AN ANALYSIS OF ACTUAL COUNTRYWIDE DOMESTIC ROAD FREIGHT PATTERNS IN THAILAND USING GPS DATA

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ABSTRACT

Fortunately, in 2017 Department of Land Transport (DLT) has launched a regulation to enforce all trucks public passenger vehicles to equip Global Positioning System (GPS) devices for safety and law enforcement purpose. Even if the main purposes are not pointed to transport planning, the GPS can provide valuable raw data to analyze and give the answers to the questions of what is the current situation of road freight transport in Thailand, what is the domestics truck travelling pattern in different days of week, and what are the factors influencing provincial road freight demands throughout the country.

Data gathering, data analysis, and multiple linear regression are the methods used to analyze the truck transportation behavior by interpreting GPS data. The data consists of truck identification number, number of wheels, latitude and longitude, travel time, and distances between November 1-30, 2018. The volume of transportation in November 2018 in term of trip, distance, and number of vehicles gets along the same direction. Mostly, traffic intensity is highest during the middle of the week while Saturday and Sunday have the lowest number of trucks consecutively. Since it is holiday, Sunday has the smallest trucks number. The highest numbers of trucks was at the end of November 2018.

The data for Multiple Linear Regression (MLR) are from 2018. There are four models using SPSS which are MLR Bangkok-included calculating, and MLR Result Bangkok-excluded calculating (Trip-per-Day and Destination are dependent variables for each model).

MLR results of Included and Excluded Bangkok Calculating Models explain that around 86 percent of the variance in the data is based on Trip-per-day dependent variable while Destination dependent variable explains around 53 percent of the variance in the data. For MLR result of Included Bangkok Calculating Model, Transportation Company has the highest impact than other. Surprisingly, Factory has a negative relation to Trip-per-day dependent variable. For all the models, Transportation Companies and Poppulation Surrounding are the most influential factors.

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Virunya Rimchaisith

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CHAPTER 1
INTRODUCTION

1.1 Background

Introduction to tracking system, modern vehicle tracking system uses GPS technology to monitor and locate our vehicle anywhere on earth. There are also different types of automatic vehicle location technology are used. GPS is one of the technologies used to determine the location of a vehicle using and other navigation system operating via satellite and ground based stations. The vehicle tracking system is an entire security and fleet management solution. The vehicle tracking system is fitted inside the car that provides effective real time location and the data can even be stored and downloaded to a computer which can be used for analysis in future (Ahmed, Rahman, Costa, 2015). The device includes modern hardware and software components that help tracking and locating automobiles both online and offline. A tracking system comprises of mainly three-part vehicle unit, fixed based station and database with software system, which can be later displayed in a screen using an electronic map such as google map (Upadhayay, Bothera, Gupta, 2014).

GPS were designed by the United States Government and military, which the design was intended to be used as surveillance. The GPS was invented as a collaborative effort by the United States Department of Defense and Dr. Ivan Getting as methods to create a satellite course-plotting system, primarily used for navigation purposes (Upadhayay, Bothera, Gupta, 2014).

At that time, the GPS project cost approximately $12 billion for the design and launch of 18 satellites, six in each of the orbital planes spaced 120 degrees apart, and their ground stations. GPS uses these satellites as reference points to determine and the accurate geographical positions on map.

The initially planned for a global positioning system was to be used by military and intelligence organizational during the Cold War, with the introduction of the project stemming from the Soviet-launched spacecraft Sputnik. Since its introduction in the 1960s, GPS has developed into a larger and more advanced satellite network constellation that orbits Earth at fixed points in space to send signals to anyone with a GPS receiver. The signals carry a time code and geographic data point that enables us to display a device's exact position anywhere on the planet.

In the early 1940s, the GPS design is partly similar to the design of ground-based radio navigation systems, such as LORAN and the Decca Navigator, during World War II used, was developed. In 1957, additional inspiration for the GPS system came when the Soviet Union launched the first Sputnik. A team of U.S. scientists led by Dr. Richard B. Kershner were monitoring Sputnik's radio transmissions. They discovered that, because of the Doppler Effect, the frequency of the signal being transmitted by Sputnik was higher as the satellite approached and lower as it moves away from them. They realized that since they knew their exact location on the globe, by measuring the Doppler distortion it was possible to pinpoint where the satellite was along its orbit.

In 1960, the first satellite navigation system was first successfully tested. It delivers a navigational fix approximately once per hour using a constellation of five satellites. In 1967, the U.S. Navy introduced the timation satellite which demonstrated the ability to place accurate clocks in space that is the technology used by the GPS system. In the 1970s, the ground-based Omega Navigation System, based on signal phase comparison, became the first world-wide radio navigation system.

In February 1978 the first experimental Block-I GPS satellite was launched. The GPS satellites were initially manufactured by Rockwell International and are now mass-produced by Lockheed Martin.

In 1983, after Soviet interceptor aircraft shot down the civilian airliner KAL 007, killing all 269 people on board, in restricted Soviet airspace. The U.S. President Ronald Reagan announced that the GPS system would be made available for civilian. Hence, the government signed a treaty to allow civilians to buy GPS units also only the civilians would get precise downgraded ratings.

The oldest GPS satellite still in operation was launched in August 1991. By December 1993 the GPS system achieved initial operational capability and a complete constellation of 24 satellites was in orbit by January 17, 1994 (Iler, 2016).

Tracking only two radios in the initial period were used to exchange the information. One was attached to the vehicle while another at base station by which drivers were enabled to talk to their masters. Fleet operators could identify the their routes progress.

The distance was limitation of the early technology. It was restricted by which became a hurdle in accuracy and better connectivity between driver and fleet operators. Base station was dependent on the driver for the information and a huge size fleet could not have been managed depending on man-power only (Upadhaya ,Bothera , Gupta, 2014).

The dependence on man-power is reduced as the scene of vehicle tracking underwent a change with the arrival of GPS technology. The information is authentic because most of the work of tracking became electronic as computers proved a great help in managing a large fleet of vehicle. As this technology was available at affordable cost, people could take benefit of this technology.

Because of the accessibility of the device computer tracking facilities has associated with enhanced management. Nowadays each vehicle carries tracking unit which is monitored from the base station, receiving the data from the unit. All these facilities require a heavy investment of capital for the installation of the infrastructure of tracking system for monitoring and dispatching.

Today's GPS applications have vastly improved. It is possible to use the Global Positioning Systems to design expense reports, create time sheets, or reduce the costs of fuel consumption. Moreover, the GPS unit allows us to create Geo-Fences about a designated location, which gives us alerts once the driver passes through that location. This means we have added security combined with more powerful customer support for our workers that is for increasing efficiency of employee driving (Upadhayay, Bothera, Gupta, 2014).

Nowadays GPS units are great tracking devices benefit fleet managers stay in control of their business. Since we can build automated expense reports anytime, GPS units do more than just allow companies to create reports. These devices also help to put an end to thieves. According to recent reports, car theft is increasing. If we have the right GPS unit, we can decrease thefts problem as we can lock and unlock our car anytime we want to. GPS is small tracking device installed in a car and it will supply feedback data from tracking software that loads from a satellite (Ahmed, Rahman, Costa, 2015).

