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Optimizing Loading Weight in Vehicles for Transportation Cost Reduction of Wholesaler Business

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by

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Abstract

The main problem that most distribution centers face is high transportation costs. Distribution center is a non-profit part of the company. This means reducing distribution cost is very important method for a company. For the company that was studied, increasing the loading weight in container has been one of the important issues. It is one issue that can be improved for reducing transportation cost by solving and finding the loading weight and determining which products should be packaged in terms of volume, value, and weight. The aims of this study were to find the right balance between the company loading regulations and the Highway Law. Then, we try to optimize loading weight in the vehicles to reduce transportation costs and maximize the capacity utilization. In this study, the researchers found that by selecting the 7,900 kg. tractor for use in 15 stores, the company can save 399,000 baht per week which means the company saves 1,599,600 baht per month and 19,195,200 baht per year.

Keywords: Capacity, Container, Cost, Highway law, Increasing, Limitation, Loading, Logistics, Optimizing, Reduction, Shipping, Tractor, Trailer, Transportation, Warehousing Weight

1. Introduction

The company was established to operate wholesaler distribution center for the members. The company also expanded its distribution centers to efficiently distribute products to its members and operators across the country including retailers, entrepreneurs, restaurants, hotels, catering businesses, service business operators, government agencies, and education institutions and other businesses. The company has 2 distribution centers at Wangnoi and Bangna. The distribution center at Wangnoi has to distribute dry food to 115 stores in Center, East, of Thailand. They divided the stores into 3 type which are large stores, middle stores, and small stores. The company has 1 type of transportation truck which is 45 feet high cube container with 300 tractors and 500 containers. So every type of store has to use 45 feet high cube container to deliver.

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Increasing the loading weight in these containers has been one of the important issue. It is one issue that can be improved for reducing transportation cost by solving and finding the loading weight in which products should be determined in terms of volume, value, and weight. By using the maximum loading weight for products without exceeding the legal requirements is one of interesting point. The objectives of this study were to: 1) optimize loading weight in vehicles to reduce transportation costs, 2) to maximize the capacity utilization, and 3) to find the right balance between the company regulations and the Highway Law.

2.1 Material Handling

Material handling is the preparation of the location and position of the material to facilitate the movement and storage, and the appropriate equipment and methods of work. Material handling includes short movements within the boundaries of the building or between the building and the transport vehicle (Coyle, 1992). It uses a variety of devices, both semi-automatic and automatic, including storage and material control considerations throughout warehouse production, distribution, disposal, and use (McKay, 2012). Material management can be utilized to manage storage and material control because it creates place utility, different from production, which deals with form utility by converting the raw material to a more beneficial form (Apply, 1972).

In the present, industrial production is tremendously growing. In the world of technology, systems for transporting materials used in the production of industrial systems are very important. This is important for entrepreneurs as well. Engineers should be given priority regarding production technology, to support the production process, from raw materials coming to the factory and processed until released as a finished product to the warehouse. Moving or transport by unloading materials should be considered as a system to try to reduce the problem of unloading to make material handling fast, safe, and effective. Material transportation and handling requires many different types of equipment such as conveyor belts, cranes and hoists, and industrial trucks. The type of system required to be efficient depends on the type of equipment used.

2.2 Container

The container is used for packing products for shipment. It has a duty to make transportation easy and safe.

Type of container
In addition to conventional multi-purpose containers, there are many variants for different products. The most notable of these are the cold containers for perishable goods, which accounted for 6% of the world's shipping boxes and many tanks in the frame for liquids account for another 0.75% of the fleet containers around the world (2008). Although these formats are not standard, most of them are ISO containers. In fact, ISO 6346 classifies the container into pieces. In addition to the various size options, the most important types of containers are (2006):

1. General container
Using of dry vans, for pallets, bales, sacks, cases, boxes, cartons, etc., special interior layouts are known, such as: rolling-floor containers, for difficult-to-handle cargo. Garment containers are used for shipping garments by hangers (Schenker, 2010).

2. Ventilated containers

Special propose dry vans, for ventilated products such as for organic products that ventilation is required.

3. Temperature controlled

Temperature controlled refrigerated, insulated, and/or heated containers, for fragility goods.

4. Tank containers

For liquid/ gas often it is dangerous. One delivery unit of gas may hold several cylinders.

