and concerns various suppliers to export part. Therefore, a Spanish plant is interesting for 23 customers for testing. The Spanish plant has many types of vehicle models (95% of the order is parts for assembling) and engines (5% of the order is to supply in a powertrain plant) which produce and sell in GCC countries (gulf countries; Bahrain, Kuwait, Oman, Qatar Saudi Arabia and United Arab Emirates)

Three-month forecast is provide to suppliers who find a variation forecast in each month as referred to in Figure 3.16. They have 1,506 part numbers and 140,188 order issues to 135 suppliers exporting to Spain. Moreover, they do not only have a high demand, but their vehicle models are from common domestic production plants, which means that the amount of parts production will be shared with domestic plants in order to prevent production halt.

The volume of each month is compared between the firm orders and forecasts, which are changeable every month, and it is found that in each month the number of actual orders is different from the forecast. For example, in November 2016, suppliers received the forecast of 4,800 parts, but the actual number of orders was 4,800 parts. Figure 3.17 shows 3-month forecast and firm order from April 2016 – April 2017. In November, the volume of firm order is higher than 3-month forecast which results in high demand in the European market.




| | Apr-16 | May-16 | Jun-16 | Jul-16 | Aug-16 | Sep-16 | Oct-16 | Nov-16 | Dec-16 | Jan-17 | Feb-17 | Mar-17 | Apr-17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 M | 5330 | 5330 | 2235 | 5307 | 5060 | 5358 | 3771 | 4736 | 7559 | 5564 | 4322 | 5896 | 5158 |
| 2 M | 5183 | 5064 | 1959 | 6160 | 4960 | 5208 | 3720 | 4736 | 4862 | 6440 | 3752 | 5896 | |
| 1 M | 5183 | 5064 | 1652 | 5442 | 4920 | 5208 | 3720 | 4810 | 5451 | 5994 | 3752 | 5896 | 5072 |
| Firm order | 5183 | 5064 | 1860 | 5446 | 4920 | 5208 | 3720 | 5320 | 4675 | 5994 | 3752 | 5778 | |

**Figure 3.16** Trend Volume of 3-Month Forecast for Parts Export

Consequently, the method is to find out the abnormal trend volume from customers such as increasing orders, no volume but firm order in that week, and the regional production control team must observe and negotiate with customers and suppliers.

**Objectives of Order Fluctuation Management**

1. To set 2-way communication flow between the regional production control and customers and the regional production control and suppliers in order to monitor order trends and feedback impacts.
2. To create understanding between the regional production control and customers after arranging orders.
3. To provide more opportunities for customers to improve forecast accuracy in case of high fluctuation.
4. Suppliers will get data 1 week earlier, and then supplier will have more time to set an action plan (raw material and manpower adjustment) to support the increasing volume.
5. If suppliers cannot deliver parts on time due to very high rate of order fluctuation, suppliers can propose a recovery plan, and then the regional production control will request customers to place orders based on suppliers' recovery plan.

