



CHAPTER 4

Data Analysis and Results

This chapter presented the data from secondary data sources for exploring, analyzing, and developing the proposed model from a case study. Then observing how the case study company applied the proposed model of green issues was influencing the process of improving as the contributor to innovation and presented their practices and results for further analysis. The next part explained the results of extending the proposed model to other stakeholders that aimed to obtain their attitude and perception towards green logistics. This research was extended beyond the environmental aspects of green supply chain management and green logistics innovation within the wider framework of sustainable development and relating to social issues, since the environmentalism mindset trend has been emerged.

4.1 Data Preparation

4.1.1 Operations and logistics of pharmaceutical distribution practices and carbon emission

Same as many organizations focused to improve their effective, efficiency and increasing customer satisfaction, the case study company also intended to increase work efficiency and effectiveness by applying total quality control issues related to the law and regulation, comply with safety issues and cost reduction that concerned less about environmental issues. The company objective, strategy, and planning focused to control all the quality of the operation and logistics procedures according to the nature of the business, which require premium standard of service for distributing the pharmaceutical product to all healthcare service providers. The case study put their effort to develop and improve technology system solutions, facilities, devices, including RF device, temperature devices, warehouse system, and transportation equipments. The improvement based on the increasing demand of

customer and advancement of technology and set up the KPI related to the efficiency of work process for many decades. As this case study is done in collaboration with one of leading pharmaceutical distributor which gained a market share of more than 37.50% in year 2008, which is approximately THB 37,000 billion and with a distribution coverage of 38% of total 43,258 healthcare outlets in year 2006 based on the Thailand health profile 2005-2007 report. It presented that this case study company's operations and logistics activities create quite big impact to environment more than other medium and small organizations and also, it was a key connection of pharmaceutical logistics distribution channels.

This study began to gather all potential secondary data, including carbon footprint reports, previous operations and logistics KPI reports, customer feedback reports, and related cost of operation, these data were used to define the proposed model, potential activities to be for improving of company environmental performance and analysis. This study defined the assessment methodology to obtain the data related to carbon footprint by observing and gathering data of activities which potentially led to greenhouse gas emissions, such as energy consumption data, including electricity, gasoline, diesel, and chemical consumption data which included the amount of using leaking refrigerants and business travel data. Then study the emission factor which is the emission rate of the greenhouse gas emissions for the each specific activity or fuel consumption. With gathering the data from secondary data sources, the majority of emission factors used in this study were based on intergovernmental Panel on Climate change (IPCC). This data excludes the carbon emission create from office paper due to the various types of paper to be used and limited to gain the information from its suppliers that require to collect the data from the plant type they use, fuel consumption, water consumption, energy consumption for producing the paper from their factory. Then, the data was classified in two components, which was the value of carbon emission that was generate by current operations and logistics activities prior to applying the proposed model related to green concept; the second part presented the current practices of operations procedures and

explored the enhancement areas to implemented the proposed model that reduced the environmental impact. Moreover the data was presented as approximate number due to the information and market concern.

4.1.1.1 Carbon emissions generation

Based on the case study report the overall operations and logistics activities of the case study company generated the carbon emission approximately 9,200 tCO₂e in year 2007. The 2007 carbon emission was increased from 2006 in the amount of approximate 8,000 tCO₂e or 15.00% via-versa business growth more than 16% as presented in Figure 18. The carbon emission of this case study was calculated from the energy consumption of fuel consumption, liquefied petroleum gas, refrigerant, grid electricity, and air transport compare to overall business transactions in term of amount and business value.

Overall Carbon Emissions in 2006/2007

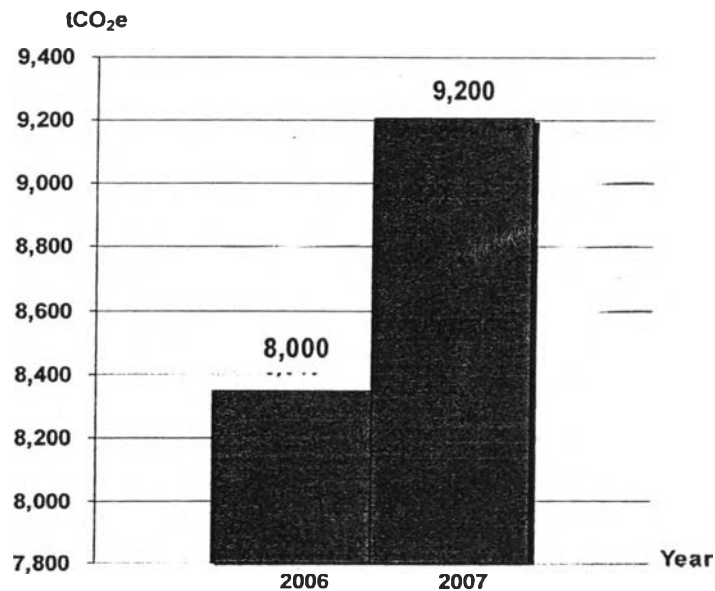


Figure 18: Overall carbon emissions in year 2006-2007

Source: Carbon footprint report of a case study in year 2007

Comparing the carbon emission by sources in Figure 19 presented 63% carbon emission of fuel combustion from overall sources in year 2007, approximately 5,624 tCO₂e and it calculated from diesel consumption, LPG consumption and gasoline consumption. The grid electricity that created carbon emission of 33% was approximately 3,184 tCO₂e and 4% of refrigerant which was approximately 378 tCO₂e. With the carbon emissions split by sources of year 2006 and year 2007 was presented in Table 11. The emission from fuel combustion had the highest share in both years and grid electricity was the second and refrigerant was the third emission source in year 2006 and 2007. The carbon emission from air transport gained the smallest share with the percentage share of less than 1% which was not show on the chart.

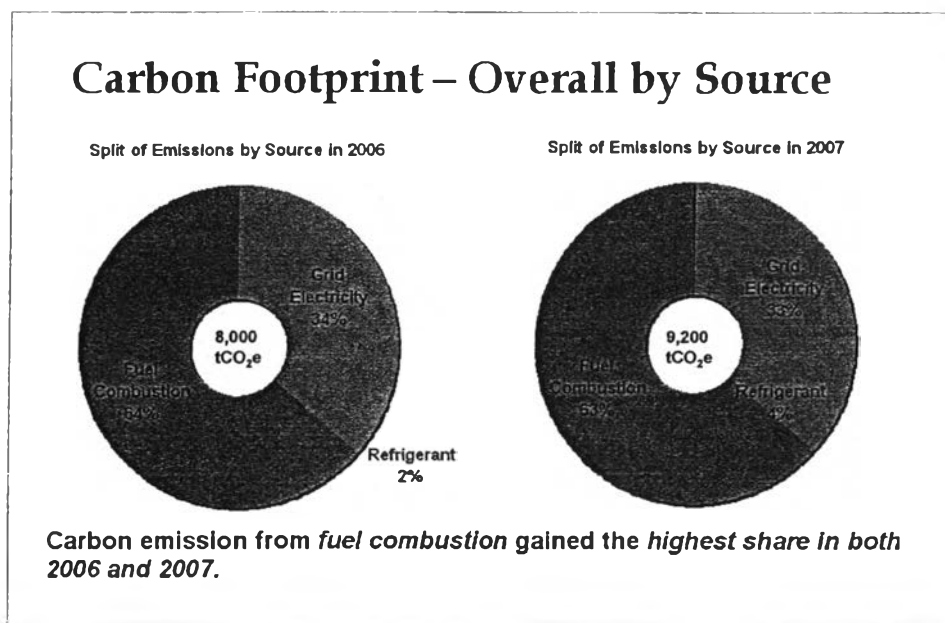


Figure 19: Carbon Footprint Results by Sources

Source: Carbon footprint report of a case study in year 2007

Table 11: Carbon Emissions Split by Sources in year 2006-2007

Carbon Emissions Split by Sources	2006	2007
	Carbon Emission (tCO ₂ e)	Carbon Emission (tCO ₂ e)
Grid Electricity	2,720.50	3,184.17
Refrigerant	160.00	377.90
Fuel Combustion	5,107.00	5,624.48
Air Transport	12.50	13.46
Total	8,000.00	9,200.00

Source: Carbon footprint report of a case study in year 2007

In term of business units presented in Figure 20 and Table 12, in year 2006, the carbon emission mainly came from distribution centers and transportation with the percentage share of 33% and 31% respectively. The third contributor came from main business travel with the percentage share of 27%. But in year 2007, the highest emission contributed from transportation with the percentage share of 37% and the distribution centers and main business travel contributed 33% and 22% respectively as the second and third emission contributors. (See: Appendix B for the relevant carbon emission factors)

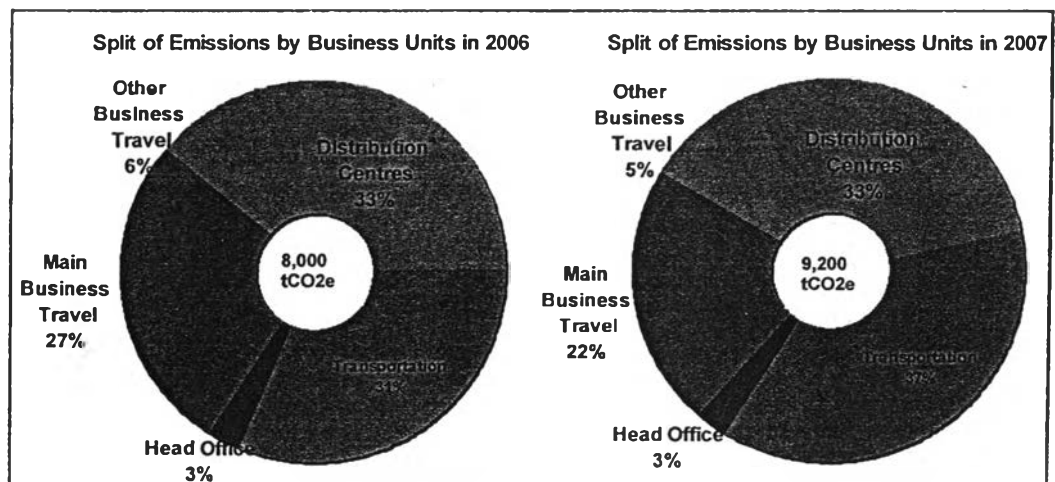


Figure 20: Carbon Footprint Results by Business Units

Source: Carbon footprint report of a case study in year 2007

Table 12: Carbon Emissions Split by Business Units in year 2006-2007

Carbon Emissions Split by Business Units

Item	2006	2007
	Carbon Emission (tCO ₂ e)	Carbon Emission (tCO ₂ e)
Distribution Centers	2,640.00	3,213.66
Transportation	2,480.00	3,502.51
Head Office	240.00	272.17
Main Business Travel	2,160.00	1,736.40
Other Business Travel	480.00	475.27
Total	8,000.00	9,200.00

Source: Carbon footprint report of a case study in year 2007

In Table 13 was presented the details of carbon emission calculation by emission source in each business unit of year 2007. The carbon emission data in this study is based on the assumption of activities which potentially lead to greenhouse gas emissions and follow the emission factors of IPCC.

Table 13: Carbon Emissions Calculation

Carbon Emission Calculation by Emission Source in each Business Unit in 2007

Emission Source	Activity Data (A)	Unit	Emission Factor (B)	Unit	Carbon Emission (tCO ₂ e) (AxB)
Transportation					
Diesel Consumption	1,184,060.00	litre	0.0027	tCO ₂ e/litre	3,196.96
NGV Consumption	85,017.00	kg	0.0026	tCO ₂ e/kg	221.04
Leaking Refrigerant (R134A)	0.065	tonne	1,300.00	tCO ₂ e/unit	84.50
Distribution Centres					
Electricity Consumption	5,200.00	MWh	0.56	tCO ₂ e/MWh	2,912.00
Diesel Consumption	1,680.00	litre	0.0027	tCO ₂ e/litre	4.54
LPG Consumption	1,200.05	kg	0.0031	tCO ₂ e/kg	3.72
Leaking Refrigerant (R404A)	0.09	tonne	3,260.00	tCO ₂ e/unit	293.40
Main Business Travel					
Gasoline Consumption	471,842.00	litre	0.0022	tCO ₂ e/litre	1,038.05
Diesel Consumption	258,647.00	litre	0.0027	tCO ₂ e/litre	698.35
Other Business Travel					
Gasoline Consumption	161,044.00	litre	0.0022	tCO ₂ e/litre	354.30
Diesel Consumption	38,023.00	litre	0.0027	tCO ₂ e/litre	102.66
LPG Consumption	1,567.00	kg	0.0031	tCO ₂ e/kg	4.86
Air Transport	134,582.00	km	0.0001	tCO ₂ e/km	13.46
Head Office					
Electricity Consumption	486.01	MWh	0.56	tCO ₂ e/MWh	272.17
Total					9,200.00

Source: Carbon footprint report of a case study in year 2007

4.1.1.2 Current operations practices and enhancement plan

The pharmaceutical distributor played a crucial role in distributing the products to other stakeholders, including wholesalers, retailers, hospitals, and other health organizations. The firm's need for continuous improvement for sustainable growth and to gain competitive advantages with new strategies, the green issues were considered as new opportunities. Previously, the company focused on improving and increasing working efficiency, effectiveness, and applying total quality management as the core operations management to serve the unique customer demand and comply with the law and regulations of FDA with less environmental concern. Drugs and biological products have unique product characteristics and high risks in terms of quality, it does not only require special treatment and control more than other products, but also the business operation varies by stakeholders of each channel, such as government hospitals which are strict in issuing their orders, using paper as the evidence and complicating the instruction of each purchasing order, even the name of drugs. Especially in the Thai pharmaceutical industry, the operation of government healthcare service providers is different from private organizations and drug stores that have different and unique standards. These factors affected the operation service of a pharmaceutical distributor. As Figure 21, this research will focus to implement the proposed model within operations and outbound logistics regarding the limitation of information security and existing implementation of technology innovation, also it excluded the inventory management and inbound activities in the warehouse for which already many research exists.

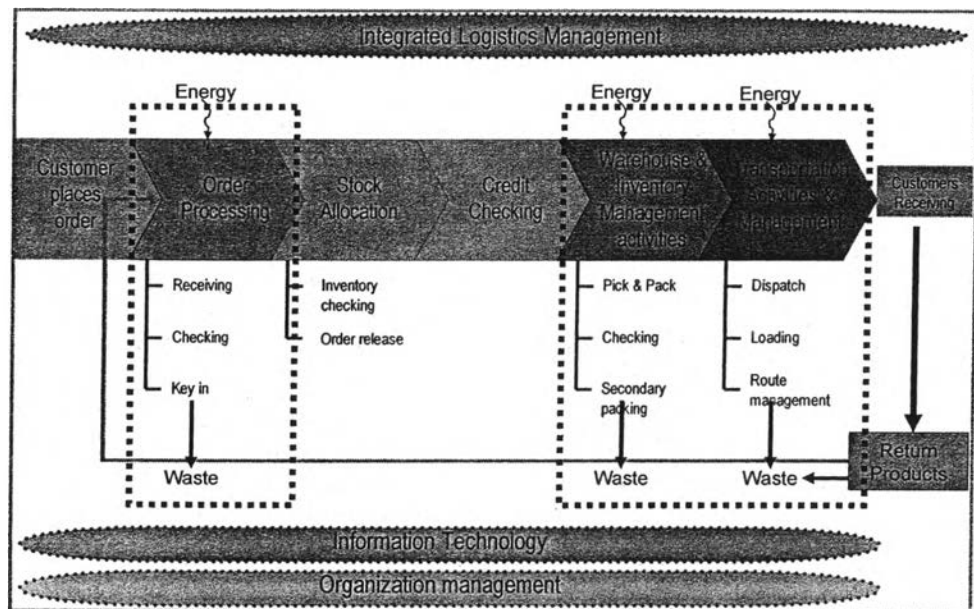


Figure 21: Scope of applying green concept, lean logistics, and tailor logistics as the strategy

Based on the study, the order processing flow started with multiple order sources, including telephone, fax, e-mail, mail, and paper by hand. There was an Internet based system as e-commerce business available for the customer but it had limitation of use due to technology system, infrastructures of each customer, and financial support. Then, this study focused only on the orders that were processed by ordering team which is more than 70% and their activities created the impact to environment. After issuing the order in the system, the stock allocation and credit checking procedure would be processed. Then the order was passed through the inbound logistics part.