5. Bulk containers

Either closed with a roof cover or open top unit, solid or hard on top for loading, such as minerals.

6. Open-top and open-side containers

For heavy machinery or large pallets loading. The open area for easy decay ventilation, such as apples or potatoes.

7. Platform based containers such as:

Bolster and Flat rack containers - For goods, crates, drums and cylinders which are not too much large or heavy loads, such as processed timber or semi-finished products. Flat blank stands may be shipped or stacked to other ISO containers (Caru, 2016).

3. Research Methodology

3.1 Research Design

The design will be based on questionnaire or survey research because it best served for answering the questions, objectives, and the purpose of the study. From this survey research, research design can be described as a structure or master plan of the method that can be collecting and analyzing data by decision maker.

3.2 Target Population

The target population of this research is defined to include the management team, accountant team, operation team, warehouse staff, transportation team and many parts of staff or people from the wholesaler company.

3.3 Sample Size

This section is important to choose an example or representative sample in qualitative research for the results to the target population or target audience. A sample size is a size of group that can select the representative from the whole accessible population. For some studies, all population have been involved in this study but only some of them that giving data to researcher. The sample size of this research is to study and collect data from transportation team. Collect data from sample as following:

- Sample of the population
- Sample of the management team
- Sample of the accountant team

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- Sample of the operation team
- Sample of the warehouse team
- Sample of the transportation team

3.4 Sampling Procedure

Sampling procedure in this research is an interview, procedure, process, step, system or technique. For sampling procedure was used for selecting the participants in this research study. The main topic of the research study is about transportation, so the first procedure is to interview from transportation team about the company truck weight and then compare with highway law for knowing truck weight limitation. So, if trucks have less than limitation of weight of Highway Law that means it can receive more products unit.

3.5 Description of Data Collection Instruments

For the purpose of this research, interview is the method that is used in this research. Researchers gather questions to interview staff from different department according to questions. This interview is face-to-face data collection. The interview should mention the relevant and clearly questions so that interviewees would give a detail answer to complex problems. The main benefit of interview is keep focus, accurate screening, capture emotions and behaviors, capture verbal and non-verbal question, quality of data by interviewer and also they involve personal contact between interviewers and interviewees. As far as the data collection instrument were concerned, the face-to-face interview is good guide for the researcher because if additional questions arise during the interview, they can be immediately asked.

3.6 Data Analysis and Statistics

Quantitative approaches will be used for data analysis procedures. Data analysis procedure is the procedure to the categorized of verbal or behavioral data for the purpose of classification, summarization and grouping. The quantitative data obtained from interview guide will be categorized into topics based on research objectives and interpret data from the interview along with quantitative presentation. This research reinforces the quantitative data by used the quantitative data.

4. Results Analysis

Due to the higher transportation costs such as higher oil prices, higher raw material prices and increased freight costs, this research has suggested solving the problem of truck weight for the company to reduce transportation cost by optimizing the capacity of the container utilization to the maximum weight. One of the factors that contribute to the company high transportation costs is the company uses different types of tractor weights. Different types of tractor come from different brand, model, and fuel types. The tractor has not enough volume for the container which means there are more trailers than tractors. So the company needs for a rotating tractor that why the company cannot control the type of tractor or the weight of tractor used for each load. The difference of the weight of the tractor makes it difficult to calculate the total weight of the truck. If the company is able to set the tractor, they will able to calculate with certainty the total weight of the truck and will load the goods into the container with the maximum efficiency. The size of the container also affects the container utilizations as well. It is necessary to study the efficiency of container space utilization.

The researchers have selected 15 stores from 115 stores to be an example of this research. These 15 stores will calculate load using the tractor of 7,900kg. Because to reduce tractor weight can be improving trailer weight so this will be the solution of this research. The researcher selected the store by looking for a high gap between total weight of truck and weight of truck from highways law, high number of routes, distance between store and distribution center, and cost of transportation.

