ANALYSIS AND EVALUATION OF THE TRANSPORTATION UTILIZATION OF A POLYMER TRADING COMPANY

By
TOUNGPORN PONGSAKORNCHAI

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

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

Martin de Tours School of Management
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1. Asst. Prof. Dr. Nucharee Supatn (Chair) .....
2. Dr. Piyawan Puttibarncharoensri (Member) .....
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Approved for Graduation on: February 11, 2012

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Assumption University
Martin de Tours School of Management and Economics
Master of Science in Supply Chain Management

Declaration of Authorship Form

I, Toungporn Pongsakornchai

declare that this thesis/project and the work presented in it are my own and has been generated by me as the result of my own original research.

Analysis and Evaluation of the Transportation Utilization of A Polymer Trading Company.

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2. Where any part of this dissertation has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
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I confirm that this thesis/project has been carried out under my supervision and it represents the original work of the candidate.

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Date 10/04/2012

ACKNOWLEDGEMENTS

I would like to take this opportunity to express my deepest gratitude to my advisor, Dr. Wuthichai Wongthatsanekorn, who has supported, and guided me during the period of my project work. His willingness to help and his good advice helped me complete this project.

I also wish to express my sincere gratitude to the committee members, Asst. Prof. Dr. Nucharee Supatn, Dr. Ismail Ali Siad and Dr. Piyawan Puttibarncharoensri, who contributed valuable suggestions and guidance for this project to be complete.

Finally, I would like to express a sense of gratitude and love to my beloved family and my friends for their support during the period of my study.

Toungporn Pongsakornchai
Assumption University

February 2012

ABSTRACT

In the world of growth today, transportation is vital to the business because products or services have to be delivered to complete the commitment or the contract. Transportation utilization is the factor that determines how well the company can manage their resources with limited capacity at the lowest cost in order to accomplish the company target and also satisfy the customer's expectations.

In this research study, to improve the transportation process, transportation utilization is calculated for the normal process to investigate daily trailer usage, the number of round trips made, and number of containers loaded from the warehouse. Additionally, the criteria are created for the alternative solutions, such as double trailer, container yard, divided set of trailers, and extend operating hour process. There are four alternatives for the management to consider in order to evaluating the most suitable for the company's operation process and customers.

Then, two alternatives are selected by adding the criteria. The alternatives are simulated by using the Arena program to imitate and observe the process and find out if the two alternatives can be used or operated in the real business with limited condition. The utilization of trailer and number of the outcomes are the key results of this simulation. Moreover, the suggestions and the decisions made by the management team for enhancing the company's operations and improving customer satisfaction and included.

Finally, for the final decision, the management team selected only three criteria which included double trailer, container yard, and two sets of trailers for the alternative. In addition, the conclusion of the management was selected based on appropriate cost of the operation process and most benefits to the end customers.

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Master of Science in Supply Chain Management

Form signed by Proofreader of the Graduate Project

I, Asst. Prof. Dr. June Bernadette D'Souza, has proofread this Graduate Project entitled Analysis and Evaluation of the Transportation Utilization of a Polymer Trading Company

Ms. Toungporn Pongsakornchai

and she hereby certifies that the verbiage, spelling and format is commensurate with the quality of internationally acceptable writing standards for a Master Degree in Supply Chain Management.

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CHAPTER I

GENERALITIES OF THE STUDY

On-time delivery, high quality, and right quantity are the key factors of transportation and distribution in every business all over the world. To improve these key factors to achieve customer' satisfaction, every company must have a strong process to compete with others because of growing competition. Not only does the transportation's process affect the quality service of the company, but it also the total cost of the service which is significant for global competition. Total transportation cost normally accounts for major part of total logistics cost. In addition to this, logistics is an important activity in any supply chain management for every business. Finally, for effective customer satisfaction, every transportation activity should be carefully planned and controlled.

Rapid changes have occurred in external factors of the market environment like political, technological and legal. These factors could affect the international business in every industry. The result is every country tries to adapt itself to be acceptable by business partners or customers.

In Thailand, business logistics has become a popular issue in the past decade. Because of global competition, companies compete with each other with supply chain activity to achieve profitability and marketability. Moreover, they also plan to present Thailand as a hub of connectivity for increasing efficiency in transportation systems. The main focus is to develop public transport and transportation's infrastructure for better accessibility and mobility.

A multinational company like ABC Company, is a subsidiary of ABC Group, provides service logistics for ABC's petrochemical companies. Distribution activity is the major part of the company. Transportation scheduling is important for export shipments because it affects the shipment's arrival time for the customers.

Furthermore, reducing cost of transport should be considered in order to increase company's revenue.

1.1 Background of the Study

1.1.1 Company Background

ABC Group and subsidiaries have planned to invest in downstream Petrochemical Industries, such as, Polyethylene (PE) and Polypropylene (PP). ABC group and subsidiaries also plan to sell these plastic resins to the world market at an amount of 1.65 million tons per year.

Hence, to provide full service logistics and let manufacturers focus on their research and development (R&D), ABC has studied the probability of polymer logistics management's project to support plastic resins manufacturers in ABC subsidiaries.

The ABC Trading Company (ABC-T) was established as a logistics provider to ABC Petrochemical Group with competitive cost and advances technology. This competitiveness is compatible with the ABC Petrochemical Business Group for potential enhancement.

ABC Trading Company (ABC-T) services consist of:

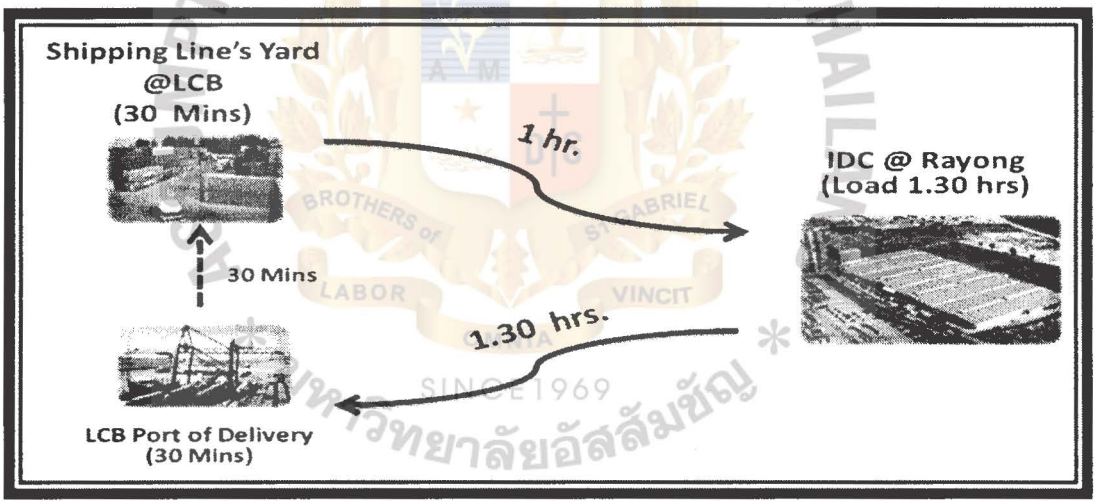
1. Packaging
   - Receiving Plastic Resins into silos through Filling Pipe and Tank Car.
   - Packing Plastic Resins in different kinds of bags as customer's requests and moving it into the warehouse.
2. Warehouse Management
   - Product storage and preparation to move to trucks or containers as customer's orders.
3. Distribution
   - Provide delivery to domestic and international customers with many kinds of transportation modes such as, trucks, ships, or rail.

1.1.2 Normal Process of ABC-T

The normal process of the research as shown in Figure 1.1 indicates the overall picture of transportation activity starting from shipping liner's yard, international distribution centre (IDC), a warehouse at Rayong province, to Laem Chabang (LCB) Port for returning laden container preparing export activity to the customer. The working hours at each place will be explained as below:

- Working hours at Liner's Yard: 08.00AM – 17.00PM* = 8 hrs
- Working hours at IDC: 08.00AM – 20.00PM* = 12 hrs (1 shift)
- Working hours at LCB Port of Delivery: 24 hrs* (The trailer can return laden container at all time.)

Figure 1.1: Normal Process Flow of the Research



Source: Company Data

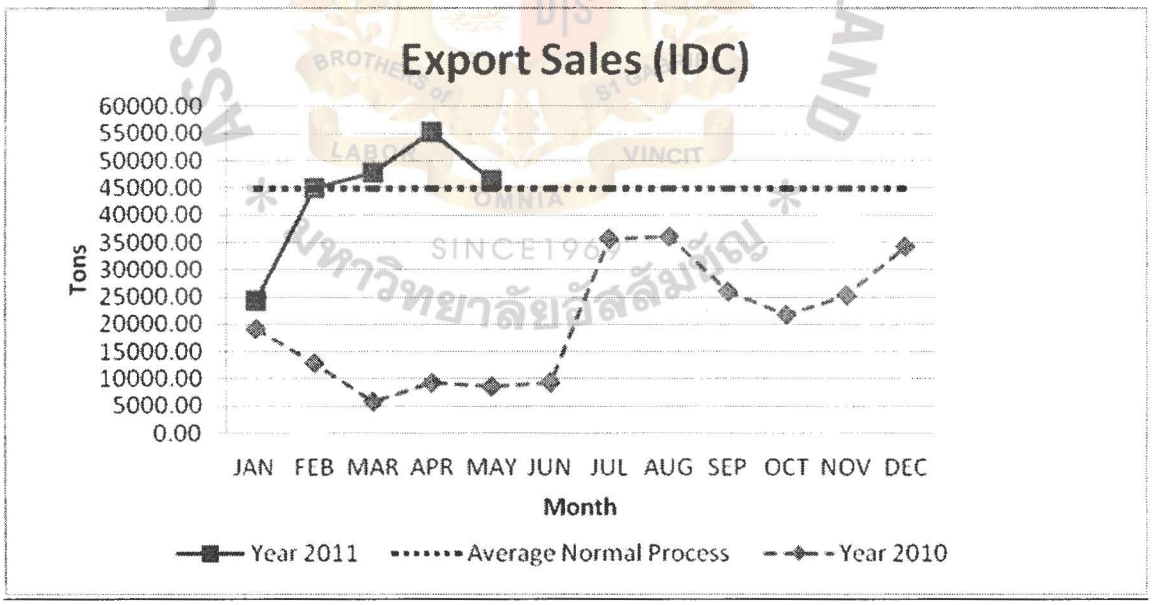
Additionally, the detailed process activity will start with trailer runs to pick up empty containers at liner's yard, drive to load the product at IDC, and back to return laden containers at LCB Port. The total time for one round trip of the process will be 5.30 hours per one trailer, or two round trips per day.

1.1.3 Sales Trend of ABC-T

The company's sales data in the year 2010 and 2011of IDC in Figure 1.2, indicates that the trend of exporting products is increasing and this trend will be affect the transportation activities. However, the normal process of trailer that can run around 1,800 tons per day, or 45,000 tons per month, which is not enough for the demand in the future and affects to some problems in the present activity, for example, unavailable resources (drivers or empty containers), or uncertain situation (port congestion or bad traffic).

Hence, the alternative process should be considered to solve container's shortages from port congestion or from container yards that provide empty containers for company. Moreover the new process can serve all the demands from the customers in the future with reducing total logistics costs and increasing more service levels.

Figure 1.2: Export Sales Volumes at International Distribution Centre (IDC)



Source: Company Data

1.2 Statement of the Problem

The customer's complaints were that their shipment was shut out or split shipments from shipping line, which affected their production schedule and final customers. Then the list below represented the causes of the problem:

- ABC can't serve loading with full capacity of the warehouse (IDC).
- ABC can't achieve trailer's utilization due to demand fluctuation.

Moreover, during some periods of the year, there are many export shipments needed to be deliver. This situation affected container shortage at liner's container yard and there were road congestions at the port of delivery. Then, the trailers have to wait for the queue both for picking up empty containers and also returning laden containers. The total round trips for each container increase from normal process. As a result, the trailers may take longer time for one round trip. For example, if they have to wait for empty container around two hours, they can run only one round trip per day. In addition to this, if they have to wait for the queue for returning laden containers due to port congestion, ABC may have to postpone loading some shipment to another day, which finally affects the end customer or consignee.

Table 1.1: Total Export Loading in Year 2010

Month	IDC	Other plants	Total	Percentage
Jan	19,245.50	25,825.75	45,071.25	42.70%
Feb	12,780.70	20,038.50	32,819.20	38.94%
Mar	5,755.50	18,658.85	24,414.35	23.57%
Apr	9,336.65	20,199.75	29,536.40	31.61%
May	8,498.50	22,323.96	30,822.46	27.57%
Jun	9,354.40	19,639.61	28,994.01	32.26%
Jul	35,549.00	24,163.05	59,712.05	59.53%
Aug	36,078.40	31,330.11	67,408.51	53.52%
Sep	25,985.10	37,450.15	63,435.25	40.96%
Oct	23,920.50	26,202.50	50,123.00	47.72%
Nov	25,135.63	27,893.05	53,028.68	47.40%
Dec	34,107.68	31,144.35	65,252.03	52.27%

Source: Company Data

Table 1.1 indicates the Total Export Loading in the year 2010. The International Distribution Centre (IDC) had a total average export loading of less than 50% of the total export loading. However, the quantity increases every month due to increases in production's capacity.