At operations point, the total orders per day were approximately 5,000 in average from year 2006 to year 2008, orders came from various sources, 60% of total order sources passed via paper and was used as the mean and reference for issuing orders. The customer placed their order via fax, e-mail, mail, paper on hand or telephone. Current working process based on using paper for various objectives,

sometimes, the paper was used as reference, tracking information, instructions, and evidence of original order sources except telephone and e-electronic orders. The order center staff did not know either the real time order status or if order was rejected due to the limited credit of each customer. The customer or ordering center team would notice the rejected order by credit checking function only when staff contacted back to customer and informed the remit that was rejected order to customer or ordering staff. In the meantime the customer expected to receive the product on the delivery date. Sometimes, it took one or two day to get updated order status, and for the worst cases it took more than four days. Then all parties had to find and tracking back their order number and all reference detail which written on the paper as evidence. This tracking process was quite time intensive for all parties. Most of the times, that critical order paper was copied and sent via fax or e-mail to concerned people more than 3 sets which copy for order part, customer party, and credit function. Moreover, in a serious case of missing issued the order, the apologizing letter was issued. According to this circumstance, more papers were used and it implied more environmental impact.

The smoothness of order flow depended on the clear working process as other factor and human resource is the important part of the organization, especially at ordering team multiple skills of employee are required to process all various customer demands. The errors by human influence the company performance, such as wrong product information key in, price, promotions, and special delivery address of customers. Most of the mistakes occurred from human errors and lack of technology support on daily working process. Hence, raising the proposed model by applying lean principles collaborate with tailored strategy by implementing in operation areas. As the above data from observing the case study company there were several problems occurred which presented in Figure 22.

According to the carbon footprint by business units report, it is assumed that one processed order had the carbon impact of approximately 7.86 kgCO₂e/order in year 2007 and 7.70 kgCO₂e/order in year 2006. It implies that any one mistake order

that had to be reprocessed again created carbon emission of more than 7.78 kgCO₂e per order in average for both years. At this point, there were enhancement areas to improve for both working process and to reduce the impact to environment

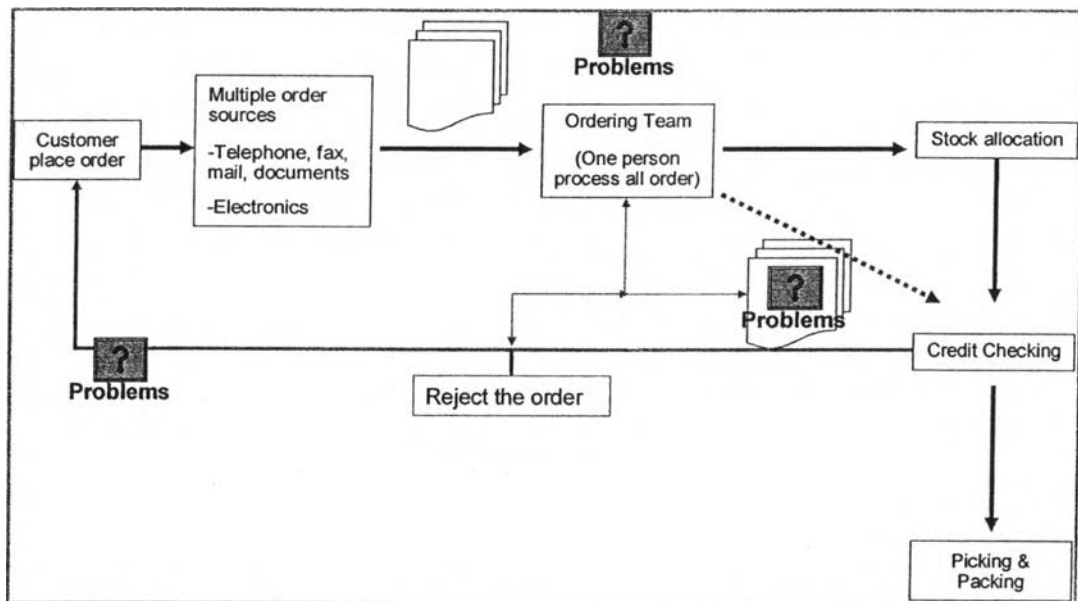


Figure 22: Potential areas to enhance the proposed model into operation practice to process order

4.1.1.3 Current logistics practices and enhancement plan

Since the order was keyed in the system and processed by operations function that completed order was passed through inbound and outbound functions. Based on the observation and data from relevant reports, such as the case study carbon footprints, in term of business unit, the distribution center and transportation contributed the majority carbon emission more than other business units. In order to explore the potential areas to develop and implement the proposed model, this study excluded to study the process and system in the warehousing, including technology system, equipments, machines, devices and reverse logistics regarding the investment cost, technology innovation already existing including the Advance Warehousing

System, Radio frequency (RF) technology and information security. Moreover, there are various researches available in those areas.

According to the observing the case study environment, the management team realized to improve their business procedures by searching for the new strategy and plan, also combine with the secondary data reports presented. The team organized the brainstorming session to explore the ideas for the improvement, then the meeting agreed to begin gathering the relevant information of the shipping container and transportation activities areas which seemed to be the key impact factors toward environment pollutions according to the product characteristics, operate in compliance with law and regulations, and provide the service base on coverage strategy.

Based on the investigation, the case study focused on improvement of service performance, packaging, and delivery of outbound logistics activities. In the shipping container areas, with the good quality of product moving from the manufacturers to customer, the focus on improving shipping materials, methods, and containers are getting strong and more important. For many decades, the improvements focused to protect the products with secondary packaging and protective materials, such as bubble bags, air-filled bags, and plastic wrap with less concern on environmental impact. Moreover, packaging plays a crucial role in distributing products and intends to protect the cleanliness, integrity, freshness of goods, quality, image, and allowing long distance shipping while reducing waste and spoilage. Also, typically different types of packaging material impact the environment in different levels, generally, cardboard/paper and glass have the lowest impact per kg of material, followed by plastics such as polyethylene, polypropylene and polystyrene. In contrast, packagings made from other plastics and from tin-plate (steel) and aluminum has a greater impact on the environment per kg of material. According to the study, though, the total environmental impact of packaging also depends on how much material is required to pack a given quantity of merchandise, for instance, one liter of orange juice.

Nevertheless, most packaging are disposable and creates solid waste, air and water pollution, and energy.

Generally, Thai pharmaceutical industry customers perceive that drug has to be wrapped or put in secondary packaging for quality and sense of ease to carry or distribution within their organization. The regulations of government health institutions, healthcare services providers, hospitals, and different inventory locations to distribute drugs to the patients are other factors that influence the suppliers and distributors to provide good standard shipping containers for convenience as a customer service. Beside, the temperature control is other important factor that affects packaging material and packing practices to protect and maintain the quality of drug. Additional temperature control is an important factor concerned related to drug shipping, as it is required by the characteristic of various drug types. From the study, the author found that there were two major drugs types that required different temperature control, packaging types and materials, which are drug stores under 25 Celsius degree and cold chain drugs. The 25 Celsius temperature drug is packed with cardboard or brown paper box packaging as the second package for shipping with other damage protection materials. The box is used to keep the drug safe during the transportation and to prove that the quality and value of the drug is still same as It has been when shipped from manufacturing. More than 600 shipping boxes and plastics bags per day containing drugs are distributed to all over country to pharmaceutical stakeholders' hand on daily basis. Apart from total shipping packaging per day, there were 400 containers for cold chain packaging.

Moreover, in contrast to room temperature drugs, cold chain drugs are temperature -sensitive products, which is driven by the characteristics of the product. These products are biological and protein-based medicine. The drugs require being stored under different temperature range of a maximum acceptable deviation and from this temperature are defined for the product in three classifications.

- 'two to eight' (+2 Celsius to +8 Celsius) – must not freeze or be warmer than 8 Celsius;

- '-20' (-20 Celsius) – must never be warmer than -20 Celsius; and
- 'room temperature' (+15 Celsius to +25 Celsius) – must remain in this range.

Since the market of cold chain logistics tends to be growing, increasing requirements, cost driven but sensitive to high values and risks. The cold chain market is a high demanding healthcare market with enormous product values transported and increasing stringent requirements from the laboratory on quality, FDA regulations, and the cost which are the driving factors of logistics industry. The key of each successful cold chain is a packaging and transport solution, which is selected by the shipper and applied by all parties involved in the entire cold chain process. In the pharmaceutical industry, the temperature- sensitive products directly affect the logistics cost in the aspect of product safety and quality. At various stages of transportation it is required to apply different logistics solutions, including minimum number of days and hours, control temperature materials to keep the product within the desired level regardless of ambient temperatures. Therefore the more requirements on product safety and quality of cold chains products, there are more factors that directly impact the total logistics cost of the distributor.

The packaging practice for cold chain products, Styrofoam boxes are used as the container to protect cold chain drugs as same as the second packaging with control temperature between 2- 8 Celsius during shipping route. In the most cases they can only be used once according to the customer perception to open the box and transfer the product to their refrigerator after writing down their signature on the paper. In some case, customers want to reuse it and repack the small size to their patients. Therefore, Styrofoam boxes have a negative environmental effect with large amounts of packaging being thrown away at destination. Additional packaging material, including bubbles to fill up empty corners of the box, ice packs, and plastic cardboard collaborate with packing practice method to control the temperature during delivery route. The process of preparing packing materials uses substantial energy and electricity. These

practices affect to the labor cost and environmental impact then the initiation of new process of working of green concept is raised.

To explore the new way for competitive advantage and cost reduction parallel with environmental-friendly concept. Then green concept and lean principles has been applied in cold chain products as the first phase with focusing not only the operating and controlling the procedures comply with the regulatory requirements but also to save the total operating cost by reducing losses in the strive to preserve product quality which illustrated in Figure 22.

Apart from gathering data within shipping container areas, as the carbon footprints report based on business units, the transportation activities created a big impact to environment directly and indirectly. Especially, most technology relying heavily on the combustion of hydrocarbons, with the internal combustion engine, the impacts of transportation over environmental systems has increased with motorization and traffic congestion. Transportation activities not only consume a huge amount of energy, especially oil, gas, and water but also affect the operation cost of business. Vehicles emit numerous pollutants into the air, water, soil and human life, such as carbon dioxide, nitrogen oxide, and noise and damaged many ecological systems. As drug consumption in Thailand is growing, there are currently more than 5,000 round trips of products ship to the customer locations all over the country on daily basis.

The case study company had a distribution center that was located in the central region of Thailand. The insourcing transportation was used for Bangkok and vicinity delivery. For upcountry customers, all the transport operations were conducted by third party logistic providers in those regions (Local 2PL). This decision was due solely on financial factor because the upcountry customers were scattered and fewer in number when compared to Bangkok and vicinity, making it not worth to apply insourcing. In addition, the upcountry customers had low daily volume sales which led to low volume per order and also required the case study company to invest in cross-dock facilities in each of the upcountry regions for its transport operations.

As Figure 23, displayed their distribution logistics coverage where dark dots represented customers in Bangkok and Vicinity, and gray dots represented customers in upcountry locations.

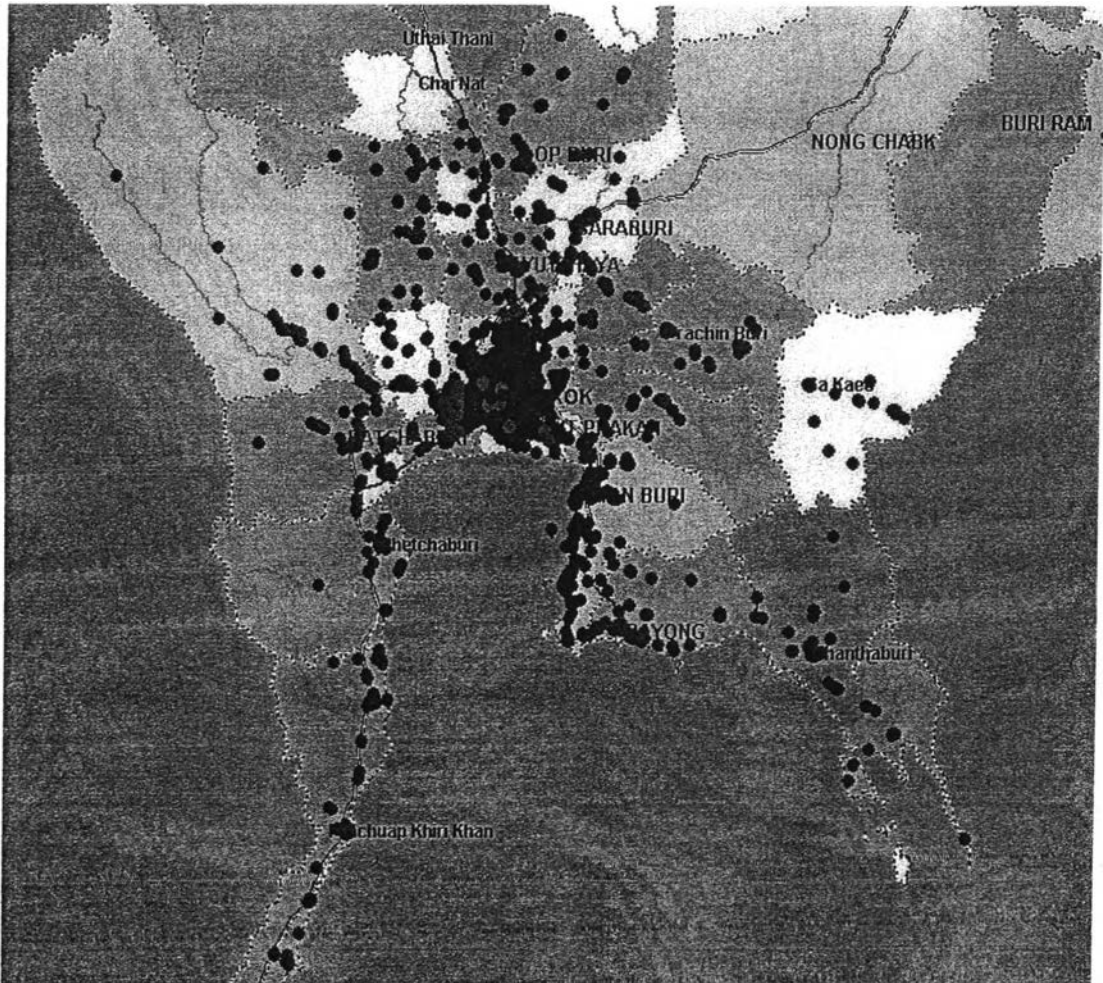


Figure 23: Distribution coverage of the case study company

Source: Secondary data report of case study in year 2008

Bangkok and central accounted for 62% by volume and 69% by value of all deliveries. The rest of the upcountry regions are evenly distributed. For Bangkok sales tended to be high in value but low in volume as presented in Figure 24 a) and b).

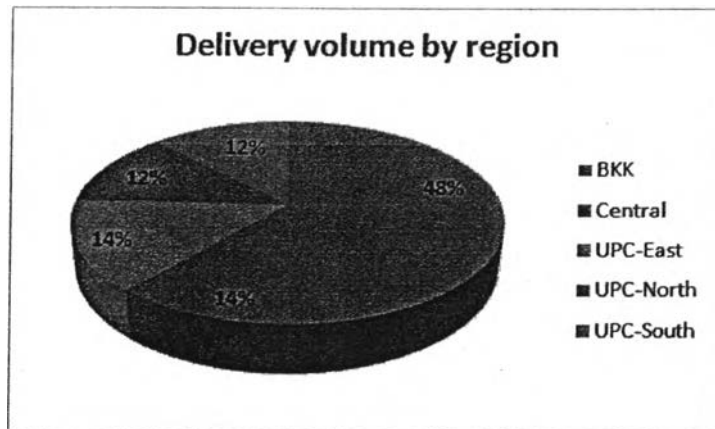


Figure 24 a): Percentage of deliver to each region base on volume



Figure 24 b): Percentage of deliver to each region base on value

Source: Secondary data report of case study in year 2008

There are two main types of customers Ethical and OTC. Ethical referred to hospitals, clinics, district health care service centers, suburban health centers, and research institutions. OTC refers to "Over the Counter" meaning the prescriptions drug stores. Ethical and OTC were in separated sections of the warehouse and handled differently. Ethical customers are the biggest segment by delivery volume and value. For order from Committee on Safety of Medicines (CSM), its sale volume was very low so that it could be neglected from the analysis which is presented in Figure 25 a) and b).