The vehicle tracking system is one of the biggest technological advancements for security purpose. It enables the owners to virtually keep an eye on his vehicle any time and from wherever. As a result, these are the reasons why Thai government realized the GPS importance and not for long Thailand's law enforcement is implemented.

For Thailand's domestic freight situation, road transport is the main mode of transportation which refers to goods-carrying 420 million tons per year. While international transport, amount of goods transportation was increasing continuously along with number of trucks from 10.4 percent in 2009 to 12.9 percent in 2013. Moreover, 90 percent of trucks were found that they are owned by operators possess less than 30 trucks (Small-sized enterprises) from overall 14,544 operators across the country (DLTC, 2017).

Previous study from Department of Land Transport (DLT), using GPS data to estimated truck activities and cargo volume in Thailand, there were about 100,000 trucks or 10 percent of whole trucks attaching GPS. The outcome exhibits trucks routes that run chiefly in lower part of Middle and East of Thailand which are principle Thailand's economic and industrial part. Not only the economic parts gaining traffic on road, but also hub provinces such as Kon Kaen, Korat, Chiang Mai, Phitsanulok, Ubonratchathani, Suratthani, and Songkla that the traffic are crowded. Main cities' traffic is busier than boarder provinces. For the ton-per-day goods carrying calculation or domestic truck and freight volumes based on the National Area Model of Thailand's government, so called NAM, gauges less than GPS around 12 percent. The information from truck possession method comparing to the theoretical methods the GPS and NAM obtain less than the actual possession calculation 34 and 52 percent respectively. Noted that NAM computes goods level from economic and social factor in stead of GPS that reckon trucks running through. Except from that NAM calculate 17 provinces or around 40,000 trucks, 80 percent are huge trucks and 30 percent are 1 ton Pickup truck. Operators are from main cities than boarder and tiny provinces which posses less than ten trucks about 80 percent and 50 trucks or more owned are about 5 percent.

1.2 Statement of Problem

Nowadays important questions for freight transport planners, such as, how much the domestic freight is moving each day, and how much is the total distance that trucks travelling domestically each day, and what is the actual truck behavior, have never been clearly answered in Thailand.

In the past, Transportation sectors, e.g. Department of Highways (DOH), Department of Land Transport (DLT), Office of Transport and Traffic Policy and Planning (OTP), as well as Ministry of Transport (MOT), always calculated the domestic truck and freight volumes based on the National Area Model so called NAM.

Although NAM has been developed and improved continuously for over 20 years, the model yet based on four-step macro-transport model. Such model considers only major links and validated using spot survey in a period of time. More importantly, sample size of data used for model validation is relatively small, compared to the total traffic volume in the country. These lead to unreliable answers given by the model.

Nowadays, Thailand faces the problem of gathering loading truck volume data because the government and private companies are unable to collect the loading and distance records. In the past, Department of Land Transportation has been implementing NAM, the demonstration engineering model of national transportation, to estimate the number of vehicles commuting on Thai roads in one day. The model cannot accurately predict the result as it does not collect the data from all roads in Thailand. It can calculate only specific roads. Moreover, budget and time spent on the project are enormous. In 2017, Thai government and Department of Land Transportation launched Global Positioning System (GPS) law for safety reason and distance statistic. Firstly, safety reason refers to controlling speed limit and rest time. Secondly, GPS convenes immediate distance, route, and time. Interestingly, if the data collected from GPS can be successfully analyzed, how the behavior of transporters and traffic in Thailand would change and the result gaining from GPS on trucks would be even more precise. These lead to the questions of this study indicated as follows.

- What is the current situation of road freight transport in Thailand?
- What is the domestic truck travelling patterns in different days of the week?
- What are the factors influencing provincial road freight demands throughout the country?

1.3 Research Objective

1. To review the current situation of road transportation by using GPS data obtained from the Department of Land Transport.
2. To examine the road freight activities truly occurred in different days of the week.
3. To develop mathematic model for defining relationship between provincial truck activity, level of connectivity, and provincial socio-demographic and economic characteristics of all provinces in Thailand.

1.4 Scope of the Study and Limitation

The study employs data obtained from the GPS devices attached on trucks across the country. The data was collected by the GPS Center at the Department of Land Transport, Ministry of Transport of Thailand. The data set consists of all truck transporting records in 30 days during 1 – 30 November 2018. As there are a large number of records, the data file is considerably large and all computerized calculations requires substantial period of time. Also, some of computerized calculation cannot be done by personal computer, so that cannot be delivered and included into this study.

The study's limitation is time limit - considering only one-month period of time. For more accurate statistics, the data should be collected a year or more to reveal seasonal and numbers of changes. Except from the period, GPS data cannot determine types of merchandises carried on the trucks as there are trucks loading special goods such as water, chemicals, or sewage suction trucks.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

This chapter involves the review of literatures, previous studies, and theories related to this study. According to scope of this study, GPS and the study of previous Thailand's Truck GPS data are also discussed.

The chapter is organized into four main sections: Global Positioning System (GPS), regulations in regard to GPS equipped on truck and public vehicle and lastly previous studies in regard to using GPS data to estimate truck activities and cargo volume in Thailand.

2.2 Domestic Freight Situation in Thailand

Thai domestic transportation still mainly relies on land transport especially road transport which costs about 80 percent of all domestic transportation or approximately 420-million tons per year as shown on table 2.2-1 below.

Table 2.2-1 Volume and Proportion Classified by Thailand Domestic Goods Transportation Patterns

Transportation Modes	2009		2010		2011		2012		2013	
	Thousand Tons	Ratio	Thousand Tons	Ratio	Thousand Tons	Ratio	Thousand Tons	Ratio	Thousand Tons	Ratio
Road fright Transport	423,677	82.70%	423,677	82.70%	423,677	82.70%	423,677	82.70%	423,677	82.70%
Railway Transportation	11,517	2.2%	11,517	2.2%	11,517	2.2%	11,517	2.2%	11,517	2.2%
Domestic Water Transport	41,561	8.1%	41,561	8.1%	41,561	8.1%	41,561	8.1%	41,561	8.1%
Coatwise Shipping	35,692	7.0%	35,692	7.0%	35,692	7.0%	35,692	7.0%	35,692	7.0%
Air Transport	104	0.0%	104	0.0%	104	0.0%	104	0.0%	104	0.0%
Total	512,551	100.0%	512,551	100.0%	512,551	100.0%	512,551	100.0%	512,551	100.0%

Source: DLT (2017)

According to import and export goods, shipment is a major transportation meanwhile trucking tends to increase in terms of number and proportion as displayed in Table 2.2-2. The increase were from 21-million tons in 2009 to 26 million tons in 2013 or rising ratio is 5.3 percent per year. At the same time, the entire international transport had been ascending only 1.0 percent per year. Trucking transportation started to emerge more on the ratio from 10.4 percent of all international transportation in 2009 to 12.3 percent in 2013 (DLTC, 2017).