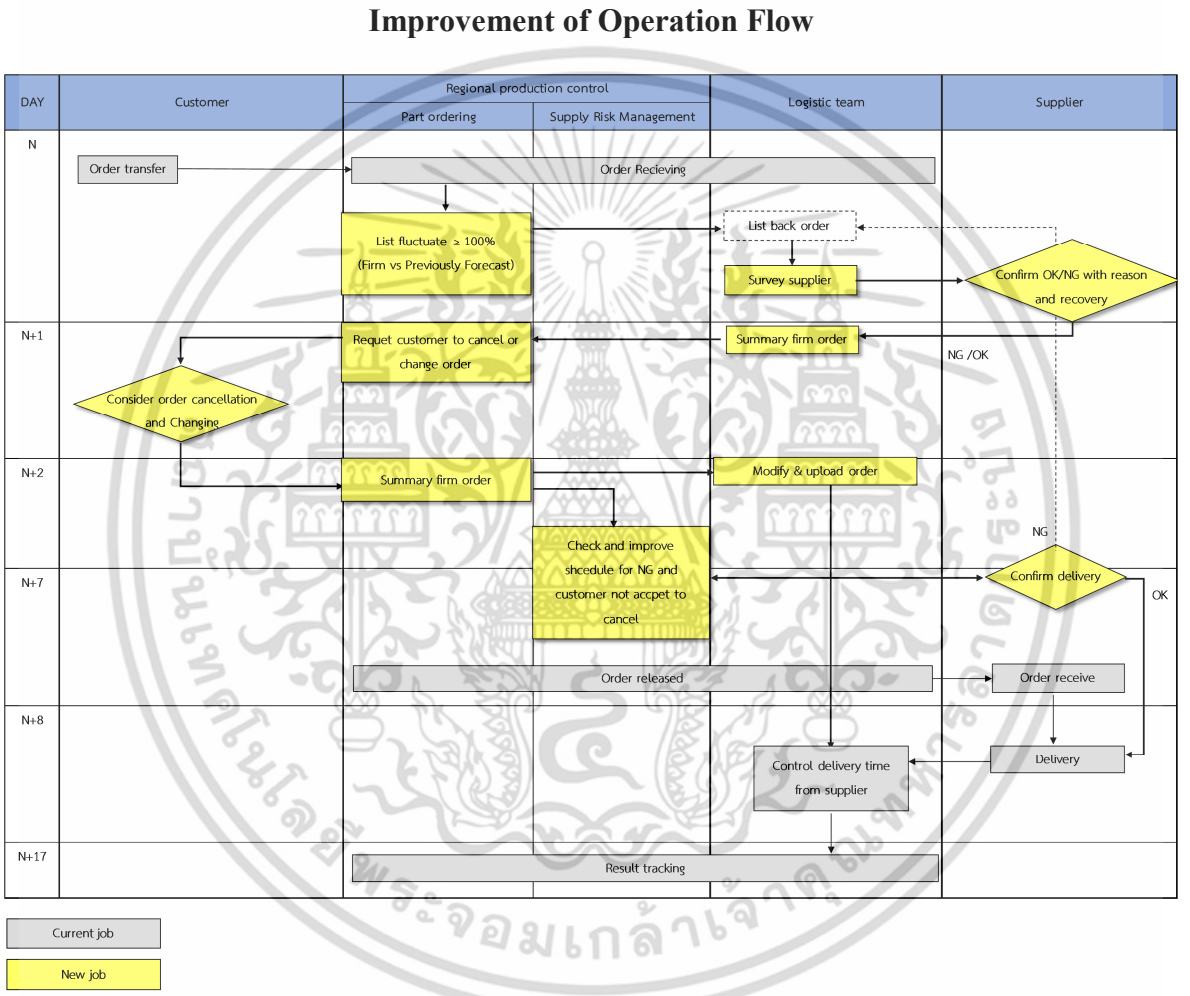



**Figure 3.17** Improvement of Operation Flow in Order Management

As shown in Figure 3.18, after the part ordering team checks the error list according to the normal process, they should compare the firm order with previous forecast. The method which the part ordering uses to calculate the order fluctuation is Excel Macro. There are 3 parts of information which the part ordering should download from the intranet as follows:

1. Build of material (BOM)
2. Packing data
3. Firm order and forecast

Then, they combine this information by Excel macro. When the processing is completed, those sort parts numbers will reveal the order fluctuation. Then when they find the volume of firm order fluctuate more than 100%, the part ordering will summarize the orders and send it to the logistic team.

The logistic team combines the order fluctuation with previous back orders, prepare information and send it to suppliers via mail. Table 3.5 shows the survey form from the logistic team. Suppliers check their production and confirm the delivery date when they can deliver parts and the amount which they can support. They set a recovery plan if they cannot support all orders in that week and keep up with the delivery date.

| BUYER | PART NO | SNP | WK09 | | | | Fluctuation RESULT DIFF% | Supplier confirm supportable volume | | Final confirm cancel order | Recovery plan from supplier (Remain Order) | | | | | Back order All destinations (PCS) | Remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Firm order | Previous forecast | Fluctuation | | | | | | | | | | | | |
| | | | D3_09 | D1_09 (Previous) | DIFF QTY | DIFF% (Adjust) | | Suplier confirm ontime | Remain order | Cut order (Roundup to SNP) | Recovery QTY1 | Recovery Date1 | Recovery QTY2 | Recovery Date2 | Total Recovery plan | | |
| 6SPA01 | 110441HC0B | 100 | 1200 | 200 | 1000 | 500% | 500% | 500 | 700 | 700 | 400 | 8-Mar-17 | 300 | 15-Mar-17 | 700 | 200 | |
| 6SPA01 | 130703RA1A | 192 | 576 | 0 | 576 | | 300% | 384 | 192 | 192 | 192 | 6-Mar-17 | | | 192 | 192 | |
| 6SPA01 | 140171HC0A | 135 | 405 | 0 | 405 | | 300% | 135 | 270 | 270 | 135 | 20-Mar-17 | 135 | 27-Mar-17 | 270 | 0 | |
| 6SPA01 | 150413RA0A | 100 | 400 | 0 | 400 | | 400% | 400 | 0 | 0 | | | | | 0 | 0 | |
| 6SPA01 | 208A08AA0B | 378 | 756 | 0 | 756 | | 200% | 756 | 0 | 0 | | | | | 0 | 0 | |
| 6SPA01 | 32803CD70A | 1000 | 2000 | 0 | 2000 | | 200% | 1000 | 1000 | 1000 | 1000 | 16-Mar-17 | | | 1000 | 0 | |
| 6SPA01 | 328964LA1A | 1344 | 2688 | 0 | 2688 | | 200% | 1344 | 1344 | 1344 | 1344 | 17-Mar-17 | | | 1344 | 0 | |

**Table 3.5** Survey Form for Supportability Firm Order in Week XX

The table shows part numbers which affect the order fluctuation more than 100%. Suppliers have to feedback their supportability in the table.

The logistic team receives feedbacks from suppliers, summarizes the information to the part ordering team and request customers to consider which shipment orders they want to accept, cancel or postpone. If customers assure the parts orders, the supply risk management team will work with suppliers regarding the hindrance that makes them unable to deliver on time.

At the same time, if customers accept a recover plan or cancel, the logistic team can also improve the schedule for delivery and shipment. They will release orders to suppliers based on the order summary from customers.

This operation is part of the ordering process as the regional production control has the intranet for operate, but that does not cover checking forecast and firm order. Currently, after data are transferred from customer to interface in the internal system, orders are computed for suppliers.

This intranet has a function to show the firm order and requirement date from customers. The information includes weekly forecast that covers 3-month forecast (12 weeks), and the system match the quantity with customers with standard packaging and

then shows the amount of packaging that the logistic team should support suppliers at that time.