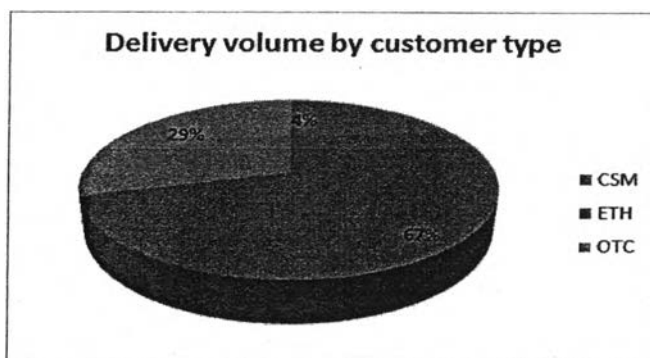


Figure 25 a): Percentage of deliver volume by customer channel

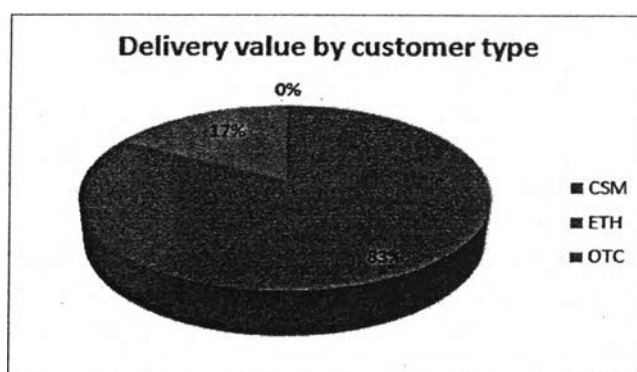


Figure 25 b): Percentage of deliver value by customer channel

Source: Secondary data report of case study in year 2008

By looking at geographical analysis in Figure 26 a) and b), 54% of the customers were located in Bangkok and central region. The rest of the upcountry regions were evenly distributed. The two main customer segments were Ethical and OTC.

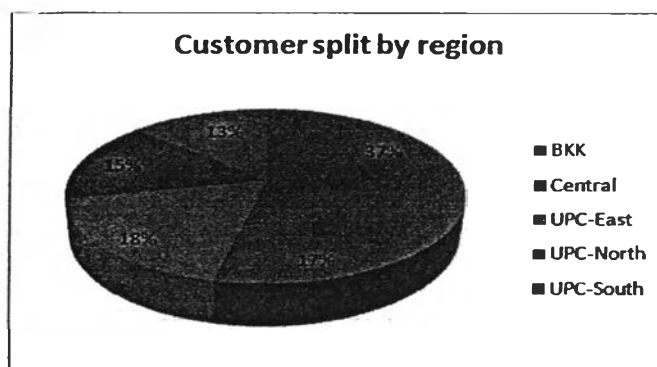


Figure 26 a): Percentage of customer base on each region

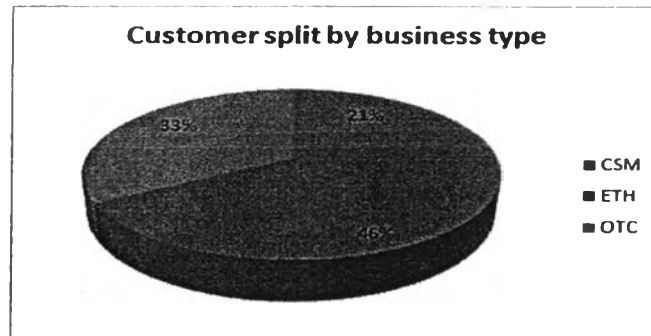


Figure 26 b): Percentage of customer base on each region

Source: Secondary data report of case study in year 2008

Therefore, as the above data, the improvement plan focused to explore and address relevant activities with customer who were located in Bangkok, vicinities, and central areas and customer of ethical and drugstores channel which implied that the majority of business activities related to these groups created the impact to environment.

Previously, case study company's fleet management focused to serve all customers within the country by removing or minimizing the risks associated with vehicle investment, improving efficiency, productivity and reducing their overall transportation costs, providing 100% compliance with government legislation (duty of care) and many more. Especially, the purpose of market coverage strategy drove the company to manage and arrange their vehicles respond to the customer demand, customer inventory management strategy as Just-in-time (JIT) and time commitment in term of increasing the number of vehicles but for other region, the hub management managed by sub-contractor was implemented, which was excluded from this study.

Therefore, it could be concluded that prior to applying green concept and lean principles, the case study company strengthened their business by focus to control the process quality, product quality, safety, premium standard for packaging and as delivery is the key factor for distribution product from manufacture to customer, the company managed their business by coverage strategy to provide better service, gain competitive advantage, focus to achieve delivery on time KPI with less concern on

environmental impact. As Figure 27, it presented that there were potential to address the activities that improve company environmental performance in both shipping container area and transportation areas.

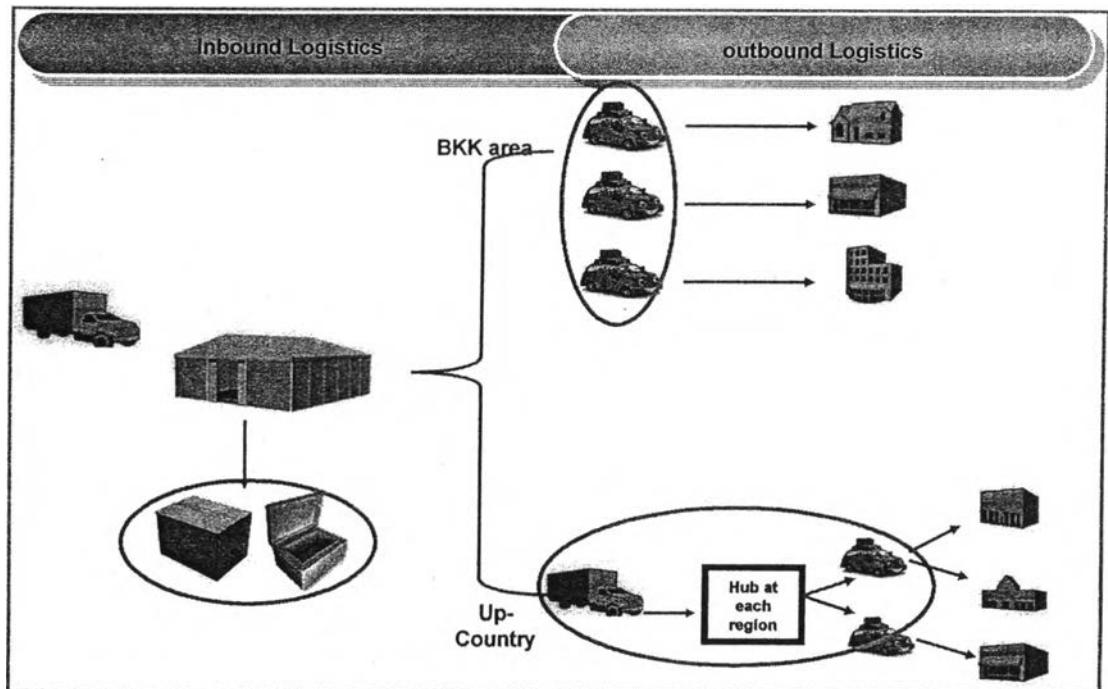


Figure 27: Potential areas to enhance the proposed model

4.2 Developing the proposed model

Literature review and collection of data from conducted case study research was used to develop the proposed model. This paper began by exploring previous functional specific research on aspects of green supply chain management, green innovation, and green innovation process collaborate with lean principles and tailored strategy. This study developed the proposed model by employing the exploratory model technique which was one development process model types that suited for the situation that was very difficult, impossible, to identify any of the requirements for a system at the beginning of the project. Most researches in these areas were based on guess-work, estimation, and hypothesis. In these cases, an assumption was made as to how the system might work and then rapid iterations are used to quickly incorporate suggested changes and build a usable system. A

distinguishing characteristic of the Exploratory Model was the absence of precise specifications. Validation was based on adequacy of the end result and not on its adherence to pre-conceived requirements. (Center for Technology in Government University at Albany, 1998; Ghobadian and O'Regan, 2000). The exploratory model composed of four steps which were Initial Specification Development with using whatever information was immediately available, second was System Construction/Modification which was a system that created and/or modified according to whatever information is available, third step was System Test which was a system that tested to see what it did, what could be learned from it, and how it may be improved. The last step was a System Implementation as "finished" and implemented.

The first step of this proposed model is based on the common goal and integrated philosophy practiced by producers of goods and services that focuses on satisfying the needs of consumers over the needs of the producing company. Adding with the marketing concept which is a management orientation for the organization to establish relationships with selected individual target customers with whom superior customer values are designed, offered, redefined and realized in close cooperation with other partners in the marketing system such as suppliers and intermediaries, in order to realize long-term profits through customer satisfaction, partner- and employee satisfaction (Janny , Peter, and Dick 1999). Then, this proposed model started with identifying customer need as the clue for developing green practices.

Second step was the analysis step based on the exploratory model technique collaborates with the nature of the business and observing the case study. This study employed value chain analysis as a tool to identify the link of case study activities as a big picture and using information to tailor or address the activities for environmental improvement. The value chain is a systematic approach to examining the development of competitive advantage. It was created by M. E. Porter in his book, *Competitive Advantage* (1985). The chain consists of a series of activities that create and build value. They culminate in the total value delivered by an organization. The

'margin' depicted in the diagram is the same as added value. The organization is split into 'primary activities' and 'support activities', which is presented in Figure 28

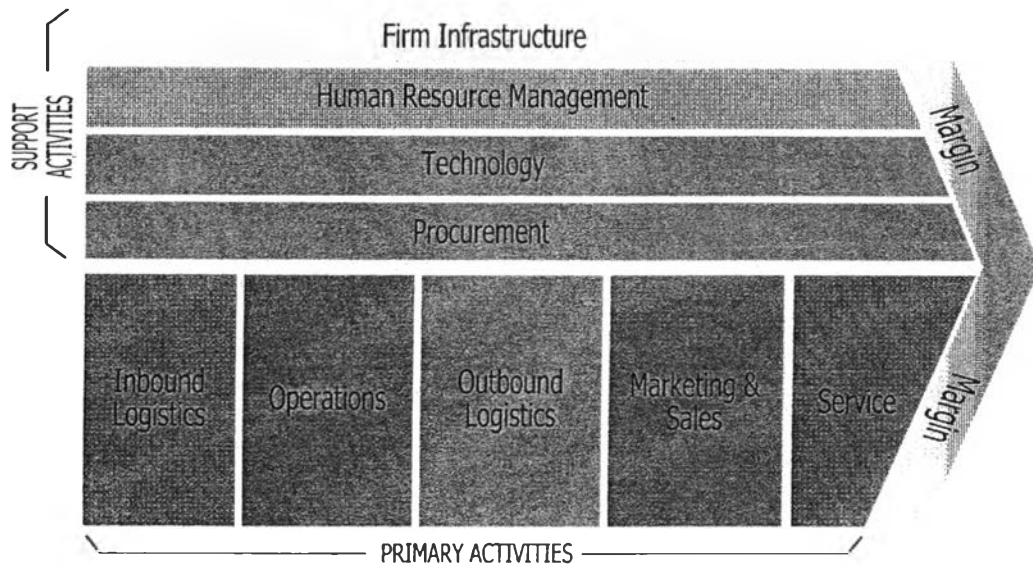


Figure 28: Value Chain Analysis

Source: M. E. Porter in his book, Competitive Advantage (1980)

Third and fourth step were applying the green logistics concept within the setting up company goals and objectives at the beginning for creating the company strategy, developing plans, and activities. Regarding observation the case study, in the previous, the company focused to develop and improve the operation without environmental concern. This empirical study aimed to push the green concept at the first stepping stone to explore the different outcomes and test it as the pilot project for new competitive strategy.



Next, the fifth step, at the phase of creating the implementation actions plan and strategy, as observation and analysis this study embraced the lean principles and tailored strategy which aimed to emphasize the integration of logistics services with the core product in order to give each customer a value added product which has been tailor made according to individual requirement.

Next, the sixth step was to set up the measurement tool of working efficiency, effectiveness, and Performance Indicators to validate this proposed model and that might lead to new strategy for sustainable growth which presented in below Figure 29. Then, this study would test this proposed model by implementing it within case study company.

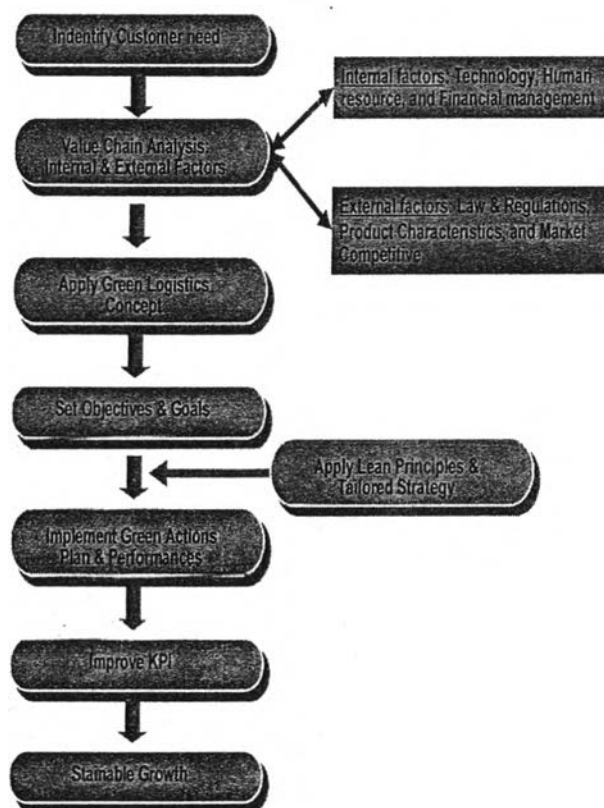


Figure 29: The proposed model base on green process innovation concept for implementation.

4.3 Data Analysis: Analytic techniques for case study

4.3.1 Implementation the proposed model and analysis

This study aimed explore green innovations and to tailor make logistical activities that raised as an inventive way of creating value for customers and sustainable growth for pharmaceutical logistics service providers in Thailand. All information from secondary data report such as carbon emission report, financial report, performance tracking report, KPI report and customer feedback report were reviewed. The brainstorming meeting was set up to draw the ideas from applying proposed model in operations and logistics areas and to examine an implementing new model that was tailored for pharmaceutical company including order process, ordering mistake-proofing, logistics procedures that lead to cost-effectiveness and smooth delivery to customers, and energy saving that can reduce the carbon emission. Working on green concept took place for a number of years and many companies have established routines practices and developed tools for introducing and implementing green concept and lean thinking. The next section would present how the proposed model was applied within the case study.

4.3.1.1 Identify customer need

To implement the proposed model began with identifying customer needs as the first step base on the information of secondary data report of the case study company. Regarding to the limited budget and time, the customer satisfaction survey in year 2007 and yearly customer feed back report of year 2007 and 2008 were used for exploring the customer needs in this study for cross- checking information.

The customer satisfaction survey was conducted among top 20 customers of the case study company base on value by depth-interview, it aimed to seek for genuine customer satisfaction and guiding operations areas of improvement

required. In Figure 30 presented the survey results of customer satisfaction with the service compare to case study competitor by operations functions that customer usually contact with. It was the crucial time for the case study company to increase their customer satisfaction more than their competitor in every service functions. Especially, order processing functions had the lowest score, which was 76% compare to other functions or even the competitor, 78% the professionalism and communications, and 79% distribution efficiency had second and third lowest score compared to the competitor. As mentioned previously, this study excluded to investigate the credit, inventory and collection functions.

