FACTORS AFFECTING EFFICIENCY OF THE AIR TRANSPORT SERVICE A CASE STUDY OF A GERMAN COMPANY IN THAILAND

PIYAWAT PORNOY

INDEPENDENT STUDY SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE IN LOGISTICS AND SUPPLY CHAIN MANAGEMENT
INTERNATIONAL COLLEGE
KING MONGKUT'S INSTITUTE OF TECHNOLOGY LADKRABANG
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INDEPENDENT STUDY TITLE	Factors affecting efficiency of the air transport service A case study of a German company in Thailand
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ABSTRACT

Air transport service is the most attractive international freight transport for logistics. It has been developed rapidly because numerous entrepreneurs realized aircraft couldmove consignments much faster than the rail transport and ship transport. For Thailand, the number of inbound and outbound international freight at Suvarnabhumi airport has grown and expanded every year.

There are three primary air transport service which are expedited, deferred and consolidated. Expedited is shipped as soon as a flight is available. Deferred is the lowest service level. Consolidated is in the middle service level which shipment consider the time constraint where that shipment must be delivered to the destination on the scheduled. Therefore, the optimize package such as the size or weight of the packaging for freight consolidation is required because they could affect the efficiency of the shipment.

This study was to study and compare the factors which influence the efficiency of the air transport service. The case study is from the German company which products are delivered weekly by consolidate shipment from Germany to Thailand. Sample This study conducted 200 shipments as sample. At the first step, the current shipping process was drawn by using the flow process chart technique. This technique was used to

identify the sequence of activities and waste within a process. Then, 200 shipments were identified wastes and analyzed the potential root cause by the 4Ms analysis and the fishbone analysis. After that, the top portion of root causes were addressed to resolve the majority of problems by the Pareto chart analysis. At the end, a new improvement process was proposed by using the flow process chart technique. The current process and new process could be compared.

The Frequency and percentage distribution used to determine the percentage of root causes and the relationship of each root cause was found by the correlation technique. The packing process and packing size were found as the top portion of causes and their frequency. Additionally, the study found that the amount of items in each shipment has relationship with packing process. The process improvement guideline is proposed to optimize the amount of items and packaging size in a shipment.

ACKNOWLEDGEMENT

Without the contribution of many people, this independent study would not have been existed. It owes the existence to the supports and inspirations from a lot of people.

To my independent study advisor Asst. Prof. Dr. Wichitsawat Suksawat Na Ayudhya of International College at King Mongkut's Institute of Technology Ladkrabang, I would like to express my deepest gratitude for the encouragement and supervision through all obstacles and challenges since the beginning until the end of my study.

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Finally, I must express my very greatest gratitude to my parents and all relatives for providing me with unfailing support and continuous motivation throughout my years of study. This accomplishment would not have been possible without them.

Piyawat Pornoy

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CHAPTER 1

INTRODUCTION

1.1 Background

The trade between Thailand and Germany started since 1860 and bilateral trade has grown and expanded. German investment in Thailand is growing over the past year which currently are more than 600 companies. The majority are not only in the industrial sector, but also service providing companies have been established with many interesting developments. Moreover, a wide range of different of essential German products such as engines, medical technologies, automobiles, machineries, chemical products, cars & spare parts and electronic products have been imported to Thailand in year 2016 increased by 5.78% with amount 5.9 billion USD which ranked as no. 4 in the overall and no. 1 in the EU after China, ASEAN and Japan. (The German-Thai Chamber of Commerce, 2017).

Freight industry in Thailand has an important role in supporting the economic development of Thailand, especially the international air freight industry. Due to its distributing structure, the number of international freight at Suvarnabhumi airport in year 2016 increased by 5.55%, whereas the inbound increased by 9.90% when compared with the previous year (Airports of Thailand Public Company Limited, 2017).

This study was examined a case of a German company in Thailand which air freight logistics is necessary for the business. Although the air freight charge is the most expensive by mean of transportation, air freight can provide high-speed service with low risk of damage, effective security, accessibility and flexibility with good frequency of regular destinations which are more substantial for business.

The most economical approach to dispatch the product from Germany to Thailand effectively is the freight consolidation. It is described that the combination of many shipments to be dispatched on the same vehicle which means cost reduction and waste reduction from the empty space of transport capacity.

To support the freight handling. Packaging or container is one of the factors which effects to the air transportation efficiency. It is linking along the supply chain. It is not only the preservation and protection of products from damage. It is an identification of the products and it also facilitates handling and freight transportation. Saghir said *"Packaging is a coordinated system that prepare goods in a safe, efficient and effective way for handling, transportation, distribution, storage, retailing, consumption, as well as recovery, reuse or disposal combined with maximizing consumers value, sales and hence the organization's profit"* (Saghir, 2004). Moreover, there is also a trend for weight product reduction which allows extra space for packaging that can increase the efficiency of air transportation. This improves the weight-to-volume ratio, makes road and rail transportation mode moving more cost effective (U.S. Department of Energy, 2013).

1.2 Problem Statement

In this business, customer expects the high service requirement and a high efficiency of handling when they buy German products. German products and their quality have an excellent reputation in Thailand, which may also justify a higher price. Customer service is an essential feature, which remains to be unique selling point for German companies.

In addition, the product in this study is spare part which classification enable managers to focus on the most important items and facilitates the decision-making

process from a maintenance perspective which is difference from an inventory or logistic view (Syntetos, 2009).

Consolidation shipment consider the time constraint where that shipment must be delivered to the destination on the scheduled. To utilize filled space as much as possible is the most productivity both logistic and maintenance view.

According what had been explained, the optimize package size for freight consolidation is required. Currently, the product is packed into the container by manufacturer, then logistically by airline or freight forwarder. After the product was handed-over to freight forwarder, the manufacturer loses control of delivery speed. One of the factors that enables manufacturer to increase the delivery speed is by preparing a suitable packaging which is easily to handle in each step of delivery.

1.3 Objective of the Study

The purpose of the study is to study and compare the factors which influence the efficiency of the air transport service. The case study is from the German company which products are delivered weekly by consolidate shipment from Germany to Thailand.

1.3.1 To study and compare the factors influencing the speed of the air transport service.

1.3.2 To propose an improvement operation.

1.4 Scope of the Study

This study area covered one German company in Thailand as a case study. The air transportation shipping details were collected during September – December 2017

which including packaging and freight detail in each step of shipping process. The packaging details such as volume, dimension of the packaging.

1.5 Plan and Timeline

This study was conducted shipping record during September – December 2017. The study's key activities and the duration of each task were listed out and plotted in the Gantt chart below. (see Table 1.1)

Table 1.1 Timeline of this study

Item	Activities	Period								
		17-Sep	17-Oct	17-Nov	17-Dec	18-Jan	18-Feb	18-Mar	18-Apr	18-May
1	**Discuss Project**									
1.1	Outline the Project									
1.2	Define Study Scope									
2	**Data Gathering**									
2.1	Literature Review									
2.2	Data Gathering									
3	**Preliminary Data Analysis**									
3.1	Primary data Analysis									
3.2	Review data and improve data									
4	**Final Data Analysis**									
4.1	Result Checking									
4.2	Data Analysis									
5	**Conclusion and Recommendation**									
5.1	Conclusion									
5.2	Describe the result									
5.3	Recommendation									

CHAPTER 2

LITERATURE REVIEW

This chapter describes several theories and previous studies which are appropriate for support the researcher's study. In the first sub chapter, it provided background in transportation and followed by the relevant information of the freight, shipping procedure and packaging of shipment.

2.1 Transportation

Transportation is the activity that facilitates physical movement of goods individuals from one place to another place. It is considered as a trade assistance in business which means that the transportation supports trade and industry in carrying raw materials to the place of production and distributing finished products for consumption. Individuals or business firms that involve themselves in such activities are called transporters. In general, transporters carry raw material, finished products, passengers, etc. from one place to another place. Nowadays people move freely throughout the world because of transport. Finished products at one place are readily available at destination places. It is associated with every step of daily life. All business units cannot be moved without transportation (The National Institute of Open Schooling, 2012).

2.1.1 Importance of Transportation

Followings points are the importance of transport.

- Important to manufacturers or producers. Transportation makes it possible to carry raw materials from places where they are available, to places where they can be processed and assembled into finished goods.

- Important to consumers and customers: Transportation makes it possible movement of goods from one place to another with great ease and speed. Therefore, consumers spread in different parts of the country have the benefit of consuming goods produced at distant places.

- Important to living standard: Transportation makes it possible to facilitates large-scale production. It gives consumers the choice to make use of different quantities of goods at different prices and low costs. With this, it raises the living standard of the people.

- Important to employment: Transportation makes it possible to provides more employment opportunity to individuals as drivers, conductors, pilots, cabin crew, captain of the ship, etc. who are directly engaged in transport business. Also, it provides employment to people indirectly in the industries producing various means of transport and other transport equipment. People can also provide repairing and maintenance services by opening service centers at convenient locations.

2.1.2 Freight Transportation

Freight transportation is the physical process of transportation commodities and merchandise goods and cargo. The original term shipping referred to transport by sea, but American English extends to refer to transport by land or air as well. A term of "Logistics" borrowed from the military environment which is also fashionably used in the same sense. Various modes of transportation are available for transporting goods between or within countries by either air, sea or overland by road and rail (Sector Publishing Intelligence, 2018).

- Sea Freight

Sea freight provides safe and wide scale cargo deliveries on long distances within a wide geography of transportation, Sea Freight combining low level of transport costs and possibility to ship the different types of goods such as general cargo, temperature-controlled and dangerous goods, oversized and heavy cargo etc. Sea freight is a less expensive method of shipping goods, but the drawback is a longer transit time. Also sea freight is a preferred mode of transport for the movement of high volume and heavy cargo such as minerals, metals, ores, steel coils, etc. which would be impossible to move by air freight.

Additionally, businesses are placing more of an emphasis on the environmental impact on shipping. An air freight service emits a higher amount of polluting gases with less space capacity compared to sea freight services which are considered a much greener transportation mode with a higher carrying capacity. Sea freight options are available based on cargo type to ensure the safe, efficient and economical transport of goods by sea. Below are some examples of sea freight options.

Sea-Freight Container: A standard container is a metallic box with a double door at one end and in which general cargo can be safely loaded and transported. Most international container traffic is carried in either 20 or 40-foot containers (UNDP Practice Series, 2008). Containerized shipments are either Full Container Load (FCL) or Less than a Container Load (LCL).

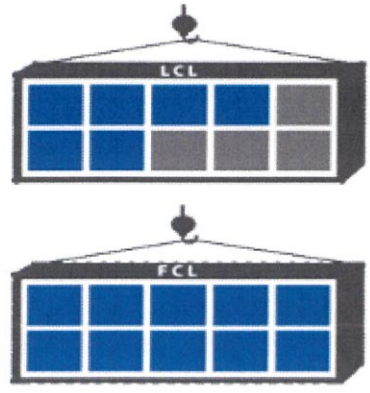

Fig 2.1 FCL Container compared to LCL

Source: Reference Global Shipping Services, LLC. Full Container Load Shipping (FCL) Services Retrieved from https://www.glship.com/

Sea-Freight Chartering: Charter cargo ships do not operate on regular routes and schedules and pick up cargo only when it is chartered from the ship operator. When a consignment represents several thousand tons or cubic meters, for instance bulk cargo like oil, coal, ore and grain, the normal procedure is to charter a vessel or part of a vessel, after contacting possible carriers for quotations. Charter shipping has the lowest freight rate per unit of weight or measurement. A charter-party can be concluded for a specific load (weight) for a journey or for a determined length of time.

Sea-Freight Roll on / Roll off (RO/RO): The RO/RO vessel derived from the traditional car ferry, where motor vehicles are driven on and off by their drivers and non-mobile traffic is loaded on flat racks. The RO/RO is equipped with ramps that make loading and unloading from the side and/or bow (front of vessel) and/ or stern (rear of vessel) possible. Benefits include fast loading and unloading.

Sea-Freight LASH (Lighter Aboard Ship): Lighter Aboard Ship is a system of water transport. LASH vessels each carry about 82 LASH barges. The barges, all of a standard size with cargo capacity of 385 tons, are towed into ports and inland waterways to various shipping points where they are loaded with cargo and then

returned to the ocean-going vessel. They are hoisted aboard by a special shipboard gantry-type crane and transported overseas where the process is reversed. LASH ships do not require special docks or terminals.

- **Air Freight**

Air freight is often used for high value/low volume shipments. The traditional method of air dispatch is to deliver a consignment covered by an individual air waybill to an air carrier (either direct or through a freight forwarder). In the case of large loads, it is possible to charter a full aircraft or arrange for what is called a split-charter if the load will not fill the aircraft to full capacity. Benefits of air freight can be described as follows (Sudalaimuthu. S. 2009).

- Airports worldwide can be reached in few hours or 1-2 days by airfreight. Delivery to certain areas may take several weeks to arrive by ocean and overland freight. Time sensitive or perishable goods such as certain pharmaceuticals often rely on airfreight.
- Air freight has a tighter control over its cargo, thus it has better security that reduces the cargo exposure to theft, pilferage and damage.
- Air freight requires less packaging because of faster delivery and better security. Less packaging may mean saving freight, packaging and labor costs.
- Air freight is faster and has better security than overland and ocean freight, thus the insurance premium rate generally is lower.