Table 2.2-2 Volume and Proportion Classified by Thailand International Goods Transportation Patterns

Transportation Modes	2009		2010		2011		2012		2013	
	Thousand Tons	Ratio	Thousand Tons	Ratio	Thousand Tons	Ratio	Thousand Tons	Ratio	Thousand Tons	Ratio
Seafreight	182,419	89.20%	192,391	89.0%	193,640	88.8%	194,318	88.4%	186,087	87.4%
Transport by Trucks	188	0.1%	172	0.1%	146	0.1%	103	0.0%	97	0.0%
Domestic Water Transportation	21,264	10.4%	22,912	10.6%	23,468	10.8%	24,574	11.3%	26,142	12.3%
Airfreight	603	0.3%	724	0.3%	725	0.3%	746	0.3%	679	0.3%
Mail and Others	1	0.0%	1	0.0%	3	0.0%	2	0.0%	1	0.0%
Total	204,475	100.0%	216,200	100.0%	217,982	100.0%	219,743	100.0%	213,006	100.0%

Source: DLT (2017)

Mainly 90 percent of truck operator's data consists of small operators owning less than 30 trucks. However, comparing numbers of trucks possessed ratio, small operators own only 29 percent of trucks nationwide (DLTC, 2017) as shown in Figure 2.2-1.

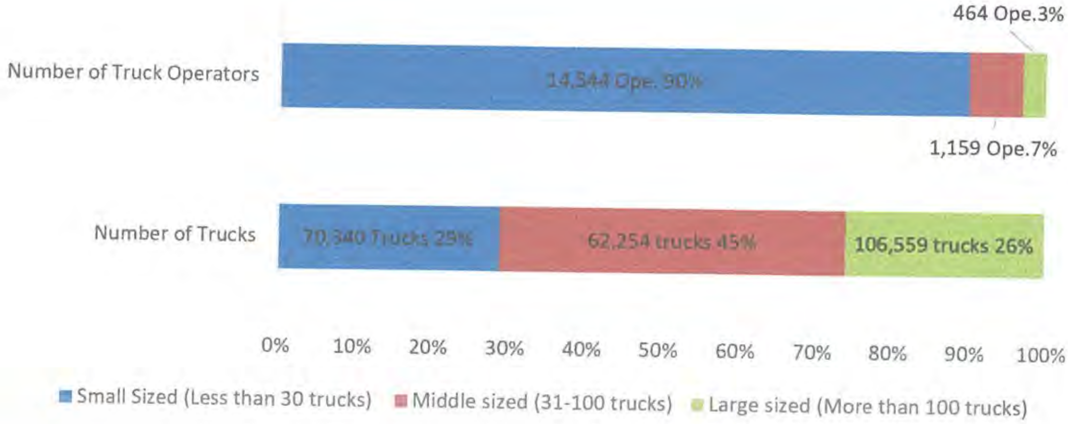

Figure 2.2-1 Number of Trucks and Truck Operators Categorized by SME Type (December 2014)

Source: DLT (2017)

2.3 Global Positioning System (GPS)

Vehicle tracking systems are commonly used by fleet operators for fleet management functions such as fleet tracking, routing, dispatch, on-board information and security. Public and private sectors implementing this system for many purposes include monitoring schedules of trucks or buses in service or triggering any change of buses' destination.

The American Public Transportation Association expected that, at the beginning of 2009, around half of the public buses in the United States were already using a tracking system to trigger automated stop impaired customers and to do any important and external announcements to the passengers already on board, (triggered by the opening of the bus's door at a bus stop, announcing the vehicle's route number and destination, primarily for the benefit of visually identifying the next stop, as the bus approaches a stop.) (Upadhaya, Bothera, Gupta, 2014).

The data as the vehicle follows its route are collected and stored in a computer system where it is compared with the location the vehicle was scheduled to be in at that very moment. This device is helpful for customers with real-time information such as time required for the arrival of the next bus at a given stop, it accelerates passengers' time saving as it provides the passenger with updated information to follow the time schedule. Also, the driver will update how early or late he is at any given time making it facile for the driver. Transport companies that offer this kind of information assign a unique number to each stop, and passengers can obtain information by entering the stop number on the transit system's website or application.

Transit companies have uploaded a map on their website, with icons indicating the current locations of buses in service on each route to provide accurate information to passengers some transit agencies. There are also some transit companies that keep this information only for their own use which can be accessed by their employees only. Other applications can also monitoring driving behavior of the driver.

The vehicle tracking system is also used as an anti-theft system. If a vehicle is stolen the owner can easily track the car and will be able to control the car by turning off the engine and lock the door of the vehicle via SMS for some GPS operators. Attachment of vehicle tracking system, the chances of recovering the car has increased immensely.

Vehicle tracking system benefits lives much better than before, for both personal and business usage. Now, car owners can easily track their cars from any corner of the world and control it if it is stolen. Passengers can even get notification about schedule of public transport to save their precious time.

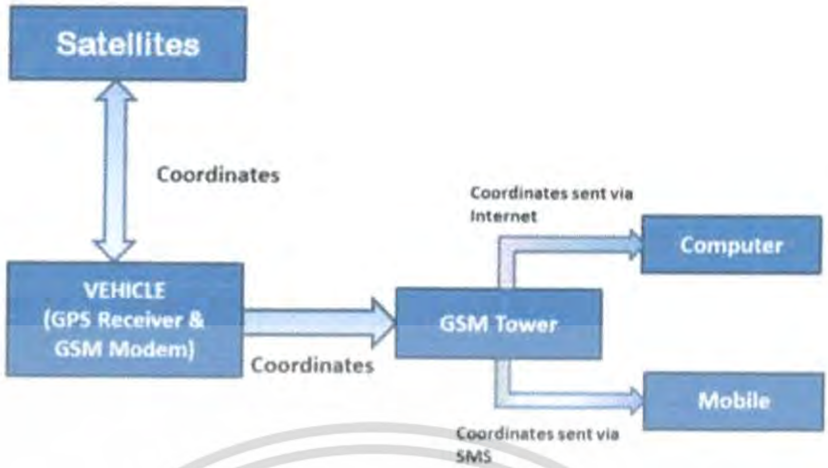

Figure 2.3-1 Block Diagram of Vehicle Tracking System
Source: Ahmed, Rahman, & Costa (2015)

The block diagram of vehicle tracking system shows how GPS system actually works. The vehicle tracking unit is installed inside the vehicle that is to be tracked. The GPS receiver gains the coordinate from the satellite which is then transfer to the GSM (Global System for Mobile Communication) tower by the GSM modem. The coordinate is then sent to a computer via internet where it is stored in the database for exposing the location on Google map. The user can also see the location of the vehicle in a mobile phone or other devices, when the user sends an SMS to the GSM modem in the vehicle, then it sends another SMS back to the user with the coordinates of the location of the vehicle along with a Google map link (Ahmed, Rahman, Costa, 2015).