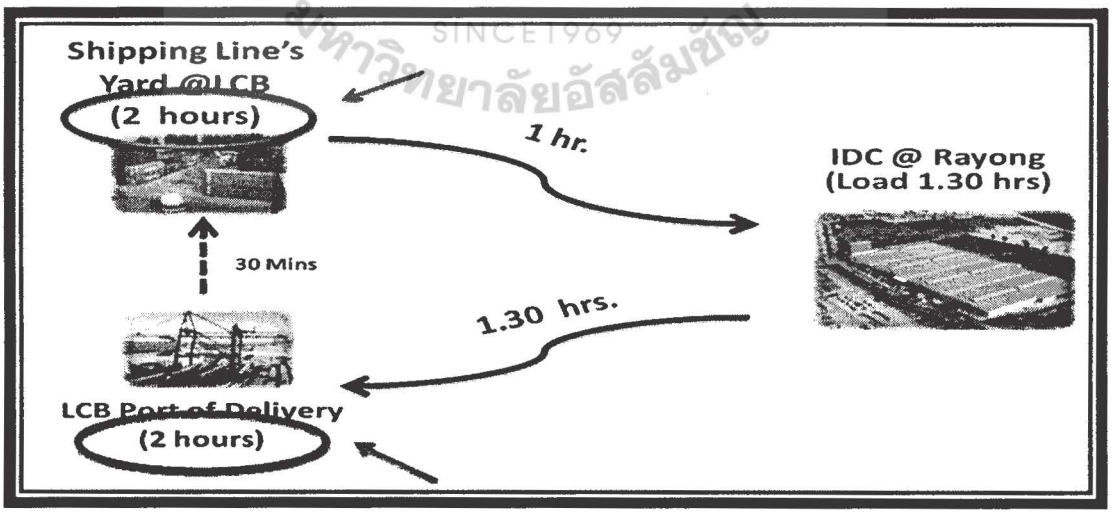
Table 1.2: Total Export Loading in Year 2011

Month	IDC	Other Plants	Total	Percentage
Jan	28,852.10	30,944.33	59,796.43	**48.25%**
Feb	45,002.18	35,210.12	80,212.30	**56.10%**
Mar	47,808.78	38,205.02	86,013.80	**55.58%**
Apr	55,257.78	35,579.42	90,837.20	**60.83%**
May	46,248.73	41,613.62	87,862.35	**52.64%**

Source: Company Data

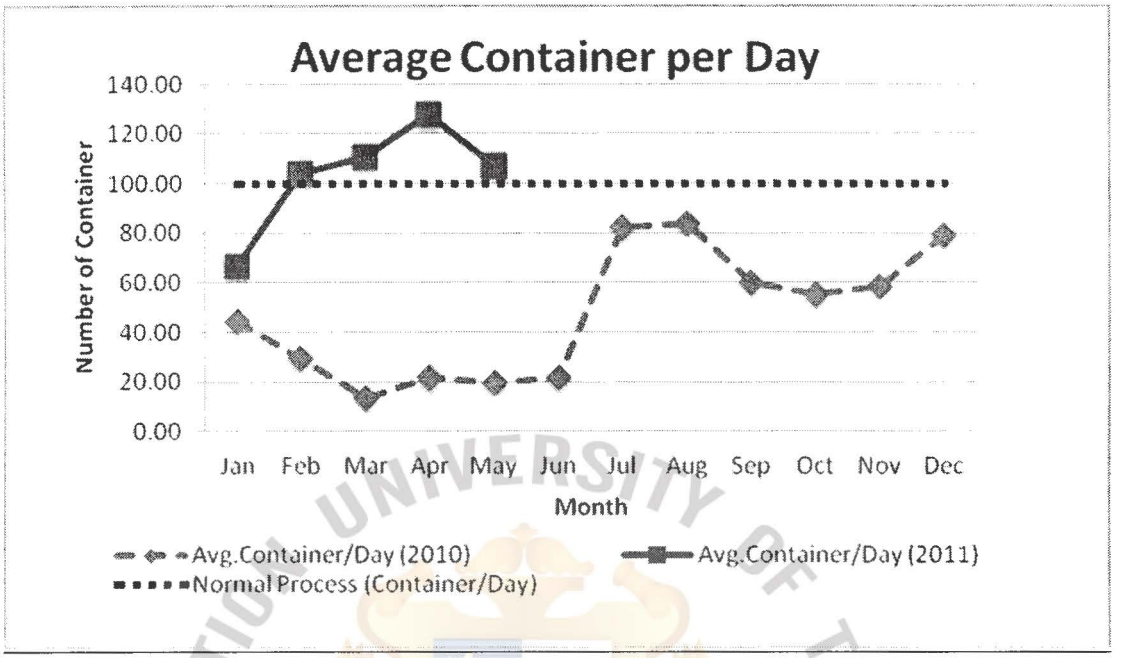
Table 1.2 indicates Total Export Loading in the year 2011. The percentage of the quantity of loading at IDC is more than a half of the total export loading quantity. It shows the higher loading capacity which affects transportation utilization because of limited trailers. Then, the company has to find the way to increase the capacity of limited trailers with minimizes total transportation cost.

Figure 1.3: Current Problem in the Normal Process Flow



Source: Company Data

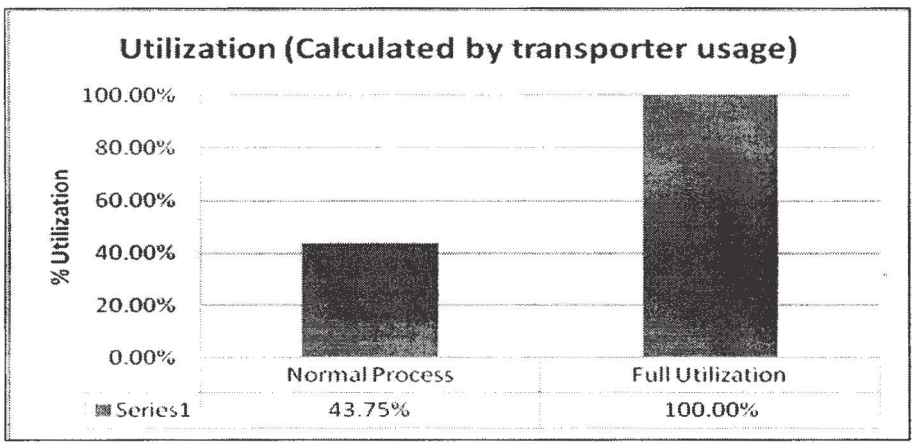
Figure 1.4: Average Trailer Round Trips (Containers) per Day at IDC



Source: Company Data

In the normal process, there are 50 trailers for exporting activity at IDC. One trailer can run two round trips approximately, or around 100 containers per day. In addition, each trailer runs 5.30 hours per round trips, and total running time per day will be equal to 10.30 hours. Therefore transportation utilization will be 43.75% as shows in Figure 1.5. However, this utilization is not sufficient using some periods of time as the Figure1.3 shows and resources have to be maximized. Also, ABC can't serve more shipments in the future because of gradually increasing volume.

Figure 1.5: Utilization (Calculated by Trailer Usage)



Utilization Calculated (by Trailer usage)

- Full utilization of the trailer = 24 hrs. or 1,440 minutes
- Real trailer usage = 10.30 hrs. or 630 minutes
- Then, utilization is = (630/1,440)*100 = 43.75%

Figure1.4 illustrated average trailer round trips per day at IDC. In the year 2010, the number of round trips per day is not excess 100 but it was increasing continuously. Additionally, there were excess 100 round trips per day in 2011 since the beginning of the year. However, with the normal process, the trailer can run only two round trips, or 100 containers per day. The operation cost is 3,280 Baht per container (or per round trip) which includes transportation cost (fixed and variable cost), warehouse cost and lift on/off at LCB cost.

Therefore the new processes are suggested as alternatives for improving utilization of trailers and increasing container loading shipment in the future. The research will identify "what is the most appropriate alternative to improve transportation utilization for enhancing the company's operational excellence and customer satisfaction?"

1.3 Research Objectives

The main objective of this project is to analyze the alternatives to improve logistics efficiency, such as loading capacity and transportation utilization to serve both present and future industry's demands.

The objectives of this project are:

1.3.1 To investigate normal transportation processes, transportation utilization and transportation cost.

1.3.2 To identify alternatives that improve transportation utilization so that the company can serve higher demands in the future.

1.4 Scope of the Research

This project will focus on the process of trailers from the pick up of empty containers from container yards of the shipping line company, loading the product into containers, and delivery of laden containers back to the port of delivery, which belongs to the liner company, for further export to the port of destination. The historical data from January year 2010 to May 2011 is used to analyze and evaluate the operation during transportation including transportation utilization, cost, loading capacity in order to improve the total process of transportation.

The time schedule of trailer's round trip and the cost of the operation will be shown and analyzed with proper methods to indicate how the normal process and new proposed alternatives run. Furthermore, ABC can identify which processes are best suitable for the company's operation.

The scope of this project is to study and evaluate the current and alternative operation process for improving efficiency and effectiveness of trailer through different tools. This project will analyze the feasibility, compare cost-benefit, sensitivity analysis and simulate the process in order to make the best decision for the company.

1.5 Significance of the Research

The purpose of the study is to find the best solution or alternatives for increasing utilization of the trailers with acceptable cost. Also, the time for each round trip could be reduced in order to add more trips per day for serving more demands in the future.

Additionally, if this transportation activity improves, service quality of the company will be also increased because transportation is the most important part in a logistics firm. The operation department also takes major account for the total cost of all departments in the organization.

The study will identify each criteria of each alternative to find the most beneficial method for the company and end customers both in present improvement and future development.

1.6 Limitations of the Research

This project shows the process of transportation that occurs during a day with different points of destination, such as, warehouse, container yard, and port of delivery. To focus on the objectives, some constraints will be discussed which are as follows:

1.6.1 Simulation Tools

The simulation of the project is applied by Arena, and the focus is only on the time scheduling of the trailers in the process. Also, this could indicate how the old or new alternatives process time schedule is appropriate for the business in the future.

1.6.2 Time Constraints

During the transportation process, total warehouse operation time is also included in total trailer's round trip. However, in-detailed process times within warehouse operation will not a concern of. For example, loading schedule time, weighting in and weighting out for container etc.

1.6.2 Shipping Line Usage

In the real process, shipping line company that ABC-T uses, will vary due to many factors, such as, freight, free time at destination, customer services, or availability of the port of destination. However, the process in this project will assume that there is one place of container yard and one place of port of delivery (Terminal) because all these places are located at LCB. Hence, time usage and distance will not be different.

1.7 Definition of Terms

Consignee	The person or the company who ordered and received the shipment by different kind of transportation modes, such as, by sea, air or truck. (Harrison & Van Hoek, 2005).
Container Depot	Storage place for empty containers which belongs to shipping line companies (Coyle, Bardi, & Langley, 1996).
Container Yard	A place for keeping full or empty containers which are received or prepared for moving to warehouse, port of delivery or other places (Coyle et al., 1996).
Double Trailer	A trailer that is used in combination with another trailer to transport goods, products or commodity (Harrison & Van Hoek, 2005).
Ineffective Scheduling	The plan that can't make the best use of time (Kelleher, El-Rhalibi, & Arshad, 2003).
Laden Container	A container with full loaded products (Coyle et al., 1996).
Port of Delivery	A place where a vessel unloaded the shipments and prepared to load the shipments for next port of destination (Tzeng, 1999).
Port of Discharge	An arrival port of shipments (Tzeng, 1999).

Round Trip	A trip from one place to another place and back to the origin (Coyle et al., 1996).
Shipment	The goods, commodities, or products that move from one place to another place by the owned or not owned company (Tzeng, 1999).
Shipping Line Company	A company that operates the vessel and manages all the shipments on the vessel from the original port to final destination port. Some may own or not own the vessel (Tzeng, 1999).
Simulation	The imitation of the real process or the real situation (Kelton, 2010).
Trailer	A vehicle that transport the goods, products or commodity (Harrison & Van Hoek, 2005).
Transportation Utilization	Trailer usage with full capacity (Tseng, Yue, & Taylor, 2005).
Utilization	To use something with profitable accounts (Tseng et al., 2005).

CHAPTER II

REVIEW OF RELATED LITERATURE

This chapter primarily describes the role of transportation and competitive advantage in transport operations with regard to time management. In addition, uncertainty in transport system is also important for the analysis. Finally, analysis methods will be discussed including cost-benefit analysis, sensitivity analysis and simulation methods.

2.1 The Role of Transportation in Logistics Activity

Transportation is the connecting factor among many organizations and industries right from the producer to the consumer. Transportation means not only carrying goods for the seller or the buyer but is more complicated. In other words, this activity is the service that affects every step in logistics or the supply chain. Additionally, transport systems or processes should be improved in order to serve the logistics activity in service quality, operation cost or efficiency (Tseng et al., 2005).

Efficient transportation goals are profitability, reduced total cost, or customer's satisfaction (Coyle, Bardi, & Novack, 1994). Some important elements should be of concern and are as follows:

2.1.1 Effective Scheduling

Transportation services cannot be stored as the products people consume. If there is not successful in scheduling, it will affect many connecting parts of the service. The delay in transport, for example, will affect the warehouse operators because the product, equipments, or labor needs to be prepared.

2.1.2 Reliability

Reliable service is important for the company's reputation. Many customers prefer arrival time that the shipper or seller promised in the first place. Delay or earlier shipment will be costly for the customer and may effects the company's service level in the future.

2.1.3 Cost Determination

The cost of transportation is a major part in logistics activity. It also depends on various factors such as, oil price, traffic, transportation routes, and equipment used. If the company could determine the cost effectively and reduce it, there will be more benefits to both its customer and company itself.

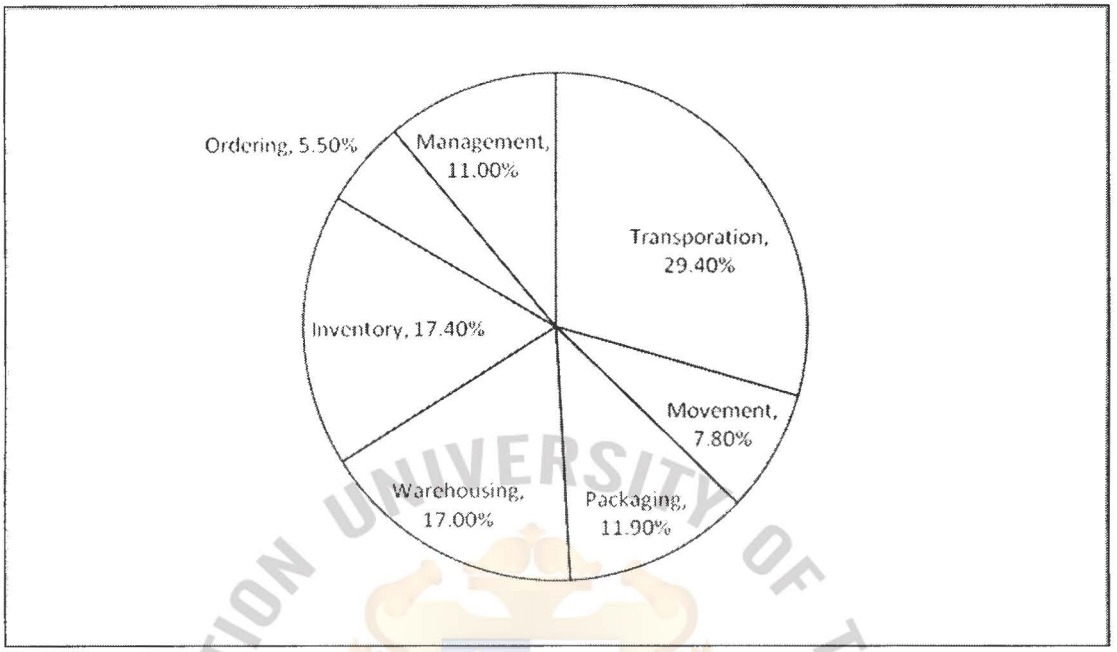
2.2 Competitive Components in Transportation

Transport services vary among service providers. Service requirements are important both to the company and also the customer. In addition, the service component can be a competitive advantage to compete with others in the industry, if it is operate successfully. The competitive components include transport costs, transit time, reliability, accessibility, capability, security (Coyle et al., 1994).