The company has about 300 tractors and 500 trailers with 4 types of tractors and a number of transport vehicles that are used for distributing goods as follows:

1. 7,900 kg.   22% of all transport vehicles
2. 8,900 kg.   42% of all transport vehicles
3. 9,900 kg.   14% of all transport vehicles
4. 11,500 kg.   23% of all transport vehicles

The researchers have selected 15 stores from 115 stores as an example as follows: Ladpraw, Chiangrai, Chiangmai, Hatyai, Nakhonratchasima, Nakhonsawan, Charansanitwong, Chiangmai, (another store at Chiangmai), Ubonratchathani, Udonthani, Samsen, Sakhon Nakhon, Srisaket, Buriram, and Nakhon Si Thammarat

Table 1 Take Current Data from the Company

No.	Store Name	Route per day	Transportation cost per route	Transportation cost per day	Tractor weight(kg.)				Empty Container weight(kg.)	Products weight(kg.)	Pallet weight (kg.)	Total truck weight(kg.)	Weight limitation of Highway law(kg.)	Gap (%)
					7,900	8,900	9,900	11,500	45FT 3Axle Box	45FT 3Axle Box	45FT 3Axle Box	45FT 3Axle Box	45FT 3Axle Box	45FT 3Axle Box
1	Ladpraw	4	4,800	19,200				11,500	11,500	19,866	840	43,686	50,500	8,602
23	Chiangrai	2	30,000	60,000				11,500	11,500	24,003	840	47,923	50,500	2,577
41	Chiangmai 2	2	15,000	30,000				11,500	11,500	21,75x	840	48,59x	50,500	4,x09
9	Hatyai	3	14,000	42,000				11,500	11,500	23,80x	840	47,73x	50,500	2,x68
7	Nakhonratchasima	4	6,500	26,000				11,500	11,500	20,68x	840	44,49x	50,500	6,x04
18	Nakhonsawan	3	6,500	19,500				11,500	11,500	18,92x	840	42,66x	50,500	7,x33
17	Charansanitwong	4	4,800	19,200				11,500	11,500	18,61x	840	42,48x	50,500	8,x41
8	Chiangmai	2	15,000	30,000				11,500	11,500	22,81x	840	46,68x	50,500	3,x48
10	Udonthani	2	15,000	30,000				11,500	11,500	23,28x	840	47,10x	50,500	3,x99
14	Ubonratchathani	2	15,000	30,000				11,500	11,500	22,91x	840	46,75x	50,500	3,x46
2	Samsen	2	4,800	9,600				11,500	11,500	17,84x	840	41,48x	50,500	9,x12
24	Sakhon Nakhon	2	13,500	27,000				11,500	11,500	22,77x	840	46,61x	50,500	3,x88
33	Srisaket	2	12,000	24,000				11,500	11,500	22,93x	840	46,77x	50,500	3,x22
32	Buriram	2	11,000	22,000				11,500	11,500	23,26x	840	47,10x	50,500	3,x93
22	Nakhon Si thammarat	2	10,600	21,200				11,500	11,500	24,09x	840	47,93x	50,500	2,x67

This figure shows the current data that the company uses by 11,500 kg tractor weight in calculation. Tractor weight + empty container weight + products weight = total truck weight. Then compare weight limitation of highway law and total truck weight. Weight limitation of highway law - total truck weight = gap. If the gap column is high it means the company can increase more products and products weight into the truck.

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Table 2 Step 2: Find the Total Weight of the Truck

No.	Store Name	Route per day	Transportation cost per route	Transportation cost per day	Tractor weight(kg.)				Empty Container weight(kg.)	Products weight(kg.)	Pallet weight (kg)	Total truck weight(kg.)	Weight limitation of Highway law(kg)	Gap (%)
					7,900	8,900	9,900	11,500	45FT 3Axel Box	45FT 3Axel Box	45FT 3Axel Box	45FT 3Axel Box	45FT 3Axel Box	45FT 3Axel Box
1	Ladpraw	4	4,800	19,200	7,900				11,500	19,955	840	40,09	50,500	10,402
23	Chiangrai	2	30,000	60,000	7,900				11,500	24,083	840	44,32	50,500	6,177
41	Chiangmai 2	2	15,000	30,000	7,900				11,500	21,75	840	41,99	50,500	8,509
9	Hatyai	3	14,000	42,000	7,900				11,500	23,894	840	44,13	50,500	6,366
7	Nakhonratchasima	4	6,500	26,000	7,900				11,500	20,656	840	40,89	50,500	9,604
16	Nakhonsawan	3	6,500	19,500	7,900				11,500	18,82	840	39,06	50,500	11,433
17	Charansanitwong	4	4,800	19,200	7,900				11,500	18,61	840	38,85	50,500	11,641
6	Chiangmai	2	15,000	30,000	7,900				11,500	22,81	840	43,05	50,500	7,448
10	Udonthani	2	15,000	30,000	7,900				11,500	23,26	840	43,50	50,500	6,999
14	Ubonratchathani	2	15,000	30,000	7,900				11,500	22,91	840	43,15	50,500	7,346
21	Samsen	2	4,800	9,600	7,900				11,500	17,64	840	37,88	50,500	12,612
24	Sakhon Nakhon	2	13,500	27,000	7,900				11,500	22,775	840	43,01	50,500	7,485
33	Srisaket	2	12,000	24,000	7,900				11,500	22,934	840	43,17	50,500	7,322
32	Buriram	2	11,000	22,000	7,900				11,500	23,26	840	43,50	50,500	6,993
22	Nakhon Si thammarat	2	10,600	21,200	7,900				11,500	24,09	840	44,33	50,500	6,167