Figure 2.3-2 Block Diagram of Vehicle Tracking System of Thailand
Source: Anonymous (2016)

Thailand's GPS tracking system consists of hardware and software. The hardware are GPS receiver, modem and driver swiper, which is special needed for GPS law. The software are for operating system, GPS signal of Department of Land Transport and privates GPS operation system. The processes of using GPS are as follows. Firstly, a driver has to swipe a driver license at swiper machine. If the driver does not swipe or swipe a wrong type of card, the machine will alarm until it gets the right type of card. Then, GPS receiver will send the driver's information and location to private server via mobile sim signal. Next, the users or the enterprises are enable to see truck's location and other reports, such as speed, route, or stops depending on the private GPS company's utilization through their computer screens, mobiles or tablets both instantly and previously. The current information will be submitted to Department of Land Transport simultaneously while the GPS company has to get the authorization from Department of Land Transport.

2.4 Regulation in Regard to GPS Equipped on Truck and Public Vehicle

In 2014, Department of Land Transport released the announcement of passengers, animals or parcels transport requirement of installing the GPS tracker. There are 6 articles.

First, determining characteristics and GPS operating system of standard 4-passenger transporting buses, so called two-storey buses in 2015 assigned a date to December 25, 2015. Second, determining characteristics and GPS operating system of transporting truck in 2015 assigned a date to December 25, 2015. Third, determining categories and characteristics of passenger buses needed to be equipped with GPS before registration in 2015 assigned a date to December 25, 2015. Forth, determining categories and characteristics of passenger buses needed to be equipped with GPS before truck performance checking for continuing license plate in 2015 assigned a date to December 25, 2015. Fifth, determining categories and characteristics of animals or parcels transporting trucks needed to be equipped with GPS before registered in 2015 assigned a date to December 25, 2015. Last, determining categories and characteristics of animals or parcels transporting trucks needed to be equipped with GPS before truck performance checking for continuing license plate in 2015 as-signed a date to December 25, 2015 (DLTC, 2016).

The announcement was implemented by passenger buses, animal or parcel trucks which newly registered, and some types and kinds of trucks were attached GPS in different period. Officials of Land Transport Department follow government milestone to equip GPS Tracking to all kinds and routes of public transport which obliged since January 25, 2016 and strictly attached to every bus in 2017. The GPS controller building will be fully run in 2019. Mr.Sanit Phromwong, Minister of Land Transport Department, reveals that safety reason is the important policy of

Department of Land Transport and Office of Transport and Traffic Policy and Planning. Speed limit is severely applied to all public and private trucks. Besides for the following rules are supporting the project of "Confident Thailand with GPS Equipped trucks", forcing the entire public and more than 10-wheel trucks to attach GPS Tracking under restricted rules. The rules of recording and transferring trucks utilizing data are truck position inland co-ordinate's inexact are not more than 20 meters, the speed miscalculation gap should be less than 1 kilometer per hour and updated every minute, driver's working hours must not exceed a minute-sensitive factor, date and time of recorded data, name and surname or the driver's driver license, and real-time data transmission should not less than 5 minutes.

The registered trucks certified by Department of Land Transport must receive the certification with the details of certificate number from DLT, GPS tracker's type and properties, GPS tracker's number, license plate number and chassis of registered truck, and GPS tracker provider.

The GPS is also with driver identification tracker, which driver license is swiped to show driver details, to show on online real-time system. This system is perfect for crucial management of all road transport in term of safety, driving behavior, traffic problem administration, co-ordinates, speed, driver's working-hour, energy data, efficiency, operation cost, logistics cost and social and economic development having their own management system with structured data. The core success factor of GPS tracker is "Focusing on execution, conduct, control, and protective care to the main causes by using benefits of online and real-time system to set 'Alert or Alarm' to monitor and guard the major causes of problems than solving any situations already happened.

In addition, the 360-degree conjoined management is the key success which becomes more effective than to fine or to punish transgressors solely. The developed system uses the same online database, "Central GPS Tracking Monitoring Department" of Department of Land Transport, combined with "Provincial GPS Tracking Department" around Thailand to execute their own areas, routes, trucks, and also designing the system for SME (Small and Medium-sized Enterprise) and huge companies to audit the entire trucks in their own network. Combined with others who interested with related or serviced truck can track the trucks by Application: DLT GPS via all operating mobile phone systems on the same real-time online data. "Confident Thailand with GPS Equipped trucks" project is firmly implemented since January 2016 and was compulsorily applied to all buses within 2017. For 10-wheel trucks and above, project has been executed since 2016 and will be fully equipped to all trucks in 2019 (DTLC, 2017).

2.5 Previous Study in Regard to Using GPS Data to Estimate Truck Activities and Cargo Volume in Thailand

Previous study in regard to using GPS data to estimate truck activities and cargo volume in Thailand from Department of Land Transport at the present numbers of dangerous goods carrying trucks and public transportation, which attaching GPS and connecting the signal to Department of Land Transport, are about 100,000 trucks or about 10 percent of whole trucks that running in Thailand. Despite to the GPS law and system, which is on developing process, are considered as the crucial information to this study.

The developing GPS system enables the establishment of Origin-Destination Matrix of truck attached GPS. Data of Origin-Destination Matrix in February 2017 and numbers of trucks delivering merchandises in and out of focused provinces exhibited on Figure 2.5-1 and Table 2.5-1 consecutively. Figure 2.5-1 presents the character of Thailand's transportation that mostly shows trucks voyage in central region's lower part and eastern region. These two regions are Thailand's main economic and industrial areas.

Nevertheless all important burges were developing truck terminal plan in major cities of Khon Kaen, Nakonrachasima, Chiang Mai, Phitsanulok, Ubonracha-thani, Suratthani and Songkla which appear to be congregating and distributing points or hubs. Moreover, important boarder provinces are also considered as goods transportation links.

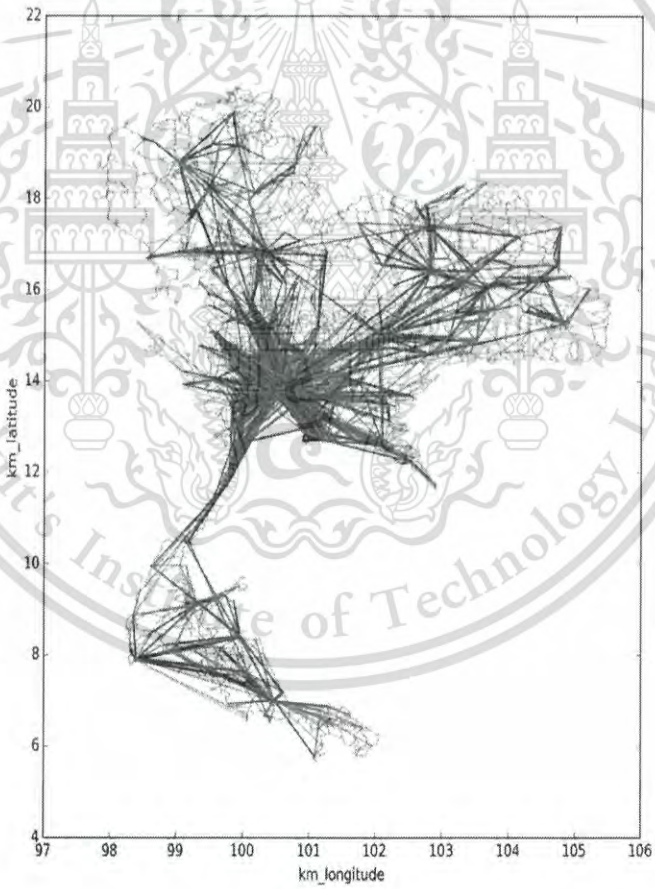

Figure 2.5-1 Map Showing Origin-Destination Matrix of Trucks Attaching GPS Equipment
Source: DLT (2017)