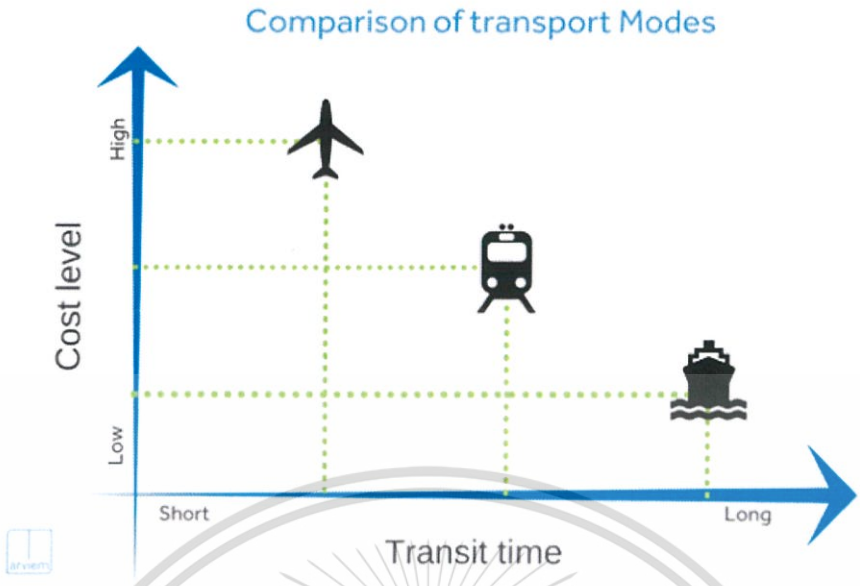

Figure 2.2 Comparison of transport modes

Source: reference Stefan Reidy, Oct 2017. The New Silk Road: What should shippers of goods expect from the new era of Trans-Eurasian Freight Forwarding Retrieved from http://arviem.com/

- **Post**

Where postal services are reliable, small parcels can often be sent more cheaply by air parcel post, or even surface parcel post if the time element is not of primary importance. The main considerations are the reliability of the postal service at the destination and advising consignees of the arrival of parcels which, in most instances, have to be cleared through customs before they can be delivered.

- **Multimodal Transportation**

Multimodal transportation is the movement of one-unit load from origin to destination by several methods or transportation under one document without breaking up the unit load. The development of container traffic has made this possible, as containers can travel from end to end without being opened, unloaded, reloaded during the journey. Companies which can offer multimodal transportation are large firms or forwarding agents who specialize in such traffic, as it obviously requires diligent

organization to ensure that the chain of transport events works smoothly. The advantage for those who make use of multimodal transportation is that they have one document only for the whole operation and that the operator is legally responsible for a satisfactory overall performance by his own staff and by the agents or branches that he is employing.

2.2 Consolidation Shipment

A consolidated shipment is a shipment which combining multiple shipments from various shippers into one full container shipment. This shipping allows shippers to earn preferred rates and helps optimize supply chain logistics by saving time and reducing cost (Freight quote. 2017).

In general, there are three primary air transport service options which are expedited, deferred and consolidated. Expedited is hipped as soon as a flight is available. Deferred is the lower service level. Consolidated is in the middle service level which shipment considers the time constraint where that shipment must be delivered to the destination on the scheduled.

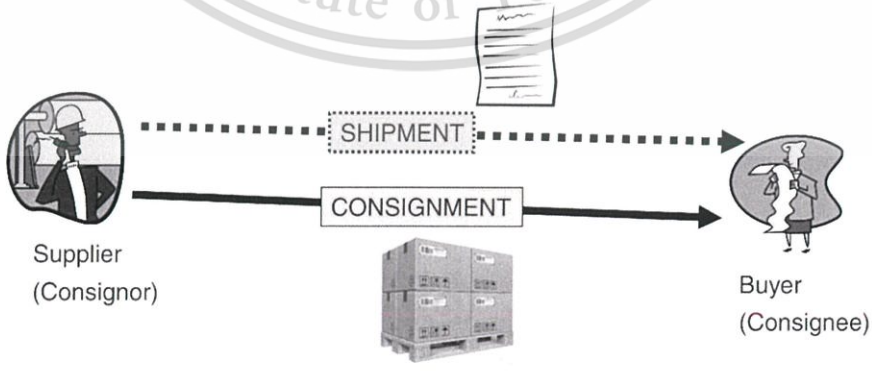

Figure 2.3 Simple Fulfilment Shipment

Source: reference OASIS Open 2018 Mar 2018 Universal Business Language Version 2.2 Retrieved from http://docs.oasis-open.org/ubl/cs01-UBL-2.2/UBL-2.2.html

Consolidated shipping is an ideal for someone that might only have a few pallets of freight or smaller shipments that need packaged and shipped in one container. To help break down consolidated shipping the term and its relationship with the freight industry are to be clarified. Followings are outline of benefits and potential challenges of consolidated shipping.

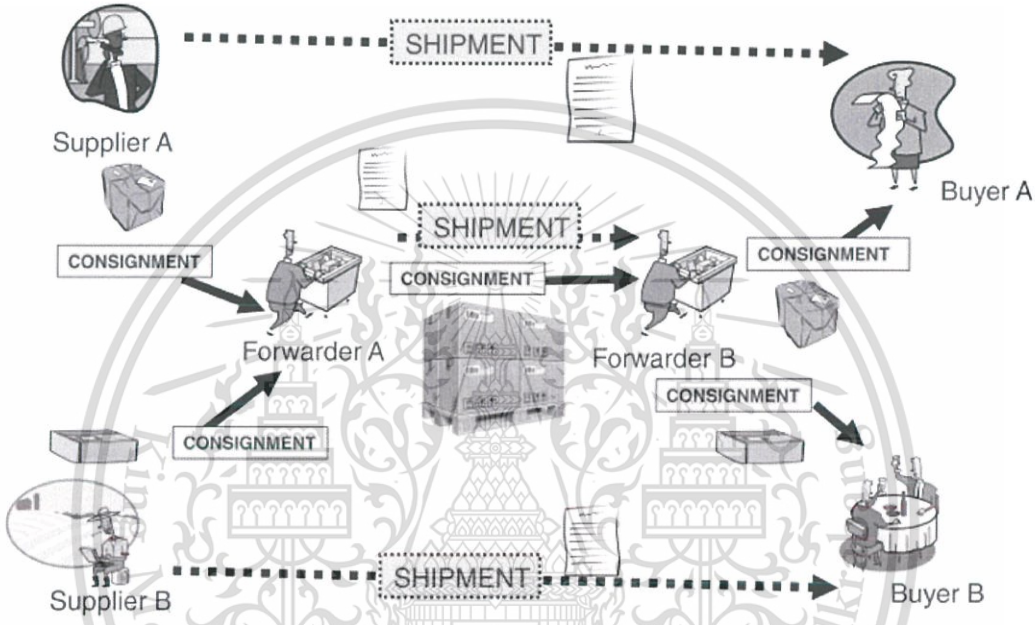

Figure 2.4 Consolidated Fulfilment shipment

Source: reference OASIS Open 2018 Mar 2018 Universal Business Language Version 2.2 Retrieved from http://docs.oasis-open.org/ubl/cs01-UBL-2.2/UBL-2.2.html

2.2.1 Benefits of consolidated shipping

- Cost efficient: Many shippers believe this is the most important benefit of consolidation. Consolidation allows to combine multiple LTL shipments that are traveling in the same vicinity into one full truckload shipment, while only paying for the space that their freight takes up.

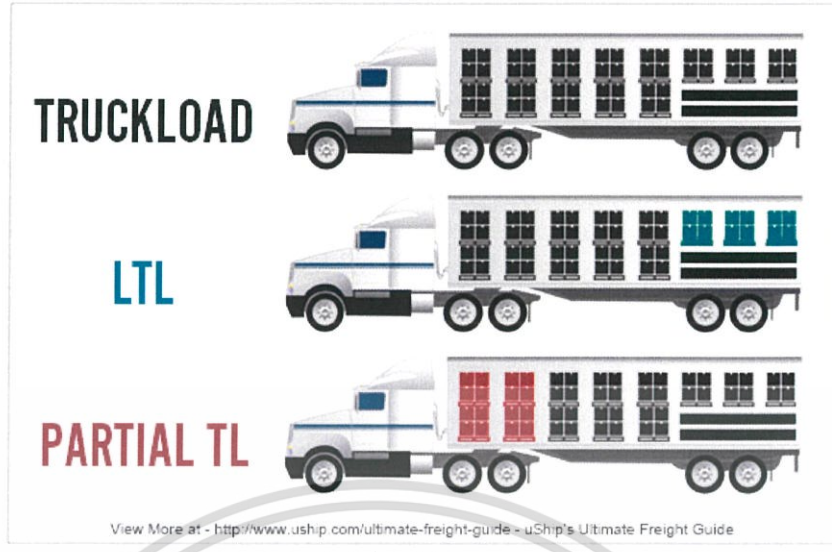

Figure 2.5 Types of Freight and Freight Modes

Source: reference uShip Inc. and its licensors. Freight Basics
Retrieved from https://www.uship.com/ultimate-freight-guide

- Reduced damage risk: The risk of damaged goods is significantly lowered with fewer touchpoints Consolidated shipping uses a method that not only is more cost efficient, but also considerably reduces the handling of the product, as freight only must travel between the shipper, consolidation center and receiver/consignee.
- Improved quality control: Another benefit of consolidation which is possible to take control of goods. Consolidation allows to perform quality control measures as soon as the product even reaches the warehouse which in turn reduces the chances of losing time and control due to unforeseen problems with the order.

2.3 Shipping Documentation

Shipping documentation includes the process of generating all required documents and labels for a shipment in compliance with customer, carrier and government regulation. Proper shipping documentation is required for both domestic and international shipments. Normally each customer may have very specific

requirements for product labeling and shipping documents (WERC and Supply Chain Visions. 2007). Shipping documentation commonly includes as follows.

2.3.1 Bill of Landing

A transportation document that is the contract of carriage containing the terms and conditions between the shipper and carrier. The documentation includes all delivery information and instructions. A dock receipt may also be used to transfer shipments from domestic to foreign carriers.

2.3.2 Commercial invoice

A bill for the goods from the seller to the buyer. Governments use the commercial invoice to determine the true value of goods when assessing customers duties and taxes. A commercial invoice is often the primary document used for import/ export control.

2.3.3 Shippers Export Declaration (SED)

A document used by the government to control export and used as a source for official export statistics.

2.3.4 Export Packing List

An itemized detail list of the material in each package. The packing list includes unit weights and gross shipment weights. It may also include the dimensions of each package or pallet.

2.3.5 Certificate of Origin

Document/ statement that gives the origin of the export item.

2.3.6 NAFTA Certificate

Certificate required for product trades between NAFTA countries.

2.3.7 Export License

Some goods require the shipper to have an export licenses which are government approval to export and a specific product in designated quantities to a specified consignee. An export license may be required for all exports to specific countries or for only particular commodities to some countries.

2.4 Packaging

The container acts both a package as well as a means of transport. Nevertheless, the cargo requires a package during transport within the container. The kind and amount of package depends on the cargo, the way of transport and the used type of container. If cargo stowed together with different sizes and weights within a container, more stable packaging is required. If cartons or cases are stacked several layers on top of each other, the lowest layer must be capable to support the upper ones. The required stacking strength depends on the packaging material, transport duration and humidity conditions. Standard containers can be equipped with special packaging for transport of dry bulk, clothes or to prevent cargo from humidity. If the cargo is handled conventionally on flat-racks during certain stages of transport, its packaging must be able to withstand the strains of climate, weather and conventional handling.

2.4.1 Freight Packaging Type

The following general design recommendations are presented in three categories of freight shipment package types:

- Type 1- Factory packed in pre-engineered custom packages

The freight package designer should determine the product's level of fragility to assure suitable protection from shock and vibration. Fragility level identifies required force to cause an unacceptable level of damage to the product. The most accurate way to do this is damage boundary assessment using laboratory shock and vibration equipment referring ASTM Test Methods. If that is not available, a reasonable estimate should be made based on similar products or by working with the product designer to develop an estimate.

Freight products of higher value should be packaged using higher strength and level of product protection than that used with moderate value products. Establishing a benchmark of percent cost of packaging to total product manufacturing cost will assist in determining if packaging costs are equitable within a shipper's product line. However, other cost factors such as cost of failures, shipment returns, and assembly of packaged products, usability and transportation costs can far exceed the direct packaging costs.

Customer preferences regarding package aesthetics, design features, and environmental impact may affect exterior and interior packaging choices, but must be balanced against the need to minimize costs, while providing the product with adequate protection.

- Type 2- Miscellaneous items packed in random order:

The freight package of this type is one or more freight items are packed together as a single freight shipment. Many companies have successfully developed packaging

guidelines that define relative product fragility and the amount/thickness of protective packaging required. In the absence of these, a minimum of 3-4 inches thickness of protective packaging or space separation between contents and container walls should be provided. The packager generally considers product fragility during packing. Items deemed more fragile should have greater clearance from container walls and more separation from other items inside the container. The same rationale should be applied to products of higher than average value, such as products having much higher value than the shipper's average value for the same cubic volume should be packed in larger and

- Type 3- Occasional packaging of miscellaneous freight items:

These are freight packages prepared infrequently on an occasional basis by factories, warehouses, mailing stores, or individuals. The contents vary each time and may be any item acceptable for shipment by freight carriers.

Although fragility levels of these types of items are important, fragility is often not known or easily estimated and the most important factor in determining amount of packaging becomes the intrinsic value of the item. Higher value items should be packed in stronger containers with more cushioning protection than average value items.

2.4.2 Oversized and heavy cargo

Out of gauge and heavy cargo can be loaded either pre-lashed or as break bulk. Pre-lashed means the cargo is placed and secured on the flat-rack or in the open top container before being loaded onto the vessel. If the weight or dimension of the cargo exceeds the limits for a pre-lashed move, they must be loaded as a break bulk move. This means that empty flat-racks will be loaded as the foundation inside the vessel,

bedding from wood or steel will be arranged and then the cargo will be loaded on top by a gantry or floating crane (Hapag-Lloyd, 2005).

