Empty Trucks Run Reduction in Bangkok Area Towards Sustainable Transportation

Chaiyot Peetijade and Athikom Bangviwat

Abstract—**The research was conducted to examine manufacturers' truck runs in Bangkok area. The findings of the survey reveal the characteristics of the manufacturers who have their own trucks for transportation. Empty truck run is a typical problem for transportation sector for an increase in the transportation cost and inefficient use of energy. The survey found that out of a distance of 245,118 km. (per week), 85.75% of the backhauls were empty, which accounted for 210,193 km. of empty truck run and 2,350,402 Baht worth of inefficient use of energy in one week. The number of empty truck runs will be lower with matching process enabling, where 14.59% of the total empty truck runs will be saved. The lower number of empty truck runs not only benefits the manufacturers for the lower transportation cost but also provides a good impact to the society as a whole.**

Index Terms—**Backhaul, empty truck run, inefficient use of energy, transportation survey.**

I. Introduction

Thailand logistics report 2010 by the Office of the National Economic and Social Development Board (NESDB) reported the logistics cost in Thailand in year 2009 was 16.8 percent of the Gross Domestic Product (GDP), while the transportation cost was 8.3 percent of GDP [1].

Srisurapanon (2008) calculated logistics cost by using Input – Output, gross domestic product and energy consumption. The logistics cost of business sector, it was classified into 9 sectors. The manufacturing sector was the dominant sector. It shared 35% of logistics cost of all business sectors for the year 2000 and expected to be 40% in 2020. This is number show the high logistics cost for manufacturing sector [2].

Bangkok is not only a capital city but also a manufacturing base of Thailand. Bangkok containing 1,568.7 square kilometer, the road network is dominated mean of transportation more than 4,700 kilometer in length. Bangkok has 6.9 million registered vehicles (2012) 1.03 million is van and pick-up truck and 119,290 is truck (under Land Transport Act) [3]. The high growth of city brings the high movement of freights, both inflow and outflow of product. Most of the freight transportation in Bangkok is a flow of product from manufacturers to wholesalers and retailers, truck terminals, freight forwarders, factories and modern trade outlets, depending on the type of business. The increasing usage for all types of trucks has a major impact on traffic conditions, road safety and environment.

The rise of fuel price leads to an increase in transportation cost which directly impacts logistics cost. Transportation collaboration is playing a key role to reduce transportation cost, but it needs more collaboration through information sharing among different organizations. The success of transportation collaboration benefits both corporates and society.

The backhaul or empty run is a classic problem in transportation, both in freight and passenger transport. It presents to the situation when the demand and supply of freight is imbalanced. The volume of freight represents the economic activities especially for production sector. The shipment flows between regions differ due to differences in demand. The truck runs bound to high demand of production base usually runs with full load but return with empty or less than truck load.

According to a study of Council of Engineers in year 2006, Thailand freight movement had 690,000 trucks with more than 71.74 million trips and total distance for truck run was around 12,415 million kilometers per year. 46% of the figure was empty truck runs, or 33 million trips that included 5,586 million kilometers per year. The amount of empty truck runs created a problem in road transportation. The empty truck run problem could be relieved if the relevant stakeholders in transportation realize how serious problem was. The information sharing among organizations is the major factor which can be contributed to the reduction of empty truck runs.

Bailey, *et el.,* (2011) studies how small, mediums sized truckload carrier can reduce empty backhauls to depot or distribution center location. Two optimization models are developed to route the carrier of interest's backhaul routes and select collaborative shipments to fulfill by adding pickup and delivery tasks of collaborative shippers or carriers to their backhaul. Numerical analysis reveals that the percentage of cost savings for backhaul routes can be as high as 27% [4].

Cruijssen, et al studied the overall insight in the nature of the total savings that partners can attain by means of joint route planning; up to 37% of total distribution costs can be saved [5].

Limanond, T et al explored the average annual vehicle kilometer of travel (VRT) of vehicles in Bangkok, VRT of pick-up trucks is 32,475 kilometers. The total VKT for all type of vehicles is about 138,101 million vehicle-kilometers, pick-up truck take 21.25% of total. [6]

The empty truck problem could be solved if organizations were to engage in transportation exchange with one another. The kind of inter-organizational collaboration, however, is not easy. Many such collaborations fail, especially those among competitors. Asawasakul [7] introduced partner

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selection criteria in two perspective: economic and social. The economic perspective has two constructs leading to success in the collaboration: perceived cost reduction, and transportation complementarity. The social perspective constructs are trust, commitment, and direct prior alliance.