Table 2.5-1 Numbers of Trucks Delivering Merchandises In and Out of Focused Provinces

Province	Trips Originated in the Study Area		Trips Destinated in the Study Area	
	Volume (Trips/Day)	No. of Destinations	Volume (Trips/Day)	No. of Origins
Kanchanaburi	307	14	246	13
Khon Kaen	263	17	320	17
Trat	27	5	23	4
Tak	50	9	43	8
Nakhon Ratchasima	587	22	585	23
Nakhon Sawan	371	20	354	25
Narathiwat	21	3	31	3
Prachin Buri	485	21	427	13
Phitsanulok	173	13	175	10
Mukdahan	47	8	28	6
Songkhla	214	13	172	10
Sa Kaeo	140	12	169	12
Surat Thani	190	11	212	12
Nong Khai	123	8	92	7
Ubon Ratchathani	98	10	76	10
Chiang Rai	60	8	36	5
Chiang Mai	213	11	165	12

Source: DLT (2017)

According to Table 2.5-1, Nakornrachasrima, Prachinburi, Nakonsawan, and Kanchanaburi are the first forth provinces with the biggest delivering volume of GPS attached trucks. As seen in the table, the reason of high-volume transportation is due to the geographical reason of being the gateway provinces to Northeast and North region. Interestingly, Kanchanaburi and Prachinburi are considered small cities and are not regarded as the bypass cargo transportation provinces. Critically, both provinces have numerous factories that producing commodities to economic tracts. Meantime material transportation to factories is needed. Another point from this data is that Nakonrachasrima and Nakonsawan are two provinces that link conjoin goods transportation than 20 other provinces as they are the gateways to Northeastern and Northern Thailand.

Referring to the data in Table 2.5-1, the amount of goods transporting between provinces that have origin and destination in the focused provinces can be calculated by the following important hypothesis. The proportion of GPS-tracking system attached on truck is estimated to be 10 percent of the entire trucks. The number would partly represent the behavior of the entire conveying-goods trucks in Thailand.

Thailand trucks' traffic composition and utilization rate were compiled by Bureau of Planning of Department of Highways's survey data in 2015. The result of merchandises transferring volume estimation between origins or destinations in the focused areas is exposed by the table below.

Table 2.5-2 Merchandises Transferring Volume Estimation Between Origins or Destinations in Focused Areas

Province	Merchadises Volume(Tons/day)			NAM (2015)	
	Originated in the province	Destinated in the Province	Total	Total	Differences
Kanchanaburi	18,420	14,760	33,180	16,370	51%
Khon Kaen	15,780	19,200	34,980	29,982	14%
Trat	1,620	1,380	3,000	5,164	72%
Tak	3,000	2,580	5,580	9,654	73%
Nakhon Ratchasima	35,220	35,100	70,320	91,196	30%
Nakhon Sawan	22,260	21,240	43,500	13,270	69%
Narathiwat	1,260	1,860	3,120	4,012	29%
Prachin Buri	29,100	25,620	54,720	46,466	15%
Phitsanulok	10,380	10,500	20,880	8,778	58%
Mukdahan	2,820	1,680	4,500	3,530	22%
Songkhla	12,840	10,320	23,160	27,662	19%
Sa Kaeo	8,400	10,140	18,540	6,634	64%
Surat Thani	11,400	12,720	24,120	22,388	7%
Nong Khai	7,380	5,520	12,900	4,556	65%
Ubon Ratchathani	5,880	4,560	10,440	28,246	171%
Chiang Rai	3,600	2,160	5,760	8,174	42%
Chiang Mai	12,780	9,900	22,680	19,432	14%
Total	**202,140**	**189,240**	**391,380**	**345,514**	**12%**

Source: DLT (2017)

From Table 2.5-2 displays an overall image of 17 provinces implementing NAM for the estimated proportion of transportation in 2015 with the forecasted volume of wares to be less than GPS analyzation around 12 percent. This can be concluded that it is quite precise. When cogitating in detail, NAM has the ability to anticipate total goods transporting proportion conformed to GPS data.

Excepting from Ubonrachathani, NAM predicts transportation volume to be two times higher than GPS analyzing data. In addition, the accuracy of NAM tends to be more exact on major regions than boarder provinces because it calculates goods transportation from each province's economic and social's background. At the same time, the GPS data gathers vehicles delivering to boarders into groups, which does not allow the trivial representative by NAM. Nevertheless, these two statistics sets of data were found strongly connected, calculated by Pearson's Correlation (r) (Cohen, 1988), computed by GPS data comparing to NAM data (r = 0.833).

Besides, there are critic on wares transporting volume by truck possession. Although, GPS data properly reflects quantity of merchandise transportation in the focused provinces, it is unable to categorize types of transportation and the varieties of goods while these two are portentous. From the GPS data, it can sort the focused area operators by base operators' data and Q-Mark of Department of Land Transport exhibiting from Table 2.5-3 to Table 2.5-5.

According to Table 2.5-3, the conclusion follows the expectation as major provinces have more operators than boarder and small provinces lucidly. These provinces are also regional transportation hubs or provincial divisions related to GPS data. In addition, this is just the overview of the 17 provinces that approximately 80 of the focused operators whichever large or small owning trucks less than 10 trucks. Meantime there are only 5 percent owning trucks more than 50 trucks.