2.2.1 Transport Cost

Transportation cost normally accounts for the largest percentages of the logistics activity. This transportation cost can have impact on products or services cost, which finally affect the customer. However, management should reduce this cost by improving the operation process or system.

Figure 2.1: Cost Ratio of Logistics Items



Source: Tseng et al. (2005)

2.2.2 Transit Time

If transit time is longer, the level of inventory will be higher in order to stock more inventories for waiting shipment arrival. Therefore inventory carrying cost is also higher. Transit time is an important factor because it affects the customer's cost and service level.

2.2.3 Transit Time Reliability

Reliability in transportation is another service component of the company. This factor affects the level of inventory due to stock out problems. The consistency of time also means a promise to the consignee or the customer for delivery of goods and services on time.

2.2.4 Accessibility

Limitations of transport's infrastructure are different due to different specific origins and destinations. Air, water or rail carriers have limited accessibility. Roads way are the most accessible but this kind of transport service may require more cost of transportation while returning.

2.2.5 Capability

Capability means an ability of the carrier whether to provide specific transport service or unique equipment. There is some special equipment required by the customer about some specific product, such as high cube, controlled-temperature, tank vehicles for different products. Moreover, transport service capability also includes electronic data interchange, delivery and pick-up time.

2.2.6 Security

Some damaged shipments may cause breaking a contract by the customer if the product is of high value. Due to this damage, the customer needs to have more level of inventory and also stock out cost for this unreliable transit time. In addition to the damaged or lost shipment, the product cannot be used or sold in the future.

2.3 Importance of Time in Transportation

'Timely' in term of delivery or transportation concept, means response to customers' needs on time. The customer will not receive the product or service early or late. In addition, this powerful competitive advantage is widely used in many organizations. In the past, low cost with high quality, fast delivery with high quality or low cost with fast delivery couldn't match many people's view (Harrison & Hoek, 2005).

However, the trade-off relationship can be reduced if the organization has developed a new strategy. In other words, the cost does not have to increase if lead time is faster, quality is improved or variety of the product is increased by redesigning the process or developing the system (Harrison & Hoek, 2005).

There are several benefits for the customer if the company can use time competitive for adding value (Harrison & Hoek, 2005). This includes the follows:

2.3.1 Improved responsiveness to customer needs

Cost saving is an important benefit when lead time is reduced. The customer does not need to pay for carrying more stocks. Also, this will be beneficial for the company because they will get loyalty from customers in return.

2.3.2 Variety of the product is increased

For shortened lead time, the company can deliver the product to their customer more frequently with smaller batch sizes. This means the customer can also order different products more often because of fast delivery.

2.3.3 Reducing Plant and Equipment capital

For some processes, there are lots of inventory levels. However, if the process is faster for example, in the warehouse, racking or pallets will move quickly. Moreover, there will be more floor space to store other necessary equipment.

2.4 Simulation Process

The improved business operations are considered as effective tools in every business. Thus, the operations may include production, delivery, or quality capability of the company. As a result, each business should closely analyze the process with proper understanding in order to develop the right tools, or applications (Kumar & Phrommathed, 2005).

Simulation is an analysis tool that integrates many methods or applications to imitate the real situation. The system that can simulated are of various types such as, distribution networks, service operations, or field-systems (Kelton, 2010).

2.4.1 The Importance and Concept of Simulation

Simulation is also defined as a model to act like stand-in for studying the overall performance, improving its operation, changing the trial, or designing the new one if it never exists in the process (Kelton, 2010). There are many benefits of simulation which are as follows:

- Able to deal with complicated models of any system.
- Improve the performance, and cost effectiveness.
- Easy to use and make a quick decision-making.

2.4.2 Measuring Factors in Simulation

When using simulation, there are many outputs that the user should measure for its performance in order to achieve understanding of the situation (Kelton, 2010).

- The total production
- The average waiting time in queue
- The maximum waiting time in queue
- The average total time in system
- The maximum total time in system
- The time-average number in queue
- The maximum number in queue
- The utilization

2.4.3 Model Formulation

To meet the simulation model objective, some criteria should be considered such as, data structures and constraints, type of analysis, animation, or scenarios. Accurate information and some activity required are important to demonstrate the real system effectively.

2.4.4 Model Verification and Validation

Model Verification is done to ensure that simulating model is performed as planned. If the model is larger and more complex, it will be more difficult to review the activity within the model (Kelton, 2010). Additionally, to be sure of validation of the model, more test should be performed, the errors will be found and corrected in time (Macal, 2005).

The goal of model validation is to solve the right problem, have accurate information, and be finally used (Macal, 2005). To validate the simulation model, the model's

result must be compared to the real world system but the user has to make sure that it is actually does exist (Kelton, 2010).

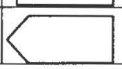
2.4.5 Model Analysis

After designing the experiment and testing the model, analysis of the simulation model is also important. There are many tools of analyzing the model. It depends on which method will achieve the goal of each model (Kelton, 2010).

2.4.6 Arena Simulation Model

Arena is an effective simulation tool. This is flexible and easy to use because it includes familiar features such as, Window software, CAD packages, so the user can easily understand these normal basic applications (Kelton, 2010).

Table 2.1: Example of Basic Application in Arena

No.	Module Name	Symbol	Description
1.	Create Module		Starting Point for entities in a simulation model
2.	Process Module		The main processing method in the simulation
3.	Decide Module		Decision making processes in the system
4.	Assign Module		Assigning new values in variables
5.	Batch Module		The grouping mechanism within the simulation model
6.	Separate Module		Split a previously batched activity
7.	Record Module		Collect statistics in the simulation model
8.	Dispose Module		Ending point for entities in a simulation model

Source: Rustom & Yahis (2007)

2.5 Summary of Selected Literature

In literature review of the study, the researcher mainly focuses on transport operation which includes many factors such as, the system, resources, and some economic or

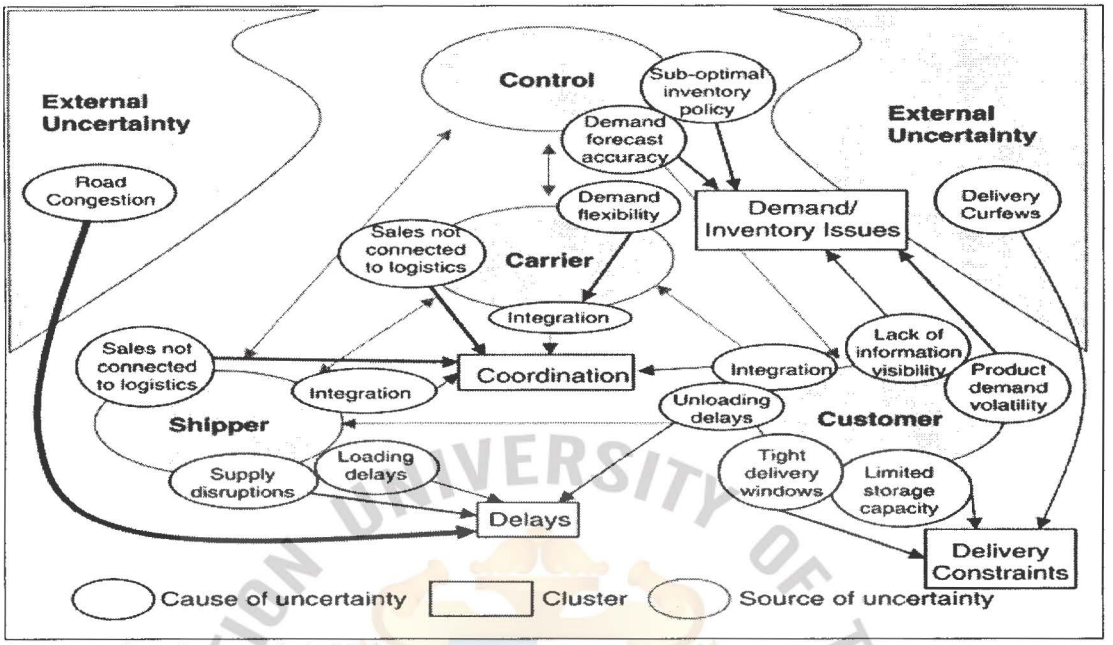
environment that effects the operations. Moreover, most studies relate to transport scheduling for solving different problems in each research paper or case study. The cost-effectiveness and optimum transport scheduling are important issues of the studies as stated in the Table 2.2:

Table 2.2: Summary of Selected Literature

Authors	Purpose	Result/Finding
Sanchez et al. (2010)	To identify different type of uncertainty in transport operations	The major results of uncertainty are delays, delivery constraint and lack of coordination which affected to the efficiency of transport operations.
Kelleher et al. (2003)	To prove how internet-based system can help in transport scheduling	The integrated system can minimize distance travelled for intermodal transport.
Tzeng (1999)	To propose vehicles control and scheduling system for multi depot physical distribution.	The system that can operate vehicles scheduling effectively including global information collection system, route planning, vehicles scheduling, depot controlling, and time table feedback system.
Eibl et al. (1994)	To implement the best system of vehicles routing and scheduling in order to achieve the cost-effective.	The computerized vehicle routing and scheduling (CVRS) systems is performed effectively for reducing the cost of transportation and benefits to interaction of different level in supply chain.
Lancioni (1991)	To measure and identify which functional accounts for major logistics cost.	The operational and administrative costs are important for logistics operation. And the manager should keep tracking for these functional teams.

The table 2.2 indicates that transportation normally represents a major cost of total logistics chain costs in many companies (Coyle et al., 1996; Eibl, Mackenzie, & Kidner, 1994). Thus, vehicle scheduling should be considered as effective way for improving the quality of transport operations (Waters, 1987; Tzeng, 1999). Moreover, Lancioni (2007) identified that operational cost is the major part of logistics operation which is a factor that directly affects performance of the company.

Figure 2.2: Main Uncertainty Causes in Transportation



Source: Sanchez et al. (2010)

The transport movement's goal is to minimize the cost, distance runs and improve transportation utilization rate (Kelleher et al., 2003; Tzeng, 1999). The cost that are mentioned includes:

- Fixed Costs: of containers and vehicles for transport movement both in export and import activity.
- Variable Costs: this cost will occur while using the resources. Some resources such as, working time of drivers, or distances travelling from each destination.
- Penalty Costs: can be additional charge from missing delivery or pick up time deadlines.

In additional to the cost-effectiveness, there is different source of uncertainty effect on the supply chain. From the evaluation of the research conducted by Mason-Jones & Towill (1998) and Peck (2001), five uncertainties are shippers, customers, carriers, control systems, are external uncertainty. In addition, there are many important factors that cause transport uncertainty. Sanchez-Rodrigues, Potter, & Naim (2010) stated that top three factors of transport uncertainty are delays, demand and information

issues, and delivery constraints as shows in Figure 2.2. These factors affect the transportation of company's operations and increase the cost of the operations as well.

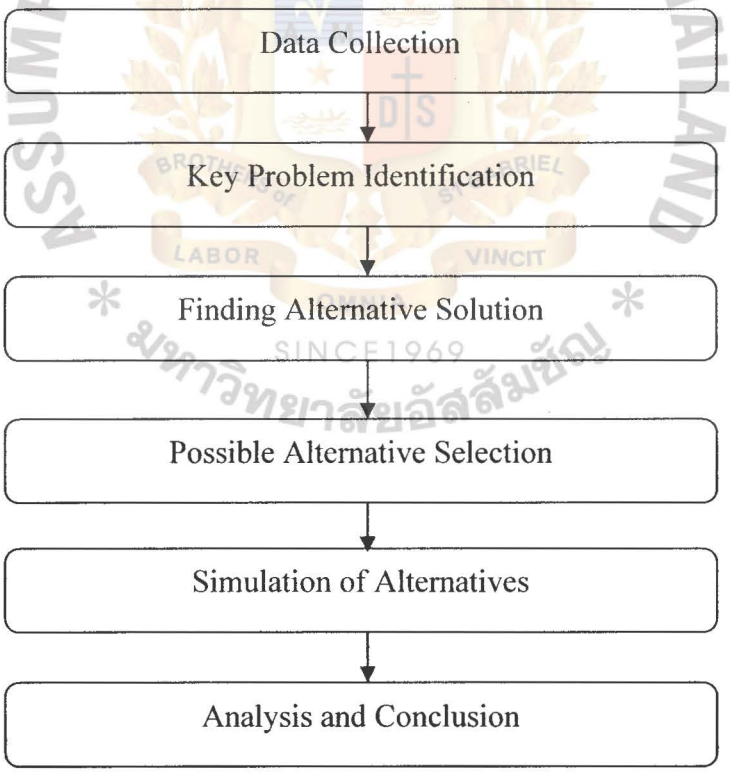
In conclusion, delay factor is the main problem in transportation. However, this problem will disappear if the management team could manage the time and the routing of transportation to improve cost-effectiveness and service quality.