# CHAPTER 4

# PILOT PROJECT WITH SPAIN CUSTOMER

## 4.1 Analysis of Spanish Export Order

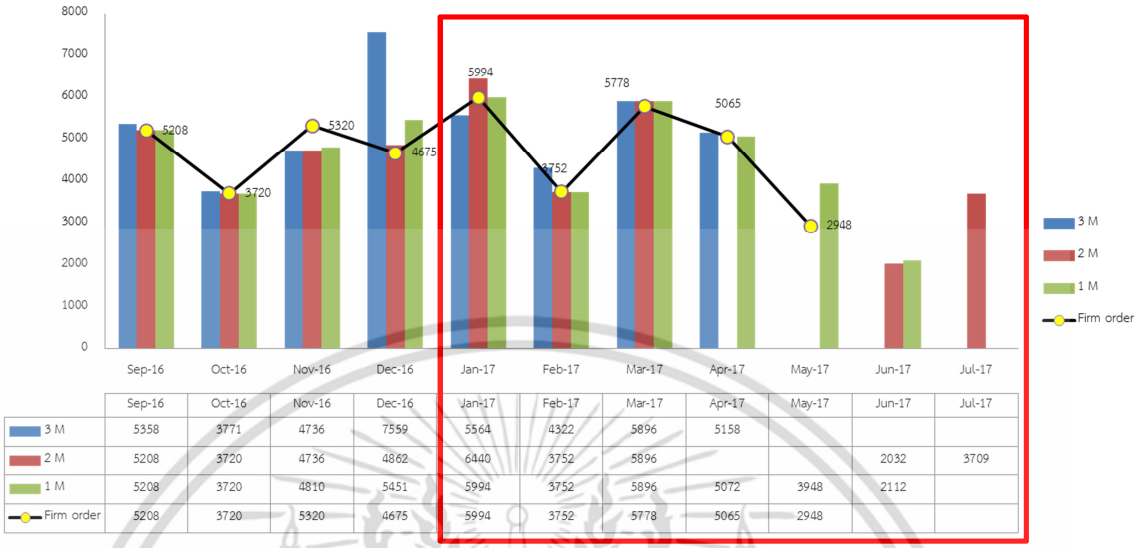
The regional production control receives orders via the system when starting the mass production, so the data transmitted to their system will be generated with the parameters in the ordering system for each regional plant. The data are the number of orders per part number, and customers will control the number of orders by considering the inventory and their production plan. The regional production control orders parts and components from suppliers and export them to customers with on-time shipment.

Spain is a large market and an important customer who imports components and parts to produce engines and vehicles. They supply the demand in the European market. In FY 2016, Spain has no order in Weeks 15 and 52. The part ordering team receives 3,717 orders per week on average. Thus, the regional production control chooses this customer to improve the order management testing because it affects most suppliers, and there are a lot of delay issues during FY16,

Regarding the trend volume in Figure 4.1, the unstable order and forecast is shown which concerns various factors which customers inform to the regional production control such as:

1. Customer ordering system's error
2. New model launching
3. Increasing volume in the European market
4. Failure in inventory management

5. Local suppliers cannot supply parts




| | Sep-16 | Oct-16 | Nov-16 | Dec-16 | Jan-17 | Feb-17 | Mar-17 | Apr-17 | May-17 | Jun-17 | Jul-17 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 M | 5358 | 3771 | 4736 | 7559 | 5564 | 4322 | 5896 | 5158 | | | |
| 2 M | 5208 | 3720 | 4736 | 4862 | 6440 | 3752 | 5896 | | | 2032 | 3709 |
| 1 M | 5208 | 3720 | 4810 | 5451 | 5994 | 3752 | 5896 | 5072 | 3948 | 2112 | |
| Firm order | 5208 | 3720 | 5320 | 4675 | 5994 | 3752 | 5778 | 5065 | 2948 | | |

**Figure 4.1** Firm Order and 3-Month Forecast during Sep 2016 – Jul 2017

Hence, suppliers cannot decline the firm order from customers, and the regional production control needs to ask suppliers to prepare parts and a recovery plan to avoid the production halt.

Figure 4.1 shows the delivery performance in FY 16 for parts export to Spain. There are 3,231 orders in Week 20 with 604 issues concerning suppliers' delayed delivery, 18.69% of which includes 505 back order issues, 63 cancel order issues and 34 change of shipment from sea to air freight issues. The reason why suppliers have a lot of delay issues is because suppliers encounter the quality problem before launching new part number, and when new models are produced, customers will have more orders to be their safety stock.