2.5 Performance in Freight Transportation

The most important part of a company is the logistics which acts as assisting the company's core business. Therefore, the effective delivery process is required to achieve delivery target. If the goods or raw material were late, and as a result delay in the execution of the project it may cause penalties in certain projects. There are several common customer service complaints. The previous research in Figure 2.6 shows what the respondents felt were the most common service failures. Late delivery, a logistics customer service variable, accounted for nearly half of the mentioned service infractions while product quality mistakes represented about a third (Rinaldi, 2015).

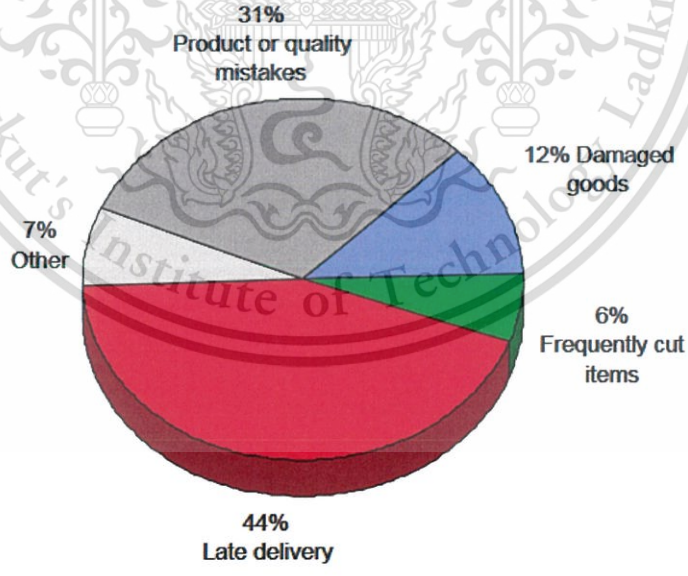

Figure 2.6 Common customer service complaint

Source: reference Derick Gregory Logistics Customer Service Strategy
Retrieved from http://slideplayer.com/slide/4664540/

Furthermore, delivery performance is one of the most obvious features. This aspect generally has two dimensions which are speed and reliability. Speed is meant in the sense of having short lead, response and delivery times as well as the being flexibility to be able to quickly adjust the organization and respond to new demands while reliability refers to the number of items delivered on time divided by total number of deliveries. Customs, business practices, and regulations can change widely from country or domestically within a country. Currently logistics involves an array of essential activities for trade-including transport, customs clearance, distribution, and payment systems. A step towards measuring delivery performance of an integrated supply chain considering procurement, manufacturing, logistics and distribution functions. In level-2 of SCOR model, delivery performance consists of 4 elements (Madhusudhana, 2011).

a) Supplier on-time and in full delivery

b) Manufacturing schedule attainment

c) Warehouse on-time and in full shipment

d) Transportation provider on-time delivery

CHAPTER 3

RESEARCH METHODOLOGY

This chapter describes the research methodology of the study. It covers the shipment process where the study was conducted, the efficiency of the air transport service and sampling including, the data collection and method implementation.

3.1 Background

The case study is from a company in a packaging and bottling machinery. The company delivers equipment for foods, beverage, chemical and health care segments. The company offers material flow systems and processing in the whole production line. Additionally, the company offers customized engineering, parts manufacturing, and after sales support.

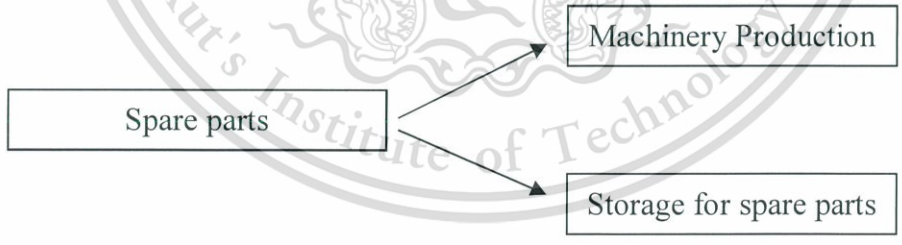

Figure 3.1 Stages of stocks formation in company

Manufacturing covers parts production for all equipment in the production line including machinery production and single spare parts. With this large manufacturing company, the spare parts storage is not defined only as a product, but they are also defined as a type of material stocks which used in production process. The figure 3.1

has shown the present production inventory process including the connection between spare parts inventories and storage (Katarzyna, 2013).

In aspect of company management, spare part is one of the product portfolio. Thailand is the biggest subsidiary in Asia which acts as a product distributor in Asia Pacific. Products are delivered weekly by consolidate shipment from Germany to Thailand. The figure 3.2 has shown the shipping process flow.

Figure 3.2 Shipping process flow

The consolidate shipment consists many inner packs in many orders. The ready spare parts are dispatched weekly to Thailand. Spare parts of each order are packed in one individual package. The pack size depends on the spare parts list of each order. In this situation, it is possible that there are multiple sizes in one consolidate shipment. The multiple size may cause the packs could not maximize utility space in the shipment.

There is a study shown the benefits to the logistic activity in order to have a right package are as follows (Hellstorm, 2007).

- Reduction of handling times
- Shorter picking times
- The cost of packing materials would be diminished
- Decreased inventory carrying cost
- The storage layout of warehouse as well as the related utilization of the storage facilities would be improved
- The handling of products at delivery points would be facilitated

3.2 Current Shipment process

To get a customer delivery performance, supply chain management is required to manage information, time, cost and products. The common metric to measure the delivery performance are on-time delivery, shipment date, receiving date and the total lead time. Along supply chain must work together to get high performance.

This study is focused on the logistics management from delivery note created until product receiving which drives by freight forwarders, shipping companies and customs clearance. There are 3 key sections involved which are manufacturer, shipping and subsidiary which shown in figure 3.2.

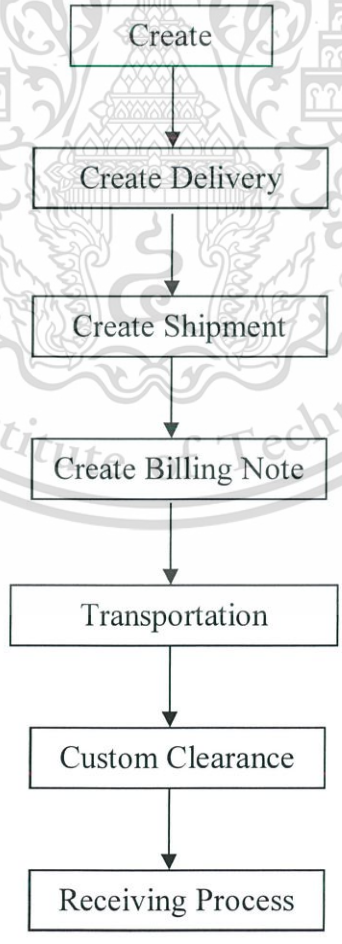

Figure 3.3 Current shipment process flow

The shipment process is drawn in figure 3.3. It starts after creation of sales order and creation of delivery note. The standard shipment process is described below (SAP MM Certification, 2014).

- Create sales order and create delivery note

After order created and order is ready, the outbound delivery will be created with reference to Sales Order. When the delivery document is created, the number of the delivery document will be shown. The packing process will be done in this step. The number of material is packed in accordance with the order. Meaning, the container size depends on number of material.

- Packing process

This step is to choose the right handling units to pack a finished product which is a packing material used for packing a finished product. The handling units can be one or more in one shipment. For example, 90 pieces of a material B must be packed in 3 small boxes which consist of 30 pieces each and then put them together in one big box. The process can be packing 30 pieces each of material. The user can choose the "packing material" and also choose "partial quantity" to 30 of material B. It generates a shipping unit/handling unit number. Then "per part. qty" whether it packed 30 pieces of material in 3 boxes.

To pack in larger box, the packing shipping unit can be chosen by entering the packaging material. The selected 3 lines of 3 boxes since the larger box is required. Now the 3 boxes are packed in one big box. Moreover, Reynolds-Feighan said air freight logistics is selected *'when the value per unit weight of shipments is relatively high and the speed of delivery is an important factor'*. (Reynolds-Feighan, 2001) The

potential root causes related to packaging and delivery are spare part packing, box labelling, oversize issue, overweight issue and shipment issuing.

- Create shipment

The product is packed in the packaging. The delivery note is created to be identified for one packaging. The deliveries normally based on information in the delivery note but the user can select by using the selection criteria based on shipping point, route, delivery numbers. In this study, the shipping is fixed consolidate shipment.

After loading the goods on the truck, the user should create Goods Issues posting for the delivery. Picked quantity should be entered by reference delivery number and Post Goods Issue. Then, Cost type Shipment cost document is created with reference to the shipment document. After that transfer shipment cost document.

- Create billing note

After delivery is completed, the users can create billing document in selected billing type. The billing document will be created with data from delivery document and its related sales order. Finally, invoice verification is done via MIRO transaction. Before issuing, the user should check all information whether it is correct such as the price difference, date and purchase order number. With this step, the shipment is completed.

- Current transportation process

This case study uses the third party logistic company to operate the delivery. The character of the business is to distribute the product from manufacturer in Germany to the warehouse in Thailand. Consolidated shipment is the best solution as its combination multiple orders into one tracking number. With this, all orders are delivered together without unpacking. When multiple orders are shipped together on

the same airway bill to the same address, the transportation will be less cost, the number of transports are reduced and more transparency.

In addition, the freight forwarder implements end-to-end by supply chain integration. The cargo in Germany was consolidated by milk runs. The advantage is an amount of transports reduction, which lower the environmental impact and lower cost.

- Receiving process

A company in this study takes an advantage by using a free trade zone. Once shipment arrives at Bangkok airport, the shipments are transferred to the free trade zone for commercial operations such as unpacking and new labelling. At this stage, it is not subject to import taxes and duties.

Once the shipment transferred to warehouse in free zone, the company must do the goods receipt. The goods receipt is the step to transfer material in the inventory which increase in the warehouse stock. The goods receipt can be posted against PO when the material is received by the ordering party. Also, the condition and quality of the material are inspected and verified.

3.3 Problem

This study work on the delivery performance. Mainly focused on the shipping process which starting from delivery note created until product receiving. According to the current Shipping process, transportation process and receiving process, the flow process chart can be drawn as shown in the figure 3.4.

Step #	Activity description	Time (days)	Operation ○	Transport ⇨	Inspection □	Delay D	Storage ▽
1	Create Delivery Note				x		
2	Packing Process	2	x				
3	Wait for Shipment	7				x	
4	Create Shipment				x		
5	Create Billing Note				x		
6	Transportation Process	5		x			
7	Wait for Transportation	3				x	
8	Customs Clearance	2	x				
9	Wait for Clearance	2				x	
10	Receiving Process						x
		Count:	2	1	3	3	1
		Time per process step:	4	5	0	12	0

Figure 3.4 Current shipment process in flow process chart

From figure 3.4, It can be identified that there are 3 activities may cause the delay from waiting activity as follows. 1. Waiting for Shipment in Packing process. The waiting time in this process can be up to 9 days. 2. Waiting for transportation in transportation process. The waiting time in this process can be up to 8 days. 3. Waiting for clearance in custom clearance process. The waiting time in this process can be up to 4 days. To be more understanding about possible root causes, which effect to deliver performance in each process, they are illustrated in figure 3.5 – 3.8.

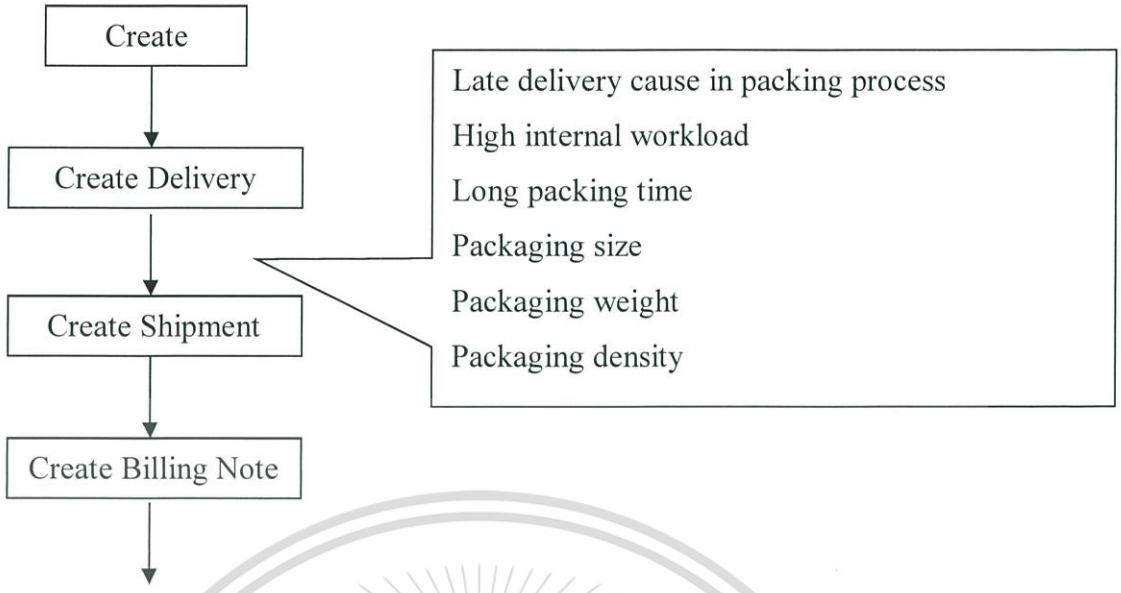

Figure 3.5 Possible late delivery cause in packing process

3.3.1 Late delivery cause in packing process

- High internal workload

When the order is ready, the delivery document is created the number of the delivery. The number of material is packed in accordance with the order. Meaning, the number of material depends on the order size which can be varied from 1 piece to many pieces. In operation view, the number of material increase, the workload also increases.