Table 2.5-3 Numbers of Transportation Operators Categorized by Numbers of Truck Possession

No.	Province		Numbers of Operators Classified by Numbers of Truck Possession				Total
			1-10	11-30	31-100	>100	
1	Chiang Rai	Amount	28	24	21	7	80
		Ratio	35.00%	30.00%	26.20%	8.80%	100%
2	Chiang Mai	Amount	413	62	33	4	512
		Ratio	80.70%	12.10%	6.50%	0.80%	100%
3	Tak	Amount	273	24	8	3	308
		Ratio	88.60%	7.80%	2.60%	1.00%	100%
4	Phitsanulok	Amount	290	14	8	2	314
		Ratio	92.40%	4.50%	2.50%	0.60%	100%
5	Nakhon Sawan	Amount	124	22	15	13	174
		Ratio	71.30%	12.60%	8.60%	7.50%	100%
6	Nong Khai	Amount	121	8	9	3	141
		Ratio	85.80%	5.70%	6.40%	2.10%	100%
7	Mukdahan	Amount	89	16	2	2	109
		Ratio	81.70%	14.70%	1.80%	1.80%	100%
8	Ubon Ratchathani	Amount	573	19	10	3	605
		Ratio	94.70%	3.10%	1.70%	0.50%	100%
9	Khon Kaen	Amount	415	31	15	6	467
		Ratio	88.90%	6.60%	3.20%	1.30%	100%
10	Nakhon Ratchasima	Amount	478	43	30	13	564
		Ratio	84.80%	7.60%	5.30%	2.30%	100%
11	Prachin Buri	Amount	253	16	3	1	273
		Ratio	92.70%	5.90%	1.10%	0.40%	100%
12	Sa Kaeo	Amount	123	11	4	3	141
		Ratio	87.20%	7.80%	2.90%	2.10%	100%
13	Trat	Amount	4	5	2	1	12
		Ratio	33.30%	41.70%	16.70%	8.30%	100%
14	Kanchanaburi	Amount	50	17	7	7	81
		Ratio	61.70%	21.00%	8.60%	8.60%	100%
15	Surat Thani	Amount	172	38	22	4	236
		Ratio	72.90%	16.10%	9.30%	1.70%	1
16	Songkhla	Amount	140	72	63	24	299
		Ratio	46.80%	24.10%	21.10%	8.00%	100%
17	Narathiwat	Amount	18	11	2	0	31
		Ratio	58.10%	35.50%	6.40%	0.00%	100%
Total 17 Provinces		Amount	**3,564**	**433**	**254**	**96**	**4,347**
		Ratio	**82.00%**	**10.00%**	**5.80%**	**2.20%**	**100%**

Source: DLT (2017)

Table 2.5-4 Numbers of Each Type of Trucks Possessed by Truck Operators in Focused Areas

No.	Province	Pick up Truck	Semi-trailer Truck	Semi-trailer Long	Container Truck	Liquid-carrying Truck	Special Truck	Dangerous Goods-carrying	Trailer Truck	Tow Truck	Total
1	Chiang Rai	1,700	614	0	76	1	155	17	881	552	3,996
2	Chiang Mai	1,746	867	5	393	43	498	201	453	837	5,043
3	Tak	767	248	0	26	2	27	6	492	225	1,793
4	Phitsanulok	422	307	0	48	7	138	23	101	343	1,389
5	Nakhon Saw	1,190	1,175	2	71	4	179	30	1,148	1,039	4,838
6	Nong Khai	467	440	0	37	3	17	38	137	413	1,552
7	Mukdahan	338	239	4	5	1	14	7	106	228	942
8	Ubon Ratch	1,243	335	0	103	26	25	33	436	304	2,505
9	Khon Kaen	814	563	0	388	1	599	22	352	532	3,271
10	Nakhon Rat	1,388	1,447	0	385	140	301	298	687	1,281	5,927
11	Prachin Buri	383	277	0	264	3	63	8	121	251	1,370
12	Sa Kaeo	423	104	0	48	11	32	3	288	102	1,011
13	Trat	116	80	0	0	0	2	0	74	82	354
14	Kanchanab	1,471	404	2	39	19	109	22	259	365	2,690
15	Surat Thani	847	843	0	115	77	96	157	427	815	3,377
16	Songkhla	1,581	3,765	8	293	9	459	120	330	2,876	9,441
17	Narathiwat	261	50	0	1	0	2	2	55	50	421
Total 17 provinces		**15,157**	**11,758**	**21**	**2,292**	**347**	**2,716**	**987**	**6,347**	**10,295**	**49,920**

Source: DLT (2017)

Table 2.5-5 Each Type of Trucks Ratio Possessed by Transportation Operators in Focused Areas

No.	Province	Pick up Truck	Semi-trailer Truck	Semi-trailer Long	Container Truck	Liquid-carrying Truck	Special Truck	Dangerous Goods-carrying	Trailer Truck	Tow Truck	Total
1	Chiang Rai	43%	15%	0%	2%	0%	4%	0%	22%	14%	100%
2	Chiang Mai	35%	17%	0%	8%	1%	10%	4%	9%	17%	100%
3	Tak	43%	14%	0%	1%	0%	2%	0%	27%	13%	100%
4	Phitsanulok	30%	22%	0%	3%	1%	10%	2%	7%	25%	100%
5	Nakhon Sawan	25%	24%	0%	1%	0%	4%	1%	24%	21%	100%
6	Nong Khai	30%	28%	0%	2%	0%	1%	2%	9%	27%	100%
7	Mukdahan	36%	25%	0%	1%	0%	1%	1%	11%	24%	100%
8	Ubon Ratchathani	50%	13%	0%	4%	1%	1%	1%	17%	12%	100%
9	Khon Kaen	25%	17%	0%	12%	0%	18%	1%	11%	16%	100%
10	Nakhon Ratchasima	23%	24%	0%	6%	2%	5%	5%	12%	22%	100%
11	Prachin Buri	28%	20%	0%	19%	0%	5%	1%	9%	18%	100%
12	Sa Kaeo	42%	10%	0%	5%	1%	3%	0%	28%	10%	100%
13	Trat	33%	23%	0%	0%	0%	1%	0%	21%	23%	100%
14	Kanchanaburi	55%	15%	0%	1%	1%	4%	1%	10%	14%	100%
15	Surat Thani	25%	25%	0%	3%	2%	3%	5%	13%	24%	100%
16	Songkhla	17%	40%	0%	3%	0%	5%	1%	3%	30%	100%
17	Narathiwat	62%	12%	0%	0%	0%	0%	0%	13%	12%	100%
Total 17 provinces		**30%**	**24%**	**0%**	**5%**	**1%**	**5%**	**2%**	**13%**	**21%**	**100%**

Source: DLT (2017)

Table 2.5-6 Goods Transportation Volume Estimation in Focused Provincesfrom Trucks Possession Comparing to Analyzing Results by GPS and NAM

Province	Goods Volume (Tons/day)		
	Calculated by Truck Possession	Calculated by GPS Data	Calculated by NAM
Kanchanaburi	19,093	33,180	16,370
Khon Kaen	35,540	34,980	29,982
Trat	3,813	3,000	5,164
Tak	16,794	5,580	9,654
Nakhon Ratchasima	67,272	70,320	91,196
Nakhon Sawan	57,130	43,500	13,270
Narathiwat	2,656	3,120	4,012
Prachin Buri	14,389	54,720	46,466
Phitsanulok	14,519	20,880	8,778
Mukdahan	9,389	4,500	3,530
Songkhla	115,071	23,160	27,662
Sa Kaeo	9,512	18,540	6,634
Surat Thani	38,259	24,120	22,388
Nong Khai	16,546	12,900	4,556
Ubon Ratchathani	20,097	10,440	28,246
Chiang Rai	36,715	5,760	8,174
Chiang Mai	48,536	22,680	19,432
Total	525,326	391,380	345,514

Source: DLT (2017)

Furthermore, in Table 2.5-4 and Table 2.5-5 demonstrate amount of trucks possessed by operators in the focused area, but only registered trucks. It was discovered that the focused 17 provinces have roughly 40,000 trucks. Fifty-eight percent of all are huge trucks such as 10-wheel, trailer, and semi-trailer. Thirty percent are 1 ton carrying truck. It obviously reflects line-haul and delivery to destination.