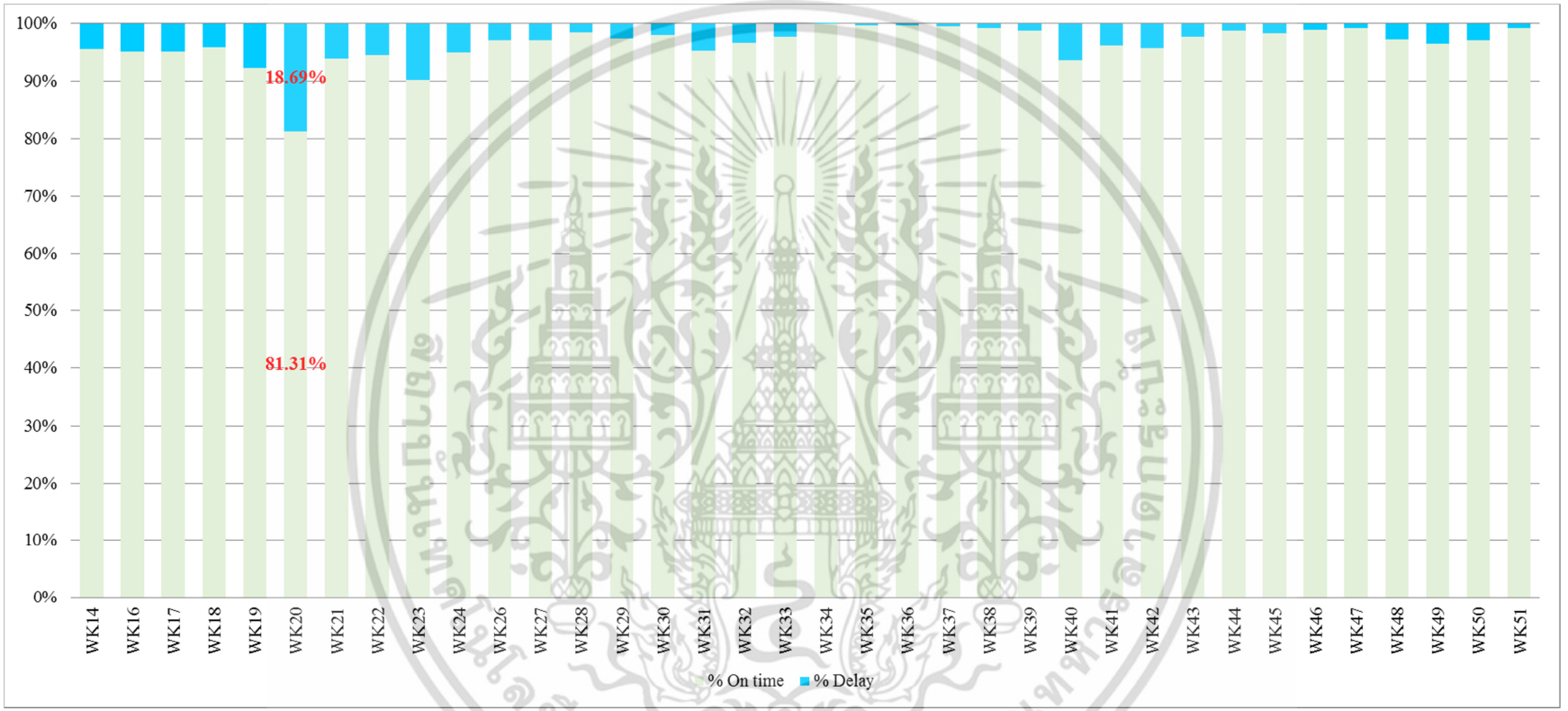



**Figure 4.2** Part Delivery Performance for Export to Spain in FY16

The part ordering team and the logistic team cannot control the delivery and achieve the container plan. The data show that some orders are canceled and the shipment mode is changed to avoid the production halt, and suppliers need lead time to prepare the production and order materials to fulfill the orders when they receive a big volume of orders, such as the orders of Week 20 where 62 orders are canceled. The part ordering team requests customers to move this volume to the next order. This is an action plan which the ordering team feedback customers when suppliers cannot supply part to the logistic team.

After the regional production control and the logistic team consult with suppliers regarding the cause of delayed delivery, in the Figure 4.2 they find an increasing volume of firm orders when compared to weekly and monthly forecast. The order fluctuation contributes to 48% of delay issues and 52% of no order over forecast. However, the problem comes from the suppliers' capacity, the logistic team operation and the regional production control operation.

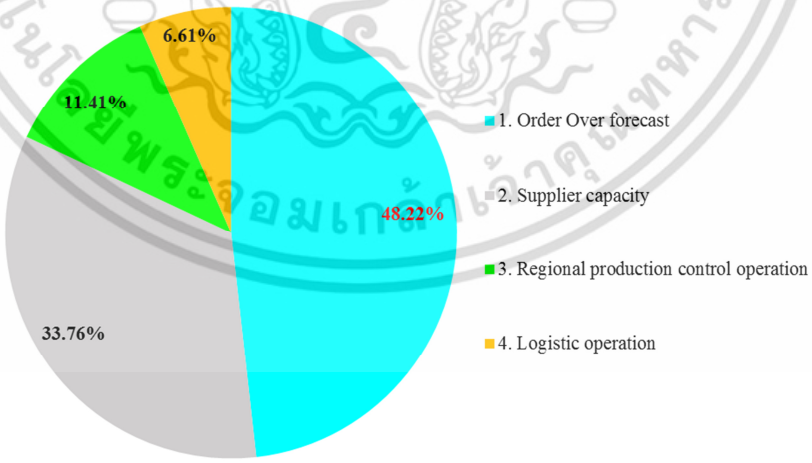



**Figure 4.3** Major Factor of Delay Delivery in FY 16

When the logistic team conducts a survey and study with suppliers concerning the risk of delayed delivery, according to Table 4.1, it shows the percentage of the factor of delayed delivery. The information shows that suppliers receive the actual number of orders which is higher than the forecast. When analyzing such problem, it is found that there are 100% more actual orders (for example, customers gives the number of 100 parts but actually orders 200 parts). Suppliers receive firm order over forecast 48.22% that make delay issue and firm order more than 100%, amount 54.92% of order over forecast. Moreover, the regional production control finds another problem concerning the suppliers' capacity, 33.76%, which is the second of problem and results in the increasing volume of orders.