- Long packing time

The packing time is directly relating to the number of material. the number of material increase, the time consume in packing process.

- Packaging size

The packing size depends on the material sizes in an order. It can be small if the product is an o-ring and it can be big if the product is a shaft. To choose the right handling units to pack a finished product is necessary because it can affect the packing process and it may affect to the shipment sourcing.

- Packaging weight

The packing weight is one of the factors in air transportation. The overweight shipment could not be delivered by air freight in normal condition. With this limitation, the heavy packaging weight may cause late delivery.

- Packaging density

The packaging density is a combination of packaging size and packaging weight. There is some material which has a bigger size but light weight such as plastic frame. In the opposite site, there is some material has a small size but heavy material such as steel bearing.

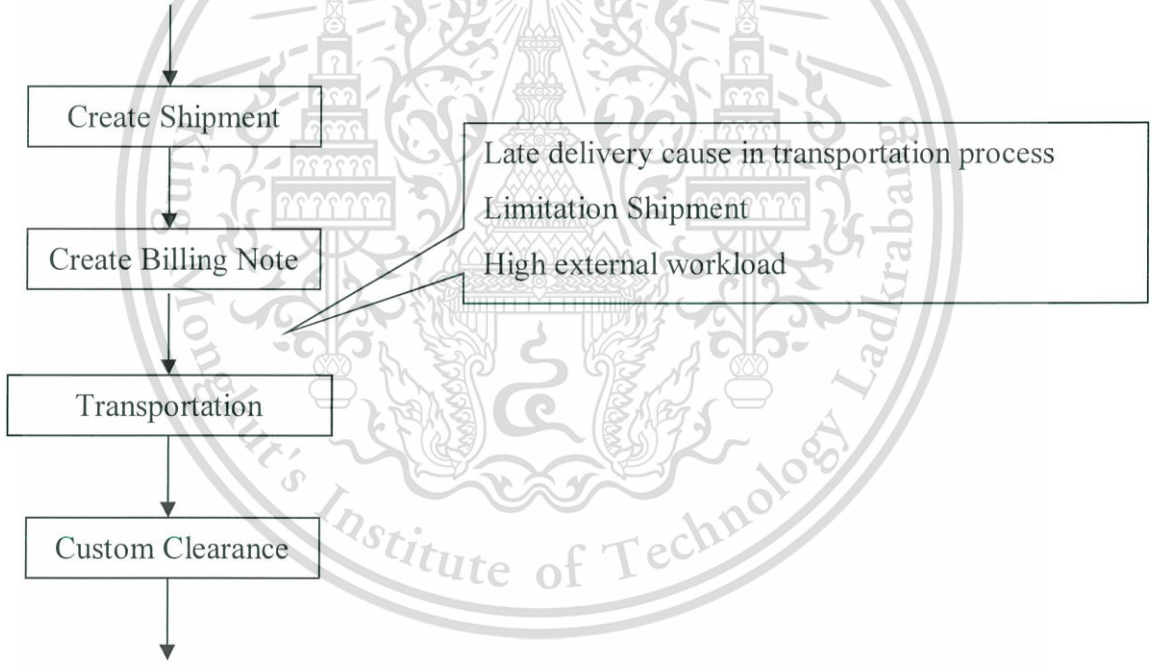

Figure 3.6 Possible late delivery cause in transportation process

3.3.2 Late delivery cause in transportation process

- Limitation shipment

The air freight has limitation because weight and size limits for the packaging. Shipment larger than limitation requires the use of special freight services or it require to be delivered in other mode such as sea or road to reduce transportation cost.

- High external workload

This is kind of external issue which the company cannot control. The root cause may be from holiday shipping, peak season shipping, or it can be that the shipment could not delivered before the cut off time.

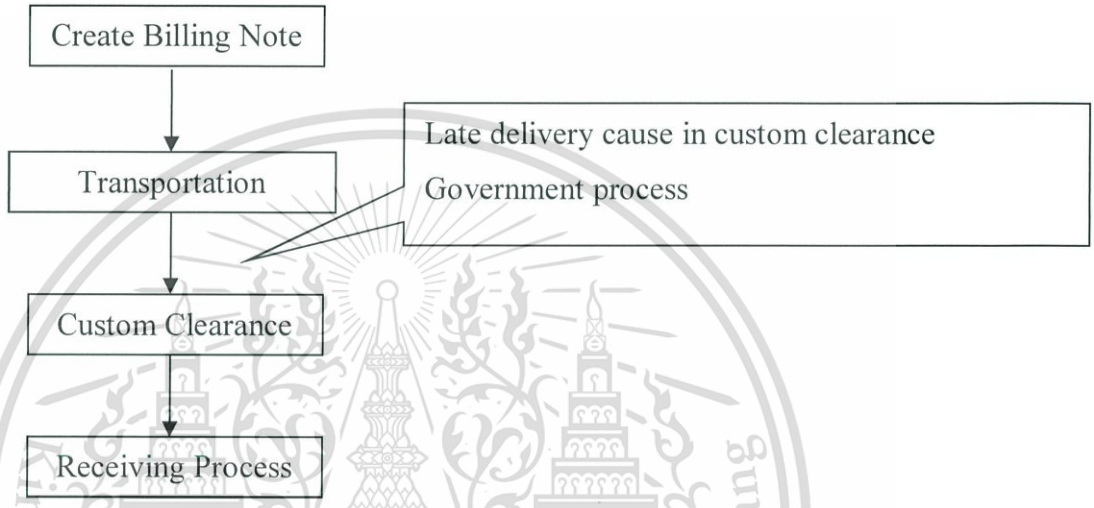

Figure 3.7 Possible late delivery cause in custom clearance process

3.3.3 Late delivery cause in custom clearance

- Government process

Customs declaration need to be well prepared. It is possible that the delay cause from custom inspection or Improper customs clearance process such as categorization of HS code.

In general, air freight is more expensive to transport heavier, bulkier goods compare with sea freight or rail. Hence, the dunnage issue cause unutilized space problem. As much as the company utilize the space means the company can reduce cost of material. To sum up, the problems can be categorized as follows.

- High internal workload
- Long packing time

- Packaging size
- Packaging weight
- Packaging density
- Limitation shipment
- High external workload
- Government process

3.4 Data Collection

This study uses documentary analysis as a data collection technique to study factor which influences the efficiency of the air transportation service. The researcher uses the Documentary analysis because it is tangible material to see the recorded.

The studied factors are amount of items, size of packing, weight of packaging, density of packaging including time constraint in each activity. The performance was collected from the shipping documents which are packing date, shipping date, departure date and arrival date of each shipment.

Table 3.1 Potential root cause from 200 shipment data

Root Cause	Unit	Average	Max	Min	SD
High internal workload	day	3.910	53.000	1.000	8.241
Long packing time	day	2.665	9.000	1.000	1.471
Packaging size	m^3	0.184	0.883	0.003	0.235
Packaging weight	kg	27.384	370.000	0.410	47.684
Packaging density	kg/m^3	214.946	1,187.857	21.739	178.210
Limitation Shipment	day	3.925	8.000	3.000	0.945
High external workload	day	4.920	10.000	4.000	0.953
Government process	day	1.995	4.000	1.000	0.275
Total leadtime	day	6.585	18.000	4.000	1.929

This study conducted 200 shipments as sample. The table 3.1 was splitted information of each activity from 200 shipments which relate to the potential root cause of late delivery following discussion in topic 3.3. The data has shown in average,

minimum, maximum and standard deviation. The detail of each potential root cause can be shown in figure 3.8-3.15.

3.4.1 High internal workload

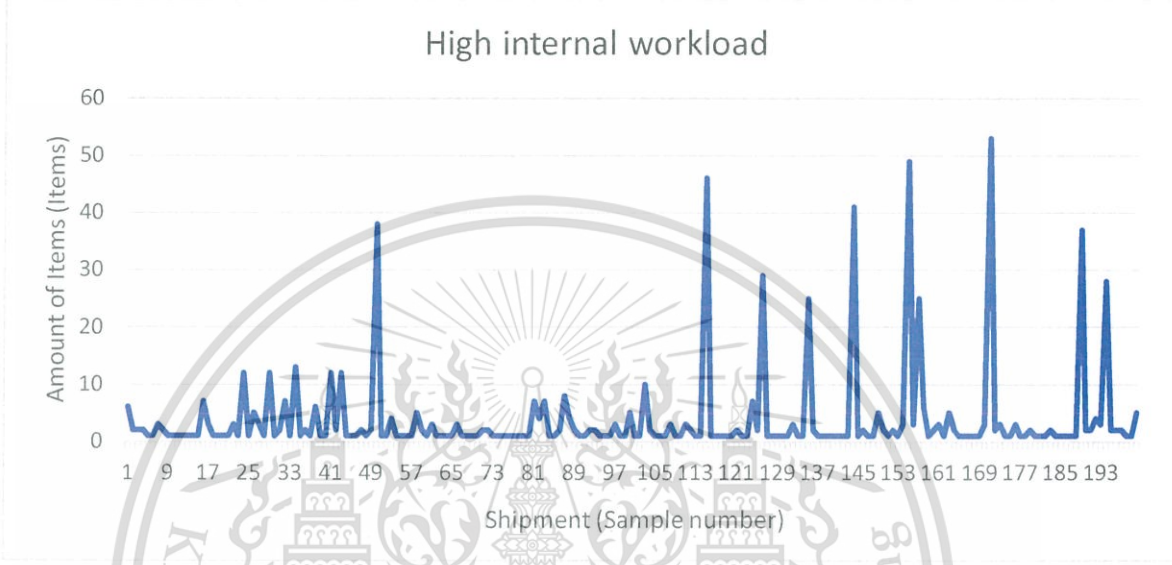

Figure 3.8 Amount of items in each shipment

A line graph has shown amount of items over 200 shipments. The horizontal axis on the graph shows the amount of items in each shipment. The vertical axis shows the number of shipment. The graph presents both the increase and decline over 200 shipments. It appears that the highest amount of items is 53.000 items and the lowest amount of items is 1.000 item. The average of the data is 3.910 items.

From the data, mostly the amount of items in each shipment is between 1-10 items. This study focuses on the items which over or equal 20 items

3.4.2 Long packing time

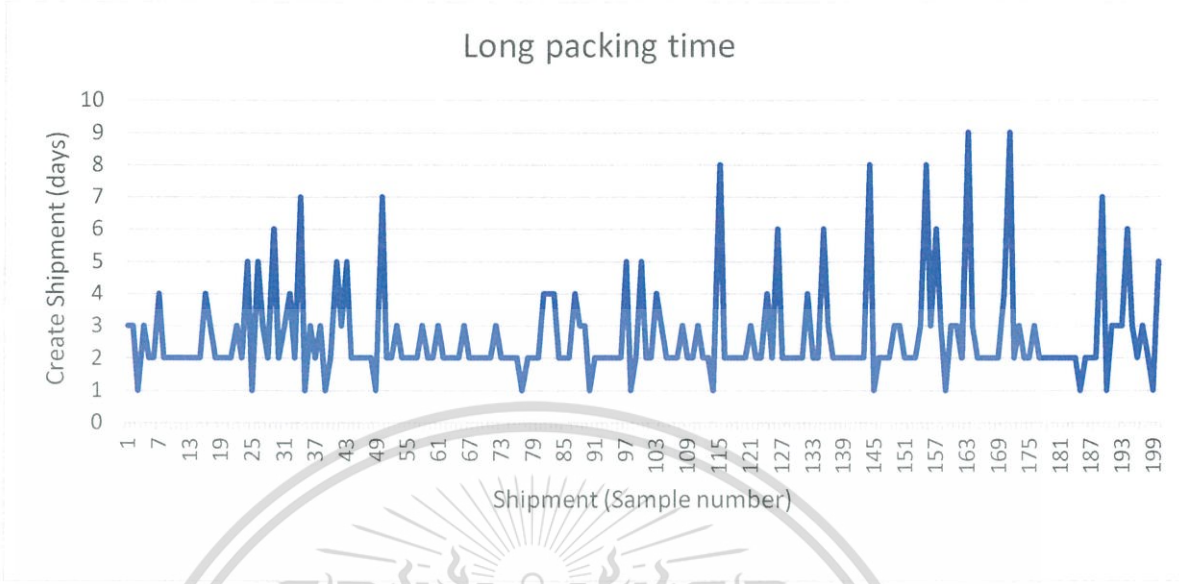

Figure 3.9 Shipment creation time in each shipment

A line graph has shown packing days which counting from the date of delivery note created until shipment created over 200 shipments. The horizontal axis on the graph shows the packing days. The vertical axis shows the number of shipment. The graph presents both the increase and decline over 200 shipments. It appears that the highest is 9 days and the lowest packing day is 1 day. The average of the data is 2.665 days.

From the data, the acceptable packing days is 2 days. This study are focuses the packing day which over or equal 3 days.

3.4.3 Packaging size

Figure 3.10 Packaging size in each shipment

A line graph has shown the volume of the packing size over 200 shipments. The horizontal axis on the graph shows the volume of the packing size. The vertical axis shows the number of shipment. The graph presents various of packing size over 200 shipments. It appears that the highest volume is 0.003 m^3 and the lowest volume of packaging is 0.883 m^3. The average of the data is 0.184 m^3.

From the data, the acceptable volume of packaging is 0.300 m^3. This study are focuses the packing day which over or equal 0.300 m^3.