CHAPTER III

RESEARCH METHODOLOGY

This research is a case study to identify the most suitable alternative process in ABC Company in order to improve transportation utilization with acceptable cost invested. The research methodology which is described in transportation performance in time-based management, and cost effectiveness, is useful for understanding of current business processes and its alternatives. The step investigated will be listed as the follows:

Figure 3.1: Framework of the Research



3.1 Data Collection

Data collection of the research is gathered in several ways in this section. For better understanding of the company's operation process, qualitative studies are considered in order to provide useful and important data. Additionally, each technique is applied for data accuracy and process clarification of the research. The different data collection methods that are used are as follows:

3.1.1 Documentation Review

The review of documents includes background context of the company, detailed process of the operation to understand the normal process. Historical data is also gathered such as, transportation cost, export shipment quantity, and trailer usage. These data can be gathered in daily, monthly or yearly.

3.1.2 Observation Method

This observation method is used for the real situation or operation of the process such as, observation of loading process time in the warehouse, timing the trailer's round trip, and gathering detail of workers or labor activities. This method is the most accurate and effective way for further analysis.

3.1.3 Informal Conversation

To understand the current process and problem of transportation, informal conversation with the worker is an appropriate method. The problem includes lack of drivers, and unavailability of the trailers. Moreover, a wide variety of information of different people participating will be collected such as these involved in transportation time usage, daily activities or daily operations.

3.2 Key Problem Identification

The transportation process of the company includes domestic and international distribution to the customer. However, exporting activity process receiving complaint from the customer concerning shipment delay to the destination and this has a major

impact on the customer's production because of large orders. Thus, the company has to list all the complaints and identify the cause as shown in Table 3.1.

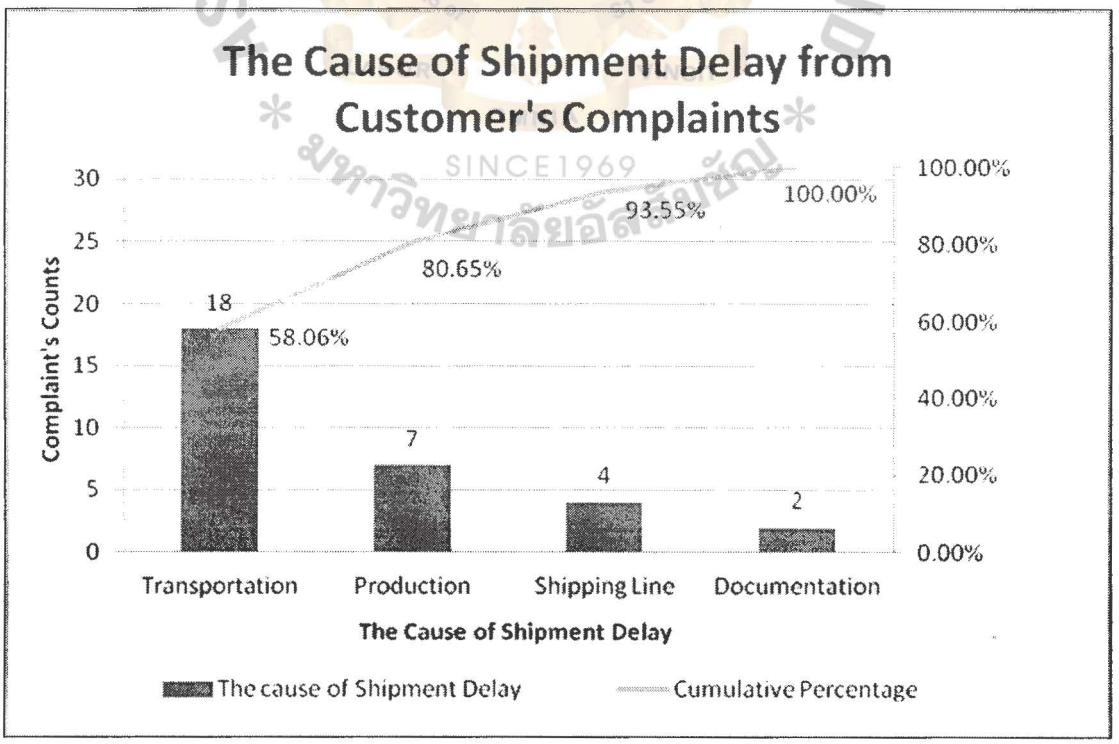
Table 3.1: Customer Complaint in Category for the Year 2010

The cause of Shipment Delay	Count	Cumulative Count	Percentage	Cumulative Percentage
Transportation	18	18	58.06%	58.06%
Production	7	25	22.58%	80.65%
Shipping Line	4	29	12.90%	93.55%
Documentation	2	31	6.45%	100.00%

Source: Company Data

In addition, Figure 3.2 illustrates the pareto chart of the cause of shipment delay. The chart indicates that the main problem of the complaint is the transportation problem with a total of 58% of the complaints.

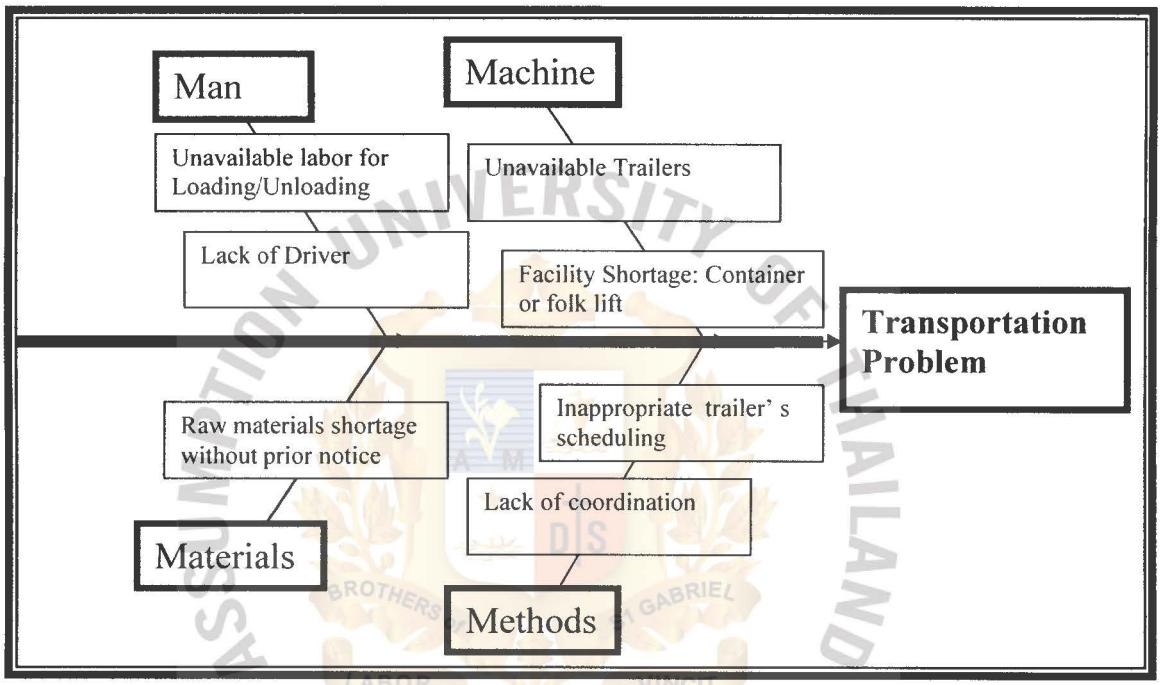
Figure 3.2: Pareto Chart of the Cause of Shipment Delay in the Year 2010



Source: Company Data

After analyzing the cause of the complaints, the main problem is the transportation issue. Thus, the cause and effect diagram is another tool for finding the relationship between the outcome and the root cause of this main problem. Figure 3.3 shows the cause and effect diagram.

Figure 3.3: Cause and Effect Diagram



Source: Company Data

From Figure 3.3, the root cause of the problem can be classified as follows:

3.2.1 Man

- Unavailable labor for loading/unloading: In the current process, unavailability of workers or labor is an important issue due to increasing production and demands from the customer. Sometimes no show of these workers can cause the transport problems.
- Lack of Drivers: If there is no available driver, the shipment needs to postponed for loading or unloading to the next day. This problem will affect the schedule of the trailers.

3.2.2 Machines

- Unavailable trailers: Facility shortage is another problem in the transport process. If there is unavailability of the trailers, the process will be stopped and has to wait until the next availability of these facilities.
- Facility Shortage: Container shortage is another main problem caused by the shipping line. However, this cause occurs because the trailer cannot pick up containers on time to inform the shipping liner.

3.2.3 Materials

- Material shortage: can cause problems in the transportation process because of no prior notification for the loading date.

3.2.4 Methods

- Inappropriate scheduling: Trailers scheduling is not proper with production scheduling or time scheduling.
- Lack of coordination: lack of coordination among workers in different departments causes problems in method field. For example, warehouse and distribution department are in different places which can cause less communication.

3.3 Finding Alternative Solution

3.3.1 Existing Model

The existing model of transportation flow is indicated in Figure 3.4. One round trip of the trailer started from liner's container yard at LCB for picking up empty containers, then it moves directly to the international distribution centre (IDC) at Rayong (RYS) province for loading the products. After loading is completed at IDC, the trailer will move again to return the laden containers at LCB port for further export activity. Finally, the trailer will move to pick up empty container for another round trip at liner's container yard. In summary, the transport can operate up to two round trips per day.

Figure 3.4: The Existing Transportation Flow of The Research

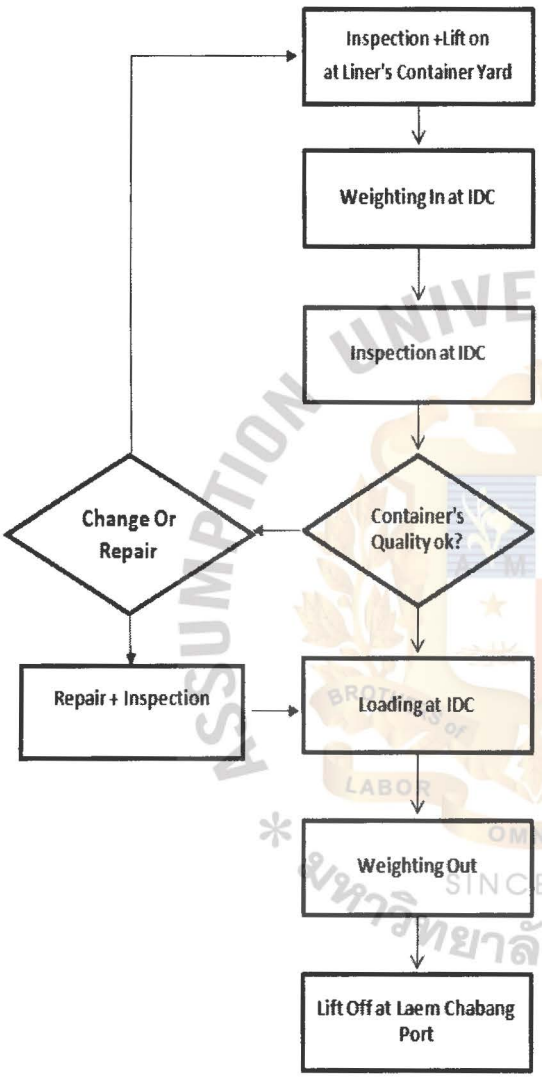
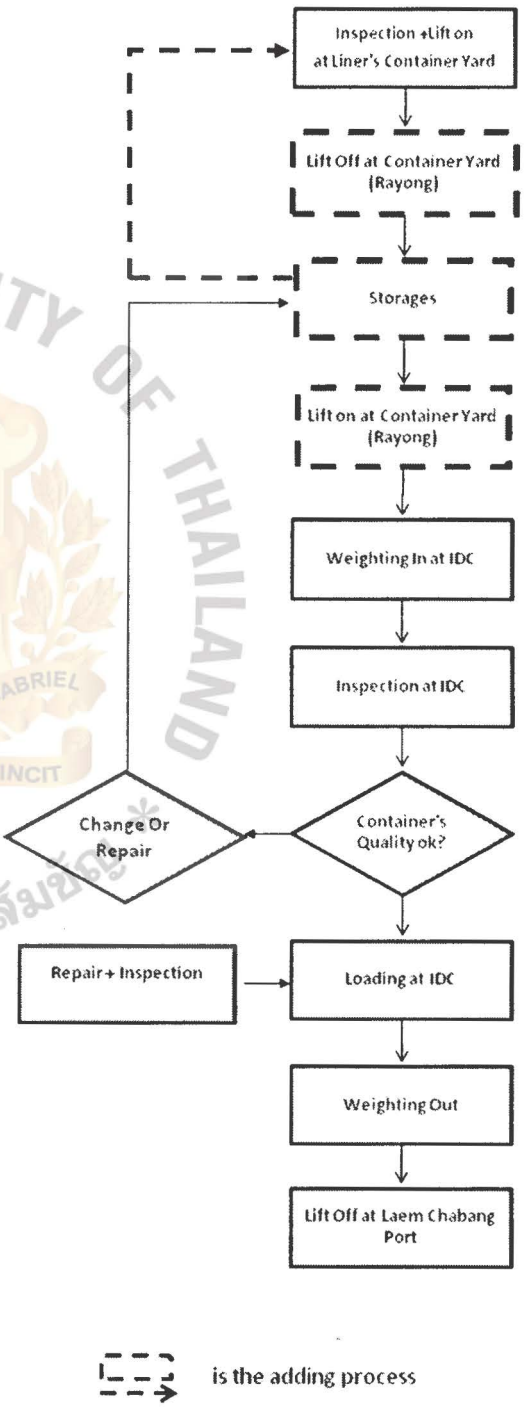


Figure 3.5: Proposed Alternatives Flow Adding Container Yard at Rayong

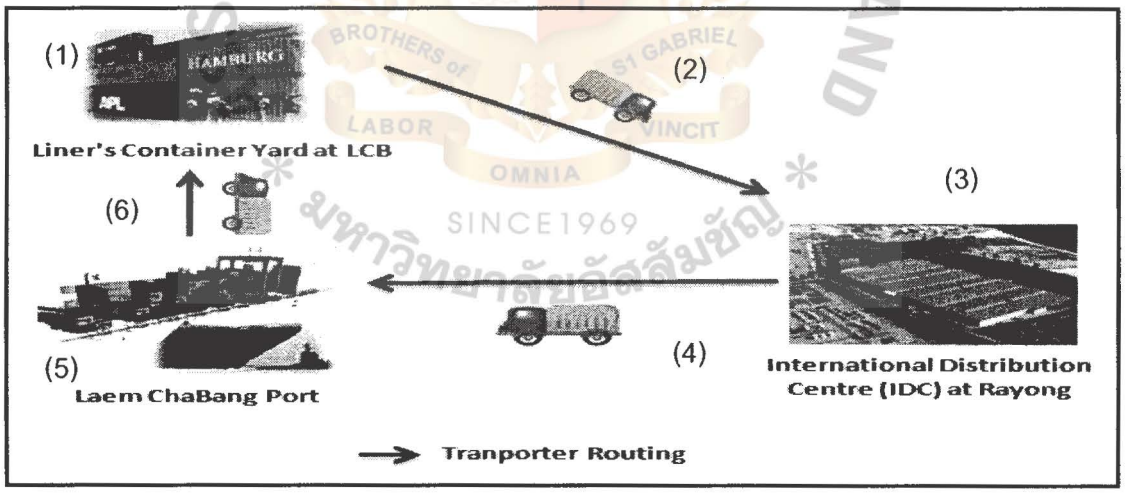


The problems of the existing process are identified for the transportation utilization because of ineffective transportation scheduling. Also, the effect of transportation scheduling is higher cost of outsourcing trailers and lack of future demand from the customer. Therefore, the new possible model will be proposed by adding some criteria such as, container yard at Rayong, Operating 24 hours at IDC or trailers investment. The proposed model will improve transportation utilization, and cost effectiveness of the operation process of the company.