| | |
|---|---|
| 1. Order Over forecast | 48.22% |
| 1.1 Order over forecast >= 20% | 7.31% |
| 1.2 Order over forecast >= 40% | 10.66% |
| 1.3 Order over forecast >= 100% | 54.92% |
| 1.4 No forecast | 6.48% |
| 1.5 Plan not Balance | 20.63% |
| 2. Supplier capacity | 33.76% |
| 2.1 Capacity Manpower | 33.50% |
| 2.2 Transportation | 4.29% |
| 2.3 Utility and facility | 1.86% |
| 2.4 Machine | 16.97% |
| 2.5 Capacity machine | 8.95% |
| 2.6 Material | 6.09% |
| 2.7 Part FG shortage | 0.37% |
| 2.8 Quality | 15.79% |
| 2.9 Packaging | 5.16% |
| 2.10 Label | 0.68% |
| 2.11 Human error | 6.34% |
| 3. Regional production control operation | 11.41% |
| 3.1 Design change | 0.55% |
| 3.2 New model | 0.55% |
| 3.3 Cancel Order | 0.18% |
| 3.4 Order Over Capacity | 98.71% |
| 4. Logistic operation | 6.61% |
| 4.1 Human error | 0.32% |
| 4.2 Unpacking / Request Hold part | 2.86% |
| 4.3 Warehouse Operation | 0.32% |
| 4.4 System | 0.32% |
| 4.5 Package | 45.40% |
| 4.6 Milk run | 9.84% |
| 4.7 Unpacking / Request Hold part | 40.95% |

**Table 4.1** Percentage of Delay Causes

### 4.2 Analysis of Operation Flow for Improvement

In this section, the solution in Chapter 3.6 for order management has been applied. The regional production control adds the process for checking firm orders before

releasing them to suppliers, and they feedback customers when they find a long-term increasing trend volume and order fluctuation in that week.

The part ordering team will check the firm order and provide forecast to suppliers because the order may contain incorrect part number or the volume does not match the standard packing. For the checking process, they have lead time of 7 days after receiving the order to examine with suppliers and reconcile with customers. So, the logistic team is a supporting team who shares the information to suppliers when finding order fluctuation.

About parts export to Spain, they notify suppliers to improve the ordering operation because suppliers should take an urgent action within 24 hours after receiving the notification from the logistic team about order fluctuation.

Then, suppliers control the order by themselves. They must keep the delivery date for normal order and back order according to the logistic team. In case suppliers have previous back orders, they should prioritize and confirm the delivery for current orders. After that, suppliers can include the order which is a recovery plan in each week.

After launching the activity, the number of delays is lower than average delay issues in 2016 as shown in Figure 4.4. The average of delay issues in 2016 are 719 issues per week and the volume is decreasing after solving the order fluctuation.

Figure 4.5 shows 94.60% delivery performance on average during Weeks 1-18, and the amount is 96.52% lower than the delivery performance before the implementation. The delivery performance is found to be decreasing in Week 16, and suppliers can keep the delivery on time at 89.30% due to problems from machine breakdown and the fact that the regional production control can detect and request customers to cancel the orders.