The main objective of this study is to examine the characteristics of manufacturers' truck runs in Bangkok area, focusing on the empty truck runs. The matching truck run from Bangkok to other regions also described. The paper is organized as follows: the first section is an introduction of Bangkok truck run in general. The second part is a method of data collection and sample size of survey. Matching results were presented in the third part. The final part is the conclusion of the study.

II. Method of Data Collection

The method of data collection for this study was a field survey. The questionnaires were distributed to manufacturers by mail, e-mail, interview, seminar session, and telephone interview. The manufacturer list from the Department of Industrial Works (DIW) was adopted for this survey. The survey included the manufacturers who had their own trucks for product delivery to wholesalers, distributors, customers or part makers. Field survey conducted within the framework of this study reviewed the attributes used in transportation planning to develop a mechanism to lower energy use in transportation especially inefficiency of truck runs by manufacturers.

TABLE I: Profile of Questionnaires

Objective	Information of truck trip both origin and destination point.
Methods	Mail, E-mail, Telephone Interview and Seminar Class
Retrieve	143 copies throughout Bangkok area
Group	Manufacturers listed as company limited and public company limited
Condition	Manufacturers with their own truck

Several means of information acquisition were applied in order to obtain useful data during the survey. Interview through telephone seemed to be the most successful method under time constraint. Other communication methods yielded much fewer respondents. Details of attempts and successes of the interviews are provided in TABLE II.

TABLE II: Numbers of Attempts and Successes by Means of Interviews

Process	Attempts	Receipts	Percentages
Interview			
- Phone	890	113	12.7
- Direct	18	8	44.0
Others			
- Email	460	6	1.3
- Fax	6	2	33.3
- Seminar	160	14	8.7

The Taro Yamane technique was applied to calculate the number of sample with 90% confidential level to the 8,100 factories registered with Department of Industrial Works (DIW) [8]. Therefore, the calculation for the sample size by using Taro Yamane's formula (Yamane, 1973) [9] is as given in (1).

$$n = \frac{N}{(1 + Ne^2)} \quad (1)$$

where: n = sample size,
N = population, and
e = error of the sampling.

So, the sample size for this study can be calculated as follows:

$n = 8{,}100 / ((1+8{,}100(0.1^2))$
$= 98.78$ or approximately 99

TABLE III: Numbers of Sample

Sample Size	Number
DIW Data	8,100
Yamane Required	99
Received	143

International Standard Industrial Classification (ISIC) was used for the classification of industry as shown in TABLE IV.

TABLE IV: Industrial Type Classification

Industry	Number	Percentages
Auto and Auto Part	3	2.10
Electric and Electrical	9	6.29
Rubber and Plastic	16	11.19
Textile and Garment	14	9.79
Food and Beverage	11	7.69
Furniture	9	6.29
Chemical and Chemical Product	20	13.99
Machinery and Equipment	15	10.49
Paper and Packaging	15	10.49
Construction Material	16	11.19
Other	15	10.49
Total	143	100.00

The data were received from all major industries in Thailand. The majority of the respondents in this survey was found to be in Chemical and Chemical Product (13.99%), and followed by Rubber and Plastic Industry, and Construction Material Industry (11.19%).

TABLE V: Classified by Number of Workers

No. Employee	Number	Percentages
Less than 50	44	30.77
51-100	26	18.18
101-150	25	17.48
151-200	9	6.29
More than 200	39	27.27
Total	143	100.00

The number of workers is indicated in Table V. The largest size of the factories included in this study hire less than 50 workers (30.77%) and followed by more than 200 workers (27.27%).

TABLE VI: TRUCK TYPE CLASSIFIED BY FUEL USE

Type (Wheel)	Benzene	Diesel	CNG	LPG	Total
4	3	753	25	13	794
6	0	655	2	2	659
10	0	68	2	0	70
18	0	18	1	0	19
Total	3	1,494	30	15	1,542

TABLE VI, It is found from the survey that the majority type of trucks are 4 wheeled trucks of 794 units and diesel is of the most popular fuel used in 1,494 units.