3.4.4 Packaging weight

Figure 3.11 Packaging weight in each shipment

A line graph has shown the weight of packaging over 200 shipments. The horizontal axis on the graph shows the weight of packaging. The vertical axis shows the number of shipment. The graph presents various of the weight of packaging over 200 shipments. It appears that the highest weight is 370.000 kg and the lowest weight is 0.410kg. The average of the data is 27.384 kg.

From the data, the acceptable weight of packaging is 100kg. This study focuses the packing day which over or equal 100kg.

3.4.5 Packaging density

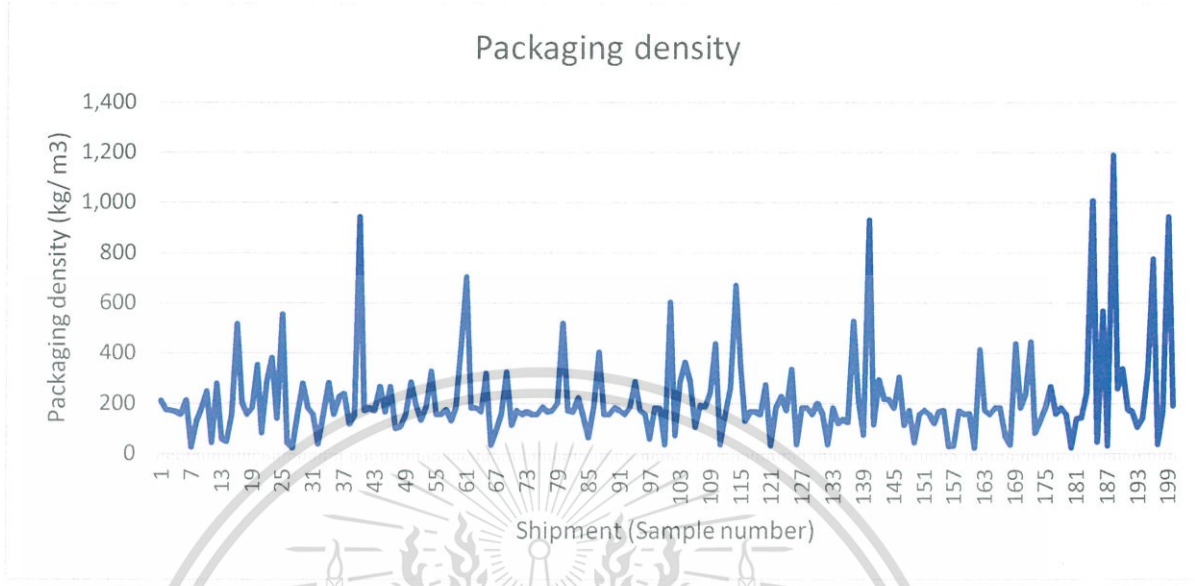

Figure 3.12 Packaging density in each shipment

A line graph has shown the packaging density over 200 shipments. The horizontal axis on the graph shows the packaging density. The vertical axis shows the number of shipment. The graph presents various of the packaging density over 200 shipments. It appears that the highest density is 1,187.857 kg/ m^3 and the lowest density is 21.739kg/ m^3. The average of the data is 214.946 kg/ m^3.

From the data, the acceptable packaging density is 500kg/ m^3. This study focuses the packing day which over or equal 500kg/ m^3.

3.4.6 Limitation Shipment

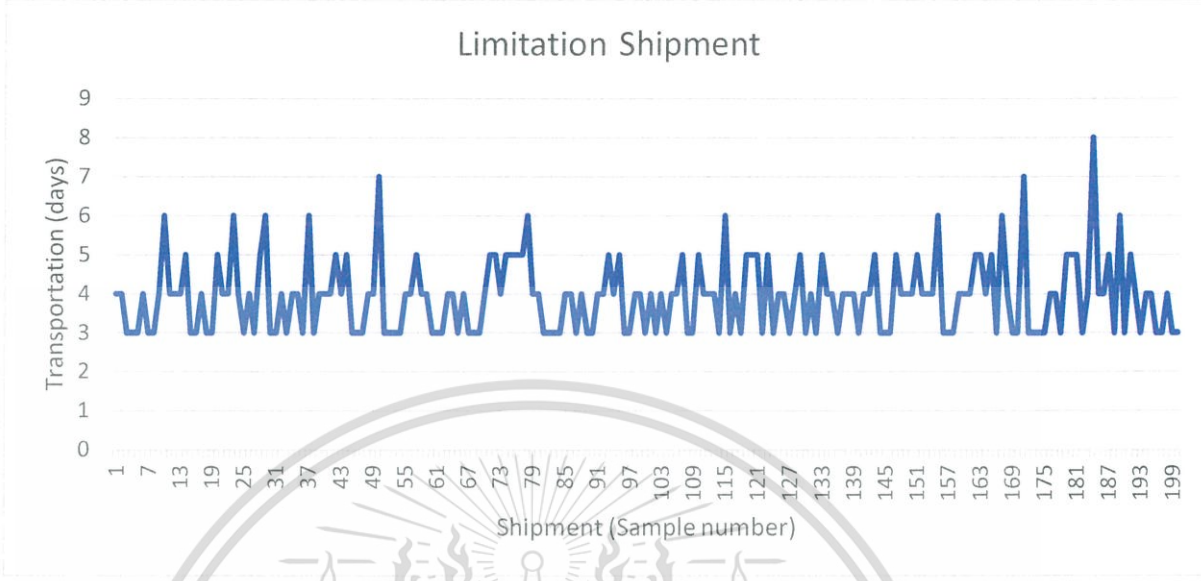

Figure 3.13 Transportation time in each shipment

A line graph has shown delivery time which counting from shipment created until arrival of shipment which are 200 shipments. The horizontal axis on the graph shows the transportation days. The vertical axis shows the number of shipment. The graph presents both the increase and decline over 200 shipments. It appears that the highest is 8 days and the lowest packing day is 3 days. The average of the data is 3.925 days.

From the data, the acceptable delivery time is 5 days. This study focuses the delivery time which over or equal 6 days.

3.4.7 High external workload

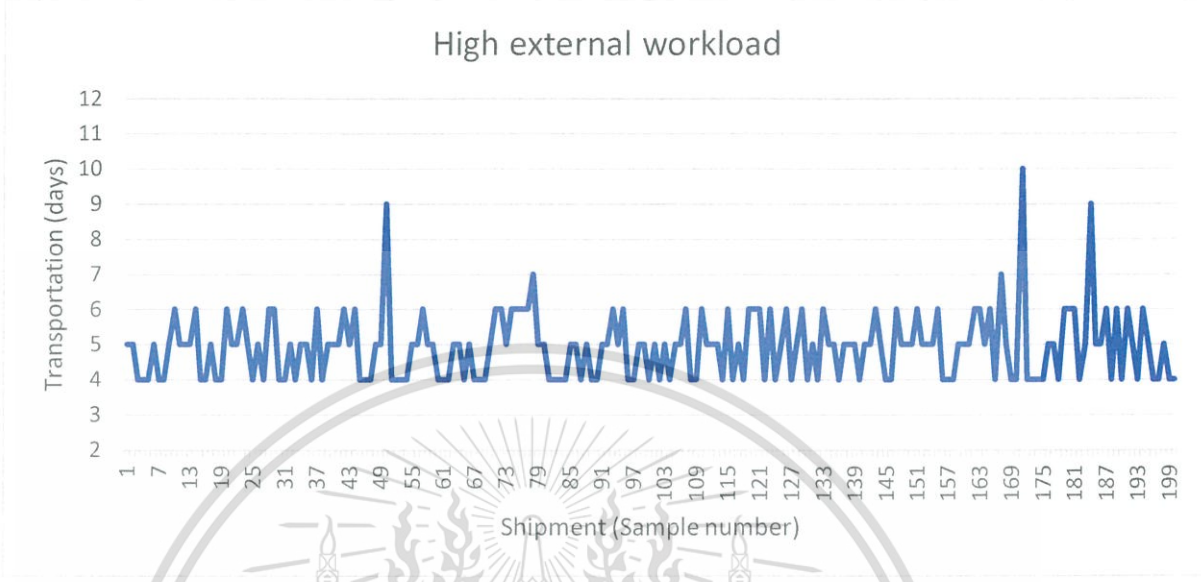

Figure 3.14 Transportation time including custom clearance in each shipment

A line graph has shown delivery time which counting from shipment created until finish receiving process over 200 shipments. The horizontal axis on the graph shows the transportation days. The vertical axis shows the number of shipment. The graph presents both the increase and decline over 200 shipments. It appears that the highest is 10 days and the lowest packing day is 4 days. The average of the data is 4.920 days.

From the data, the acceptable delivery time is 6 days. This study focuses the delivery time which over or equal 7 days.

3.4.8 Government process

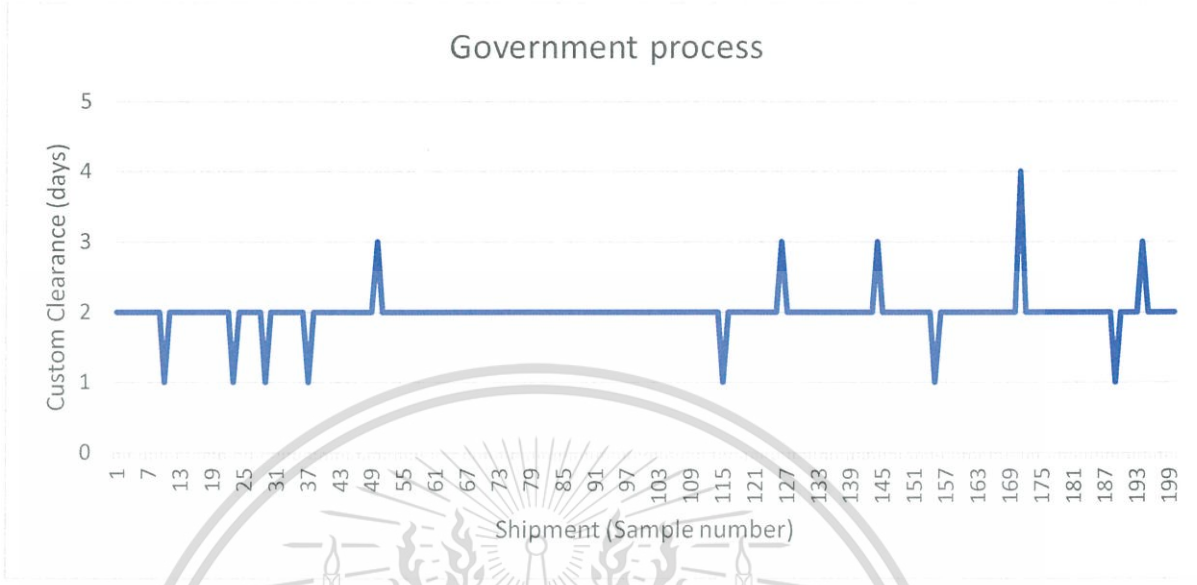

Figure 3.15 Custom clearance time in each shipment

A line graph has shown the processing time in custom clearance process over 200 shipments. The horizontal axis on the graph shows the processing time in day unit. The vertical axis shows the number of shipment. The graph presents both the increase and decline over 200 shipments. It appears that the highest is 4 days and the lowest packing day is 1 day. The average of the data is 1.995 days.

From the data, the acceptable delivery time is 2 days. This study focuses the delivery time which over or equal 3 days.

3.5 Analysis Tools

The analysis was done by using the principles of 4Ms, consisting of man, machine, material and method for solving the problems and improving the work. After that, the Fishbone Diagrams was used to identify the potential root causes of a problem.

3.5.1 "4 Ms" Analysis

The causes emerge by analysis, often through brainstorming sessions, and are grouped into categories on the main branches off the fishbone. To help structure the approach, the categories are often selected from one of the common models shown below, but may emerge as something unique to the application in a specific case. Each potential cause is traced back to find the root cause by using 4Ms Analysis (Ishikawa diagram, 2018).

The four categories can be translated in the following manners: man refers to people both trainers and trainees; machine is the tools; methods are the procedures, written instructions, activities, etc.; and materials are the training materials. A proper root-cause analysis must evaluate all these groups to uncover the cause of the problem.

Typical categories include:

Machine (equipment, technology)

Method (process)

Material (includes raw material, consumables, and information)

Man / mind power (physical or knowledge work, includes: kaizens, suggestions)

3.5.2 Fish bone analysis

The fishbone analysis identifies many possible causes for an effect or problem. It can be used to structure a brainstorming session. It immediately sorts ideas into useful categories. A Fishbone analysis is used when identifying possible causes for a problem and especially when a team's thinking tends to fall into ruts (Richardfaint, 2011).

This analysis aims to break down and organize the Causes of an issue to reveal what elements have the greatest impact. Grouping the causes show the different elements of the problem as separate from the overall process. One or two of these causes

will have a greater effect than the others and will guide to the root of the problem. This structure also allows tackle smaller chunks which have a large impact on the problem. Looking at elements of the problem and not the whole process will make problem solving more manageable.

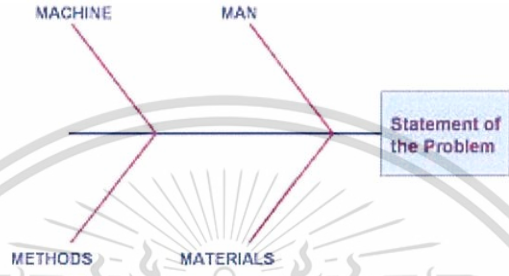

Figure 3.16 The basic Fish bone diagram

3.5.3 The Pareto chart analysis

Pareto analysis is a formal technique useful where many possible courses of action are competing for attention. In essence, the problem-solver estimates the benefit delivered by each action, then selects a number of the most effective actions that deliver a total benefit reasonably close to the maximal possible one (Pareto analysis, 2018).