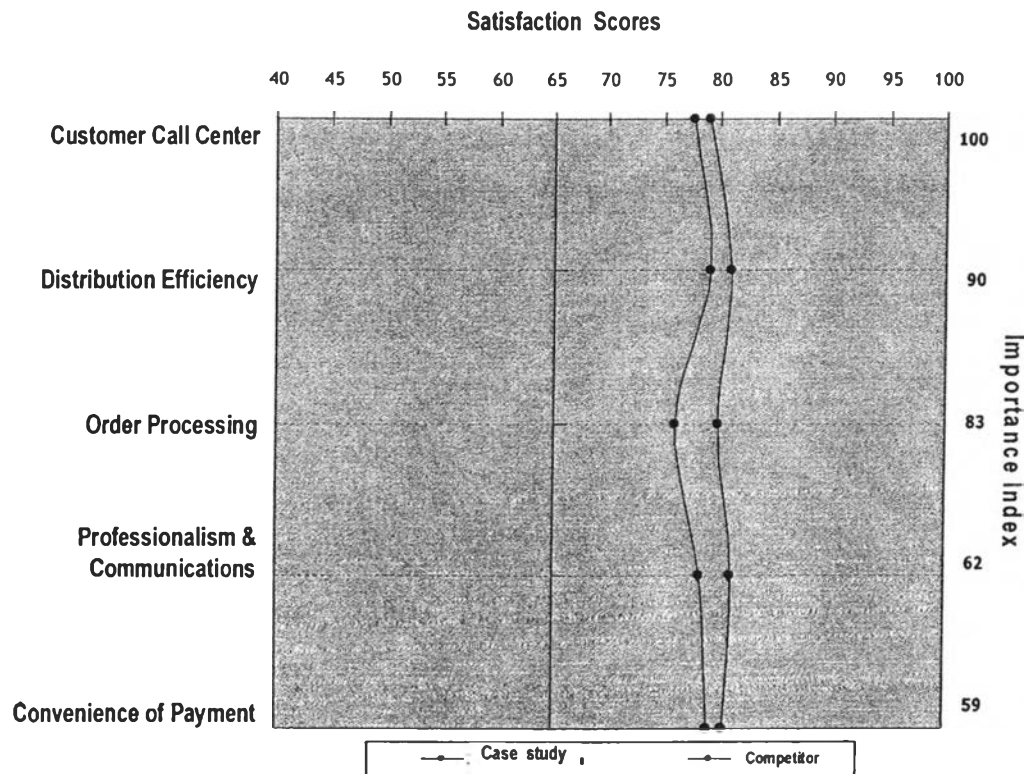


Figure 30: The customer satisfaction toward company service

Source: Company secondary data report in year 2007

As order processing function was a critical area to put more effort as Figure 31 presented more detail on each index related to the order working process. Ease of placing an order (getting through) via phone index had lowest scores which was

70%. It sounded like the customer had the problems to contact ordering center staff to place their order due to busy phone line. The second index was speed of answering phone (response time) was 73% and speed at which queries are dealt with (not frequently redirected or put on hold) was 73%. The third index was notification to customer when certain medicines ordered are out of stock. It could be assumed that the customer disappointed with the available telephone line, even the case study company set up the automatically redirect to the next line until it ended at the last line in the group when a line was busy. At this point, it could be concluded that the ordering process functions had to be seriously investigated and improved.

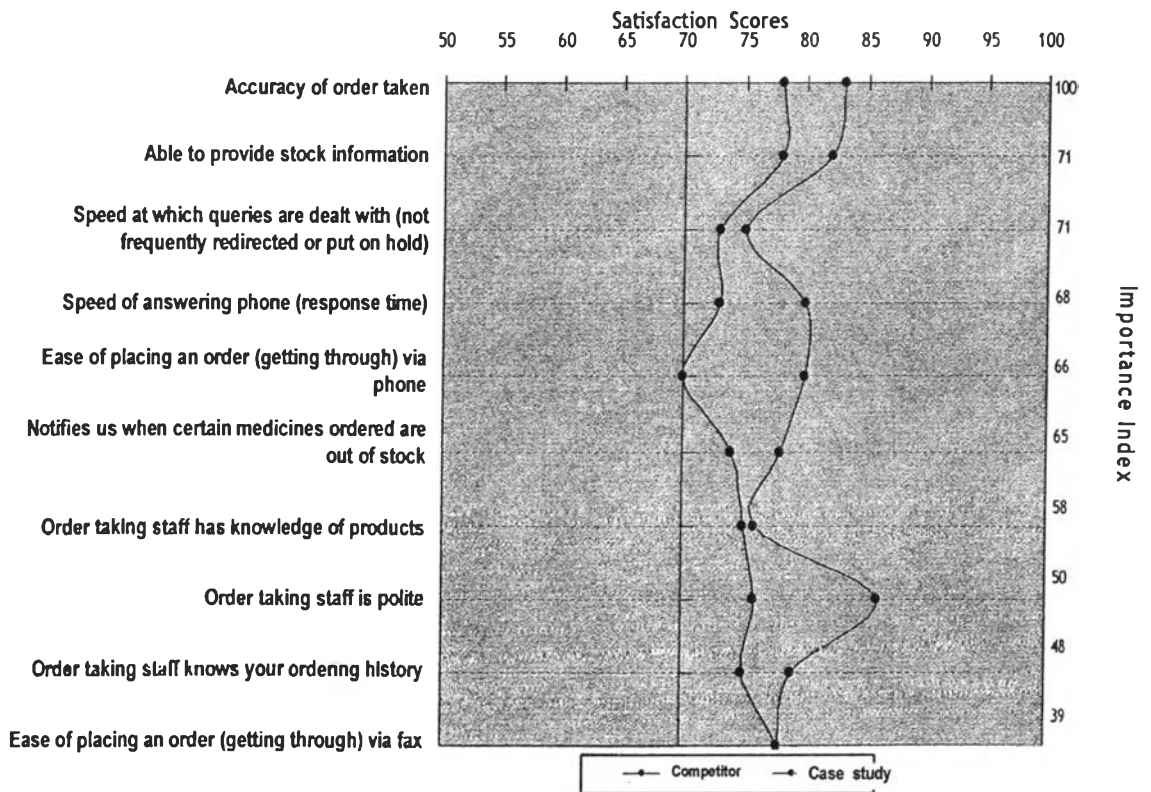


Figure 31: The customer satisfaction toward order processing

Source: Company secondary data report in year 2007

Second lowest score function was the professionalism and communications index as presented in Figure 32, which the understanding of the customer business process had 72%, in the meanwhile, 73% for the easy to reach

process personnel (not put on hold for a long time), and 75% for the good follow up to queries & complaints respectively. It seemed that the customer want the service provider understand their business process regarding to this pharmaceutical industry deal with the life and health of people, also with the nature of placing the order of hospitals or health institutions require the evidence, comply with the law and regulation and using more paper as the reference in every step of their process. If any mistake occurred only on one quantity or product, then that order had to reprocess again..

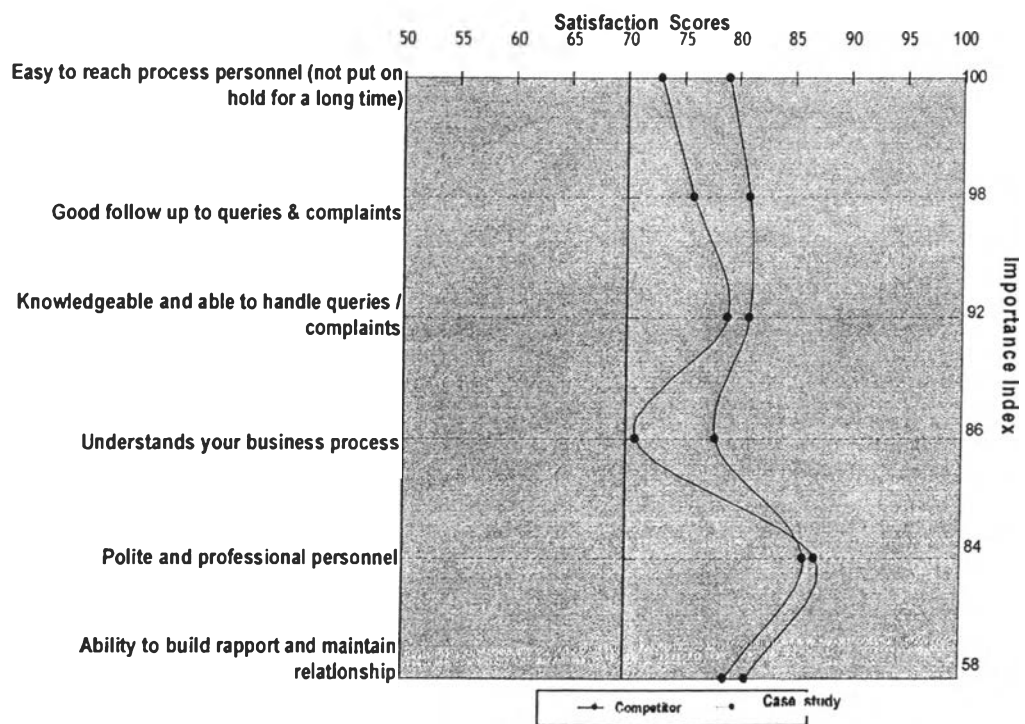


Figure 32: The customer satisfaction toward professionalism and communications

Source: Company secondary data report in year 2007

The third lowest score function was distribution efficiency index as presented in Figure 33, the percentage of willing to rearrange time if the customer are not available was 70%, and 72 % of delivery staff are able to handle queries, and 76% of accuracy of deliveries for the right products and quantities were the second and the

third index. It presented that the customer demanded to re-arrange the deliver time for them in case they were inconvenience to check their arriving product but it would cost to the company to satisfy all customer need but eventually there would be some solution to satisfy both parties. The other two indexes show that the company should provide good training for the staff to handle customer inquires at point of service with accuracy.

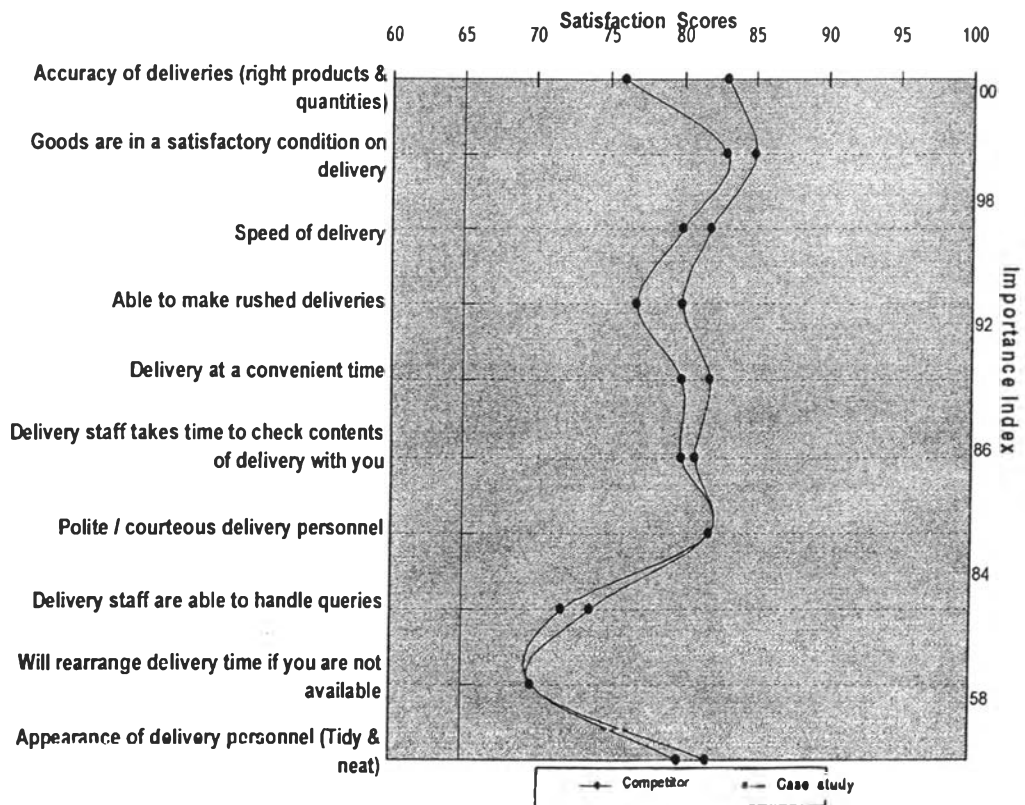


Figure 33: The customer satisfaction toward distribution efficiency

Source: Company secondary data report in year 2007

Adding information of customer feed back toward the case study service, top 5 topics in year 2007 of customer feed back on the company services were the follow up delivery order, tracking order status, placing the order through customer service center instead of ordering center, inquiry on the general information, and need

visit of sale representatives, respectively. In Figure 34, these top 5 reasons represented 80% of overall customers' feedback toward company's service. This study focused to get the components of each topic

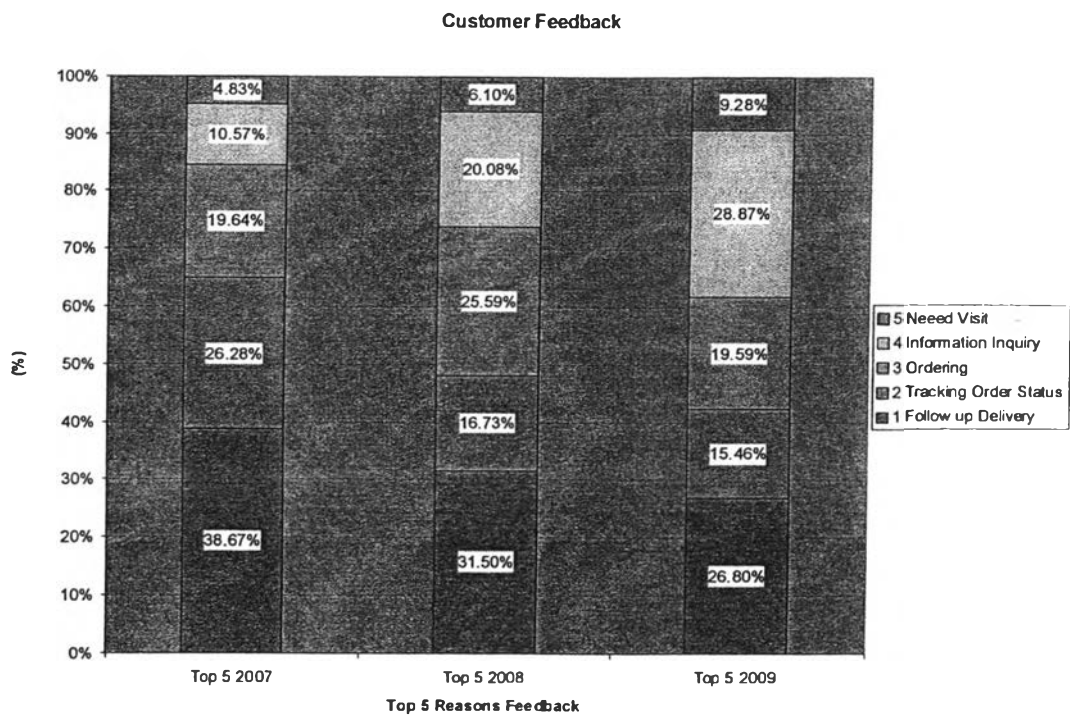


Figure 34: Current customer feedback

Source: Secondary report of customer feedback in year 2007

Based on information of both reports, customers had different needs, however they had common expectations for the order accuracy, delivery on time, and professional performance for handling their inquiries. Nevertheless, the importances of these expectations depend on the type of product and service they require. Customers expected a level of service that appropriate for their type of purchase, which high value of product require special process to protect the quality and safety.

The follow up delivery index and tracking order status had the highest percentage proration due to the customer expected to get the product within one day as the company service commitment but most of them want to know the updated status of order in term of stock available, had ability to purchase under their credit limit and

especially, the receiving product time. As explained previously for the nature order sources, sometime customer placed their order via sale representatives and got the commitment information from those sale representatives to issue orders but after the sale representative issued the order via electronic device, they were limited to get the updated status of complete order at real time. They had to wait for an hour to know their order passed or was rejected according to which types of reasons. Even the order staff had limited access to be informed for the reject order by credit limit.

Third reason, orders were taken by customer service center instead of ordering center team according to the limited capacity of call available, human resources, overlap job responsibility and limited of human skill regarding to the complex conditions of each customer requirement to issue the order such as government policy, accepting expiration of drug policy, law and regulation, price bonus contract, license, special packaging and inventory branches. These factors and the context for issuing the order require special human skill for manual process and took time to finish each order. Then this study focused to implement the proposed model in this area as its beginning process of handing the customer need to satisfy them.