3.3.2 Proposed All Alternative Solutions

From the company data, the company found that transportation utilization is accounted at only 43.75% which means it cannot use the resource to the full capacity and cannot guarantee that this utilization rate will cover the future demand. Thus, in order to solve the problem, new trailers scheduling will be considered for improving transportation utilization and reducing cost of the transportation operations.

Figure 3.6: The Existing Transportation Routing of the Research



Existing Process Explanation

Figure 3.6 shows the steps of the process activity;

- Step (1); the trailer lift on empty container at liner's container yard at LCB.
- Step (2); the container was moved to IDC for loading process.
- Step (3); loading process in IDC including weighting in, inspection, loading the product and weighting out.

- Step (4); the trailers moved the laden container in order to return to the LCB port for further exporting activity.
- Step (5); the laden was lifted off at the LCB port
- Step (6); the trailers drives to liner's container yard for the next round trip.

Figure 3.7 (Scenario I) indicates that only container yard (CY) located in Rayong province was added for being a buffer for the empty containers and laden containers. This place was added when the first set of trailers (25 trailers) that pick up empty container, move and leave it at the container yard at Rayong. The trailers drives back for picking up another container. The empty container at container yard will be picked by the second set of trailers (25 trailers) to IDC for loading and then leave the laden container at the container yard at Rayong for picking the other set of containers for further loading. The process activity can be explained as follows;

- Step (1); the first set of container lift empty containers at liner's container yard at LCB.
- Step (2); the first set of containers drive to CY, RYS
- Step (3); the empty containers are lifted off at CY RYS and kept.
- Step (4); the first set of container will drive back to liner's CY at LCB for lifting on the next empty container.
- Step (5); the second set of trailer lifts on empty container at CY RYS
- Step (6); it drives to IDC for loading process. I
- Step (7); loading process at IDC.
- Step (8); the laden containers are moved back to CY RYS and kept.
- Step (9); the laden container are moved to the LCB Port
- Step (10); the laden container are lifted at the LCB Port.

Figure 3.7: Scenario I: Adding Container Yard at Rayong

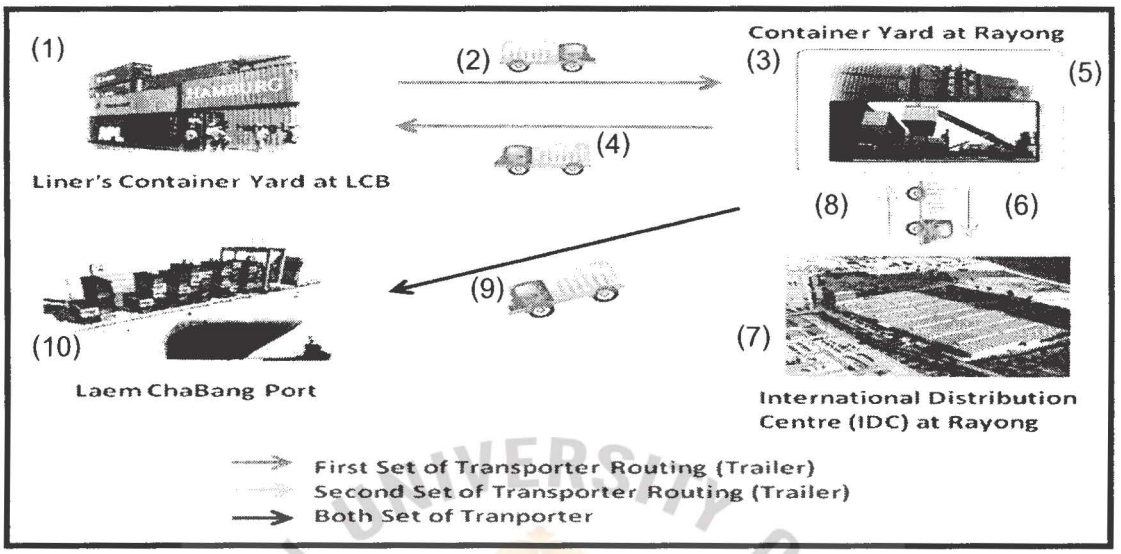


Figure 3.8 (Scenario II), CY (RYS) was added and changed. The first set of trailers are doubled (25 double trailers). In other words, 25 double trailers can pick up 50 containers at the same time. However, for returning laden containers, the trailer can return only one container at a time due to the weight control.

Figure 3.8: Scenario II: Adding Container Yard at Rayong and Double Trailer for Picking Up Empty Container

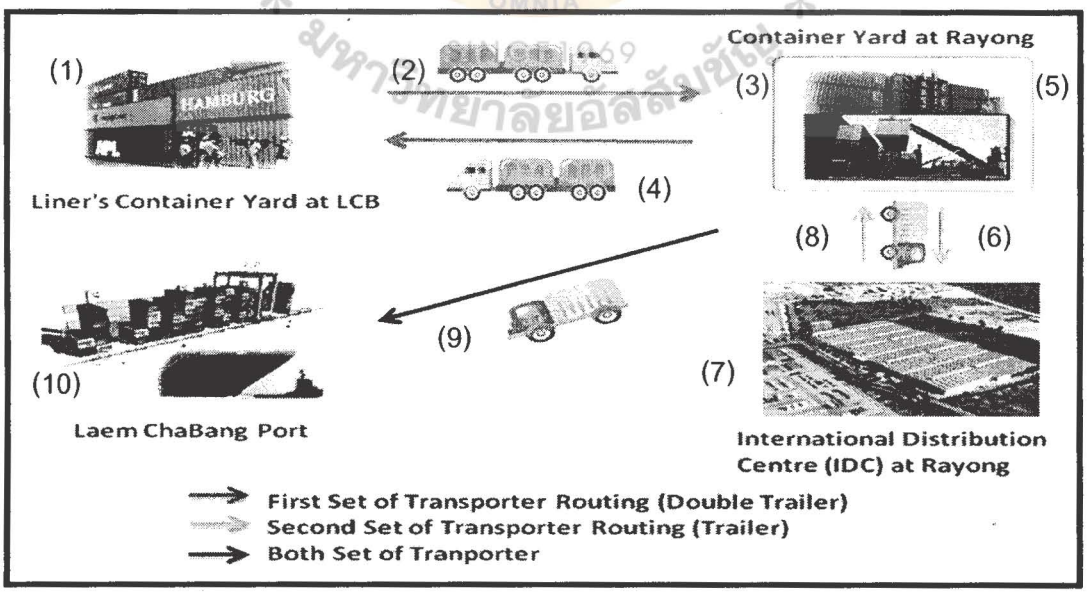
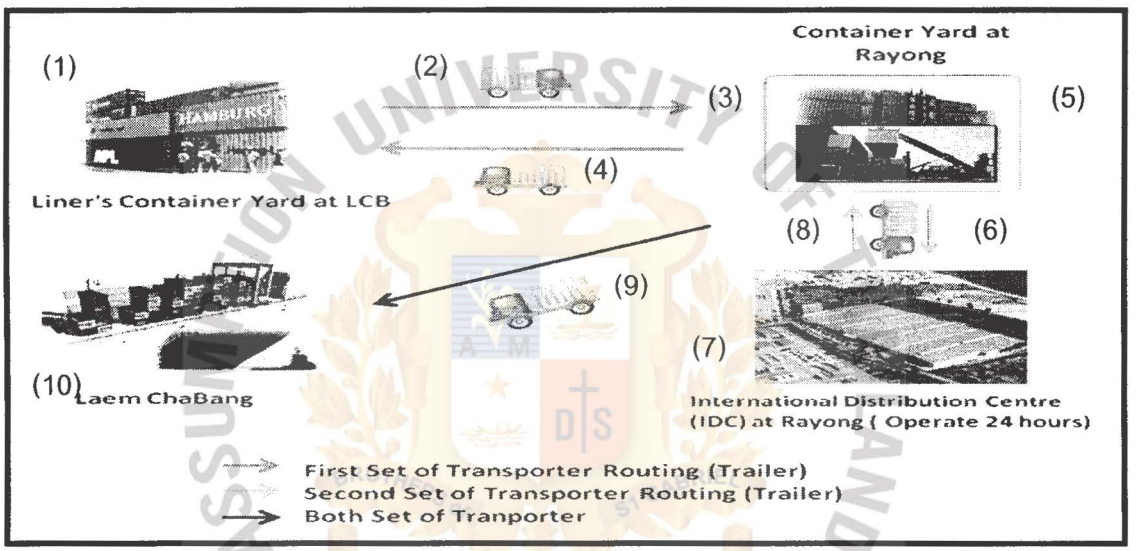


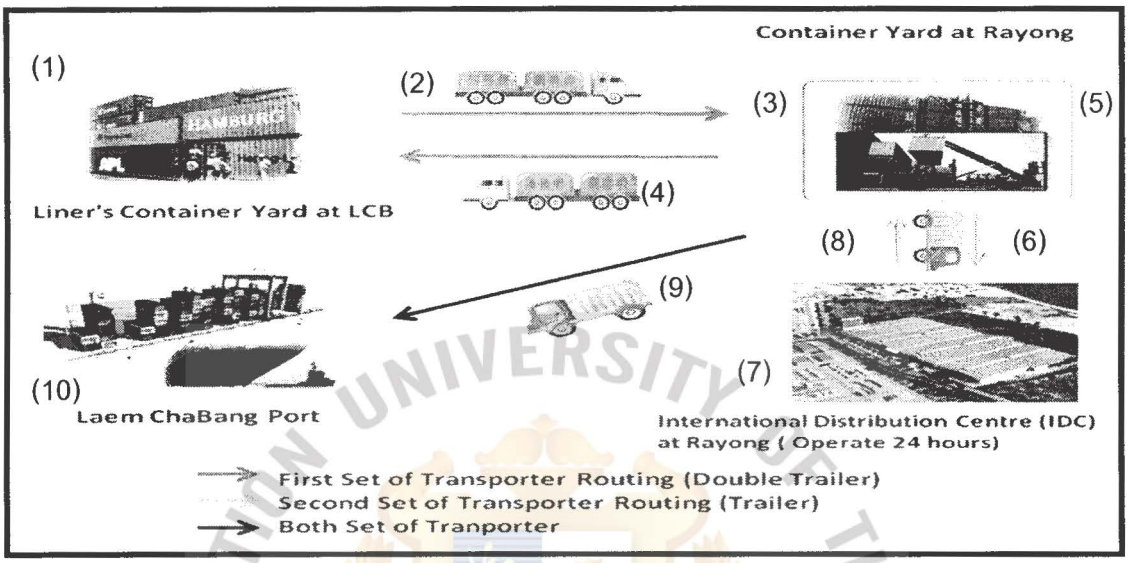
Figure 3.9 indicates for Scenario III, CY (RYS) was added and operation time was changed at IDC to be 24 hours. This operation hour at IDC was added because when the company had a container yard at Rayong, this CY can keep more containers for loading. Thus, operating for longer time may increase more volume for the increasing demand in the future.

Figure 3.9: Scenario III: Adding Container Yard at Rayong and Operates 24 Hours at International Distribution Centre (IDC)



From Scenario IV as in Figure 3.10, three criteria were added including CY (RYS), double trailer for first set of trailer, and 24 operation hours at IDC. There are more empty containers that the double trailer can pick up and when pick up is more, the company also has more space for keeping these containers. Finally, loading more containers is another effect for the 24 hours warehouse operation.

Figure 3.10: Scenario IV: Adding Container Yard at Rayong, Double Trailer for Picking Up Empty Container, and Operating 24 Hours at International Distribution Centre (IDC)



In summary, four scenarios as explained before are the possible alternative solutions that are chosen from the criteria as shows in Table 3.2. For the next part of choosing the alternative, two scenarios will be scoped down for better analysis of each criteria with cost-effective and transport utilization improvement.

Table 3.2: All Proposed Possible Solutions

Criteria	As-Is	Scenario #1	Scenario #2	Scenario #3	Scenario #4
Trailer	X	X	√	X	√
Container Yard at Rayong	X	√	√	√	√
24 hours at IDC operation	X	X	X	√	√

3.4 Possible Alternative Selection

For all possible proposed models, the main criteria of the flow is container yard adding at Rayong (CY RYS) as shows in Figure 3.5. This CY (RYS) was added in

every scenario because it is a buffer for storing empty containers and laden containers. It helps for storing empty containers because liner's container yard normally operates from 08.00AM-05.00PM and it is a short time for picking up process of the trailers. Also, it can shorten loading process because the trailer will keep laden containers at CY (RYS) before returning it in the LCB Port.