This technique helps to identify the top portion of causes that need to be addressed to resolve the major of problems. Once the main causes are identified, then tools like the Ishikawa diagram or Fish-bone Analysis can be used to identify the root causes of the problems. While it is common to refer to pareto as "80/20" rule, under the assumption that, in all situations, 20% of causes determine 80% of problems, this ratio is merely a convenient rule of thumb and is not nor should it be considered an immutable law of nature.

The application of the Pareto analysis in risk management allows management to focus on those risks that have the most impact on the project

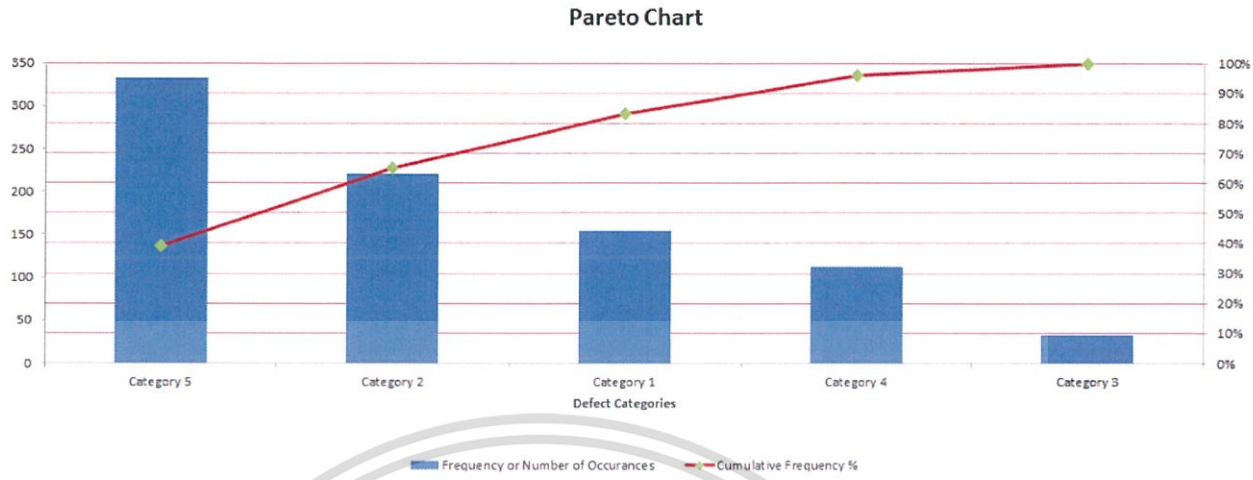

Figure 3.17 A Pareto analysis diagram

3.5.4 Flow process chart analysis

A Flow Process Chart is a representation illustrating the sequence of activities within a process. This type of process map is preferable when documenting processes that are more sequential and containing few decisions. This template allows to record the steps of a process in a tabular format. It can be used to identify waste in processes by analyzing the non-value adding steps, long delays and excessive transportation. It then produces performance indicators such as: total value-added time, distance traveled for transport activities, and value stream ratio. The chart is used to examine the overall sequence of an operation by focusing on movements of the operator or flow of materials (Continuous Improvement Toolkit, 2017).

Table 3.2 Symbol of flowchart

Symbol	Letter	Description
O	O	Operation
□	I	Inspection
→	M	Transport
D	D	Delay
∇	S	Storage

Operation: to change the physical or chemical characteristics of the material.

Inspection: to check the quality or the quantity of the material.

Move: transporting the material from one place to another.

Delay: when material cannot go to the next activity.

Storage: when the material is kept in a safe location.

#	Process Step	Time (minutes)	Distance (meters)	Operation O	Transport ⇨	Inspection □	Delay D	Storage ∇	VA ENVA NVA Value Category	Inputs, outputs, remarks, ...
1	Materials receiving				X					
2	Storing							X		Raw material warehouse
3	Raw feeding			X						
4	Pre-grinding			X						
5	Balancing			X						
6	Mixing			X						
7	Holding							X		Silos
8	Pelleting			X						
9	Cooling			X						
10	Holding							X		Silos
11	Packaging/Non packaging			X						
12	Convey to warehouse				X					
13	Storing							X		Finished product warehouse
14	Shipping				X					
15										
16										
17										
18										
19										
20										

Figure 3.18 Flow process chart

3.6 Steps for Improvement

Once the problem has been identified and assessed, an underperforming process should be selected. Then a common set of metrics and KPIs should be defined and improvement.

The new work procedure should be settle by using the flow process chart and comparable expected outcome between new procedure and current procedure.

CHAPTER 4

RESULTS AND DISCUSSIONS

This study was an attempt to find the factors which influence the efficiency of the air transport service. As stated in the previous chapter, the researcher selected a sample of 200 shipments to find the possibility root causes. Based on this sample, the root cause analysis was carried out to find the result and solution. The results obtained were analyzed using statistical analysis and presented. For the better understanding the results were divided and presented under following four items.

4.1 Background Information

4.2 Root cause Analysis

4.3 Steps of Improvement

4.1 Background Information

This study area covered one German company in Thailand as a case study. The Air transportation shipping details were collected during September – December 2017 which including packaging detail and freight detail. The studied factors are amount of items, size of packing, weight of packaging, density of packaging including time constraint in each activity. The performance was collected from the shipping documents which are packing date, shipping date, departure date and arrival date of each shipment.

4.2 Root Cause Analysis

In order to achieve the results of the root cause analysis, 3 techniques were used to analyze. First technique is "4 Ms" Analysis. Second is Fish bone analysis and the last technique is the Pareto chart analysis.

4.2.1 "4 Ms" Analysis

To determine the large category of cause according to the whole shipping process environment. These 'M's' or problem categories are used to classify each cause identified for easier analysis of data. Each possible cause can be listed in 4M category as follows.

Table 4.1 Root cause determination by category

4Ms	Causes
Method	Long Packing Process
	Government process
Material	Packaging Density
	Packaging Size
	Packaging Weight
Man	High internal workload
	High external workload
Machine	Limitation Shipment

- Man (People): Operators, Supervisors and Management

High internal workload

High external workload

- Machine (Tools): Task job and physical equipment

Limitation shipment

- Material: Materials and activities

Packaging density

Packaging size

Packaging weight

- Method (Procedures): Task work instruction

Long packing process

Government process

4.2.2 Fish bone analysis

This study uses the Fishbone Diagrams to identify the potential root causes of a problem. To improve customer deliveries, the headings on a fishbone are included Production, Order management, Suppliers, Planning, Packing and delivery and Vendor. The various potential root causes are involved causes being classified under certain headings.

A cause-and-effect diagram is also known as a "fishbone diagram" because it resembles a fishbone. Each bone represents one of the 4 Ms, and the head represents the potential root cause as following explanation.

Fig. 4.1 Fish bone analysis

From Figure 4.1, This study conducted sample of 200 shipments and determine the categories (types) of late delivery and their frequency separately by using the potential root cause from Fish bone analysis. The data has shown in Table 4.2

Table 4.2 Potential root cause compare with 4M in frequency

4Ms	Causes	Frequency
Method	Long Packing Process	68
	Government process	5
Material	Packaging Density	14
	Packaging Size	64
	Packaging Weight	22
Man	High internal workload	10
	High external workload	5
Machine	Limitation Shipment	12

Table 4.2 shows the highest frequency was the long packing process which was 68 events. Packaging size was 64 events. Follows with packaging weight, packaging density, limitation shipment and high internal workload. The lowest frequency were government process and high external workload.

4.2.3 The Pareto chart analysis

This study uses the Pareto chart analysis to identify the top portion of causes that need to be addressed to resolve the late delivery. Data was taken from Table 4.2 and analyzed in each root cause

Relative frequency shown that most of problems appeared in "Method". In this cause, the long packing process was the highest frequency.

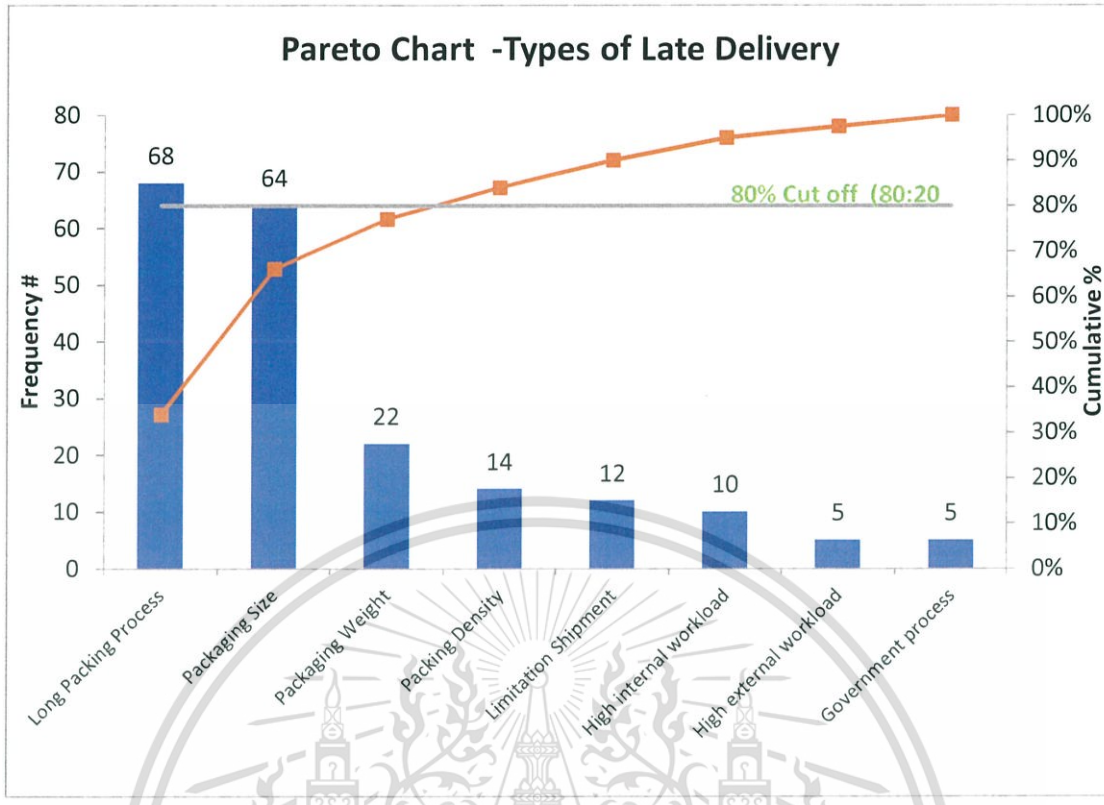

Fig. 4.2 Pareto Chart -Types of late delivery

Figure 4.2 shows a Pareto Chart types of late delivery. Data from 200 shipments were conducted to identify the top portion of causes and their frequency. The results were initially collected in then the data was placed in descending order of frequency in a Pareto Chart.

The types of late delivery that fall under the 80% cut off line indicate the 'vital few' types of late delivery that should be addressed as a priority as they contribute most to the problem as follows.

- Long packing process
- Packing size

The types of late delivery that fall above the 80% cut off line are known as the 'trivial many' and are generally seen as not a high priority to address when compared to the 'vital few' factors. However, some of the 'trivial many' factors may be simple to

address such as lack of skills can be improved by giving training to operator and therefore may be acted upon earlier rather than later.

4.2.4 Process Improvement Guideline

Below is the possibility solution to improve the type of error in late delivery which describes only the Vital few factors.

- Long packing process

As per process, the delayed in packing procedure may cause the late of shipping document issuing which cause late delivery. The possibility root cause may come from packing procedure or it may come from too many items required for packing.

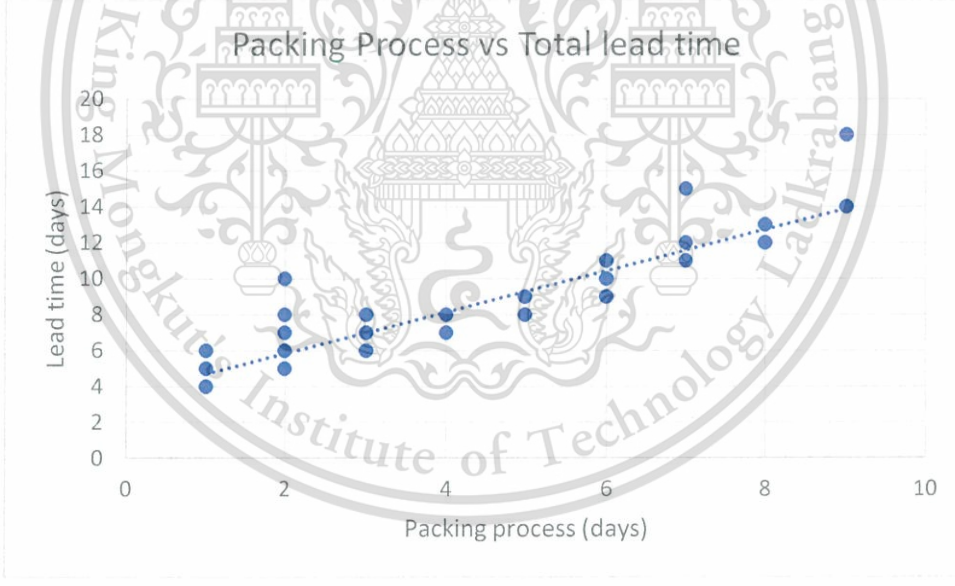

Fig 4.3 The relationship between packing process and total lead time

The study investigates 200 shipments, associated with packing process and total lead time. From figure 4.3, the correlation coefficient indicates a strong positive correlation in values of 0.877.