Find the total weight of the truck which uses data from current data but change the truck weight from 11,500kg. to 7,900kg. Then sum 3 sections which are <u>tractor weight</u> + <u>empty container weight</u> + <u>product weight</u> + <u>pallet weight</u> = <u>total truck weight</u>. After get total truck weight then find the gap between total truck weights and weight limitation of highway law. By use <u>weight limitation of highway law</u> - <u>total truck weight</u> = <u>Gap</u>.
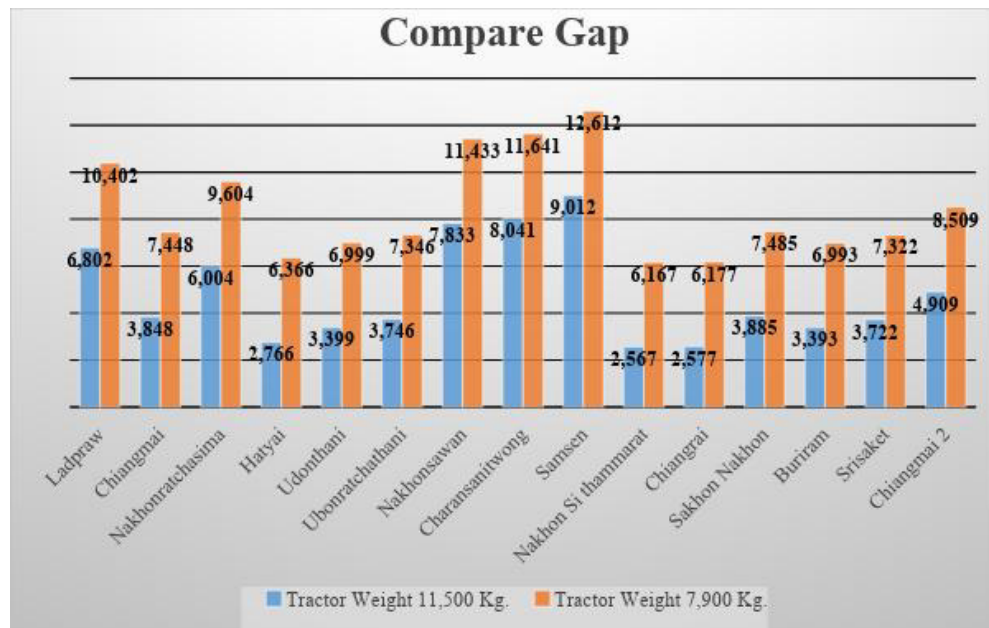

Figure 1 Graph Compare Gap between Current and Future Tractor Weight

From the calculation of current data and future data from the company in the table 4-1 and table 4-2, this graph shows comparison of gap between 11,500 kg. tractor and 7,900 kg. tractor. The result is using 7,900 kg. can improve weight of cargo per route.