The forth and fifth feedback is related to the updated information on product information, stock available, credit limited, market promotions, and cross checking special trade deal of competitor. During the order flow, there was missing communication, some case the order can not be released or even cancelled according to many factors, such as credit limit of customer, no stock available, waiting for repacking, waiting for approval for all unmatched information from price set up and unclear order instruction written on the paper. Sometimes, it depended on the market situation, including unexpected high demand regarding diseases season, accident, government policy and customer's inventory holding stock policy. Theses factors affected to the customer behavior to follow up their product. At these points, the solving problem time of customer inquiry vary by the company size and their internal procedures, such as the wholesaler might took time to inform order status to their

customer faster than big distributors.

Base on this observation, customers have expectations of quality, service level of pharmaceutical service provider and accountability on firms reputation. It could conclude that the standard service level that they expect to receive related to the delivery time commitment, order status, availability of company staffs to serve them every time they need, and require customer relation activities, especially operate the business in Thailand which base on the friends, family, and society culture. It seems that communication message, context, flow, clear information and data, and updated information are the crucial factors that companies have to focus on. Moreover customers need quick respond actions when a problem or question arises. Everyone had a need for recognition and likes to be treated as a 'priority'. Then as this research results, customers needed and expectation from service provider could be indentified as below and these factors were considered for set up the strategy, plan, and company KPI.

- Updated real time information related to order status, delivery time and date, and limitation
- Clear information
- Accuracy and accountability
- Availability
- Commitment

4.3.1.2 Analysis the operations and logistics procedures by Value Chain as a tool

Next step of applying this proposed model were analysis all contexts and factors through well known model-the value chain model to understand more on operations and logistics procedures that objected to improve and provide better service

to customer and finally, lead them to be loyalty customer.

The analysis by value chain model aimed to understand and analyze activities that needed to be addressed and were essential to implement green innovations for pharmaceutical logistics service providers, including product owners, distributors, wholesalers, and retailers. Additionally, to identify which green innovation strategy, tailor activities and lean logistics philosophy could be applied and utilized by pharmaceutical service providers.

Primary Activities.

Inbound Logistics.

This area, most activities related to receiving the product from suppliers and products are stored in the warehouse until customer place their order. Products were moved around the organization. Most drug imported from abroad which were required to repack, rewrap, change label and leaflets regarding to the local law and FDA's restriction. Sometimes, B2B organization and government institution requested special packing, billing format, or even difference process from standard practices. These complicate demands effected the using of office supply, human resource, and energy consumptions that created the pollution to the environment by direct and indirect way

Operations.

The operations in this study classified as the activities of ordering process, inventory management, and credit process. As mentioned above, applying green issues was discussed and the proposed model embraced with lean principles collaborated with tailor strategy were implemented within order area as the beginning step for eliminate all waste in the operations flow and exclude the inventory and credit areas according to the support information.

Outbound Logistics.

The activities of outbound logistics along the supply chain to

wholesalers, retailers or the final consumer consist of picking, packing, wrapping, delivery products to customer, and receive the return from customer. Majority environmental impact occurred from outbound activities, especially packing process and delivery process.

As observing results and mentioned above, especially packing activities created the pollution more than other areas. The procedures and systems appear too complex to surmount the problems and also the investment for implementing green innovation process was considered. Finally, a case study company started to make green concept happen within cold chain areas first as its high requirement, demands, high risk, and has been created environmental impact more than normal drug. Then the protocol for packing procedure was evaluated and implemented.

Marketing and Sales.

This area focuses strongly upon marketing communications and the promotions mix. Nevertheless, the materials that using for marketing activities, including printing Medias, brochure, shelf, energy consumption and oil consumption for travelling of sale activities create the impact to the environmental . Refer to the Figure 21, the carbon footprint results by business units presented that sale and marketing created the carbon emission as the second area but this study excluded to apply the proposed model according to the limitation to observe their activities.

Service.

As the pharmaceutical service provider, the core business procedure is provide the service which includes all areas of service such as installation, after-sales service, complaints handling, training and so on. From secondary data and observing, some activities overlap or present through the operation activities, inbound and outbound activities.

Support Activities.

Procurement.

This function is responsible for all purchasing of goods, services and materials. The aim is to secure the lowest possible price for purchases of the highest possible quality. Evaluation and data gathering in these areas pointed to the administration activities, purchasing office supply, and sub contract some job function.

Technology Development.

Technology is an important source of competitive advantage. Technology innovation is an important tool to reduce costs and to protect and sustain competitive advantage. This could include Internet marketing activities, call center program, Customer Relationship Management (CRM), advance warehousing system and many other technological developments. This study considered and explored the suitable technology to apply and collaborate with this proposed model. It will be discussed in the next chapter.

Human Resource Management (HRM).

Base on this study and literature data, human resources is one of the key important factors for successful applying green logistics concept. The people are an expensive and vital resource. Especially, motivate and encourage them to have environmental consciousness toward their daily life require more effort and time. Top management also, is the important factor for motivation and push into company policy.

Firm Infrastructure.

This activity includes and is driven by corporate or strategic planning. It includes financial and accounting department, and legal. Their activities created impact to environment by using office supplier, paper, and office energy consumption.

Such studies had underlined the complex combination of customer demand, product characteristics, law and regulation, economic, financial support and technical factors, each with their own dynamics that motivate innovation. These complex dynamics mean that new technology cannot simply be implemented, there was typically

much time and labor required to support and make green process performance to be succeed.

4.3.1.3 Applying green logistics concept and implementing the potential actions linked to the lean principles and tailored strategy

According to the previous data, customer behavior created the complexity when issuing orders, the ordering staff had to work using manual processes for complex requirements, paper based, lack of updated information and missing communication during order flow before picking process at warehouse. In this study, encouraging green logistics innovation into the stage of setting company objectives, while green concepts were still new and company was learning how to incorporate them into business, this was becoming an area that was effectively establishing strategic differentiation. At implementing strategy stages the lean principles and tailored strategy were embraced, from lean practices represented a solid framework for identifying waste that could be reduced or eliminated. However, when a green strategy was considered along with cost reduction and streamlining in process transformation initiatives, outcomes could be different and additional opportunities captured. Then, there were three areas to translate the proposed model into real business practices.

This study analyzed how to apply lean principles in Table 14. The discussion in this study was based on the five lean principles (Womack and Jones, 2003) as the starting point and it was presented as a measurement framework to implement the best practices within the case study company.

Table 14: The analysis of applying lean principles in ordering department

Lean Principle	Critical Success Factors	Example of measurement areas
Specify value	Accuracy of receiving product	The total number of accuracy transaction and value after order is placed
		The value of fine on wrong order
	Convenience and less time consuming	Customer satisfaction and complaints index
		The total order pay by credit card

Lean Principle	Critical Success factors	Example of measurement areas
		Deliver performance that reflect on process of order
		Productivities of order processing
	Safety	The quality of the product, such as packaging, color, smell, and etc.
Value stream	Process mapping	Transaction amount of total process being mapped for release credit card order compare to other sources
		The total order pay by credit card
	Interaction and participation	Customer satisfaction and complaints index
		Less time consuming to access to the documents and feed back to customer inquiries
	Late delivery	Deliver performance that reflect on process of order
		Productivities of order processing
	Over time	The amount of time of employee finish process the order
		Productivities of order processing
	Pending order management	Deliver performance that reflect on process of order
		Productivities of order processing
	Tracking	The number of time consuming to track order status related to credit check
		The number of time consuming to track on the required documents
		Number of paper using (Ordering department)
Flow	Line available	The total number of incoming order call during a day in relation to the number of staff
	Urgent order	The accuracy of urgent order was processed on daily basis
	Muti-skilled team	The number of people belong to each team
	Transparency of information	The available of busy line, available and on process show on visual graph on daily basis
Pull	Convenience and less time consuming	Customer satisfaction and complaints index
		The total order pay by credit card
		Productivities of order processing
	Interaction and participation	Customer satisfaction and complaints index
		Less time consuming to access to the documents and feed back to customer inquiries
Perfection	Continuous improvement	The number of action and reaction plan for the error
		Customer satisfaction and complaints index
		The number people involve to improve the system
	Process control	The amount of set up control process for mapping process
		The amount of system error

4.3.1.3.1 Action plan for green practices

In this empirical study the green concept was tailored to each company's function needs. The strategic innovations focusing on pollution prevention can provide win-win opportunities through process innovations leading to resource-efficiency (Bernauer et., al, 2006). Hence, applying the proposed model as the green process innovation that was implemented as the corporate management strategy, and related to energy-saving, pollution-prevention and waste recycling or no toxicity to gain positively on competitive advantage (Chen et al., 2006), Embracing with lean principles, the illustrations practices were presented through reducing paper consumption within the ordering process.

At order process, there were three action plans that were implemented.

Firstly, the plan was called "go digital with less paper use project", which sounds simple and similar to other business green practices but it required cooperation from all staff and involved parties by looking for innovative ways to reduce consumption and waste, the entire office can be more economical, healthier and more productive. The company encouraged the staff to reduce the way of using paper regarding to the nature of working process and the company operated with paper-based systems, spreadsheets and human memory same as many companies who operate business in traditional way. Then the highlight area that aptly demonstrates its green practice was saving paper in its working process by converting almost completely paper forms to electronic data processing to gain competitive advantage and cost saving (Symonds, 1992).

As above information, paper was the important evidence for customers and other internal parties in case something was missing. Then the process was redesigned by changing the way of tracking and recording papers as reference and turn into electronic files. The company started to invest to utilize the internal information systems to store the scanned documents. Then, all documents from various order

sources were scanned and saved in the center server. Additionally, this process change needed the clear working instructions for the order staff. In order to make green concept success, well organized file names, sequences, and access permissions were considered as important factors.

This electronic format benefitted the order team by saving their time to track back for the information from electronic files, more space on desk or even cabinet to store paper and it was a good practice as the back up plan for losing paper, even other department within the organization could get the benefit by tracking back and having the option to reprint if necessary.

Secondly, to achieve lean principles approaches by minimizing of non-value adding activities, efficient work, and applicable human resource management. The ordering center team was restructured and reorganized by setting up and delegating people into a group follow the sources of order. Each team responded only one source type of order which differed from the previous that one person had to serve all types. Among each team, each person was in charged small group of customer as their key accounts. Also, the working instruction process of each relevant SOP was reviewed and revised in order to reduce the unvalued add working process. This changing aimed to provide the better service, eliminate errors, wastes, non-valued, less human effort and saving the time and other action was applied collaborative cross-checking strategy which defined as a strategy where at least two individuals or groups with different perspectives examine the others' assumptions and/or actions to assess validity or accuracy (Patterson et al., 2007).

Third, adopting technology for process improvement was considered. Credit Cards were used as the customer means to place their orders, this technology tool affected the customer buying behavior in pharmaceutical industry due to the availability of credit terms. This order process influenced customers to change their buying style. They gain on less time consuming order process, get updated order status, stock availability, and updated information on their budget limits and got some

promotions from financial institution but they would disadvantage from credit term payment period. Moreover, they could ensure that they received the product on the expected date. However, changing and motivating customers to adopt the new order process took time to educate and encourage them to see the benefit and to establish trust. These paperless processes resulted in benefits to the case study company when it was applied to as many transactions as possible. But it required the set up of a new system, especially set up the new working processes to eliminate all unexpected outcomes, such as setting up the matching security information to identify customer authorization, changing internal application of order processing to match with banking systems, and combined with the clear instructions. With these strategies, error or actions could be detected to eliminate negative consequences. Therefore, the proposed model led to the incremental changing process of order division, which was presented in Figure 35.

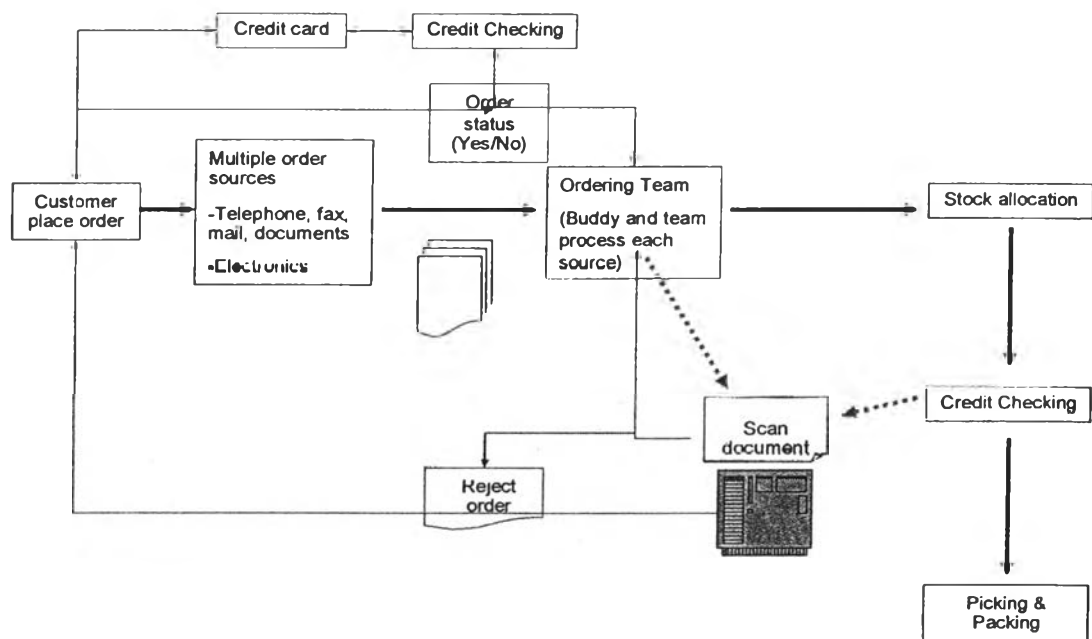


Figure 35: Enhancement areas to implement green logistics innovation concept to operation practices

However, to motivate environmental awareness among employees require well training that was more likely to include elements of green and the impacts

employees could have on improving the environment as they learned to perform their roles and responsibilities on daily work. Moreover, communication and awareness campaigns were more likely to emphasize green objectives, highlight key successes, and recognize significant green contributors.

In the logistics areas, based on the previous information to address the activities for environmental improvement were focused to two areas, which were shipping containers and fleet management of transportation. The ideas of changing the packaging of the most valuable products were initiated as the first phase because it represented the most significant cost savings to reduce and reuse the resources.

The pilot study of packaging of temperature-sensitive products or cold chain product was studied. In the past the cold chain products were stored in Styrofoam boxes regarding to their product characteristics which were mentioned in the previous section. This pilot project required testing of a number of packing materials, packing methods and container materials to replace the Styrofoam box, then polyethylene (PE) containers or plastic boxes have been replacing Styrofoam boxes. The test based on many scenarios that intended to control the temperature during delivery route, condensation of packing, dimensions of thickness/density of the containers, weight, the number of cooling material were considered and evaluated.

Packing in plastics boxes required new protocol packing practice to control the temperature and material such as gel pack and plastics board, which aimed for recycling, reuse and reduction of the number of boxes used. Generally, changing packing for cold chain products required high cooperation from customers and stakeholders because in their perception for many years to get the Styrofoam box was worth value to protect the product and confinement for them to check the product after receiving it. Some cases it related to difference inventory locations of customer, busy time and light weight to carry. Mostly, it is used only one time for delivery. To change customer perception to accept this new concept required the firm to inform their

customers and suppliers on green issue and guarantee for the quality and safety and it required more financial investment and efforts.

To ensure the best practices required the validation process and devices to measure and set up as the standard formula. The success of new packaging of cold chain product would be the best practices and guidelines for the company to develop and improve the working process coupled with reducing environmental impact for other product types.

This new operation practices seem similar to other industries but for many decades, the companies operated under the pressure of total quality management. Efforts in rationalizing packaging have generated innovations which have positive effects on cost and environmental impact without compromising the product performance.

Recent green practices addressed the transportation area, in order to mitigate the negative impact of transport on the environment, the integration of forward and reverse flow in the lean supply chain was determined. The improvement of changing process considered optimizing loads and transport efficiency improvement to enhance environmental performance, minimize waste and achieve cost savings.