It can be described that the short packing process is more likely to be shorten the lead time and the long packing process is more likely to be longer lead time which cause late delivery.

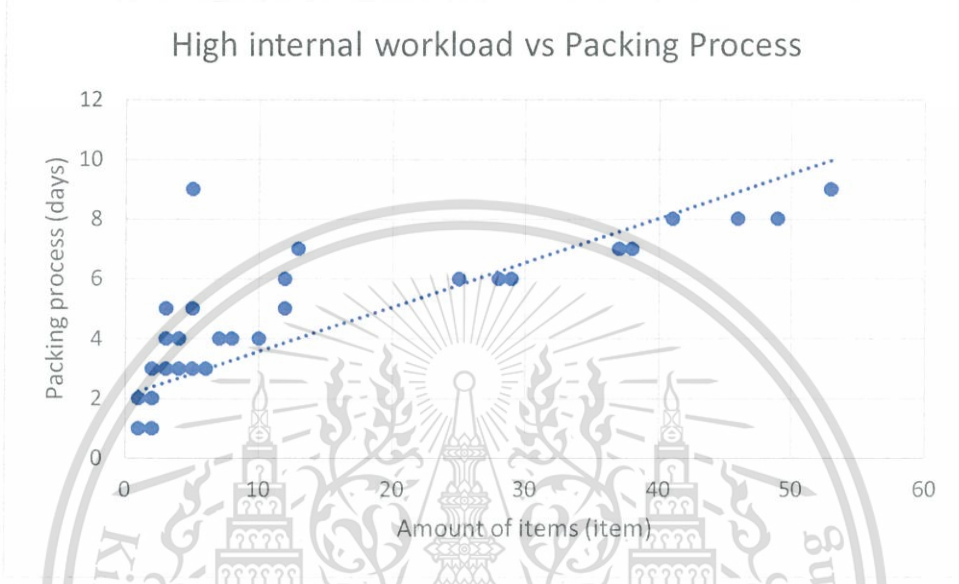

Fig 4.4 The relationship between high internal workload and packing process

In addition, the study found that the amount of items in each shipment has relationship with packing process. Figure 4.4 shows the correlation coefficient of 0.831 indicates a strong positive correlation between high internal workload and packing process. High number of items in shipment, so does high number of packing days.

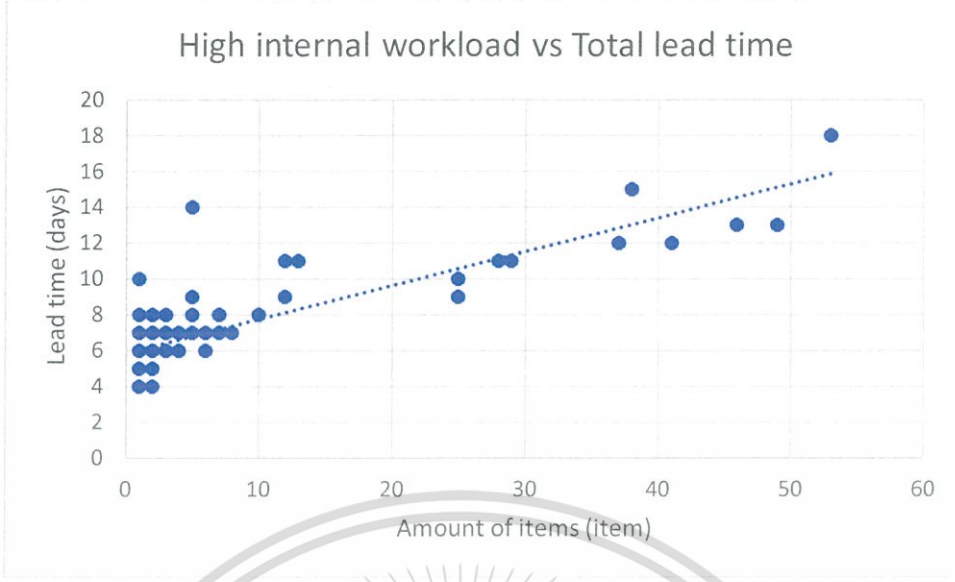

Fig 4.5 The relationship between high internal workload and total lead time

Likewise, the amount of items in each shipment has relationship with total lead time which is similar with the packing process. the correlation coefficient indicates a strong positive correlation in values of 0.807. Meaning, the amount of items in each shipment, the packing process and leadtime indicates a strong positive correlation between each other. It can be concluded that the high number of items, is more packing process, and more lead time.

The process improvement guideline can be proposed that the optimization the amount of items in a shipment could improve the packing process time and improve the lead time.

- Packaging size

The studied process, the packaging size depends on the amount of items and size of items in an order. The multiple size of packaging in one consolidate shipment may be a disadvantage. There is a study proposed that the multiple size may cause the packs could not maximize utility space in the shipment. With this, the optimization of the packaging will be an improvement.

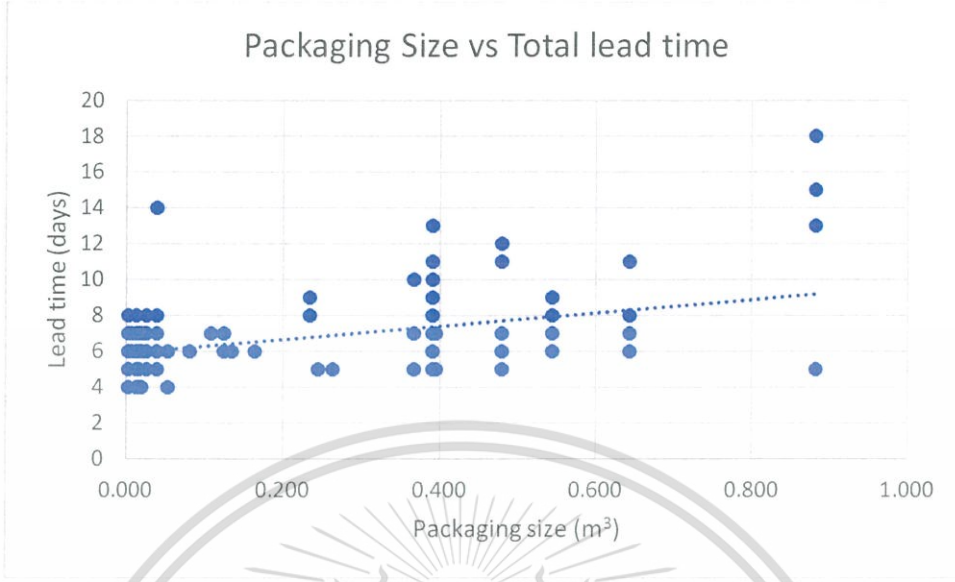

Fig 4.6 The relationship between packaging size and total lead time

However, 200 shipments were investigated the association between packaging size and total lead time. Figure 4.6 shows the correlation coefficient of 0.452 indicates weaker correlation between packaging size and total lead time. It could be described that the lead time tends to increase with the size of packaging.

By carrying out the fish bone diagram and Pareto chart analysis, this study is able to focus on the packaging as an issue, rather than other root causes. According to the result, the late delivery will get the biggest improved by optimization the amount of items and packaging. Once it is done, the next priority is manpower, method and machines. With this, there is a space to improve the product packaging. The improvement step can be described in 4.2.4.

4.3 Steps for Improvement

An improvement process is a set of activities performed by people along the shipping process with the aim of achieving the best lead time. below is a process improvement initiation.

4.3.1 Select an underperforming process

From Root cause analysis in 4.2, The study shown that the underperforming process cause from long packing process and packaging size.

4.3.2 Define a common set of metrics and KPIs

Figure 4.7 shows the current shipping process in flow process chart. As described in chapter 3, there are 3 activities in the current shipping process may cause the delay from waiting activity.

It was identified that the longest delay was 7 days which cause from wait for shipment. The normal packing process is 2 days. Measurement the packing process that is counted from delivery note created until shipment created.

Step #	Activity description	Time (days)	Operation ○	Transport ⇨	Inspection □	Delay D	Storage ▽
1	Create Delivery Note						
2	Packing Process	2					
3	Wait for Shipment	7					
4	Create Shipment						
5	Create Billing Note						
6	Transportation Process	5					
7	Wait for Transportation	3					
8	Customs Clearance	2					
9	Wait for Clearance	2					
10	Receiving Process						
		Count (numbers):	2	1	3	3	1
		Time per process step (days):	4	5	0	12	0

Figure 4.7 Current shipment process in flow process chart

4.3.3 Define how to improve key process parameters

Referring the process improvement guideline, the optimization the amount of items in a shipment could improve the packing process time and improve the lead time. Also, the optimized packaging size is defined as a parameter.

4.3.4 Propose a new work procedure

Below figure shows a new work procedure in flow process chart. The delay was eliminated.

Step #	Activity description	Time (days)	Operation	Transport	Inspection	Delay	Storage
			○	⇨	□	D	▽
1	Create Delivery Note				x		
2	Packing Process	2	x				
3	Create Shipment				x		
4	Create Billing Note				x		
5	Transportation Process	5		x			
6	Customs Clearance	2	x				
7	Receiving Process						x
		Count (numbers):	2	1	3	0	1
		Time per process step (days):	4	5	0	0	0

Figure 4.8 New shipment process in flow process chart

4.3.5 Present expected outcome of a new work procedure.

The goal of implementation a new work procedure is to put the new practices in place at selected top portion of cause. The expected outcomes after implementation is as follows.

- Amount of items will be optimized for one shipment.
- The packing time and workload of packing can be reduced.
- The packaging size can be optimized.
- The outcomes were measured and showed intended results.
- On-going monitoring and targeted continuous improvement

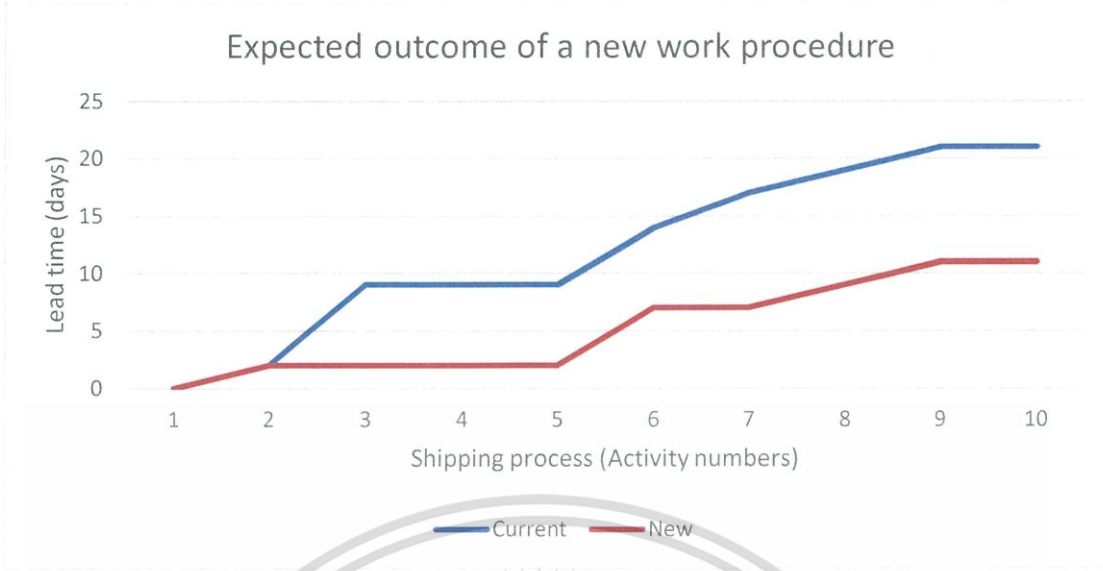

Figure 4.9 Expected outcome of a new work procedure

Figure 4.9 shows the comparison of lead time between current work procedure (Figure 4.8) and new work procedure (Figure 4.9). The maximum lead time in current work procedure can be taken up to 21 days but after improvement, the expected maximum lead time of new current work procedure can be taken 11 days. It appears that 11 days could be reduced.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

In this chapter the conclusions derived from the findings of this study on the factors which influence the efficiency of the air transport service. The case study is from a German company which products are delivered weekly by consolidate shipment from Germany to Thailand. The conclusions were based on the purpose and results of the study. The implications of these findings and the recommendations will also be explained. Recommendations were based on the conclusions and purpose of the study.

5.2 Overview of the Study

The findings and recommendations described below are based from the data analysis. The research found that the important factors which influence the efficiency of the air transport service are packing process and packing size. By data analysis, the study achieved the following objectives

- To study and compare the factors which influence the efficiency of the air transport service.
- To propose an improvement process

5.3 Limitations

Certain limitations were identified in the study: period of time, data collection and analysis.

5.3.1 Period of time

The Air transportation shipping details were collected during September – December 2017. There might be possible that the root cause may be from holiday shipping, peak season shipping which were not in studied period.

5.3.2 data collection and analysis

Several limitations in the collection and analysis of data were identified as follows.

A studied company offers wide range products. Small size to huge size of products, light weight to heavy weight of products. A bigger population of sample might be more accuracy. If the research is conducted by using other company, the result may be different.

This study considered the leadtime as the priority and did not consider shipping cost. In case the shipping cost is included in the study, the result may be changed.

A studied freight forwarder was an external company which a company cannot directly controlled.

Some part of root cause analysis relied on the researcher's judgements of data collection and analysis. The researcher was the main data collection instrument for the unstructured interviews and analysis of the data. However, the possibility of bias was minimized by Pareto chart analysis and statistical analysis throughout the study.

5.4 Recommendations for further research

In the limitations identified and the findings of the study, the following are recommended as future research subjects:

There were a lot of various in products and packaging.