The data in Table 2.5-4 and Table 2.5-5 can calculate merchandise transportation volume in each the focused province for revising the GPS data analyzation and NAM by these significant hypotheses. First, assuming that 1 truck would operate 1 run and the utilization rate equals to mean from Bureau of Planning Department of Highways's survey outcome in 2015 which is 0.49 percent exposing in Table 2.5-6.

Table 2.5-6 reveals the merchandise transportation volume carried by trucks in 17 provinces. The average volume is 520,000 tons a day which is 34 and 52 percent higher than GPS data and NAM accordingly. It is interesting that analyzing process from truck possession data reveals that boarder provinces distinctively have higher goods quantity in comparison to the results computed by GPS data and NAM. The result was due to the difference of scopes of calculation since both models do not consider within- province, within-city, or specific-activity-boarder-area route.

Criticizing truck possession data reflects transportation activities better than the first two methods or interpreting that peculiar area transportation volume or within the province has the ratio of 35 to 50 percent of intercity within each province.

Despite contemplating, Table 2.5-6 shows the operation in the focused province. Nevertheless, many kinds of huge truck calculated are special task truck such as water-carrying truck, chemical-carrying truck and sewage suction truck. The calculation will consider only the amount of pick up, 10-wheel trailer, trailer, and semi-trailer truck per place and per day. Assuming that 1 truck would operate 1 run and the utilization rate equals to 0.49 percent as referred from the mean indicated in the sur-vey of Bureau of Planning of Department of Highways in 2015.

According to NAM from Department of Highways in 2014, domestic goods transportation expectation is divided into two parts which are current merchandise transportation and future expanding goods transportation on Thailand road network's estimation.

Firstly, the current merchandise transportation's estimation refers to the origin of truck transportation's need model which is adjusted by Department of Highways from roadside overview throughout Thailand. The variable and coefficient are as follows.

$$PROD\ Truck\ Freight = 78.228*GPP + 7.157*GPP\_InfProv + 0.437*POWER$$
$$(R^2=0.826)$$
$$ATT\ Truck\ Freight = 81.426*GPP + 7.103*GPP\_InfProv + 0.412*POWER$$
$$(R^2=0.813) \qquad (2.5\text{-}6)$$

As

PROD Truck Freight = Origin of Product Delivering by Truck Freight Volume (Tons per Day)

ATT Truck Freight = Attraction of Product Delivering by Truck Freight Volume (Tons per Day)

GPP = Gross Provincial Product (GPP) in Chain Volume (Trillion Baht)

GPP_InfProv = Gross Provincial Product (GPP) Including Adjacent Province in Chain Volume (Trillion Baht)

POWER = Horsepower in Provincial Factory (Thousand Horsepower)

According to this model, inserting variable which is the provincial data basis in the model can estimate goods volume rotating in each province. Nonetheless, the model has to adjust and revise for the result by factual survey's outcome.

Secondly, future of expanding goods transportation on Thailand road network's estimation. For product truck delivering by truck freight, each province will be categorized by Growth Model using 2 factors of the numbers of populations in the province and Gross Provincial Product as follows.

$$Growth\ Truck\ Freight = 0.1004*POPG + 0.4909*GPPG \qquad (2.5\text{-}6)$$

As

Growth Truck Freight = Growth Truck Freight Increasing Ratio (Percent per Year)

POPG = Population Growth Ratio (Percent per Year)

GPPG = Gross Provincial Product (GPP) Ratio in Chain Volume (Percent per Year)

Accordance with recent domestic transportation and future of expanding goods transportation on Thailand road network's estimation are adapted and inspected the correction by roadside survey can conclude present product volume and forthcoming expansion as represented in Table 2.5-7.

Table 2.5-7 Present and Future Merchandises Expanding Volume Estimation

No.	Province	Shipment Volume in 2014 (Tons/day)	Daily Shipment Estimation (Tons/day)			
			2019	2029	2039	2049
1	Kanchanaburi	8,185	9,944	14,453	21,006	28,230
2	Khon Kaen	14,991	18,942	29,501	45,946	61,748
3	Chiang Rai	4,087	5,118	7,782	11,833	15,902
4	Chiang Mai	9,716	11,935	17,548	25,801	34,675
5	Trat	2,582	3,236	4,940	7,540	10,133
6	Tak	4,827	6,064	9,284	14,211	19,099
7	Nakhon Ratchasima	45,598	50,815	62,983	78,065	104,913
8	Nakhon Sawan	6,635	8,408	13,120	20,472	27,513
9	Narathiwat	2,006	2,620	4,301	7,060	9,487
10	Prachin Buri	23,233	26,466	34,244	44,308	59,546
11	Phitsanulok	4,389	5,488	8,361	12,738	17,118
12	Mukdahan	1,765	2,287	3,718	6,045	8,125
13	Songkhla	13,831	17,418	26,921	41,607	55,917
14	Sa Kaeo	3,317	4,286	6,929	11,200	15,052
15	Suratthani	11,194	14,444	23,216	37,315	50,148
16	Nong Khai	2,278	2,829	4,241	6,356	8,542
17	Ubon Ratchathani	14,123	15,320	17,973	21,085	28,337

Source: DLT (2017)

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

An outstanding amount of attention has been given to the fact that the majority of the empirical research and studies in the fields of logistics, operations and materials management, typically focus on the quantitative research methods. The quantitative methods include simulations and mathematic model constructions as well as statistical analysis.

Conversely, qualitative techniques are not widely used and accepted in logistics, operations, and materials management research (Mentzer and Kahn, 1993). Nevertheless, a case study may also gather quantitative data. A quantitative case research design generally concentrates on a small number of cases due to an in-depth analysis required (Larsson, 1993).

This study attempts to provide a better understanding on the relationship between numbers of trucks and several other influential factors. Data and information obtained from several reliable sources are used as raw data of the study. Statistic tools and mathematic modeling techniques are employed to answer research questions.

3.2 Study Area and Data Used in This Study

According to GPS data of Department of Land Transport, all real-time utilized time, speed, and route can be collected. As a result, all Thailand-registered trucks and buses are presented to the federal system which means the study area can cover all areas around the country while the data can be analyzed for only main roads and specific time under NAM. In conclusion, the study area of this independent research is the data such as routes, distance, time, or amount of the entire number of equipped GPS trucks tracking illustrating the data provided from GPS tracking.