Table 3 Step 3: Calculate the weight to be transported per day

No.	Store Name	Route per day	Transportation cost per route	Transportation cost per day	Tractor weight(kg.)				Total truck weight(kg.)	Weight Limitation of Highway law(kg.)	Gap (%)	Weight to be Transported per Day
					7,900	8,900	9,900	11,500	45FT 3Axel Box	45FT 3Axel Box	45FT 3Axel Box	
1 Ladpraw			4,800	19,200	7,900				40,098	50,500	10,402	160,393
23 Chiangrai			30,000	60,000	7,900				44,323	50,500	6,177	88,646
41 Chiangmai 2			15,000	30,000	7,900				41,991	50,500	8,509	83,982
9 Hatyai			14,000	42,000	7,900				44,134	50,500	6,366	132,403
7 Nakhonratchasima			6,500	26,000	7,900				40,896	50,500	9,604	163,585
16 Nakhonsawan			6,500	19,500	7,900				39,067	50,500	11,433	117,202
17 Charansanitwong			4,800	19,200	7,900				38,859	50,500	11,641	155,434
6 Chiangmai			15,000	30,000	7,900				43,052	50,500	7,448	86,104
10 Udonthani			15,000	30,000	7,900				43,501	50,500	6,999	87,001
14 Ubonratchathani			15,000	30,000	7,900				43,154	50,500	7,346	86,309
21 Samsen			4,800	9,600	7,900				37,888	50,500	12,612	75,775
24 Sakhon Nakhon			13,500	27,000	7,900				43,015	50,500	7,485	86,031
33 Srisaket			12,000	24,000	7,900				43,178	50,500	7,322	86,356
32 Buriram			11,000	22,000	7,900				43,507	50,500	6,993	87,014
22 Nakhon Si thammarat			10,600	21,200	7,900				44,333	50,500	6,167	88,665

After knowing total truck weight from using 7,900 kg. tractor then calculate the weight to be transported per day by using total truck weight * current number of route per day = weight to be transported per day.

Table 4 Step 4: Find the Number of Routes per Day

No.	Store Name	Route per day	Transportation cost per route	Tractor weight(kg.)	Total truck weight(kg.)	Weight Limitation of Highway law(kg.)	Gap (%)	Weight to be Transported per Day	Number of route per day (under Highway law)
				7,900	45FT 3Axel Box	45FT 3Axel Box	45FT 3Axel Box		
1 Ladpraw		4	4,800	7,900	40,098	50,500	10,402	160,393	3.18
23 Chiangrai		2	30,000	7,900	44,323	50,500	6,177	88,646	1.76
41 Chiangmai 2		2	15,000	7,900	41,991	50,500	8,509	83,982	1.66
9 Hatyai		3	14,000	7,900	44,134	50,500	6,366	132,403	2.62
7 Nakhonratchasima		4	6,500	7,900	40,896	50,500	9,604	163,585	3.24
16 Nakhonsawan		3	6,500	7,900	39,067	50,500	11,433	117,202	2.32
17 Charansanitwong		4	4,800	7,900	38,859	50,500	11,641	155,434	3.08
6 Chiangmai		2	15,000	7,900	43,052	50,500	7,448	86,104	1.71
10 Udonthani		2	15,000	7,900	43,501	50,500	6,999	87,001	1.72
14 Ubonratchathani		2	15,000	7,900	43,154	50,500	7,346	86,309	1.71
21 Samsen		2	4,800	7,900	37,888	50,500	12,612	75,775	1.50
24 Sakhon Nakhon		2	13,500	7,900	43,015	50,500	7,485	86,031	1.70
33 Srisaket		2	12,000	7,900	43,178	50,500	7,322	86,356	1.71
32 Buriram		2	11,000	7,900	43,507	50,500	6,993	87,014	1.72
22 Nakhon Si thammarat		2	10,600	7,900	44,333	50,500	6,167	88,665	1.76

Note: (If the vehicle weight is maximum by highway law)