Table 3.3 shows the possible alternative selection of four solutions was scoped into two scenarios which are scenario#2 and scenario#4.

The reason for not choosing scenario#1 and 3 is:

1. If there is no double trailer, it can pick up only one empty container from liner's yard.
2. Operation hours at liner's yard is from 8AM to 5PM. It is a short period for picking up process.

Thus, if double trailers (two containers) are not used, the company cannot pick the empty containers in time and also wasted time with congestion or traffic inside the yard.

Table 3.3: Possible Alternatives Selection

Criteria	As-Is	Scenario #1	Scenario #2	Scenario #3	Scenario #4
Double Trailer	X	X	√	X	√
Container Yard at Rayong	X	√	√	√	√
24 hours at IDC operation	X	X	X	√	√

From the two scenarios that are selected, the transportation utilization can be analyzed by simulation program, Arena, for comparison between these two alternatives and for finding the most appropriate one in order to improve transport operations of the company. Moreover, the outcome of the analysis in next chapter will help to make decisions for the company as to whether they should invest in CY RYS, double trailer or operating hours at IDC or not by comparing the cost-benefits analysis.

CHAPTER IV

PRESENTATION AND CRITICAL DISCUSSION OF RESULTS

This chapter will discuss the steps that are involved in the transportation process. The first part is the evaluation of normal process which includes the total cost of operation, number of containers and volume of the products. The second part is to propose two alternative solutions with the additional cost of its operation. The following part will simulate transportation utilization of each alternative by Arena. The fourth part will compare the operations and transportation costs that affect each transportation process. Finally, there is summary of all alternative solutions with total cost and total volume differentiation.

4.1 Evaluation of Normal Transportation Process

Figure 1.1 indicates the normal transportation process of the company. The average volume is 100 containers per day. There are only three points of destination which includes liner's yard, IDC, and LCB Port in the process. However, the company found that in some emergencies cases for example, for container shortage or port congestion, the average volume may not reach 100 containers as the company expected.

Table 4.1: Parameter Setting (Normal Process)

Parameter setting	Units
Container in	100 containers
Workstations	3 stations
Trailer usage	50 trailers
Length of the process	24 hours
Number of days running	10 days

Table 4.2: Simulation Result (Normal Process)

Simulated Process	Result
Container out	100 containers
Transportation utilization	40.63%

Before conducting the simulation, the parameter in Table 4.1 is set, including container in the process, workstations, trailer usage, length of running process, and number of replications for the entire running process. The process starts with picking up 100 containers at liner's yard station, loading the product at IDC station, and finally returning all laden containers at LCB port station.

Additionally, the simulated result in Table 4.2 shows the container out, 100 containers and the utilization. 40.63% means the capacity of using trailers in scenario II is 40.63% out of 100% trailer's full capacity.

The company's data in Table 4.3 indicates that the average volume for one container contains 18 tons of the product which is packed in bags (25 kilograms per bag). Total average operation cost per container is 3,280 that include transportation cost 3,100 Baht and warehouse cost 180 Baht.

Table 4.3: Average Transportation Revenue and Cost per Container (Normal Process)

Container	Average Volume (Metric Tons)	Average Revenue per Container (Baht)	Average Transportation Cost per Container (Baht)
1	18	4,200	3,100

Source: Company Data

The average volume (tons and containers) have increased since July 2010 as shown in Table 4.4, which made transportation cost and operation cost also increase respectively. Moreover, the revenue per container is also increased due to the higher volume during each month.

Table 4.4: Average Transportation Cost per Container Year 2010

(Normal Process)

Month 2010	Average Container per day	Total Average Container per Month	Average Revenue per Month (Baht)	Average Transportation Cost per Month (Baht)
Jan	45	1,170	4,914,000	3,627,000
Feb	30	780	3,276,000	2,418,000
Mar	13	338	1,419,600	1,047,800
Apr	22	572	2,402,400	1,773,200
May	20	520	2,184,000	1,612,000
Jun	22	572	2,402,400	1,773,200
Jul	82	2,132	8,954,400	6,609,200
Aug	84	2,184	9,172,800	6,770,400
Sep	60	1,560	6,552,000	4,836,000
Oct	55	1,430	6,006,000	4,433,000
Nov	58	1,508	6,333,600	4,674,800
Dec	79	2,054	8,626,800	6,367,400
Total		14,820	52,634,400	45,942,000

Source: Company Data

Table 4.5: Average Transportation Cost per Container Year 2011

(Normal Process)

Month 2010	Average Container per day	Total Average Container per Month	Average Revenue per Month (Baht)	Average Transportation Cost per Month (Baht)
Jan	67	1,742	7,316,400	5,400,200
Feb	104	2,704	11,356,800	8,382,400
Mar	111	2,886	12,121,200	8,946,600
Apr	128	3,328	13,977,600	10,316,800
May	107	2,782	11,684,400	8,624,200

Source: Company Data

However, from the company's data, the demand of the products increased and this affects the operation process because there are limited resources of 50 trailers. Table 4.5 shows the average volume per day in 2011 is more than 100 containers, and the

trend is higher in the future. Then, the alternative solutions will be analyzed the factors that affect the cost and utilization and the volume that can be used in the future.

4.2 Model Verification and Validation

To ensure the model is useful for the process and solves the right problems, validating the model is necessary for applying it to the real world system.

Table 4.6 indicates the actual and simulated average numbers are equal, so there is zero percentage error for this outcome.

Table 4.6: Validation of Average Number of Containers (Normal Process)

Process	Average Number of Containers		
	Actual	Simulate	% Error
Normal	100	100	0%

The average transport utilization in Table 4.7 shows that the error is 3.12% because the actual number is higher than the simulated one.

Table 4.7: Validation of Average Transportation Utilization (Normal Process)

Process	Average Transportation Utilization		
	Actual	Simulate	% Error
Normal	43.75%	40.63%	3.12%

In conclusion, the simulation model is accurate and appropriate for the real situation because ABC could accept the validation of +10% to -10% of the percentage error.

4.3 Alternative Solutions

From chapter 3, scenario II and scenario IV are the two alternatives that are chosen from the four solutions. Both scenarios added CY (Container Yard) at RYS (Rayong)

and added trailers, but only alternative IV will add 24 hours operation at IDC (International Distribution Center). The comparison of the two scenarios will be explained in Table 4.8.

Table 4.8: Alternative Solution Comparisons

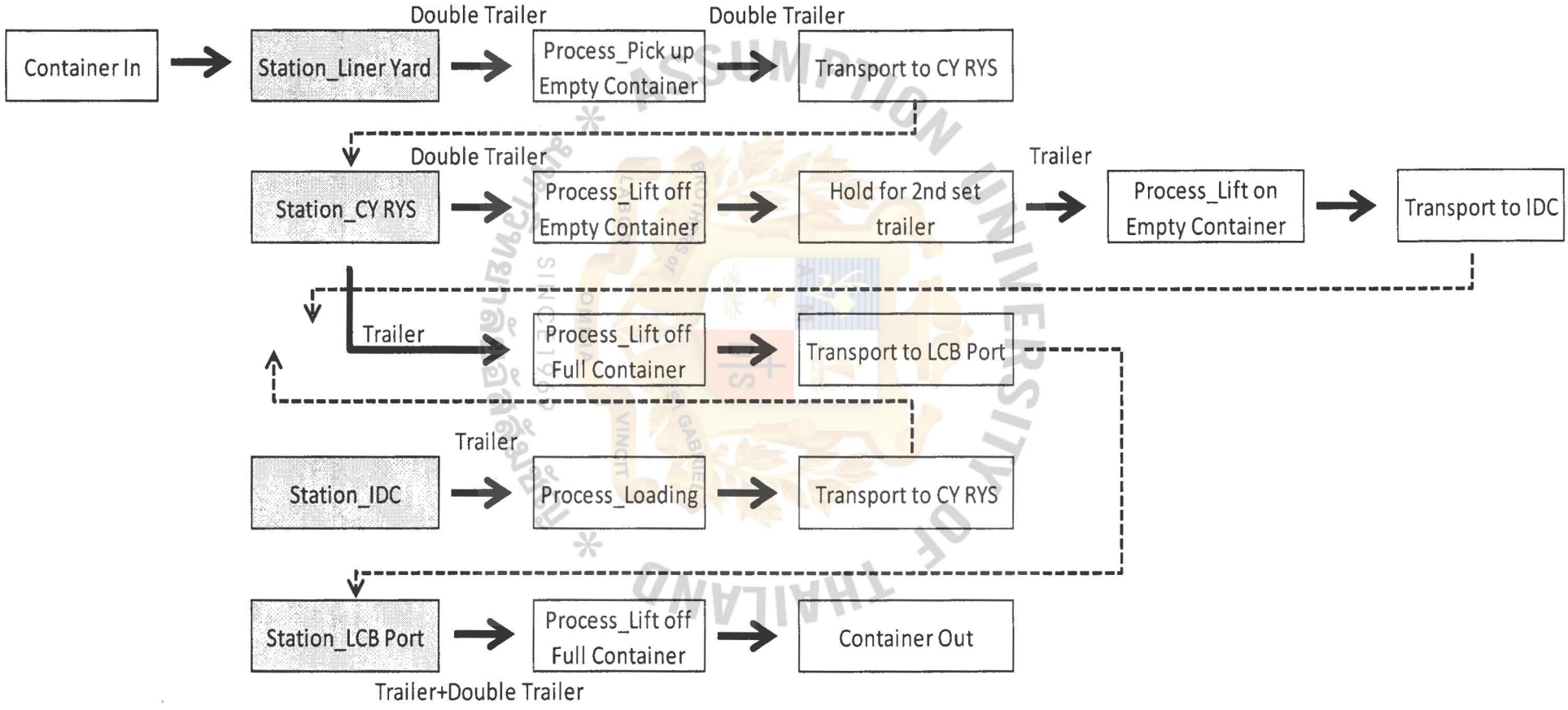
Solutions	Scenario II	Scenario IV
Process :	1. The first set double trailer (25 double trailers) only runs between liner's yard and CY RYS for picking up empty containers from liner's yard and leave it at CY RYS. **(08.00AM-17.00PM)** 2. The second set trailer (25 trailers) runs between CY RYS and IDC for taking empty container to load at IDC. **(08.00AM-20.00PM)** 3. Then, both set trailers will take all full container loaded at CY RYS returns at LCB port. **(24 hours)**	1. The first set double trailer (25 double trailers) only runs between liner's yard and CY RYS for picking up empty containers from liner's yard and leave it at CY RYS. **(08.00AM-17.00PM)** 2. The second set trailer (25 trailers) runs between CY RYS and IDC for taking empty container to load at IDC. **(24 hours)** 3. Then, both set trailers will take all full container loaded at CY RYS returns at LCB port. **(24 hours)**
Criteria Adding :	1. Trailers 2. CY RYS	1. Trailers 2. CY RYS 3. 24 hrs operation at IDC
Cost Adding:	1. Fixed Cost - Container Yard at Rayong - Trailers	1. Fixed Cost - Container Yard at Rayong - Trailers - Resources at IDC for overnight shift

Table 4.8 indicates that the process of the two alternative solutions is the same but there are differ in the 24 hrs operation at the IDC station. In addition to this, the cost of scenario IV added more resources in the 24 hours operation. Finally, both scenarios have more fixed cost from CY RYS.

4.4 Simulating Transportation Utilization by Arena for Each Alternative

Figure 4.1 indicates that the overview process that is applied by using Arena represents both Alternative II and Alternative IV. First, the process will start from the station liner yard in order to pick up the empty containers by the first set trailer. Then, it will lift off at the station CY RYS to wait for loading and first will go back to take another container until all round trips are completed. Second, the second set trailer pick up empty containers at the station CY RYS to load at IDC and go back to keep the full container at CY RYS again, in order to wait to return the LCB port. Finally, both sets of trailers will help each other to bring full containers back to the LCB port after they have finished their task of picking up and loading.

Figure 4.1: The Overview of Alternative II and Alternative IV Transportation Process by Arena



The difference between Scenario II and Scenario IV is the time schedule in IDC loading process, Alternative II will start at 8.00AM until 20.00PM, but Alternative IV will run for 24 hours.

4.4.1 Transportation Usage and Utilization of Scenario II

Table 4.9 shows that the parameter set in Scenario II consists of 130 containers for the process due to the maximum production in the future, four workstations, 2 sets of trailer, 12 hours of warehouse operating hour, 24 hours for model running length, and 10 replication numbers.

After running the model, the simulation result in Table 4.10 show that the number out , 130 containers, means these containers could return at LCB port or that the transportation represents the round trip of the process. In addition, the availability of first trailer set is 25. The first set average transportation utilization is 60.52% and the second set average transportation utilization is 69.60%. Then, the total average utilization for both set trailers is 65.06%.

Table 4.9: Parameter Settings (Scenario II)

Parameter	Units
Container in	130 containers
Workstations	4 stations
Trailer usage	1st set double trailer = 25 2nd set trailer = 25
Warehouse operation hour	08.00AM – 20.00PM
Model Run-Length of the Process	24 hours
Number of Replications	10 days

Table 4.10: Simulation Results (Scenario II)

Simulated Process	Result
Container out	130 containers
1st set double trailer average utilization	60.52%
2nd set trailer average utilization	69.60%
Estimated two sets utilization	65.06%

4.4.2 Average Transportation Usage and Average Utilization of Scenario IV

In Table 4.11, the operation time process in the warehouse (IDC) of Scenario IV is set to 24 hours to compare the different results between Scenario II and Scenario IV.

The simulation process result of Scenario IV in Table 4.12 illustrates that the number out or container returned is 130 containers which is the same as Scenario II. However, the transportation utilization got the same results, which shows first set average utilization is 60.52 % and the second set is 69.60%. The total average for both set trailers is 65.06%.