III. RESULTS AND ANALYSIS

In this section, the data from survey is summarized to elaborate the characteristics of truck runs, percentages of backhauls with shipment and empty backhaul, and their energy consumptions.

TABLE VII: CHARACTERISTICS OF TRUCK RUNS

Fact Found	Total Truck Runs	Empty Backhauls	Backhauls with Shipment
Distance (Km.) One-way	59,537	51,524	8,013
	100%	86.54%	13.46%
Total Distance (Km/Week)	245,118	210,193	34,925
	100%	85.75%	14.25%
Leg	451	343	108
	100%	76.05%	23.95%
Trips (Per Week)	2,063	1,598	465
	100%	77.46%	22.54%
Total Fuel Use (Baht/Week)	2,862,557	2,350,402	512,155
	100%	82.11%	17.89%
- Fronthaul Fuel Use	1,563,290	1,284,820	278,470
- Backhaul Fuel Use	1,299,267	1,065,582	233,685

The characteristics of truck runs in this survey, shown in Table VII, are accounted for one week time period, where :

Leg is a course of truck travel, with origin, destination, and all consecutive segments of route for a single journey,

Trip is a set of truck travel for some purpose usually including the return,

Fronthaul means the first leg of the truck trip that involved carrying a load or several loads to targeted destination, while

Backhaul is the return of truck from the targeted destination to the point of origin,

Total fuel use for truck run that comprises of fronthaul and backhaul, either with load or empty for backhaul trip.

Normally, fronthaul truck runs usually depart with shipments because manufacturers attempt to fully utilize of their truck loads. Unfortunately, the backhaul trips are different from the fronthaul trips. The facts found from the survey are shown on Table VII, where the total distance per week for this survey was 245,118 kilometers with 451 legs and 2,063 trips. The total fuel consumed was 2,862,557 Baht which included 1,563,290 Baht for fronthauls 1,299,267 Baht for backhauls. The total distance per week for empty backhaul was 210,193 kilometers with 343legs and 1,598 trips. The total fuel consumed by these truck runs was 2,350,402 Baht, of which 1,065,582 Baht was for backhauls fuel use. The total distance per week for backhaul with shipment was 34,925 kilometers with only 108 legs and 465trips. The fuel uses was 512,155 Baht, i.e. 278,470 Baht for fronthauls and 233,685 Baht for backhauls. There has been a problem of empty truck only 14.25 % of total distances of truck runs per week carried backhaul shipments while 85.74 % of the run distance was empty. The energy consumed in Baht term was 82.01% for empty backhauls while 17.99 % was for backhauls with shipment.

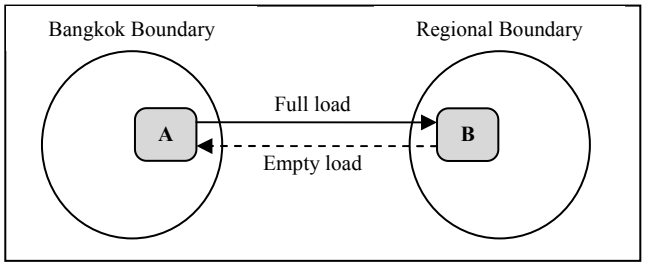

Fig. 1. Truck run without matching process.

Fig. 1 shows the traditional truck run that carries full load from the origin to destination point but the return leg is usually empty and causes high transportation cost, waste of energy and pollution.

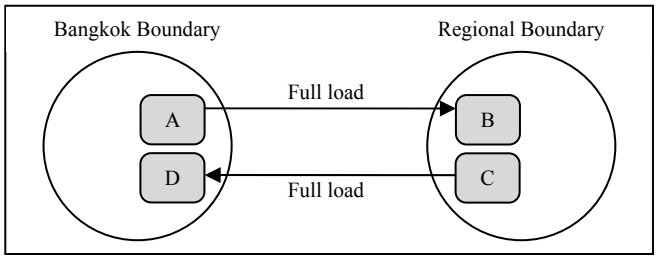

Fig. 2. Truck run with matching process.

The truck run from original is full load to destination point (A to B) and the return leg of truck can carry shipment for the original point on the same region back to Bangkok destination (C to D) in Fig. 2. The matching process is based on several parameters, such as size of load, type of goods, and etc. If the size of the truck of fronthaul trip (A) is equal or larger than the truck of return trip (C), then matching process is enabling.