In this section, as implementing the proposed model, it described how green logistics can help the case study company to reduce delivery time while increasing the efficiency of its transport operations. The case study company set up the special team to collect all relevant data that aimed to investigate all aspects of logistics operations and identify maximum transport savings consistent with the right service level. The team began to collect all the data of the total number of working days, total number of trips, total number of drops, total trip per day, average volume per trip, average number of cartons, average value (THB) per trip to explore the utilization of vehicles. The study gathered the number of vehicles compared with customer locations of each routing. Currently, there are 100 vehicles serving customers in Bangkok and

vicinities for normal and urgent orders. One vehicle carried more than 50 boxes in average per day

This study focused on insourcing transportation for Bangkok and central region whereas other provinces would rely on third-party logistic providers. The information was based on the activities of the first quarter in the year 2009, as investigation, the vehicle usage pattern showed that hospital customers took longer time to make a delivery for one drop, requiring approximately 0.53 hour (2.6 hrs delivery time per day / average 4.9 drops per trip) compared to 0.22 hour/drop per delivery to vicinity areas (3.9 hrs delivery time per day / average 18.1 drops per trip), and one drop by motorcycle required 0.15 hour (0.4 hrs delivery time per day / average 2.6 drops per trip). For normal deliveries within Bangkok, customers located closer together, therefore vehicle usage was low as one drop for Bangkok (normal- Bangkok healthcare institution) was 0.20 (2.4 hrs delivery time per day / average 11.9 drops per trip) Vehicle covering central area travelled twice the mileage of the city and vicinity areas as presented in Table 15. It implied that delivery at the hospital require the company to train and educate the delivery man to unload the products with checking all documents in short period of time and educated them for the pattern of truck loading. This information quite sensitive issue for sharing the information so this study exclude on this part.

Table 15: Vehicle usage pattern

Route Type	Ave drops / trip	Working hours per day (hours)	Driving hours per day (hours)	Delivery time per day (hours)	Distance per day (km)	Ave Speed (km/h)
Bangkok (Normal)	11.9	6.9	4.5	2.4	138.3	30.8
Bangkok (Hospital)	4.9	10.5	7.9	2.6	159.5	20.2
Bangkok (M Cycle)	2.6	4.5	4.1	0.4	133.4	32.8
Bangkok (Vicinity)	18.1	10.4	6.4	3.9	240.6	37.3
Central	15.4	6.9	4.6	2.4	326.2	71.7

Source: The case study secondary report of driver log book.

The purpose of green logistic was to minimize pollutions released to the surrounding environment during every procedure. Hence, the main objective for the case study company was to reduce the number of vehicles required and delivery time while still maintaining the high standard of service that exceed customers' expectation. The case study company would need to perform data analysis and used this finding to adjust its operation to eliminate unnecessary activities. This would be separated into 2 operations views, Bangkok and its vicinity and upcountry areas.

Delivery to Bangkok and Vicinity Customers

This was the main customer group who contributed almost 70% of total sale revenue. They also had the highest volume order which translated into high number of transport trips for the case study company had to make per day. In order to achieve green logistics, the case study company had to reorganize the routing and scheduling to optimize routing and scheduling, resource management and transport execution to cut transport costs, improve operational efficiency, reduce planning time and raise customer service levels. The new solutions based on the simulation the exact sequence of events as per the drivers. A road speed was then calibrated from reference data.

From this collected data, speed adjustments for major cities and towns were considered to gather for traffic conditions. The new fleet management used to calculate the time needed to deliver the product to each location. Multiple invoices to same customer per day were consolidated into a single drop to reduce number of trips per day. At the test phase, this new fleet pilot study collected the route and scheduled every single day's calls for 4 weeks in the test phase. For this purpose, two scenarios would be set up. Scenario 1 (Best case scenario)- there would be no defined territory, no loading bay restriction and no cap on calls per trip. Scenario 2 (More realistic scenario), optimized territory, loading bay restriction (30 bays) and calls per trip limited to 30 calls per trip.

To optimize the territory, the Territory Optimizer project was initiated by dividing delivery regions into compact territories with balanced workloads. It provided a fair allocation of work to drivers and enabled drivers to develop rapport with customers. Besides these, compact territory reduces inter-call travel time. It would use true road-based journey calculations to accurately calculate transport workloads and the compactness of each territory. The disadvantage was that too many territories would limit the amount of optimization from routing and scheduling, therefore it needed to strike a balance. As applying the territory optimizer approach, it helped to remove the duplicated routes and resulted in less vehicles needed (from current 96 routes to 75 routes in scenarios 2). The vehicle utilization rate increased as each vehicle was efficiently used. Furthermore, the time utilization had gone up because the drivers were now being worked at an optimal efficiency as well as required fewer drivers to perform the same amount of work done. On another hand, the central transportation would have to incur higher cost because the deliveries to certain areas which were previously covered by Bangkok routes had to be on its own. This led to an increase in number of vehicles required (up from current 18 to 23) and inevitably caused lower vehicle utilization rate as well as higher time utilization. Despite this, it would still offer a better overall benefit for the case study company.

Delivery to Upcountry Customers

Although local 2PL had the lowest distribution rates for upcountry, it had many disadvantages. Firstly, most of local 2PL lacked of knowledge about pharmaceutical distribution requirements. Since pharmaceutical products are sensitive products because its quality can be deteriorate with improper handling or unsuitable transport conditions, it would be very difficult to control the quality of every local 2PL performance. Secondly, these local 2PL did not possess specialized vehicles such as temperature controlled air-conditioner storage compartments which are required for transporting certain pharmaceutical products, causing the limited availability of such pharmaceutical products in upcountry areas. Lastly, each local 2PL could only cover

specific area which meant that the case study company had to outsource to a large number of contractors. This would also lead to higher administrative cost and unable to closely monitor every local 2PL's performance.

The solution to this problem would be to use the service of 3PL (third party logistics service provider). The case study company could shift the administrative work to this 3PL who would have better knowledge in managing logistics over the large scale areas and possess an effective logistics network system. In this way, the case study company could concentrate its transport operations in Bangkok and vicinity. By transferring its upcountry operation to 3PL, the case study company could expect cost saving in managing 2PL and improve delivery operations which lead to fewer vehicles used to transport goods to customers in upcountry. This saving should be able to offset the increase in cost from hiring this 3PL service provider.

From this analysis, it could be concluded that customers in Bangkok and center area should be serviced by dedicated fleets. As the current transport charge within Bangkok and center areas was per drop, to keep delivery cost down, the order should be consolidated so the number of drop per day would be minimized. In contrast, the upcountry customers would be charged per carton rate so the case study company needed to maximize the value per carton. The success of this action would require the mutual cooperation between the case study company and customers to produce the accurate forecast so that the number of delivery required could be reduced.

As mentioned above, transportation of outbound logistics areas created a big impact to the environment in direct and indirect way. The case study company reviewed and revised their fleet management database by analyzing fleet schedules, fuel consumptions, the number of vehicles per route and customers' location compared with the carbon emissions of current practice to ensure that appropriate tracking and monitoring systems are in place and up to date across the department. Based on the research method results, the following are some relevant practices related to procedure of the case study company.

- The management set up the goals and target to reduce the environmental impact by rearranging transportations pattern in their KPI of related department.
- Explore alternative transportation sources and the opportunity to meet new transportation requirements through the use of existing fleet assets.
- Explore and analyze alternative transportation fuels (ethanol, biodiesel, natural gas, propane, hydrogen) and fuel-efficient vehicles (hybrid or best in class). Also, in the past few years, the fuel price had skyrocketed and this trend was deemed to continue into the future. The Thai government had encouraged the use alternative fuel and thus, provided the incentive for those who used them. Natural Gas Vehicles (NGV) was the promoted by government and its pricing had been maintained at lower than real market price. Although, the cost of hardware installations required to use NGV was considered high, it was still worth the investment in the long run. The vehicles would not have to receive any special maintenance. As the diesel price was around THB24.39 whereas NGV was kept at THB8.50 (price as of 5 October 2009), the price difference was significant. Even the consumption rate for NGV was significantly higher than diesel fuel; the pollution released was much lower for NGV. As NGV became more widely used, the NGV stations had been building around Bangkok and vicinity. Therefore, the current route and schedule would not be affected. This would help to save both the case study company transport expense as well as reduce the air pollution emitted to the surround environment.
- Upgrade aircon system within vehicle to use refrigerant which is friendlier to environment.
- Develop a departmental work plan and/or action plan by describe roles and responsibilities for achieving green fleet targets and objectives, including travel and routing schedules to maximize vehicle use efficiency and minimize mileage driven, especially during peak travel times.

- Eliminates needless round trips, half-empty trucks and other outdated, inefficient practices that push up transportation costs, and waste fuel.
- Communicate and train managers, supervisors and staffs of concerned department on their roles and responsibilities to achieve the target, such as encourage the driver to avoid speeding and idling component, to minimize practices and habits that increase fuel consumption and vehicle emissions.
- Rearrange the number of vehicles for each route by combining the nearby customer locations and pick up the products from the company branches, stop carrying small quantity orders, optimizing loading capacity, and back-loading, and change in trip structure (more multiple collections and drops), growth in reverse logistics and new management initiatives
- Set up appropriate tracking and monitoring systems.

4.4 Results of applying proposed model within the case study company

This research collected the information about the management system and KPI in 2007 which occurred before the implementation of the proposed model. The tailor-made proposed model was implemented in 2008. As implementing the green issues as the new tool for improving the company performance and determining proper practices for competitive advantage and improving corporate image. After completing the implementation, the authors observed and gathered information from January 2009 to June 2009 and presented the organization outputs based on the ISO 14031 guideline and the measurements for the basic purpose of green supply chain management performance measurement, or GSCM/PM concept which were: internal control, internal analysis and external reporting (Hervan, Helms and Sarkis, 2005). The results of improvements of work efficiency, accuracy, and Key Performance Indicators (KPI) are presented in Table 16:

Table 16: The improvement of management system and Key performance indicators (KPI)

Dimensions	Before proposed model implemented (2007)	During proposed model implemented (2008)-Action plan & Green practices	After proposed model implemented (January-June 2009)
KPI-Management performance			
Design of work	<p>Overlap on functionality specialized serving as many customers as possible in shortest time period</p> <p>-Measuring from the number of working instruct on(WI form) of company's SOP anc the steps process of each WI, such as the WI of Order center was 1' WI forms</p>	<p>The management reviewed and revised the order structure by setting up the team based on the order sources and implementing checking process.</p> <p>- Set up clear work instructions by written policy</p> <p>- Reorganized and restructured the ordering team</p> <p>- Applying lean principles as company strategy</p> <p>Changing the ordering process flow from paper based to electronic base</p>	<p>-Emphasis on delivery value at the point of service for customer.</p> <p>-Empower employee to resolve customer issues independently and checking process</p> <p>-Measuring from reducing the WI forms of each SOP, such as WI of Order center was decrease to 7 WI forms</p>

Dimensions	Before proposed model implemented (2007)	During proposed model implemented (2008)-Action plan & Green practices	After proposed model implemented (January-June 2009)
Employee turnover	<ul style="list-style-type: none"> -Narrow from high level for initial work process and improving process. -Measuring from the turn over rate of each department on quarterly basis* 	<ul style="list-style-type: none"> - Reorganized and restructure the ordering team - Communicate clear working instruction for new green process on paperless and how to organize work. -Constraint training in process improvement. 	<ul style="list-style-type: none"> -The percentage of employee turnover rate was decreased*
Motivation of rewards	<ul style="list-style-type: none"> Individual incentives linked to job evaluatic and productivity -Measuring from the average incentive per team of each achievement project 	<ul style="list-style-type: none"> - Encourage team to participate in green practices by giving rewards to the team to achieve the paper saving target. - Educate and train staff to be aware on repeating working processes due to all mistakes and errors that take to more resource. 	<ul style="list-style-type: none"> Group incentives and buddy incentives linked with skills and service processes -The increasing number of the team that achieve the company project and the value of group incentive was increase *

Remark: * Limited information regarding to the security information of case study company

Dimensions	Before proposed model implemented (2007)	During proposed model implemented (2008)-Action plan & Green practices	After proposed model implemented (January-June 2009)
KPI-Operations performance			
<p>Accuracy (Total number of Transactions)</p>	<p>92% of -Calculated from =Total number complete issued orders (issuing orders with accurate data, including price, item , bonus ad customer requirement) minus the total number of mistakes (data from the number of return order and cancel order) and divide by the total issuing order per day</p> <p>Accuracy= $\frac{1,074,483}{1,170,483} = 92\%$</p>	<p>- Encourage team to participate in green practices by giving rewards to the team to achieve the paper saving target. - Reorganized and restructure the ordering team</p> <p>Accuracy= $\frac{1,409,375}{1,493,375} = 94\%$</p>	<p>97% =Total number complete issued orders (issuing orders with accurate data, including price, item , bonus ad customer requirement) minus the total number of mistakes (data from the number of return order and cancel order) and divide by the total issuing order on monthly basis</p> <p>Accuracy= $\frac{605,203}{625,603} = 97\%$</p>

Dimensions	Before proposed model implemented (2007)	During proposed model implemented (2008)-Action plan & Green practices	After proposed model implemented (January-June 2009)
KPI-Operations performance			
Fine on wrong process order	Approximate y 1.5 million THB, which calculate from the hospital fine due to the order mis:ake	<ul style="list-style-type: none"> - Encourage team to participate in green practices by giving rewards to the team to achieve the paper saving target. - Educate and train staff to aware on repeat working process due to all mistakes and error that take to more energy consumption and resource consumption. - Applying lean principles as company strategy - Changing the ordering process flow from paper base to electronic base - Approximately 1.1 million THB, which calculate from the hospital fine due to the order mistake 	Approximately 500,000 THB,

Dimensions	Before proposed model implemented (2007)	During proposed model implemented (2008)-Action plan & Green practices	After proposed model implemented (January-June 2009)
Productivities of order processing on daily basis	<p>90% process order on time</p> <p>=The total number of receiving order for both manual order sources and electronic orders within a day minus pending order on hand or in the system divided by the total issuing order per day</p> <p>Productivities= $\frac{1,055,000}{1,170,483} = 90\%$</p>	<ul style="list-style-type: none"> - Educate and train staff to be aware on repeated working processes due to mistakes and errors that take to more resources. - Applying lean principles as company strategy - Changing the ordering process flow from paper based to electronic based - Reorganized and restructure the ordering team - Communicate clear working instructions for new green process on paperless and how to organize work. - Encourage team to participate in green practices by giving rewards to the team to achieve the paper saving target. 	<p>95% process order on time, which represent 3 % increase from 2008 And 5% increase from 2007</p> <p>Accuracy= $\frac{595,000}{625,603} = 95\%$</p>

Dimensions	Before proposed model implemented (2007)	During proposed model implemented (2008)-Action plan & Green practices	After proposed model implemented (January-June 2009)
		Productivities= $\frac{1.380.000}{1.493,375} = 92\%$	
Number of paper using after implementing the green practices (Only ordering department)	90,000 pieces per month, cost approx. THB 17,100 per month and THB 205.200 per annual	<ul style="list-style-type: none"> -Applying "go digital with less paper use project" within the ordering process - Educate and train staff to be aware on repeated working processes due to all mistakes and errors that take to more resources. - Communicate clear working instructions for new green processes on paperless and how to organize work. - Encourage team to participate in green practices by give rewards to the team to - 	67,500 pieces per month, cost approx. THB 12,894 per month and THB 77,366 per half year which was 20% decrease from 2008

Dimensions	Before proposed model implemented (2007)	During proposed model implemented (2008)-Action plan & Green practices	After proposed model implemented (January-June 2009)
		<p>achieve the paper saving target.</p> <p>81,000 pieces per month, cost approx. THB 15,390 per month and THB 184,680 per annual, which was 10% decrease from year 2007</p>	
<p>Cost saving for renewable cold chain packaging</p>	<p>The cost of using Styrofoam box = Approximately THB15 Million per annual (Calculating from the total shipping box per day * the cost per box, which was THB 150 * The total number of working day) -Comparing to use it for 3 years The total cost approximately THB 27.16 Million, see more detail Table 22</p>	<p>-Changing the packaging from Styrofoam box to plastic box as reusable packaging -Saving the material for previous packing method</p>	<p>Total saving approximately THB 4.03 million base on 3 year for initial investment and replacement 15% every year and the cost THB1,500 per box (Total saving figure base on the interview with the area owner, which calculated from their pilot study and negotiation with the suppliers)</p>

Dimensions	Before proposed model implemented (2007)	During proposed model implemented (2008)-Action plan & Green practices	After proposed model implemented (January-June 2009)
Percentage of renewable resource use of packaging	0% (Single use) of using for temperature control product with Styrofoam box		100% Re-usable of using Temperature control with polyethylene (PU) containers
Delivery Performance	96% delivery on time = The total number of confirmed invoice that delivered with in one working day after order was issued divide by the total number of invoice for dispatch **	- Rearrange routing management, fleet management , including optimize the territory and speed adjusted	99% delivery on time = The total number of confirmed invoice that delivered with in one working day after order was issued divide by the total number of invoice for dispatch **
Company Image	Distributors as only business partner	-Conducting customer satisfaction survey on the company customer relationship event at Q4 2008	Increase customer perception for corporate image on environmental and community (95% perceive that the company care for the local community)
Note: ** Regarding to the limitation of information and sensitive issues.			