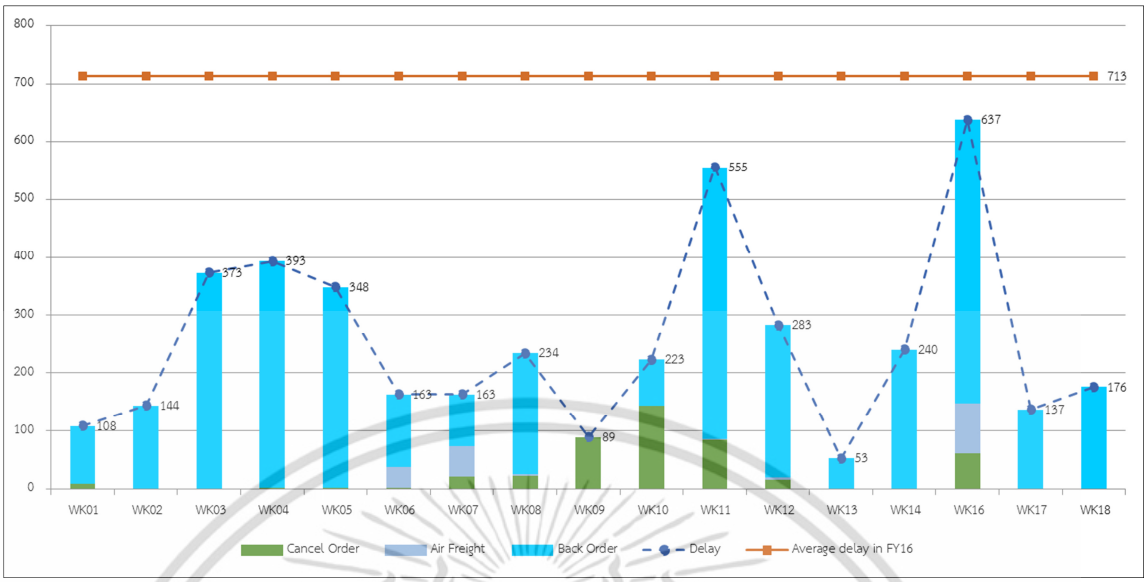



**Figure 4.4** Delay Issue in Weeks 1-18

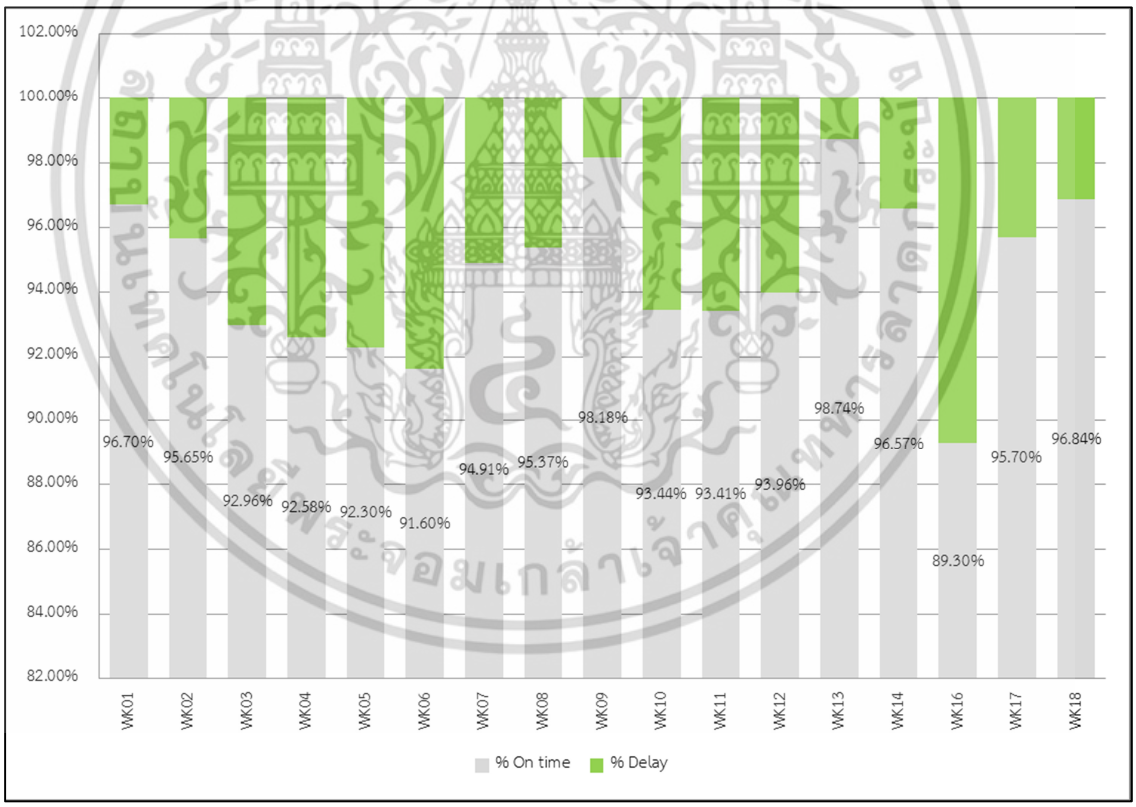



**Figure 4. 5** Delivery Performances in Week 1-18

### 4.3 Achievement of Container Planning

Because of logistic team have container plan when receive order from order system. They divide area for each part in container and utilize when supplier cannot keep delivery on time to avoid delay shipment plan to customer.

The logistic team has to check the quantity and timing for milk run load part in their warehouse. This operation is material requirement date (MRD). Regarding the shipment plan, the regional production control has to agree with a forwarder or third party who controls shipment for customers. They have a plan for using space in the warehouse and containers in each year to support sea and air freight shipments. Then, the logistic team will arrange containers and vanning at that week because it concerns lead time and contract with a forwarder.

When the logistic team cannot achieve planning, the reason comes from suppliers' delayed delivery of the first shipment. The logistic team has to revise the container planning to fulfill containers and move the volume to the next shipment if they cannot wait for the suppliers' delivery. According to the statistics in Figure 4.6, it shows that the logistic team can proceed with their plan, except Weeks 3, 4, 6, 7, 10, 16 and 17. The logistic team achieves 78.78% on average for arranging parts in containers which is nearly the average in FY16 which is 79.44%. Therefore, the suppliers' feedback is useful for container planning after implementing the checking operation.