TABLE VIII: RESULT OF MATCHING CLASSIFY BY DESTINATION

Destination	Before Matching		Matching		Percentage	
Region	Legs	Distance (Km.)	Legs	Distance (Km.)	Legs	Distance (Km.)
Vicinity	229	9,061	79	2,935	34.50	32.39
Central	170	20,005	29	2,949	17.06	14.74
North	16	9,926	2	1,315	12.50	13.25
Northeastern	23	10,138	-	-	-	-
South	13	10,407	2	1,490	15.38	14.32
Total	451	59,537	112	8,689	24.83	14.59

TABLE VIII describes the number of total truck runs from Bangkok origin to 6 regions destination in total legs of truck

runs and total distance. In the matching column, the number of total legs and distance of the successful matching are shown. After matching process, the result shows total distance saved from matching is 8,689 kilometers or 14.59 % of total distance. Trips from Bangkok to vicinity region have the highest potential to match their backhaul trips with shipments in return trips. 32.39 % of their total distance can saved from empty truck run matching, followed by 14.74% from Bangkok to central region.

TABLE IX: TRANSSPORT MANAGEMENT FOR EMPTY TRUCK RUNS

Factor	Mean	SD	Rank
Same / nearby route	2.57	1.77	1
Same destination	3.15	2.06	2
Demand for back trip	3.45	2.12	3
Distribution center	4.92	1.79	5
Milk run	5.01	1.77	6
Industrial clustering	4.91	1.95	4
Partnership / Alliance	5.83	1.97	7
Information Center	6.08	2.17	8

TABLE IX shows, the respondents for this survey suggested that those, who are in the same and nearby truck route, had the most potential to collaborate and solve the empty truck run problem followed by the issues of same destination, demand for back trip, and industrial clustering respectively, while the information center is the least important to solve the empty truck run problem.

IV. DISCUSSION

The results show that there are potentials for matching backhaul truck runs that can reduce transportation cost. Information sharing is a key success factor for matching process. The information required is simple and general data such as origin and destination point, type of truck use, constraint of container, time window for delivery product. etc.

Managing transportation requires production plan and execution capabilities in advanced. One truck load need 1 week plant requirement [10]. The integration planning for all tasks in factory such as purchasing, inventory control, line production, customer service are required. The transportation planning makes a mode of selection decisions, full load or partial load for fronthaul trip, consolidates truck trip, linked routes to customer. Execute the backhaul trip based on the information of their suppliers and partner for high utilized space of truck to reduce cost of return trip for transportation.

The inefficient truck run, especially for backhaul trip, should be improved for better transportation planning both internal integration and external integration [11]. The traditional transport task is just pushing the product from production process or warehouse to customers without concern about efficient energy consumption. Both internal and external organizations must plan and work together to avoid any waste in energy for transportation. Internal integration means the manufacturing department must plan its production process along with the sale team, while the sale department needs to work with the transport department to arrange for optimal transportation.

Proper planning among departments can reduce inefficient transportation of partially loaded truck. External integration is the cooperation with other factories in nearby location or on the same route of transport. The alliance of transport should be able to share truck load so as to reduce empty truck run in backhaul trip. External integration should start with the familiar organizations such as customers and suppliers, etc.

Fig. 3. Internal and external integration for transport.

V. CONCLUSION

This paper has described the status of Bangkok manufacturers' truck runs and has focused on the inefficient empty truck runs. It has revealed that more than 85.75% of weekly truck runs on the road came back empty, which resulted in high energy consumption and a waste of 37.42% of the expense for fuel on empty backhauls. It is suggested that the empty truck runs can be reduced with the matching process in transportation, approximately 14.59% of total distance can reduced. The logistics model and matching could be employed and quantified in future study for the reduction of energy consumption in the country-wide transportation. The responsible management of manufacturers should be concerned of the issue, because the empty truck run reduction will also help in lowering the external costs, such as traffic congestion, emission, pollution, accident on the public road, which have been borne by the society.

VI. FUTURE RECOMMENDATIONS

The expansion of survey should conduct in the country-wide. The national truck trip information will increase the possibility to matching empty truck run. The environment issues could be taking to account to calculate the reduction of Carbon Dioxide (CO_2) and other emission after the matching process enable.

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