Table 4.11: Parameter Settings (Scenario II)

Parameter	Units
Container in	130 containers
Workstations	4 stations
Trailer usage	1st set double trailer = 25 2nd set trailer = 25
Warehouse operation hour	24 hours
Length of the process	24 hours
Number of days running	10 days

Table 4.12: Simulation Results (Scenario IV)

Simulated Process	Result
Container out	130 containers
1st set double trailer average utilization	60.52%
2nd set trailer average utilization	69.60%
Estimated two sets utilization	65.06%

The results of these two Scenarios (number out and transportation utilization) are the same because total output is 130 containers, and the trailer usage is equal. Loading time extended at IDC for scenario IV can't improve container out and cannot increase transportation utilization because loading process finished before extended time.

4.5 Comparing Transportation Cost and Operation Cost

Transportation cost is the major part of many businesses especially in logistics companies. Moreover, the operation department also treats the major benefits for the company. If the company can reduce operating costs or transportation costs while gaining more revenue, it will be excellent operation process in the business and supply chain management.

For ABC Company, Table 4.13 illustrates that the transportation costs is 3,100 baht and the operation costs is 3,280 baht which are from transportation costs plus warehouse costs at IDC. Total operation costs of the existing process are 3,280 baht per container.

Table 4.13: Total Operation Costs of the Existing Process

Total Operation Cost per Container	
1. Transportation Cost	3,100
2. Lift on/Lift off at CY RYS	-
3. Warehouse Cost (IDC)	180
Total	**3,280**

Table 4.14 compares the transportation cost of the existing process and two scenarios. In the existing process, the 3,100 baht/container, means more products for exporting, more cost that the company has to pay. For both Scenario II and IV, the transportation process is the same with two set of trailers. The first set is 1,800 baht that pick up empty containers, and second set is 1,200 baht which load the process until it is returned at the LCB port. So the total transportation costs for scenario II and IV totals 3,000 baht per container.

The operation cost in Table 4.15 includes the normal process which consists of transportation costs of 3,100 Baht and warehouse costs of 180 Baht per container. Total operation costs of the normal process are 3,280 baht per container. However, the cost in scenario II decreases to 3,000 Baht per container due to increase in utilization. Then total operation costs of scenario II is 3,180 Baht per container. In scenario IV, the operation costs will be added by warehouse costs at IDC because there is more shift in operating the warehouse. Then total costs of scenario IV is 3,540 baht per container.

Table 4.14: Transportation Cost Comparison

	Transportation Cost		
	Existing Process	**Scenario II**	**Scenario IV**
1st Set trailer	3,100	1,800	1,800
2nd Set trailer		1,200	1,200
Total	3,100	3,000	3,000

Table 4.15: Comparison of Operation Cost

Cost	Operation Cost		
	Existing Process	**Scenario II**	**Scenario IV**
1. Transportation Cost (Baht/Container)	3,100	3,000	3,000
2. Warehouse Cost (Baht/Container)	180	180	540
Total	**3,280**	**3,180**	**3,540**

Fuel expense is another variable costs of the transportation activity. However, the fuel costs are included in one round trip cost of the transport contractor. It is not necessary to add more diesel cost to total operation costs of the company. In addition, the transportation costs and revenue will adjust the price according to changes in oil and gasoline prices. Table 4.16 shows if oil price is higher by every one Baht, ABC has to pay 100 Baht more and the company will also charge 150 Baht higher to the customer for transportation expense. If oil price is lower by every one Baht, the changing price mores will be the same direction as above.

Table 4.16: Fuel Cost Factor

Fuel Cost Factor (Diesel)		
Diesel Price Range (Baht)	Cost per Container (Baht)	Revenue per Container (Baht)
28.01 - 29.00	2,800	3,900
29.01 - 30.00	2,900	4,050
30.01 - 31.00	3,000	4,200
31.01 - 32.00	3,100	4,350
32.01 - 33.00	3,200	4,500
33.01 - 34.00	3,300	4,650

From the comparison of total operation costs in Table 4.15, ABC can conclude that the total costs of scenario II has decreased from the existing process because of increase in utilization and because of trailers contractors who could control its resources. For scenario IV, the costs is higher than the existing process due to more shifts in warehouse costs. However, both scenarios can serve more demand in the future which is presented in next part.

4.6 Cost-Benefit Analysis

In the comparison table of average operation cost (Table 4.17), scenario II has an operation costs of around 3,180 Baht per container, which is lower than the existing process of 100 Baht. Cost saving is 3.14% compared to the existing process cost.

Moreover, scenario IV has 3,540 Baht in operation cost, which is higher than the existing one at around 260 Baht or 7.93%.

Table 4.17: Comparison of Average Operation Cost each Scenario

Cost	Average Operation Cost (Baht)		
	As-Is	Scenario II	Scenario IV
Average Operation Cost per Container	3,280.00	3,180.00	3,540.00
Cost Saving Each Scenario (Baht)	-	100	-260
Cost Saving Each Scenario in Percentage	-	3.14%	-7.93%

Table 4.18: New CY RYS Cost

Cost	Baht/Month
New CY RYS	
- Lift on/off machine + Workers	180,000.00
- Rent Cost (CY RYS)	130,000.00
Total New CY RYS Cost	310,000.00

Table 4.18 shows that adding container yard for keeping the container has increased the total costs for the company. The new CY RYS costs consists of two parts. First is lift on/off machine plus workers costs, which is 180,000 Baht/month. Second costs is rent costs, which is 130,000 Baht /month. Total cost for new CY RYS is 310,000 Baht/month.

Table 4.19: Comparison of the Total Cost of each Scenario

Cost	Average Total Cost (Baht)		
	As-Is	Scenario II	Scenario IV
Total Cost per Month	11,476,400.00	11,058,400.00	12,275,200.00
Cost Saving Each Scenario (Baht)	-	418,000.00	-798,800.00
Cost Saving Each Scenario in Percentage	-	3.78%	-6.96%

Table 4.19 shows that the average total cost per month of each scenario compared 130 containers per day. Scenario II sums up to 11,058,400 Baht for total costs, saving costs around 418,000 Baht per month or 3.78%. Scenario IV sums up to 12,275,200 Baht per month, which is higher than the existing process at around 709,800 Baht or

6.96%. In addition, there are 30 more outsourced trailers to cover additional production plan, which costs 3,600 Baht. Thus, total cost for as-is model will be 11,476,400 Baht per month.

Table 4.20: Total Benefits of the Company (130 Containers)

Benefit	Baht	
Revenue		
- Export Transport (x130 cntr. x26 days)	4,200/Container	14,196,000.00
- Export Service (Booking : 26 Baht/ton) (x130 cntr. x26 days)	468/Container	1,581,840.00
- Export Service (Shipping : 15 Baht/ton) (x130 cntr. x26 days)	270/Container	912,600.00
Total Benefit		16,690,440.00

The benefit that the company largely generates from three parts, export transport, export services (booking and shipping), are calculated monthly. Thus, the profits of ABC can be calculated by the total benefits and total cost per month as shown in Table 4.21. Table 4.21 shows the highest total profit is from scenario II. This profit amounts to higher than both the existing process and the scenario IV).

Table 4.21: Average Cost-Benefit of the Company (130 Containers)

Cost-Benefit	Average Profits (Baht)		
	As-Is	Scenario II	Scenario IV
Average Benefits per Month	16,690,440.00	16,690,440.00	16,690,440.00
Average Cost per Month	11,476,400.00	11,058,400.00	12,275,200.00
Average Profit per Month	5,214,040.00	5,632,040.00	4,415,240.00

In conclusion, Scenario II has the lowest cost among three processes. Thus, the profit of this scenario is the highest one, which is 5,632,040 Baht per month. Moreover, Scenario IV has the highest cost and this also affects the total profit of 4,415,240 Baht per month.

4.7 Analysis of Future Production Scheduling

From the company's data, the production scheduling of the manufacturer will increase to 80% at the end of year 2011. Moreover, it will increase by 5% every year until they get 100% full capacity of production.

In the past, production volume of the manufacturer was 60% at the end of 2010, and it would increase each year. Table 4.22 illustrates the percentage growth of production schedule, will increase to 85% at the end of year 2012 and continue to increase until 100% at the end of year 2015. The volume with full capacity of manufacturer will be 730,080 tons per year or 130 containers per day at the end of year 2015.

Table 4.22: Future Production Scheduling

	2011	2012	2013	2014	2015
Production Scheduling (Tons/year)	584,064	620,568	657,072	693,576	730,080
Production Scheduling (Tons/day)	1,872	1,989	2,106	2,223	2,340
Production Scheduling (Container/day)	104	110.5	117	123.5	130
% Growth	80%	85%	90%	95%	100%

Table 4.23: Comparison of Factor Results in each Scenario

	Existing Process	Scenario II	Scenario IV
Average Transportation utilization	40.63%	65.06%	65.06%
Container per Day	100	130	130
Average Transportation cost/Container	3,100	3,000	3,000
Total Operation cost/Container	3,280	3,180	3,540
Average Cost/Month	11,476,400	11,058,400	12,275,200

Table 4.23 shows that total operation cost of scenario IV is the highest at 3,540 Baht per container or average total cost of 12,275,200 Baht. Container out is 130 per day. For scenario II, the container per day is equal to scenario IV, which is 130 containers,

but total operation cost is 3,180 Baht, and 11,058,400 Baht for the average total cost which is lower than the existing process and scenario IV.

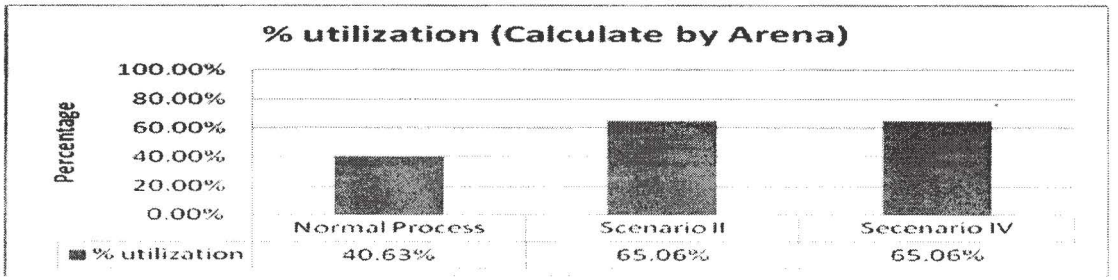
4.8 Summary

The transportation utilization has improved as presented by the simulation model using Arena and applying some factors and criteria to the normal transportation process. Moreover, the operation cost of each alternative is different from the normal process due to many factors, such as adding resources of 24 hours in the operation warehouse (IDC) or cost saving from transportation cost.

Figure 4.2: Comparison of Total Operation Cost (Baht)

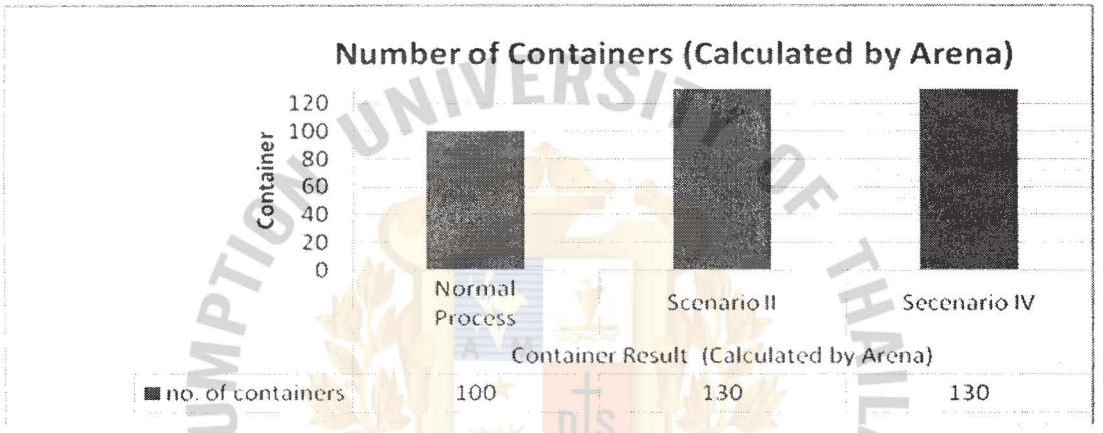
In scenario II, transportation cost decreased from 3,100 Baht to 3,000 Baht because there are two set of trailers and this could increase in transport utilization. Additionally, total operation cost of scenario II will be 3,180 baht per container (Figure 4.2) and average transportation utilization in the simulating model increased to 65.06%.

Figure 4.3: Comparison of Transportation Utilization



For scenario IV, transportation cost is 3,000 per container, which is the same as scenario II. However, 24 hours operation in the warehouse added more cost of 540 baht per container. The total operation cost increased to 3,540 baht per container. Finally, transportation utilization also increased to 65.06% (Figure 4.3), which is equal to scenario II because all containers could be loaded during normal operation time.

Figure 4.4: Comparison of Number of Containers Result



The result of each alternative shows that ABC can adding a container yard at Rayong is better than none because the transportation utilization can increase from 40.63% to 65.06% in both scenario II and IV (Figure 4.3) and can it increase the container per day from 100 to 130 (Figure 4.4). Moreover, extending operation hours in IDC (loading process) of scenario IV cannot improve container per day from scenario II and the utilization is not different from scenario II.

CHAPTER V

SUMMARY FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

Transportation and the operation processes are the key indicators of the logistics business. The findings and conclusions with some recommendations in this chapter will answer the question "what is the most appropriate alternative to improve transportation utilization for enhancing the company's operational excellence and customer satisfaction?".

5.1 Summary of the Findings

The results of the two alternatives indicate three factors that affect company's operation process. These three factors are transportation utilization, containers per day, and total cost per month. These factors can improve the transportation process and satisfy production scheduling in the future.

This study focused only on one warehouse (IDC). Thus sales volume and production scheduling are also limited to the product in IDC. The factor results, such as transportation utilization, container volume, and transportation cost are determined and applied in every scenario and existing process.

For the five years plan of the future production scheduling of the company, the maximum containers will be 130 per day at the end of 2015. For the result of scenario II and IV, resulted in 130 containers per day. This volume can serve the demand until 2015 by adding container yard at Rayong and separating trailers into two sets (normal trailer and double trailer). This improvement can satisfy the customer's demand and gain the benefits for the future growth.

According to the normal transportation process, the utilization is 40.63%. After improvement in Scenario II and IV, new utilization is 65.06%, which is more than the normal process at around 25%. The percentage has improved due to the separation and managing of trailers. Each trailer does not have to wait for some process, such as loading or picking up process, and can reduce queue and time usage at each step.