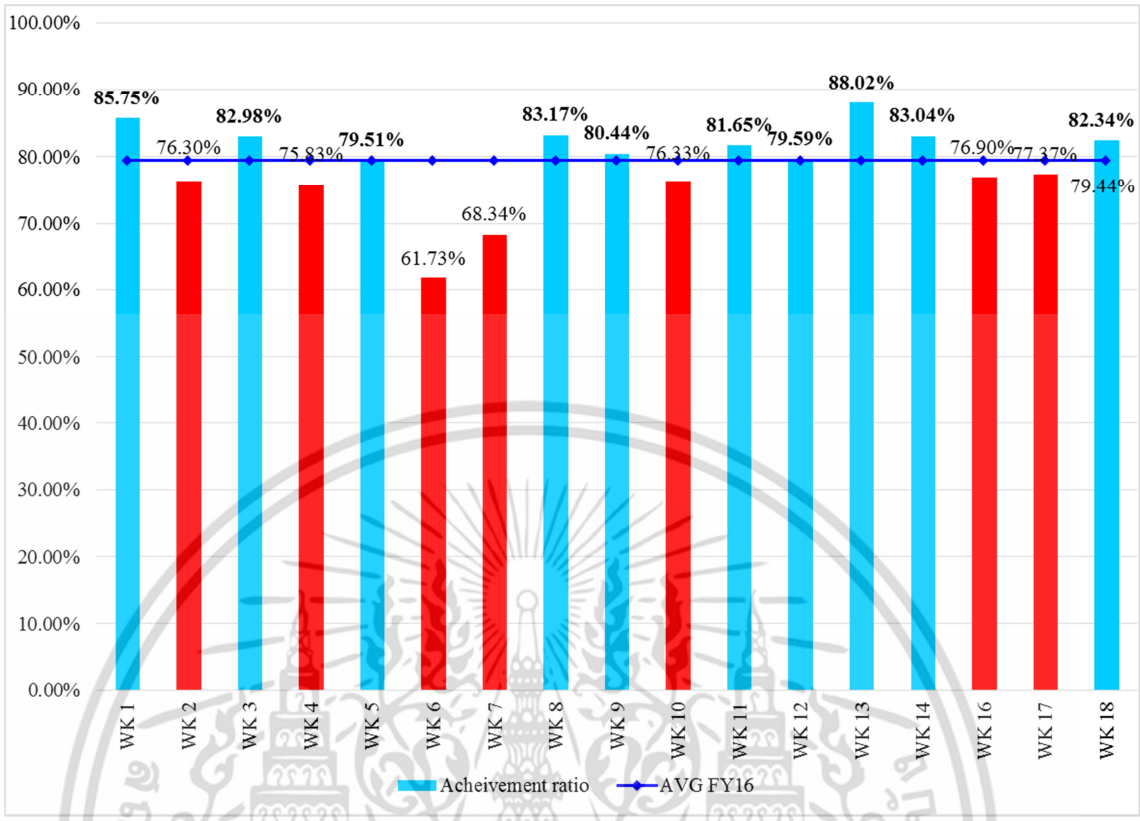



**Figure 4.6** Achievement Ratio of Container Planning

The logistic team needs full capacity container loading. In Figure 4.7, they can plan containers based on suppliers' confirmation. In Week 18, they can employ 32 containers out of 55 containers. For the Spanish plant, there is lead time for shipment of 30 days after ETD from Thailand port. They prepare 57 containers per week, but they use only 47 containers per week in actual. So, if they can control orders, it is possible to reduce cost for using containers.

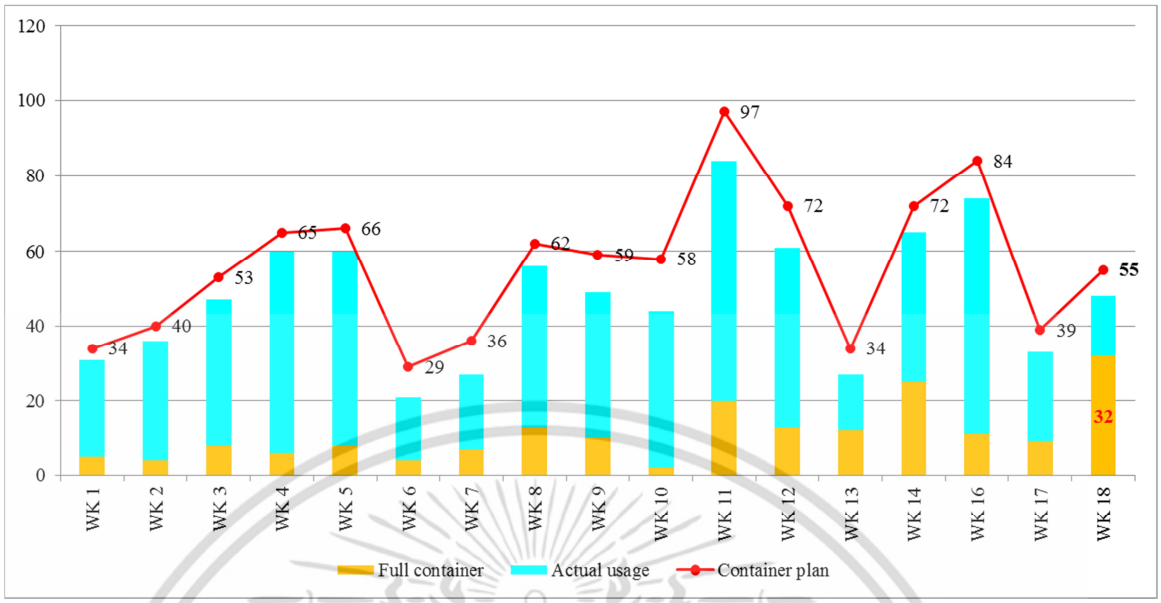



**Figure 4.7** Usage Containers in Weeks 1-18

## 4.4 Analysis Supplier Performance Improvement

In Figure 4.8, after notifying the order improvement plan to suppliers, the regional production control finds top 10 suppliers, such as 1CC5, C009, 1AJ1, 1BP7, C001, A018 and A003. They can reduce delay issues compared to the data in FY16, except A013, L021 and 1BW0. They have a design change that concerns customers' satisfaction and quality issues which require suppliers' action and immediate parts development. Hence, they have delay issues that customer and design should accept to lead time for production from suppliers.

Especially A013, they have 43.70% of delay issues because suppliers have a design change since starting the trial production and importing component parts for assembling. The regional production control has to monitor the order that concerns parts with specification change such as change of materials for more durability, change of the

size of hole to facilitate assembling, etc. They should report supplier's situations to customers and when suppliers can supply parts with full capacity. This is the responsibility of the regional production control to negotiate with customers about the production and recovery plan from suppliers.