Find the number of routes per day if the vehicle weight is maximum by highway law by using weight to be transported per day / weight limitation of highway law = number of routes per day.
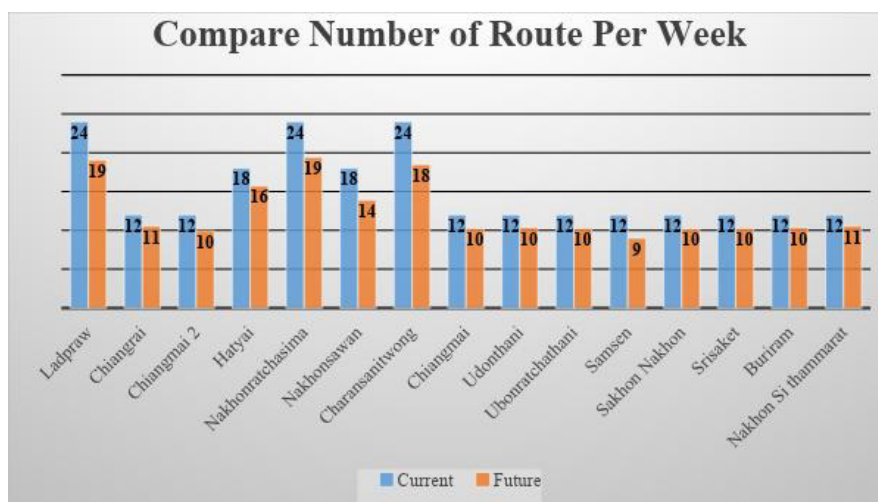
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Figure 2 Graph Compare Number of Route per Week

This graph above shows total number of route of transportation per week by comparing current and future number of route per week. The current series is represented by blue color and the future series is represented by orange color. After calculation, number of routes per week of the future series is less than current series. That means the company will save more cost and this calculation is effective.

Table 7 Step 7: Finding Current Transportation Cost per Week

No.	Store Name	Route per day	Transportation cost per route	Total truck weight(kg.)	Weight Limitation of Highway law(kg.)	Gap (%)	Number of route per week (Current)	Transportation cost per week (Current)
				45FT 3Axel Box	45FT 3Axel Box	45FT 3Axel Box		
1	Ladpraw	4	4,800	40,098	50,500	10,402	24	115,200
23	Chiangrai	2	30,000	44,323	50,500	6,177	12	360,000
41	Chiangmai 2	2	15,000	41,991	50,500	8,509	12	180,000
9	Hatyai	3	14,000	44,134	50,500	6,366	18	252,000
7	Nakhonratchasima	4	6,500	40,896	50,500	9,604	24	156,000
16	Nakhonsawan	3	6,500	39,067	50,500	11,433	18	117,000
17	Charansanitwong	4	4,800	38,859	50,500	11,641	24	115,200
6	Chiangmai	2	15,000	43,052	50,500	7,448	12	180,000
10	Udonthani	2	15,000	43,501	50,500	6,999	12	180,000
14	Ubonratchathani	2	15,000	43,154	50,500	7,346	12	180,000
21	Samsen	2	4,800	37,888	50,500	12,612	12	57,600
24	Sakhon Nakhon	2	13,500	43,015	50,500	7,485	12	162,000
33	Srisaket	2	12,000	43,178	50,500	7,322	12	144,000
32	Buriram	2	11,000	43,507	50,500	6,993	12	132,000
22	Nakhon Si thammarat	2	10,600	44,333	50,500	6,167	12	127,200
Sum							192	1,983,000

Finding current transportation cost per week by using <u>number of routing per week</u> * <u>transportation cost per route</u> = <u>future transportation cost per week.</u> The transportation cost per route for 11,500 kg. tractor and 7,900 kg. tractor are the same.
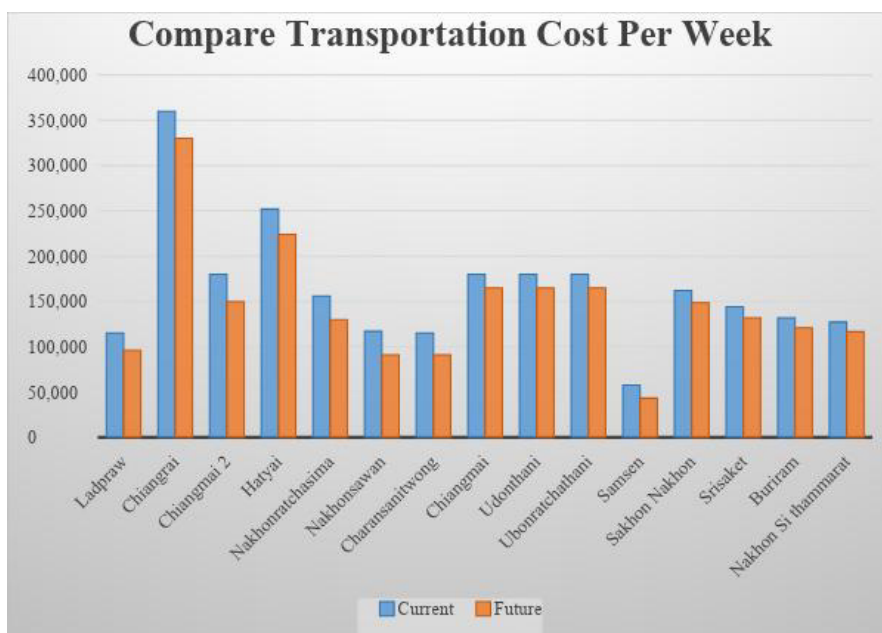
Figure 3 Graph to Compare Transportation Cost per Week