Dimensions	Before proposed model implemented (2007)	During proposed model implemented (2008)-Action plan & Green practices	After proposed model implemented (January-June 2009)
KPI-Environmental performance			
Carbon emission and Percentage of carbon emission	The overall carbon emission approximately 9,200 tCO ₂ e in the year 2007. The 2007 carbon emission increased from 2006 approximately 8,000 tCO ₂ e or 15.00% via-versa business growth more than 16% was presented in Figure 1E.	-By applying and implement the proposed model within case study	Target 15% carbon reduction in 2012 and the decrease figure was explained below
Fuel combustion	63% carbon emission of fuel combustion from over all sources in the year 2007, approximately 5,624 tCO ₂ e and it calculated from diesel consumption, LPG consumption and gasoline	-By applying and implement the proposed model within case study	Approximately 4,206.30 tCO ₂ e More detail see Table 19: Carbon Emissions Calculation in year 2009

Dimensions	Before proposed model implemented (2007)	During proposed model implemented (2008)-Action plan & Green practices	After proposed model implemented (January-June 2009)
KPI-Environmental performance			
	consumption. More detail see Table 13: Carbon Emissions Calculation in year 2007		
Carbon Intensity tCO ₂ e/sales (Million Baht)	0.32 tCO ₂ e/sales (Million Baht)***	-By applying and implement the proposed model within the case study	0.27 tCO ₂ e/sales (Million Baht)***
Invoice Carbon Intensity (kgCO ₂ e/invoice)	7.65 in year 2007***	-By applying and implement the proposed model within the case study	6.54 in year 2009 (Jan-June)***
Order Carbon Intensity (kgCO ₂ e/order)	7.86 in year 2007***	-By applying and implement the proposed model within the case study	6.72 in year 2009 (Jan-June)***
Remark: *** See more detail and calculation method in Table 19			

The data collection method and the calculation for carbon emission, fuel combustion and carbon intensity were presented in Table 17 and the Relevant Carbon Emission Factors was presented in Appendix B

Table 17: The data collection method for carbon calculation

Data Collection

Business Unit	Data Collection				
	Electricity	Fuel Combustion	Refrigerant	Air Transport	Other Business Activity Data
Transportation	-	Record amount and type of fuel consumption monthly	Record amount of refilling refrigerant including its type for each filling event	-	- Record freight mileage and update upon any changes in transportation routes. - Record quantity of drop and freight cases monthly.
Distribution Centres	Record amount of electricity consumption (kWh) monthly	Record amount and type of fuel consumption monthly	Record amount of refilling refrigerant including its type for each filling event	-	-
Main Business Travel	-	Record amount and type of fuel consumption monthly	-	-	Record freight mileage and update upon any changes in transport routes.
Other Business Travel	-	Record amount and type of fuel consumption monthly	-	Record destination of the air transportation in each flight	-
Head Office	Record amount of electricity consumption (kWh) monthly	-	-	-	-

The Calculation Method

Carbon emission = (Total consumption of LPG (kg) * 0.0031)+(Total consumption Diesel (litre)* 0.0027)+ (Total consumption of Gasoline (litre) * 0.0022)+ (Total consumption of Electricity (kWh) * 0.0031)+(Total consumption of Leaking refrigerant (R404A) *3.26)

Fuel combustion = (Total consumption of LPG (kg) * 0.0031)+(Total consumption Diesel (litre)* 0.0027)+ (Total consumption of Gasoline (litre) * 0.0022)

Carbon Intensity tCO₂e/sales (Million Baht) =Total carbon/ Total sale value

Invoice Carbon Intensity (kgCO₂e/invoice) =Total carbon/ Total invoice number

Order Carbon Intensity (kgCO₂e/order) =Total carbon/ Total order number

Base on the study results of applying the proposed model of green logistics, in Table 19 presented the calculation for carbon emission from each energy consumption sources and activities.

Table18: Carbon Emission Calculation in year 2009 between Januarys to June

Carbon Emission Calculation by Emission Source in each Business Unit in (Jan - June)2009

Emission Source	Activity Data	Unit	Emission Factor	Unit	Carbon Emission (tCO ₂ e)
	(A)		(B)		(AxB)
Transportation					
Diesel Consumption	500,000.00	litre	0.0027	tCO ₂ e/litre	1,350.00
NGV Consumption	50,000.00	kg	0.0026	tCO ₂ e/kg	130.00
Leaking Refrigerant: (R134A)	0.0325	tonne	1,300.00	tCO ₂ e/unit	42.25
Distribution Centres					
Electricity Consumption	2,600.00	MWh	0.56	tCO ₂ e/MWh	1,456.00
Diesel Consumption	840.00	litre	0.0027	tCO ₂ e/litre	2.27
LPG Consumption	1,200.05	kg	0.0031	tCO ₂ e/kg	3.72
Leaking Refrigerant (R404A)	0.045	tonne	3,260.00	tCO ₂ e/unit	146.70
Main Business Travel					
Gasoline Consumption	235,921.00	litre	0.0022	tCO ₂ e/litre	519.03
Diesel Consumption	90,526.45	litre	0.0027	tCO ₂ e/litre	244.42
Other Business Travel					
Gasoline Consumption	64,417.60	litre	0.0022	tCO ₂ e/litre	141.72
Diesel Consumption	15,209.20	litre	0.0027	tCO ₂ e/litre	41.06
LPG Consumption	626.80	kg	0.0031	tCO ₂ e/kg	1.94
Air Transport	47,103.70	km	0.0001	tCO ₂ e/km	4.71
Head Office					
Electricity Consumption	218.7045	MWh	0.56	tCO ₂ e/MWh	122.47
Total					4,206.30

The proposed model of green logistics innovation transfer to real business practices, in the Table 19 was presented the carbon performance of the case study after implementing the proposed model. The trend growth of pharmaceutical industry decreased from year 2007 to 2008 14.17% but the case study company growth trend increased, which gained a market share of 37.50% in the year 2008. The case study company embraced the green concept and converted into business practices, including promoting the paperless project within the ordering process, restructured and reorganized the order procedure, applying credit card tools, changing the sensitive packaging and optimization on route management. In the year 2008, these practices contributed to the overall carbon emission 11,000 tCO₂e which was an increase of 19.57% followed the increasing trend of company growth rate 27.59% but comparing in term of carbon intensity for every one million bath of sale, it generated 0.30 tCO₂e, which was a decrease from year the 2007 and 2006. Also, in term of Invoice Carbon Intensity was 7.17 kgCO₂e/invoice and Order Carbon Intensity was 7.37kgCO₂e/order. These figures were trended to be a decrease from the year 2007.

Table 19: The carbon performance of the case study

	2006	2007	2008	2009	2009
	Jan-Dec	Jan-Dec	Jan-Dec	Jan-Jun	Jan-Dec
Total market (Million THB)	75,100.00	86,800.00	99,100.00	47,987.62	112,002.82
Market growth (%)	18.10%	15.58%	14.17%		13.02%
Case study (Million THB)	25,000.00	29,000.00	37,000.00	15,500.00	36,176.91
Market share of case study (%)	33.29%	33.41%	37.50%	32.30%	32.30%
Market growth of case study (Million THB)		4,000.00	8,000.00		- 823.09
Market growth of case study (%)		16.00%	27.59%		-2.22%
Carbon Emission (tCO ₂ e)	8,000.00	9,200.00	11,000.00	9,767.77	9,767.77
Carbon Increasing		1,200.00	1,800.00		- 1,232.23
Carbon Increasing (%)		15.00%	19.57%		-11.20%
Carbon Intensity (tCO ₂ e/sales (Million Baht))		0.32	0.30	0.27	0.27
Invoice Carbon Intensity (kgCO ₂ e/invoice)	7.49	7.65	7.17	6.54	6.51
Order Carbon Intensity (kgCO ₂ e/order)	7.70	7.86	7.37	6.72	6.69

The case study company maintained to implement and enhance this green logistics concept, in the year 2009, the carbon intensity per one million trend to decrease to 0.27 tCO₂e and the Invoice Carbon Intensity was 6.54 kgCO₂e/invoice and Order Carbon Intensity was 6.72 kgCO₂e/order. These figures also decreased from the year 2008. Moreover, comparing with the carbon intensity per one million baht in the year 2009 was lower than the figure in the year 2007 around 0.05 tCO₂e/sales. Based on the assumption to maintain the green logistics innovation process within this case study, at the end of the year 2009, the carbon intensity of each one million baht was 0.27 tCO₂e/sales and in term of overall carbon emission was 9,767.77 tCO₂e which 11.20 % decreased from the year 2008. This performance implied that keep working on green concept by focusing on the internal operational practices and focus to improve the environmental performances, it will significantly be a positive effect to cost reduction and efficiency to the company and it would be a way for sustainable growth.

Nevertheless, if the case study company would not maintain to implement and encourage the green concept within the organization, the carbon emission would be increased to 11,476.81tCO₂e in year 2009, and in term of carbon intensity was 0.32 tCO₂e which was the same figure as operate the business without green mindset but the trend of carbon increasing rate was follow the company growth rate, it implied that the company might create pollution equal or more than the figure in 2007 as the data presented in Table 20.

Table 20: The carbon emission performance without applying the proposed model of green logistics

	2006	2007	2008	2009	2009
	Jan-Dec	Jan-Dec	Jan-Dec	Jan-Jun	Jan-Dec
Total market (Million THB)	75,100.00	86,800.00	99,100.00	47,987.62	112,002.82
Market growth (%)	18.10%	15.58%	14.17%		13.02%
Case study (Million THB)	25,000.00	29,000.00	37,000.00	15,500.00	36,176.91
Market share of case study (%)	33.29%	33.41%	37.50%	32.30%	32.30%
Market growth of case study (Million THB)		4,000.00	8,000.00		823.09
Market growth of case study(%)		16.00%	27.59%		-2.22%
Carbon Emission (tCO ₂ e)	8,000.00	9,200.00	11,737.93		11,476.81
Carbon Increasing		1,200.00	2,537.93		
Carbon Increasing (%)		15.00%	27.59%		
Carbon Intensity (CO ₂ /sales (Million Baht)	0.32	0.32	0.32		0.32

In Table 21, presented the cost performance of the case study company based on two assumptions, which were the cost performance before implementing the proposed model of green logistics innovation process concept and another was the cost performance after implementing this model. Both assumptions based on the activities cost of Table 17 and assumed that the percentage of cold chain sale value was the same every years, which was 15% of the total sale, the price of the paper, Styrofoam

box, plastics box and vehicles annual fee pay to sub contractor for one vehicle were remain unchanged. The percentage proportion of consumption trend of fine on wrong order processing, paper consumption, packaging, and transportation varied to the sale growth of case study company.

The first assumption, fine on the wrong order processing was THB 1.5 Million and the proportion was 0.005% of total sale, which was remaining the same in every year. Then, if the case study company did not improve their performance, the fine in year 2008 was THB 1.9 Million and would be THB 0.8 for the first half year of 2009. The paper expense, packaging and transportation were the same calculation method. The total expense in 2008 was THB 107.3 Million and the first half year of 2009 was THB 44.5 Million. The total cost of 1.5 year was THB151.87 Million, if the case study operated with unawareness of environmental impact.

Table 21: The cost performance before implementing the proposed model

Cost before implementation (Million Baht)	Case study			
	2007 Jan-Dec	2008 Jan-Dec	2009 Jan-Jun	2009 Forecast Jan-Dec
Sales	29,000.0	37,000.0	15,500.0	36,176.9
Sales for cold chain	4,350.0	5,550.0	2,325.0	5,426.5
Expenses	83.9	107.3	44	104.8
Fine on wrong order processing	1.5	1.9	0.8	1.9
Paper	0.2	0.3	0.1	0.3
Packaging (Styrofoam)	15.0	19.1	8.0	18.7
Transportation	67.2	86.0	35.6	84.0
Information				
Numbers of cars required	100.0	128.0	53.0	125.0
Annual fee	0.7	0.7	0.7	0.7
Numbers of Styrofoam boxes	100,000.0	127,586.0	53,448.0	124,748.0
Styrofoam price per box	0.00015	0.00015	0.00015	0.00015
Based on the percentage of sales				
Fine on wrong order processing	0.005%	0.005%	0.005%	0.005%
Paper	0.001%	0.001%	0.001%	0.001%
Packaging	0.052%	0.052%	0.052%	0.052%
Transportation	0.232%	0.232%	0.230%	0.232%

The second assumption, the cost of each expense item based on the actual expense in Table 17, so the percentage proportion was varied every year. Regarding the case study company applied and implemented the green logistics

concept, it presented to the paper consumption rate was reduced and replacing the plastics box for reusable with 3 years useful life, 90% return by one day, and estimate 15% for replacement in the year, and rearrange the number of vehicles every year. The actual expense was THB 84.3 Million in 2008 and THB 29.8 Million for the first half year of 2009. The total cost of 1.5 year was THB 114.08 Million according to the case study company implemented the green logistics concept, the more detail was shown in Table 22.

Table 22: The cost performance after implementing the proposed model

Cost after implementation [Million Baht]	Case study			
	2007 Jan-Dec	2008 Jan-Dec	2009 Jan-Jun	2009 Forecast Jan-Dec
Sales	29,000.0	37,000.0	15,500.0	36,176.9
Sales for cold chain	4,350.0	5,550.0	2,325.0	5,426.5
Expenses	83.9	84.3	29.8	72.2
Fine on wrong order processing	1.5	1.1	0.5	1.2
Paper	0.2	0.2	0.1	0.2
Packaging [plastic box]	15.0	3.8	0.3	0.6
Transportation	67.2	79.3	28.9	70.6
Information				
Numbers of cars required	100.0	118.0	43.0	105.0
Annual fee	0.7	0.7	0.7	0.7
Numbers of plastic boxes	100,000.0	2,500.0	188.0	375.0
Plastic price per box	0.0015	0.00150	0.00150	0.00150
Based on the percentage of sales				
Fine on wrong order processing	0.005%	0.003%	0.003%	0.003%
Paper	0.001%	0.0005%	0.0005%	0.0005%
Packaging	0.052%	0.010%	0.002%	0.002%
Transportation	0.232%	0.214%	0.186%	0.195%

Therefore, the cost saving for implementing the green innovation during year 2008 and the first half year 2009, the company achieved the total cost saving approximately THB 37.7 Million for 1.5 years, since this proposed model was began. This saving came from the decreasing amount of fine on wrong order process approximately THB 1.1 Million, reducing paper using THB 0.1 Million, changing the cold chain packaging from Styrofoam box to plastics box approximately THB 23.1 Million, and THB13.4 Million from rearrange on fleet management by rerouting, scheduling, speed adjustment, optimize the territory and encouraging biofuel using as presented in Table 23. Moreover, to start this project was require initial investment to conducted the protocol and collect the data for rearrange the fleet management, which were THB 0.3

Million and the other project included changing to paperless process, applying credit card and restructure the team was the operation expense of the case study company which was not calculated to this green logistics project. It could be assumed that the total cost saving of this project was THB 37.4 Million for 1.5 years during implementing the green logistics concept.

Table 23: Total cost saving for implementing the green logistics

Total Cost Saving (Million Baht)	Case study			
	2007	2008	2009	2009 Forecast
	Jan-Dec	Jan-Dec	Jan-Jun	Jan-Dec
Sales	29,000.0	37,000.0	15,500.0	36,176.9
Expenses	0.0	-23.0	-14.8	-32.4
Fine on wrong order processing	0.0	-0.8	-0.3	-0.7
Paper	0.0	-0.1	-0.0	-0.1
Packaging [Styrofoam]	0.0	-15.4	-7.7	-18.1
Transportation	0.0	-6.7	-6.7	-13.4
Information				
Numbers of cars required	0.0	-10.0	-10.0	-20.0
Numbers of boxes	0.0	-125,086.0	-53,260.0	-124,373.0

Based on the study results, adopting green innovation in the organization were influenced by the organizational encouragement factor, which included quality of humane resources, company culture and top management support. These finding were the same as the study of Ho (2008) concluded that organizational encouragement was the one factor had have positive influences on the willingness to adopt green practices among three factors- technological, organizational, and environmental. Also, the Ho (2008) study addressed that high quality of human resources means that employees are capable of adopting and implementing green practices. Embracing the notion of adopting green practices requires a fundamental shift in a firms' culture and human resources and the organizational capabilities required to manage them. Management, R&D, production, and marketing all must be involved and committed if a firm is to implement a policy of using clean technologies and Ho (2008) refer to the study of

Ashford(1993) and Hart (1995). Moreover, it is found that top management support on financial investment for new packaging or process and delivery management is a crucial role to adopt and implement green process innovation. This barrier is same as mentioned by Murphy et al. (1996) who has addressed that the lack of top management support is a major obstacle to establishing environmental policies.