The data collection was collected from the shipment in a period of time. To have bigger population may get a better result.

5.5 Conclusions

This study on the factors which influence the efficiency of the air transport service. The packing process and Packing size were found as the top portion of causes and their frequency. Additionally, the study found that the amount of items in each shipment has relationship with packing process.

The process improvement guideline is proposed to optimize the amount of items and packaging size in a shipment. It could be expected an improvement of the packing process time and improve the lead time. A new work procedure in flow process chart. The delay was eliminated.

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APPENDIX A

Column	Description	Unit
#1	Shipment (Sample number)	
#2	Amount of items	Items
#3	Shipment create	days
#4	Volume of shipment	m3
#5	Weight of shipment	kg
#6	Density of shipment	kg/m3
#7	Shipment time at port	days
#8	Shipment time at receiver	days
#9	Customs clearance	days
#10	Total lead time	days

#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
1	6	3	0.480	100.040	208.417	4	5	2	7
2	2	3	0.392	68.133	173.809	4	5	2	7
3	2	1	0.054	9.259	171.463	3	4	2	4
4	2	3	0.027	4.452	164.889	3	4	2	6
5	1	2	0.014	2.166	154.714	3	4	2	5
6	1	2	0.020	4.250	212.500	4	5	2	6
7	3	4	0.644	17.000	26.398	3	4	2	7
8	2	2	0.392	50.000	127.551	3	4	2	5
9	1	2	0.003	0.542	180.667	4	5	2	6
10	1	2	0.644	160.000	248.447	6	6	1	7
11	1	2	0.392	17.000	43.367	4	5	2	6
12	1	2	0.040	11.120	278.000	4	5	2	6
13	1	2	0.007	0.410	58.571	4	5	2	6
14	1	2	0.392	19.000	48.469	5	6	2	7
15	1	2	0.014	2.166	154.714	3	4	2	5
16	7	4	0.027	13.930	515.926	3	4	2	7
17	3	3	0.040	8.100	202.500	4	5	2	7
18	1	2	0.014	2.166	154.714	3	4	2	5
19	1	2	0.003	0.542	180.667	3	4	2	5
20	1	2	0.017	6.000	352.941	5	6	2	7
21	1	2	0.545	45.000	82.569	4	5	2	6
22	3	3	0.027	7.720	285.926	4	5	2	7
23	1	2	0.368	140.000	380.435	6	6	1	7
24	12	5	0.392	55.000	140.306	4	5	2	9

25	1	1	0.020	11.105	555.250	3	4	2	4
26	5	5	0.545	23.981	44.002	4	5	2	9
27	3	3	0.644	14.000	21.739	3	4	2	6
28	1	2	0.014	2.166	154.714	5	6	2	7
29	12	6	0.480	133.000	277.083	6	6	1	11
30	1	2	0.003	0.542	180.667	3	4	2	5
31	2	3	0.014	2.166	154.714	3	4	2	6
32	7	4	0.392	15.000	38.265	4	5	2	8
33	1	2	0.014	2.166	154.714	3	4	2	5
34	13	7	0.392	110.000	280.612	4	5	2	11
35	1	1	0.014	2.166	154.714	4	5	2	5
36	2	3	0.007	1.580	225.714	3	4	2	6
37	1	2	0.545	130.000	238.532	6	6	1	7
38	6	3	0.392	46.000	117.347	3	4	2	6
39	1	1	0.014	2.166	154.714	4	5	2	5
40	1	2	0.017	16.000	941.176	4	5	2	6
41	12	5	0.235	40.000	170.213	4	5	2	9
42	2	3	0.003	0.542	180.667	5	6	2	8
43	12	5	0.235	40.000	170.213	4	5	2	9
44	1	2	0.392	104.000	265.306	5	6	2	7
45	1	2	0.027	4.452	164.889	3	4	2	5
46	1	2	0.392	104.100	265.561	3	4	2	5
47	2	2	0.396	39.215	99.028	3	4	2	5
48	1	2	0.054	5.756	106.593	4	5	2	6
49	2	1	0.014	2.166	154.714	4	5	2	5
50	38	7	0.883	251.000	284.258	7	9	3	15
51	1	2	0.368	70.000	190.217	3	4	2	5
52	1	2	0.264	35.200	133.333	3	4	2	5
53	4	3	0.545	102.100	187.339	3	4	2	6
54	1	2	0.040	13.110	327.750	3	4	2	5
55	1	2	0.014	2.166	154.714	4	5	2	6
56	1	2	0.014	2.166	154.714	4	5	2	6
57	1	2	0.392	68.000	173.469	5	6	2	7
58	5	3	0.392	50.613	129.115	4	5	2	7
59	2	2	0.003	0.542	180.667	4	5	2	6
60	1	2	0.003	1.295	431.667	3	4	2	5
61	3	3	0.007	4.915	702.143	3	4	2	6
62	1	2	0.003	0.542	180.667	3	4	2	5
63	1	2	0.003	0.542	180.667	4	5	2	6
64	1	2	0.027	4.452	164.889	4	5	2	6
65	1	2	0.014	4.480	320.000	3	4	2	5

66	3	3	0.396	13.040	32.929	4	5	2	7
67	1	2	0.392	36.000	91.837	3	4	2	5
68	1	2	0.014	2.166	154.714	3	4	2	5
69	1	2	0.003	0.975	325.000	3	4	2	5
70	1	2	0.135	15.000	111.111	4	5	2	6
71	2	2	0.040	6.796	169.900	5	6	2	7
72	2	3	0.014	2.166	154.714	5	6	2	8
73	1	2	0.027	4.452	164.889	4	5	2	6
74	1	2	0.014	2.166	154.714	5	6	2	7
75	1	2	0.014	2.166	154.714	5	6	2	7
76	1	2	0.125	22.984	183.872	5	6	2	7
77	1	1	0.027	4.452	164.889	5	6	2	6
78	1	2	0.040	6.796	169.900	6	7	2	8
79	1	2	0.125	25.000	200.000	4	5	2	6
80	1	2	0.014	7.255	518.214	4	5	2	6
81	7	4	0.040	6.796	169.900	3	4	2	7
82	4	4	0.027	4.452	164.889	3	4	2	7
83	7	4	0.480	106.000	220.833	3	4	2	7
84	1	2	0.264	38.400	145.455	3	4	2	5
85	1	2	0.125	7.956	63.648	4	5	2	6
86	2	2	0.125	22.984	183.872	4	5	2	6
87	8	4	0.027	10.870	402.593	3	4	2	7
88	4	3	0.014	2.166	154.714	4	5	2	7
89	2	3	0.014	2.166	154.714	3	4	2	6
90	1	1	0.003	0.542	180.667	3	4	2	4
91	1	2	0.020	3.398	169.900	4	5	2	6
92	2	2	0.014	2.166	154.714	4	5	2	6
93	2	2	0.027	4.955	183.519	5	6	2	7
94	1	2	0.014	4.000	285.714	4	5	2	6
95	1	2	0.020	3.398	169.900	5	6	2	7
96	1	2	0.014	2.166	154.714	3	4	2	5
97	3	5	0.392	23.000	58.673	3	4	2	8
98	1	1	0.003	0.542	180.667	4	5	2	5
99	1	2	0.003	0.542	180.667	4	5	2	6
100	5	5	0.392	13.959	35.610	3	4	2	8
101	1	2	0.014	8.420	601.429	4	5	2	6
102	1	2	0.480	34.000	70.833	3	4	2	5
103	10	4	0.392	112.000	285.714	4	5	2	8
104	2	3	0.014	5.060	361.429	3	4	2	6
105	1	2	0.003	0.860	286.667	4	5	2	6
106	1	2	0.480	49.820	103.792	4	5	2	6

107	1	2	0.040	7.660	191.500	5	6	2	7
108	3	3	0.014	2.605	186.071	3	4	2	6
109	1	2	0.003	0.725	241.667	3	4	2	5
110	1	2	0.007	3.050	435.714	5	6	2	7
111	3	3	0.644	22.960	35.652	4	5	2	7
112	2	2	0.014	2.166	154.714	4	5	2	6
113	1	2	0.392	103.000	262.755	4	5	2	6
114	1	1	0.003	2.010	670.000	3	4	2	4
115	46	8	0.392	136.000	346.939	6	6	1	13
116	1	2	0.245	31.974	130.506	3	4	2	5
117	1	2	0.027	4.452	164.889	4	5	2	6
118	1	2	0.027	4.452	164.889	3	4	2	5
119	1	2	0.014	2.166	154.714	5	6	2	7
120	1	2	0.014	3.825	273.214	5	6	2	7
121	2	3	0.545	16.796	30.818	5	6	2	8
122	1	2	0.003	0.542	180.667	3	4	2	5
123	1	2	0.014	3.180	227.143	5	6	2	7
124	7	4	0.040	6.796	169.900	3	4	2	7
125	2	2	0.007	2.345	335.000	4	5	2	6
126	29	6	0.644	22.984	35.689	4	6	3	11
127	1	2	0.003	0.542	180.667	3	4	2	5
128	1	2	0.003	0.542	180.667	4	5	2	6
129	1	2	0.014	2.166	154.714	5	6	2	7
130	1	2	0.003	0.600	200.000	3	4	2	5
131	1	2	0.014	2.166	154.714	4	5	2	6
132	3	4	0.392	14.019	35.763	3	4	2	7
133	1	2	0.003	0.542	180.667	5	6	2	7
134	1	2	0.545	66.000	121.101	4	5	2	6
135	25	6	0.392	53.000	135.204	4	5	2	10
136	2	3	0.135	17.000	125.926	3	4	2	6
137	1	2	0.007	3.685	526.429	4	5	2	6
138	1	2	0.014	2.925	208.929	4	5	2	6
139	1	2	0.480	35.000	72.917	4	5	2	6
140	1	2	0.017	15.800	929.412	3	4	2	5
141	1	2	0.164	19.000	115.854	4	5	2	6
142	1	2	0.017	5.000	294.118	4	5	2	6
143	1	2	0.024	5.202	216.750	5	6	2	7
144	41	8	0.480	103.500	215.625	3	5	3	12
145	1	1	0.003	0.542	180.667	3	4	2	4
146	2	2	0.014	4.250	303.571	3	4	2	5
147	1	2	0.545	61.050	112.018	5	6	2	7

148	1	2	0.040	6.796	169.900	4	5	2	6
149	5	3	0.545	24.000	44.037	4	5	2	7
150	2	3	0.014	2.166	154.714	4	5	2	7
151	1	2	0.020	3.398	169.900	5	6	2	7
152	2	2	0.014	2.166	154.714	4	5	2	6
153	1	2	0.054	6.507	120.500	4	5	2	6
154	3	3	0.027	4.452	164.889	4	5	2	7
155	49	8	0.883	152.000	172.140	6	6	1	13
156	3	3	0.545	14.757	27.077	3	4	2	6
157	25	6	0.545	15.989	29.338	3	4	2	9
158	6	3	0.027	4.575	169.444	3	4	2	6
159	1	1	0.014	2.166	154.714	4	5	2	5
160	2	3	0.007	1.113	159.000	4	5	2	7
161	3	3	0.392	9.259	23.620	4	5	2	7
162	1	2	0.027	11.135	412.407	5	6	2	7
163	5	9	0.040	6.796	169.900	5	6	2	14
164	2	3	0.109	17.000	155.963	4	5	2	7
165	1	2	0.003	0.542	180.667	5	6	2	7
166	1	2	0.003	0.542	180.667	3	4	2	5
167	1	2	0.644	46.000	71.429	6	7	2	8
168	1	2	0.392	14.144	36.082	4	5	2	6
169	1	2	0.264	115.000	435.606	3	4	2	5
170	3	4	0.003	0.542	180.667	3	4	2	7
171	53	9	0.883	209.000	236.693	7	10	4	18
172	2	2	0.014	6.230	445.000	3	4	2	5
173	3	3	0.480	39.000	81.250	3	4	2	6
174	1	2	0.883	114.400	129.558	3	4	2	5
175	1	2	0.003	0.542	180.667	3	4	2	5
176	3	3	0.027	7.150	264.815	4	5	2	7
177	1	2	0.014	2.230	159.286	4	5	2	6
178	1	2	0.003	0.542	180.667	3	4	2	5
179	2	2	0.014	2.166	154.714	5	6	2	7
180	1	2	0.545	12.000	22.018	5	6	2	7
181	1	2	0.392	54.000	137.755	5	6	2	7
182	1	2	0.480	69.000	143.750	3	4	2	5
183	2	2	0.480	116.000	241.667	4	5	2	6
184	1	2	0.368	370.000	1,005.435	8	9	2	10
185	1	1	0.883	41.000	46.433	4	5	2	5
186	1	2	0.007	3.965	566.429	4	5	2	6
187	1	2	0.644	20.000	31.056	5	6	2	7
188	1	2	0.014	16.630	1,187.857	3	4	2	5

189	37	7	0.480	124.000	258.333	6	6	1	12
190	2	1	0.014	4.725	337.500	3	4	2	4
191	2	3	0.235	41.600	177.021	5	6	2	8
192	4	3	0.027	4.452	164.889	4	5	2	7
193	3	3	0.082	8.580	104.634	3	4	2	6
194	28	6	0.392	53.533	136.564	4	6	3	11
195	2	3	0.040	12.985	324.625	4	5	2	7
196	2	2	0.027	20.890	773.704	3	4	2	5
197	2	3	0.392	13.959	35.610	3	4	2	6
198	1	2	0.027	4.452	164.889	4	5	2	6
199	1	1	0.017	16.000	941.176	3	4	2	4
200	5	5	0.027	5.085	188.333	3	4	2	8

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