The graph above shows transportation cost per week for current and future. The gap between both series shows the cost that the company can save. Blue color is current series which is higher than the orange color which is future series.

5. Conclusion and Recommendation

5.1 Research Result

From the results of Chapter 4 which is result and discussion. The researchers found that the efficiency maximization of cube and weight is to specify tractor size for some stores.

The company has about 300 tractors and 500 trailers with 4 different types of tractor and number of transport vehicles that are used for distributing goods as follows:
1. 7,900 kg.   22% of transport vehicles
2. 8,900 kg.   42% of transport vehicles
3. 9,900 kg.   14% of transport vehicles
4. 11,500 kg.   23% of transport vehicles

Now the company is using all types of weight because the company has less tractors than trailers so tractors must be rotated to ensure that it is available and deliver products to the stores on time. The company used only 11,500 kg. weight tractors for calculating. The researchers found that the company should select 15 stores with appropriate distance, weight, and shipping costs to identify to use the 7,900 kg. tractor only.

To selecting the minimal weight of tractor for increasing cube, case and weight in the trailer. The total weight of the truck comes from tractor weight, trailer weight, all products weight in trailer,

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and pallet weight. Then compare with limitations of weight of the highway law. So we found the gap and increase products until just below the limitation weight of highways law. The criteria of selecting the store that should use 7,900 kg. is:

1. There should be high gap between total weight of truck and weight of truck from Highway law.
2. There should have high number of routes.
3. The store should not be so far from the distribution center so that the truck will be back to distribution center on time.
4. There should be high transportation cost per round.
5. The transportation routing should have more than 2 rounds.

Table 10 Table of Transportation Cost Improvement (Every Calculation is Per Week)

Store Name	Cost Per Routing	Number of routing (Current)	Cost per week (Current)	Number of routing (Future)	Cost per week (Future)	Cost Saving
1	4,800	24	115,200	17	81,600	33,600
2	30000	12	360,000	11	330,000	30,000
3	15,000	12	180,000	10	150,000	30,200
4	14,000	18	252,000	16	224,000	28,000
5	6,500	24	156,000	20	130,000	26,000
6	6,500	18	117,000	14	91,000	26,000
7	4,800	24	115,200	19	91,200	24,000
8	15,000	12	180,000	11	165,000	15,000
9	15,000	12	180,000	11	165,000	15,000
10	15,000	12	180,000	11	165,000	15,000
11	4,800	12	57,600	9	43,200	14,400
12	13,500	12	162,000	11	148,500	13,500
13	12,000	12	144,000	11	132,000	12,000
14	11,000	12	132,000	11	121,000	11,000
15	10,600	12	127,200	11	116,600	10,600
Sum		192	1,983,000	165	1,742,500	240,500

After calculating, the table above shows that the future plan can reduce 240,500 baht per week which mean the company save 962,000 baht per month and 11,544,000 per year. The solution is quite pleasant for this research.

5.2 Suggestion

The researchers have studied the solution for weight problems. There are several ways to reduce the cost of transportation. What the researchers have tried to do in this study is only part of reducing the cost of transportation. The researchers have suggested that transportation costs will be reduced more if the company uses more 7,900kg. for transportation, it must be useful and improved in the future. For optimizing loading weight in vehicles, the following suggestions have made on the basis of the above findings. The company hire third parties for manage the warehouse and distribution center so that the company can select tractor weight 7,900 kg. as much as they can. Moreover, they can improve performance of the corporation by reducing or saving cost of transportation.

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