Moreover, the total operation cost of scenario II is 3,180 Baht per container, which has decreased from the normal process by 100 Baht per container. However, as compared to scenario IV, total operation cost is 3,540 Baht, and there is no difference in the number of containers per day as is utilization between scenario IV and II. Additionally, If ABC still follows the existing process with new demand (130 containers), there is more cost for outsourced trailers and the total cost would increase to 11,476,400 Baht per month.

5.2 Conclusions

The company's data shows that the container volume per day may vary due to the order requirement, but it will not exceed the maximum production scheduling, which is 130 containers. Thus, if ABC still continues with the normal transportation process, which can operate only 100 containers, there will be a problem in transportation management or schedules, and total cost of company, which would finally affect export activities and customer satisfaction.

From the research question, the most appropriate alternative to improve transportation utilization for enhancing the company's operational excellence and customer satisfaction is Scenario II, which adds container yards at Rayong and trailers for picking up container. The result of this scenario indicates that total containers per day is 130, transportation utilization is 65.06% and total transportation cost has decreased to 3,000 Baht per container or 3,180 Baht of total operation cost.

Moreover, it is not necessary to operate 24 hours at IDC for extend loading process time for improving utilization or containers out because the number of utilization and

containers out is the same if there is no 24 hours operated. The loading process finished in time as seen in normal operating hours.

Compared to scenario IV, the operation cost is higher than the normal process at around 260 Baht, but the result of container out and utilization is the same as scenario II. Thus, it can be conclude that 24 hours operation at IDC is not necessary for this study.

Finally, the company can solve the problems that have occurred in the current situation and future production demand, including serving loading capacity of the warehouse (IDC), also can achieving transportation utilization during some fluctuating periods.

5.3 Theoretical Implications

To improve the transportation process, transportation utilization and time-constraints are the important concept for the study. Trailer is the vital factor in the logistics business. If trailers do not run or stuck in any one process for longer time, there is reduced utilization and the company will waste the time with get less benefit, such as lower loading volume. Thus, if ABC Company can manage the trailers well enough, t profit can increase for the organization.

Moreover, Cost-Benefit Analysis is applied to investigate the overall improvement to find out if proposed alternatives of the study are appropriate for total cost and total benefit or not.

5.4 Managerial Implications

Transportation cost accounts for the major part of logistics activity (Coyle et al., 1994). ABC Company has to reduce the total cost in order to gain profits from its services with the highest utilization level. The company tries to manage and control

the usage of the trailers instead of increasing trailers because one more trailer means higher cost of operation.

Moreover, utilization rate shows the efficiency of the trailers in this study. When there is lower rate, it means the company cannot manage the time of the trailers and cannot control the resources. However, if utilization rate is high, it means the company use full capacity of the trailers which is represented in scenario II. There increase is from 40.63% to 65.06%.

5.5 Limitations and Recommendations for Future Research

This study is conducted with regard to transportation process during the day with specific products for delivery in one warehouse. Process time focuses only on transportation activity with different points of destination such as, shipping line yard, warehouse, and LCB port. Other activities in the warehouse process are not related to this research, such as schedule loading time, weight in and out time or survey process. The simulating tool focused only on utilization of the trailers with overall scheduling of four stations, such as LCB port, IDC, container yard at Rayong, and shipping line yard. Finally, ABC considers the only one shipping line yard because there is only located in one place (Laem Chabang).

For further study or research, the researcher could adapt the operation process by adding more trailers to increase utilization or volume for covering the demand in the future. Moreover, this could be applied or extended to various warehouses with constant transportation routing. Transportation management could be added for more appropriate situation or factors. Finally, warehouse management is also an important factor to managing overall loop of transportation in the future.

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APPENDICES

APPENDIX A

Utilization Rate

Normal Process and Alternatives Utilization

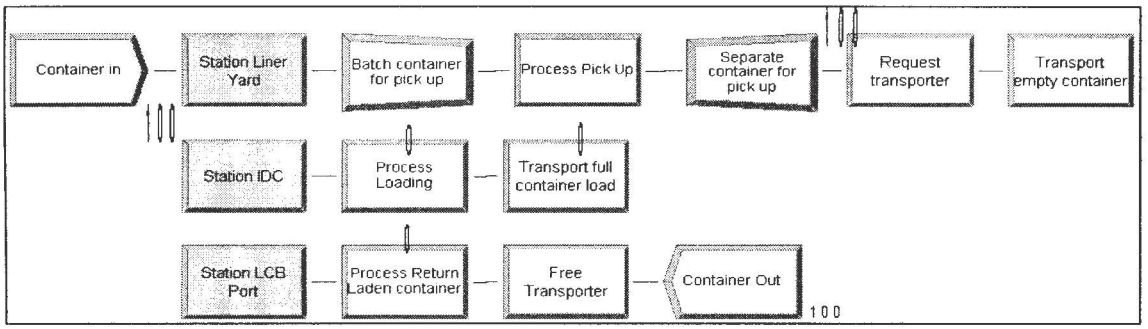
Utilization (Normal Process, Calculated by hand)			
	Trailer Usage (Hour)	Hours/Day	Utilization
1st Round Trip	5.5	24	22.92%
2nd Round Trip	5	24	20.83%
Total	10.50	24	43.75%

Utilization (Calculated by Arena)		
Normal Process	Scenario II	Scenario IV
40.63%	72.31%	72.34%

APPENDIX B

Simulation Result (Normal)

Normal Transportation Process



Transporter

Usage

Number Busy	Average	Half Width	Minimum Average	Maximum Average
Transporter 1	20.3150	0.08	20.1547	20.5026

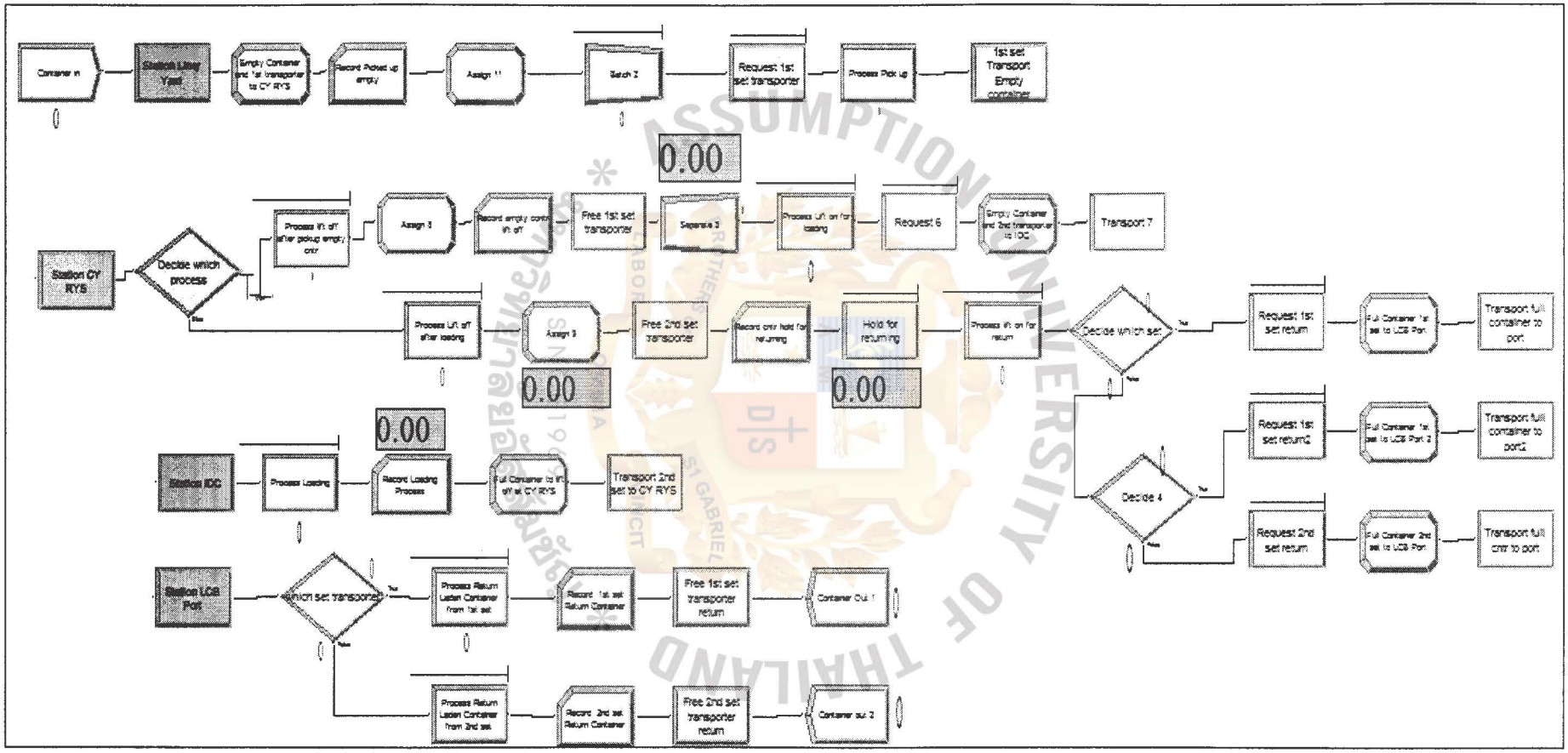
Number Scheduled	Average	Half Width	Minimum Average	Maximum Average
Transporter 1	50.0000	0.00	50.0000	50.0000

Utilization	Average	Half Width	Minimum Average	Maximum Average
Transporter 1	0.4063	0.00	0.4031	0.4101

APPENDIX C

Simulation Result (Scenario II)

Scenario II Process


Container in
Station Litter Yard
Empty Container and 1st transporter to CY RYS
Record Picked up empty
Assign 11
Batch 2
Request 1st set transporter
Process Pick up
1st set Transport Empty container
0.00
Station CY RYS
Decide which process
Process lift off after pickup empty cntr
Assign 3
Record empty cntr lift off
Free 1st set transporter
Separate 3
Process Lift on for loading
Request 6
Empty Container and 2nd transporter to IDC
Transport 7
Process Lift off after loading
Assign 9
Free 2nd set transporter
Record cntr hold for returning
Hold for returning
Process lift on for return
Decide which set
Request 1st set return
Full Container 1st set to LCB Port
Transport full container to port
0.00
0.00
Request 1st set return2
Full Container 1st set to LCB Port 2
Transport full container to port2
Decide 4
Request 2nd set return
Full Container 2nd set to LCB Port
Transport full cntr to port
0.00
Station IDC
Process Loading
Record Loading Process
Full Container to lift off at CY RYS
Transport 2nd set to CY RYS
Station LCB Port
which set transported
Process Return Laden Container from 1st set
Record 1st set Return Container
Free 1st set transporter return
Container Out 1
Process Return Laden Container from 2nd set
Record 2nd set Return Container
Free 2nd set transporter return
Container out 2

9:58:00PM

Category Overview

Values Across All Replications

TRANSPORTATION UTILIZATION OF A POLYMER TRADING COMPANY

Replications: 10 Time Units: Hours

Key Performance Indicators

System

	Average
Number Out	130

Transporter

Usage

Number Busy	Average	Half Width	Minimum Average	Maximum Average
1st set transporter	15.1299	0.47	14.1791	16.4175
2nd set transporter	17.4010	0.49	16.0817	18.3740

Number Scheduled	Average	Half Width	Minimum Average	Maximum Average
1st set transporter	25.0000	0.00	25.0000	25.0000
2nd set transporter	25.0000	0.00	25.0000	25.0000

Utilization	Average	Half Width	Minimum Average	Maximum Average
1st set transporter	0.6052	0.02	0.5672	0.6567
2nd set transporter	0.6960	0.02	0.6433	0.7350

APPENDIX D

Simulation Result (Scenario IV)

Scenario IV Process

1:44:12PM

Category Overview

Values Across All Replications

TRANSPORTATION UTILIZATION OF A POLYMER TRADING COMPANY

Replications: 10 Time Units : Hours

Key Performance Indicators

System

	Average
Number Out	130

Transporter

Usage

Number Busy	Average	Half Width	Minimum Average	Maximum Average
1st set transporter	15.1299	0.47	14.1791	16.4175
2nd set transporter	17.4010	0.49	16.0817	18.3740

Number Scheduled	Average	Half Width	Minimum Average	Maximum Average
1st set transporter	25.0000	0.00	25.0000	25.0000
2nd set transporter	25.0000	0.00	25.0000	25.0000

Utilization	Average	Half Width	Minimum Average	Maximum Average
1st set transporter	0.6052	0.02	0.5672	0.6567
2nd set transporter	0.6960	0.02	0.6433	0.7350

APPENDIX E

Cost Analysis

Cost Analysis (As-Is, Scenario II, and scenario IV)

Cost Analysis (As-Is Model)		
Cost	Baht	Baht/Month
Operation Cost		
- 50 Trailers (x100 cntr. x26 days)	3,100/Container	8,060,000.00
- Outsourced Trailers (x30 cntr. X26 days)	**3,600/Container**	2,808,000.00
- Warehouse Cost (x130 cntr. x26 days)	180/Container	608,400.00
Total Cost		11,476,400.00

Cost Analysis (Scenario II)		
Cost	Baht	Baht/Month
New CY RYS		
- Lift on/off machine + Workers	180,000/Month	180,000.00
- Rent Cost (CY RYS)	130,000/Month	130,000.00
Operation Cost		
- Two set of Trailers (x130 cntr. x26 days)	3,000/Container	10,140,000.00
- Warehouse Cost (x130 cntr. x26 days)	180/Container	608,400.00
Total Cost		11,058,400.00

Cost Analysis (Scenario IV)		
Cost	Baht	Baht/Month
New CY RYS		
- Lift on/off machine + Workers	180,000/Month	180,000.00
- Rent Cost (CY RYS)	130,000/Month	130,000.00
Operation Cost		
- Two set of Trailers (x130 cntr. x26 days)	3,000/Container	10,140,000.00
- Warehouse Cost (x130 cntr. x26 days)	540/Container	1,825,200.00
Total Cost		12,275,200.00