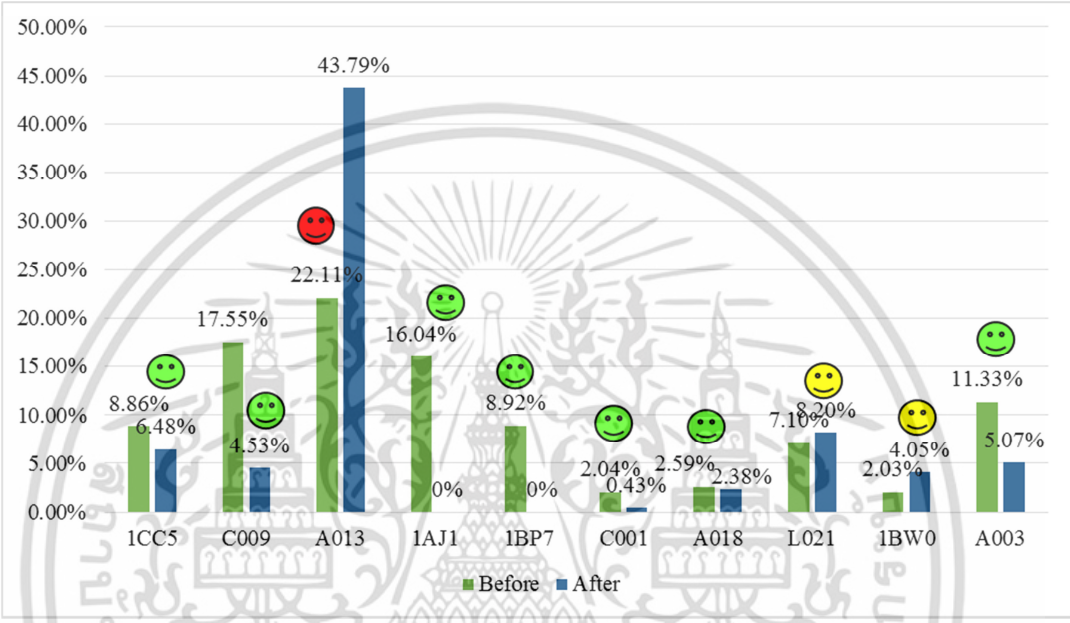



**Figure 4.8** Delay Issue before and after Launching Order Management Activity

After testing for 3 months, the logistic team who surveys with suppliers reports the result of suppliers' confirmation about the order fluctuation.

Comment and Suggestion from Suppliers

1. Lead time for checking and confirmation of delay plan is short because it may concern ordering materials and production plan in suppliers' side.
2. Machines or the production line has more production capacity than the model parts, and the production capacity can be shared.

3. This activity does not cover the volume and decreasing forecast, so suppliers request to control and notice them.

# CHAPTER 5

# CONCLUSIONS AND RECOMMENDATIONS

## 5.1 Conclusions

The parts export business in Thailand has been improved and developed continuously, especially the automobile parts. The car manufacturing business is the center of supply chain for supporting car makers in foreign countries. In this study, the export operation is part of car manufacturing business that has the regional production control cooperating with customers. Customers are production plants overseas. They order components and parts to produce to meet the demand of customers in each market. Moreover, there are 3 sections in the supply chain management department for export part such as the export quality assurance team, the logistic team and the packaging engineer which deliver parts to customers.

The regional production control consigns the order and executes requirements to suppliers. They provide data which include firm order, weekly forecast and 3-month forecast to suppliers via intranet. Then, they follow up and control shipments when receiving parts from suppliers. However, the problem which affects their shipment performance is suppliers' delayed delivery. The cause of delay is investigated in order to find out which operation has to be improved immediately.

Therefore, the tools used for analyzing the problem are the cause and effect diagram, the operation flow and the data flow diagram. There are principles applied to solving the problem. Donald S. Le Vie [3] studied "Understanding Data Flow Diagram", how to use the analysis, and develop the data flow. This tool have 4 symbols to explain

the operation and create understanding for users and analysts. Moreover, there are journals which apply the data flow diagram to their study such as the journal of process and database modeling of university Bursary system [2], the journal of a revision of data flow diagram for modeling applications using XML [4]. Therefore, the data flow diagram is useful for consideration in the regional production control operation of parts export. It concerns information from customers in overseas plants and how to generate that information to suppliers.

After the cause has been broken down by the cause and effective diagram and votes from colleagues in charge of this operation, the unstable order is the main reason as to why suppliers cannot be on time and the regional production control cannot detect and declare it to suppliers and customers. Thus, the data flow diagram is a tool to find out the information flow from customers with a step added to notify order fluctuation before the information flows into the suppliers' intranet system. Therefore, the regional production control creates the Macro excel to generate orders in comparison with firm order and forecast and then survey suppliers before releasing the orders on in intranet.

This study looks at the ordering experiment from Spain where the deviation of order is found every week. After the solution is applied, the number of delay issue is decreasing to lower than the average of 719 delay issues in 2016 and 94.60% on-time delivery performance. Moreover, the regional production control has improved the activity with top 10 suppliers who have 70% of delay issues, and suppliers can improve their delivery performance and clear back orders in a short time. When the logistic team receives parts from suppliers on time, they can plan the usage container to achieve the target. According to the statistics, 78.78% of the logistic team can utilize their container

capacity and it tends to improve in the future when suppliers can reduce the amount of delayed shipments.

Hence, the information of customers should be checked and analyzed before releasing it on the internal and suppliers because it is for planning and managing the requirements of customers and cost loss avoidance. Using the data flow diagram is a method which is applied and found to be able to solve the problem when the system has weaknesses. In addition, the activity directly concerns suppliers and customers, so they should manage lead time for communication and proceed with the order management.

## 5.2 Recommendation

5.2.1 Apply the order management with other customers and all suppliers

5.2.2 Apply the Macro excel on the intranet of the regional production control system with short operation to generate data to suppliers

5.2.3 Improve suppliers' performance to support requirements of customers such as production capacity, investment of new tooling and design flexible production when the order is unstable which is an action plan to prevent this problem

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