Base on the improvement result of the case study company, the next study aim to test and focus on extending the proposed model to other stakeholders of the pharmaceutical supply chain. In order to understand more on customer perception toward green concept, the in depth interviews was conducted to gain sufficient insight of the customer attitudes and strategies for applying the proposed model into current business operations.

4.5 Extending the proposed model to other stakeholders of pharmaceutical supply chains

This study gathered information from interviewing a total of 20 experts and were conducted in the period August- September 2009, on average 1-1.5 hours. Selected target were 10 logistics executive managers and experts of pharmaceutical service providers and other 10 drugstore owners, including wholesalers and retailers. The primary criteria used to select organizations were recommended by the interviewed organizations, through the so-called snowballing technique (Moriarty, 1983) and were identified based on their firm's size, number of transaction on monthly basis and characteristics of business to business (B2B) companies within Bangkok and vicinity areas. The selection was adjusted for the purpose of the study to represent a range of pharmaceutical stakeholders, including distributors, healthcare providers, wholesalers, and retailers. The interviews comprised 15 questions with open-ended questions. (Appendix : B) to explore and get useful information for discussion at the local level and search for future action to be considered in implementing green logistics

activities for sustainable development. The questions were designed to obtain the customer perceptions, attitude, and their understanding on green logistics. The questions aimed to explore the current practice of pharmaceutical services providers toward environmentalism consciousness on their business operations. Lastly, to obtain their opinions on applying the proposed model and seeking out the probability of firms to adopt new business process.

4.5.1 The fact finding to extend the proposed model from In-depth interview.

The data were gathered from conducting in-depth interview with a total of 20 interviewees, which consisted of top ten managers from healthcare services providers, including executive manager, policy maker, purchasing director, inventory manager, and top 10 drugstores based on value and volume of logistics transactions. Wholesalers and drugstores also included in this study. The findings of the research were illustrated hereunder;

1. *In your own words, could you tell me what is the Green Logistics?*

Most of the participants defined "Green Logistics" as the transportation activities, including transportation mode, fuel consumption, efficient and effective management process, packaging, eliminate waste or reducing energy consumptions, reuse, recycle, and optimizing resources. All activities that aimed to reduce the environmental impact and pollution, using biofuel or environmental friendly energy, eco energy, and evolved with technology innovation as a tool for reducing resource consumption.

2. *What are the effects of your business operations toward our environmental?*

Most of the pharmaceutical healthcare service providers addressed that their operation process classified into two components. First component involved all activities of back office or administration work, such as using of paper, office supplier, electricity, daily working activities and all the wastes from consuming food and water.

Second component involved with the travelling, fuel consumption, fleet management, transportation of drugs to wholesalers, retailers, and patients.

The official hospital managers, distributor managers, and drug store owners significantly stated the consumption of secondary packaging, such as plastic bag, brown paper box among the pharmaceutical industry is the key factor that effected our environment. They agreed that eliminating to use secondary package will create the big impact in reducing pollution. However, for Thai culture, it is quite difficult to handle.

They mentioned to the first packaging of drug that destroying packaging by burning or burying will create toxic environment. In addition, even turning on the air-conditioned can release the pollution.

3. Do you think it is important for pharmaceutical services provider to apply green logistics concept to their business process?

100% of participants agreed that pharmaceutical service providers have to apply green logistics concept into their business process. Improvement of company performance through green concept will support to reduce cost and gain good image.

4. Why or why not?

They mentioned that at each stage of pharmaceutical supply chain create both direct and indirect impact to the environment. It is the time to add green logistic concept to the company's goal in order to be used in the future.

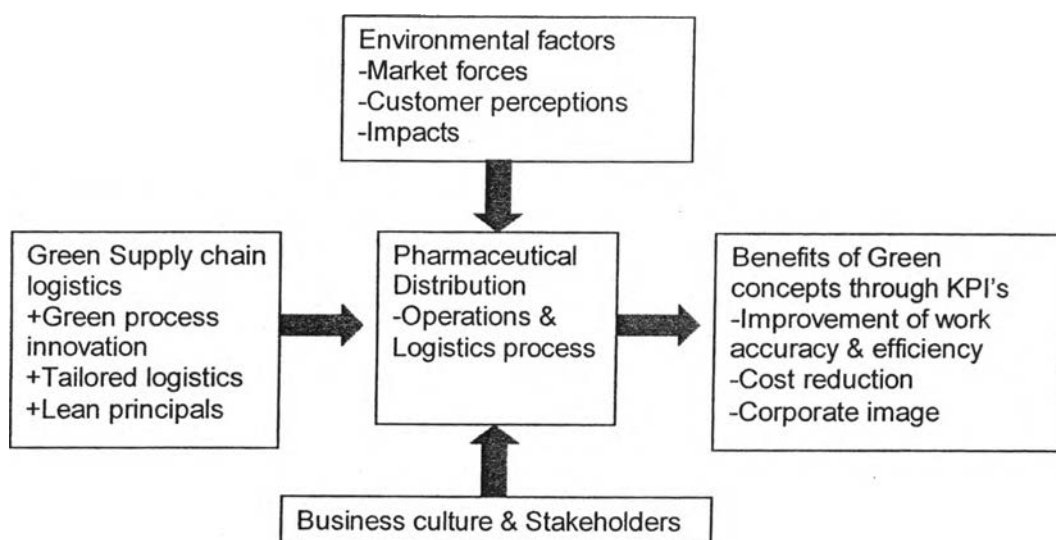
5. Do you think who should take responsibility to review their business process that effect to our environment?

Among participants, 60% (12 persons) stated that distributor is the first party who has to take responsibility for the environment and implement action plan for the industry. The rest 40% (6 persons) perceived that everyone in pharmaceutical supply chain has to take responsibility on environmental issue, especially bring it to the actions and perform seriously. It required the corporate from every party to be aware on

environmental friendly performances and take it as the first priority. Policy maker, owner, and top management are the key influencers to motivate people in their organization to know how to practice. They have to be the initiative improvement leader in order to reduce the risk of non-compliance, penalty, and threat of closure. At the same time, the link between green supply chain initiative and improvement in competitiveness and economic performance for organizations remain unclear.

6. *What do you think green logistics takes to be successful in your organization?*

Most of them agreed that the key factor to make green logistics to be successful within their organization will depend on people. Since people have to put their effort to their daily life and work, their environmental instinct have to work all the time, more sample of practices or clear instructions will support on adopting green. However, some organizations already adopted green logistics and implemented into their work, such as working by focusing on reducing invaluable working process, controlling, and eliminating all errors that would link to cost saving. Other aspect related to the improvement of the current process, including redesign working process, quality improvement, and investment on adopting technology, reducing on using office supply, packaging, plastics bag, and reducing time. These efforts aimed to improve environmental performance, reduce cost, enhance corporate image, and improve marketing competitive. Nevertheless, many organizations still look upon green initiatives as involving trade-offs between environmental performance and economic performance. The corporation from every stakeholder and their customers are the crucial factors to make green succeed within the organization.



Conceptual Frame Work of Green Logistics

7. (Show the Conceptual model) How do you apply green innovation process to your operations?

This question, the author started to explained the lean principles and definition of tailoring logistics. Then, the participants expressed their ideas among the top managers and policy makers that they will push and motivate the green concept into the company objectives by considering more on environmental factors, market potential, then compare with the existing resources. They will review and analysis the current process and determine which activities need to be addressed. Setting the clear statement of green issue and practicing through their employee are required.

Some of them already improved their current process by encouraging reuse and recycle campaign within the organization. Some organizations reuse the packaging from distributors. For the drug stores, one firm launched the return container campaign to their customers. It is quite successful but it required cooperation from their employee to promote the campaign to their customers. Other firms extend the green concept to their customers by reducing plastic bag. They try to combine small drug in one plastic bag or even one paper bag. If their patient buys only one blister or one box, they will ask customer not to use the plastic bag. The results from the interviewing presented that most American and European customers are willing to co-ordinate with the green

practices. Thai people still need more motivation and explanation. People of the East and Middle East mostly request second packaging every time since they believed that refusing the plastic bag will increase the profit of drug store owner.

8. *What major problem of applying green concept have you had to deal with recently?*

Most of participants thought that the major barrier of green successful within the organization is human. As human is the key driver for the successful of green implementation. Educating and training on how they can performance on their daily work have to be simply and easy to understand. Also, the cooperation from every party are the key obstacle to make green performance happen within the organization. Moreover, the best sample practices for other organizations to follow and present to the public are still in beginning stage. Also, they expressed that in the pharmaceutical supply chain, there are strongly require initiator of green logistics.

In addition, the participants addressed that the financial support and government regulation factors play an important role in successful changing, since the role of government would affect the adoption of green concept among the firms. The more governmental support, the more likely that logistics service providers will adopt innovation in their process. Also, they stated that green innovation will be reinforced for logistics companies if the government can provide various supports of innovation resources and continuous encouragement policies. The government can provide financial incentives, pilot projects, and tax breaks to stimulate innovation in logistics technologies for the logistics industry.

9. *How do you solve the problem?*

They stated that self motivation and self awareness on green play the key role to maintain and motive other people to follow. Green issue requires each individual aware on their action that might impact to the environment. As all of the participants are executive manager, top management, owner, therefore, they have the

power to motivate their people and act as the role model for them to follow. Setting up the incentive is another way to motivate people to improve their environmental performances.

10. What do you think will be the hardest thing to change the people adopting green concept? What will be the easiest?

Most of the participants stated that they thought that the hardest thing to change people to accept on some thing and obey to follow it. It was the human mindset toward green issues, and the willingness to practice including adopting and maintaining their performance. Well training and educating are important for their employee to have clear understanding on global environmental trends. Encouraging people to change their mind or behavior are the most difficult thing to do. Government sector could help by supporting and encouraging the firm to pay more attention on the green issue.

Most of the participant presented that, they can hardly see any easiest way to performance for green improving. However, what they can do is to support on their daily life by pushing it as the company policy.

11. How do you make change and build culture to support?

Most of them mentioned that as they are the key person who can influence other people, they will try their best to encourage the people to aware on green logistics issue. They are willing to support or strictly follow all green campaigns that originated and organized by other company or government.

12. Tell me about some of your recent green activities and what you did to achieve them?

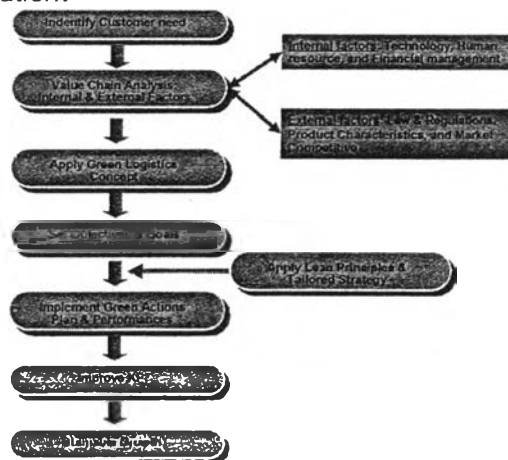
Recent practices of big and medium firms improved on their environmental performance are redesign and reviewing their existing process and put effort to green issues into the company objectives, policy, action plans and create reducing waste campaign in the market, such as redesign their packaging,

rearrange the delivery route, reuse paper box and plastics bag, and reducing the usage of paper within the organization.

Some drugstores encourage their customers not to use plastic bag or even paper bag for small unit of drug.

Interesting information that got from the interview is that using plastic box of the case study company is the outstanding practice in their perception. They recognized green issue but still lack of knowledge and information on how to create the green performance. Some of them start thinking to redesign their packaging for the customers to follow the green practices of the case study company

13. (Show proposed model) Do you think that green logistics concept benefit to your business for sustainable growth? Can you apply this model in your organization?

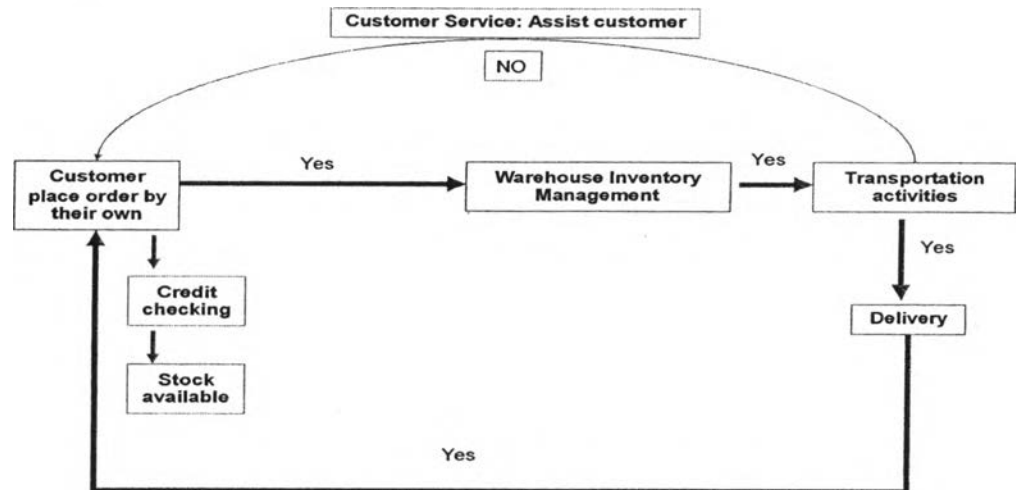


All of them believed that green logistics concept benefit their business sustainable growth. During the depth interview, the author presented the proposed model that implemented in the case study company and extend this model to other stakeholders of pharmaceutical supply chain. Most of them realized on green issue but they wondered how they could apply in their organization. In some cases, they analyzed and evaluate by their own experience and knowledge. After presenting this proposed

model to them, they accepted and willing to apply this model to improve their environmental performances. The result was summarized and presented here be

	Proposed model	Proportion (%)		
		Already implement	No plan to apply	Accept to apply
Step 1	Identify customer need	75%	0%	25%
Step 2	Analysis internal & External Factors by Value Chain Analysis	25%	0%	75%
Step 3	Apply Green Supply Chain Management concept at setting up company objectives	10%	0%	90%
Step 4	Applying Lean Principles and Tailored Logistics Strategy	10%	0%	90%
Step 5	Implement Green Action Plan and Performance	25%	0%	75%
Step 6	Measure the improvement of KPI related to green performance measurement	10%	0%	90%
Step 7	Evaluate the green innovation process will lead to sustainable growth.	10%	0%	90%
		24%	0%	76%

14. (Show new business model) What do you think about this new business model?



This new business model was explained to the participants that it was one of the channels for them to place the order via web-base system but it was different from other web-base for checking stock available and credit limit. Regarding to current web-base channel in pharmaceutical supply chain, customer just placed their order and had to wait for an hour to retrieve data from the main system of distributor or from the sale representative. Sometimes, their order was rejected because of the product out of stock, so the customer feel dissatisfy for waiting for a long time for nothing.

Most of participants expressed their opinions that it would be good if this web base could provide them for 24 hours 7 days a week to access and it had stock checking functions, and they could know their financial budget as real time data before they place an order. They feel that they can control and managed their money easily, also it support them for their inventory management, they would know which product they would order instead of out of stock one. Adding, there were stock available but they were limited from their credit level then they could contact to the distributor or their bank for extending the credit limit as soon as possible.

However, there was one big constraint that have to consider related to the assessment level of the customer, if this web-site provide for all customers in order to place the order through this scene, the wholesaler business and retailers business will be gone same as small retailers of consumer product.

15. Please explain the advantage and disadvantage to apply this model in Pharmaceutical industry.

Most of them willing to adopt this web-base application that will benefit to them for the time saving, convenience, updated status and they control every thing by themselves but it have to be providing by the drug owner or distributor. They claimed that they are limited in term of financial support.

Moreover, this application or this business model has to develop by concern to the other business, such as small drug stores. So it should limit the available channels into the market.