The data analyzed from GPS tracking system of GPS Department of Land Transport is between November 1-30, 2018. The data contains daily information, with real-time update of truck's identification number, number of wheel information, latitude and longitude, travel time and distances. This data has brought the summary of trip, distance as well as number of vehicles and trucks commuting in a day.

3.2.1 Data Gathering

In this study, quantitative data analysis is implemented as it is a primary technique used to gather required data and information. Primary data of each province is from Information and Communication Technology Center, Thailand in 2017. The data includes destination, numbers of trips per day, population, gross population product, population surrounding, areas, population density, human development index (HDI), numbers of accommodations, numbers of factories, amount of horsepower, gross population growth, and numbers of registered transportation companies in each province.

Table 3.2-1 Table of Data Collection

Destination	Trip/Day	Population	Pop_1000	GPP	GPP_bill	Population surrounding	PopSur_1000	GPP surrounding	GPPSur_bill	Area (sqkm)	Population Density	HDI	Accommodation	Factories	HP	HP_10000	GPP Growth	TransCo
16	240	374698	374.698	9044	9.0444	2331950.17	2331.95	46624	46.624	3161.2	118.5303	0.71	305	424	37744	3.774	0.03166	148

3.2.2 Data Analysis

There are three major levels for the data analysis - data reduction, data display, and verification and conclusion (Miles and Huberman, 1994). Related literature review and conceptual framework, as well as past record are together used for data analysis. Different statistical tests are used to recap and evaluate the data (Northern Illinois University, 2005).

Then, the main findings and results are interpreted and summarized. The data display are mainly in form of text while the rest is in the forms of figures and tables intended to visualize for the ease of understanding. Moreover, all data and information are verified and evaluated and, eventually, conclusions are drawn.

3.3 Conceptual Framework

A conceptual framework is demonstrated in Figure 3.3. The framework is developed from the related activities and variables, as well as the extracted from those of the literature review.

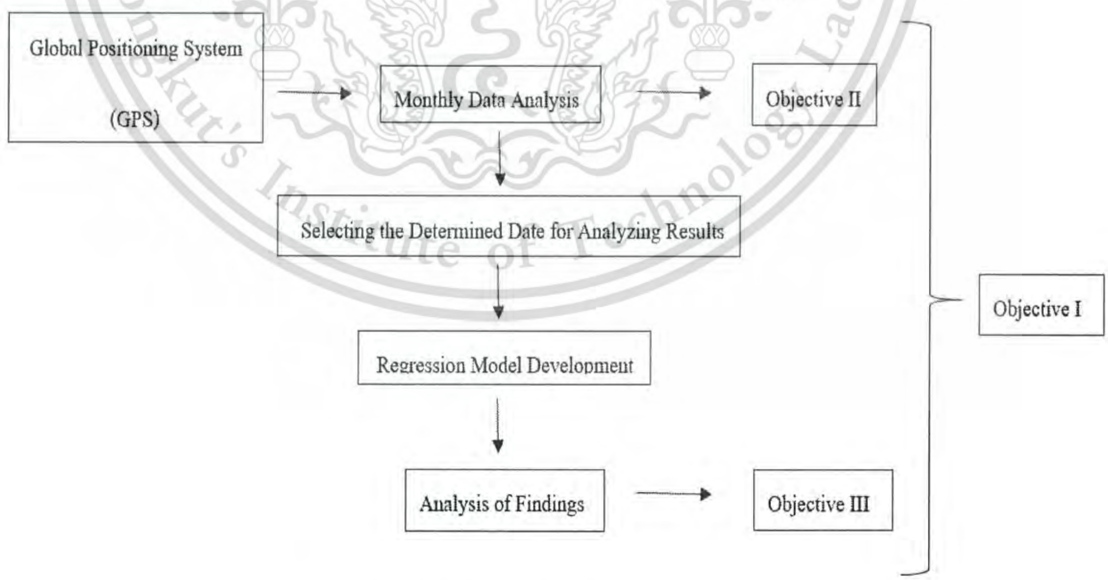

Figure 3.3-1 Conceptual Framework

3.4 Regression Modelling Technique

Regression analysis refers to the use of many techniques in modeling and analyzing several variables when emphasizing on the relationship between a dependent variable and one or more independent variables or what is called 'predictors'. Regression analysis often estimates the conditional expectation of the dependent variable to the given the independent variables, that is, the average value of the dependent variable when the independent variables are fixed. Thus, regression analysis, in statistical modeling, is defined as a set of statistical processes to predict the relationships among variables. In regression analysis, it is also of interest to characterize the variation of the dependent variable around the prediction of the regression function using a probability distribution (Freedman, 2009).

Many techniques used for carrying out regression analysis have been developed. Familiar methods such as linear regression and ordinary least squares regression are parametric, in that the regression function is defined in terms of a finite number of unknown parameters that are estimated from the data. Nonparametric regression refers to techniques that allow the regression function to lie in a specified set of functions, which may be infinite-dimensional.

The performance of regression analysis methods in practice depends on the form of the data generating process, and how it relates to the regression approach being used. Regression analysis often relies to some extent on making assumptions about this process. These assumptions are sometimes testable if a sufficient quantity of data is available. Regression models for prediction are often useful even when the assumptions are moderately violated, although they may not perform optimally. However, in many applications, especially with small effects or questions of causality based on observational data, regression methods can give misleading results (Cook, 1982).

In a narrower sense, regression may refer specifically to the estimation of continuous response dependent variables, as opposed to the discrete response variables used in classification (Bishop, 2006). The case of a continuous dependent variable may be more specifically referred to as metric regression to distinguish it from related problems (Willem, Bernard, Luc, 2008).

CHAPTER 4
ANALYSIS AND RESULTS

4.1 Monthly Data Analysis

This chapter consists of the analysis of all data and information acquired through the research methods mentioned in Chapter 3. All the historical data gathered are further processed through different statistical tests so as to determine the relationship among variables as well as their relationship pattern. Finally, the relevant findings are used for the interpretation of the results.

The analyzed data from GPS tracking system of GPS Department of Land Transport are between November 1-30, 2018 consists of truck's identification number, number of wheel information, latitude and longitude, travel time, distances. This data have brought the summary of trip, distance, and numbers of vehicles domestic trucks running in a day by line graph as shown in Figure 4.1-1. The incoming result of the X-axis, the day and date of November 2018 and Y-axis, unit of numbers of vehicles(trucks), trips(times), and distance(kilometers), is interesting. Trip, distance, and number of vehicles get along the same direction. The average of all numbers of trucks is 115,546 trucks, trip is 471,372 times, and distance is 28,135,113 kilometres per day. Moreover, mostly the highest traffic intensity occurs during the middle of the week. The numbers of trucks is 124,715 trucks, trip is 515,289 times, and distance is 31,065,692 kilometres on Wednesday.

On the other hand, the least numbers of trucks on road are during Saturday and Sunday consecutively. The numbers of trucks is 75,009 trucks, trip is 327,533 times, and distance is 20,124,649 kilometres on Sunday.

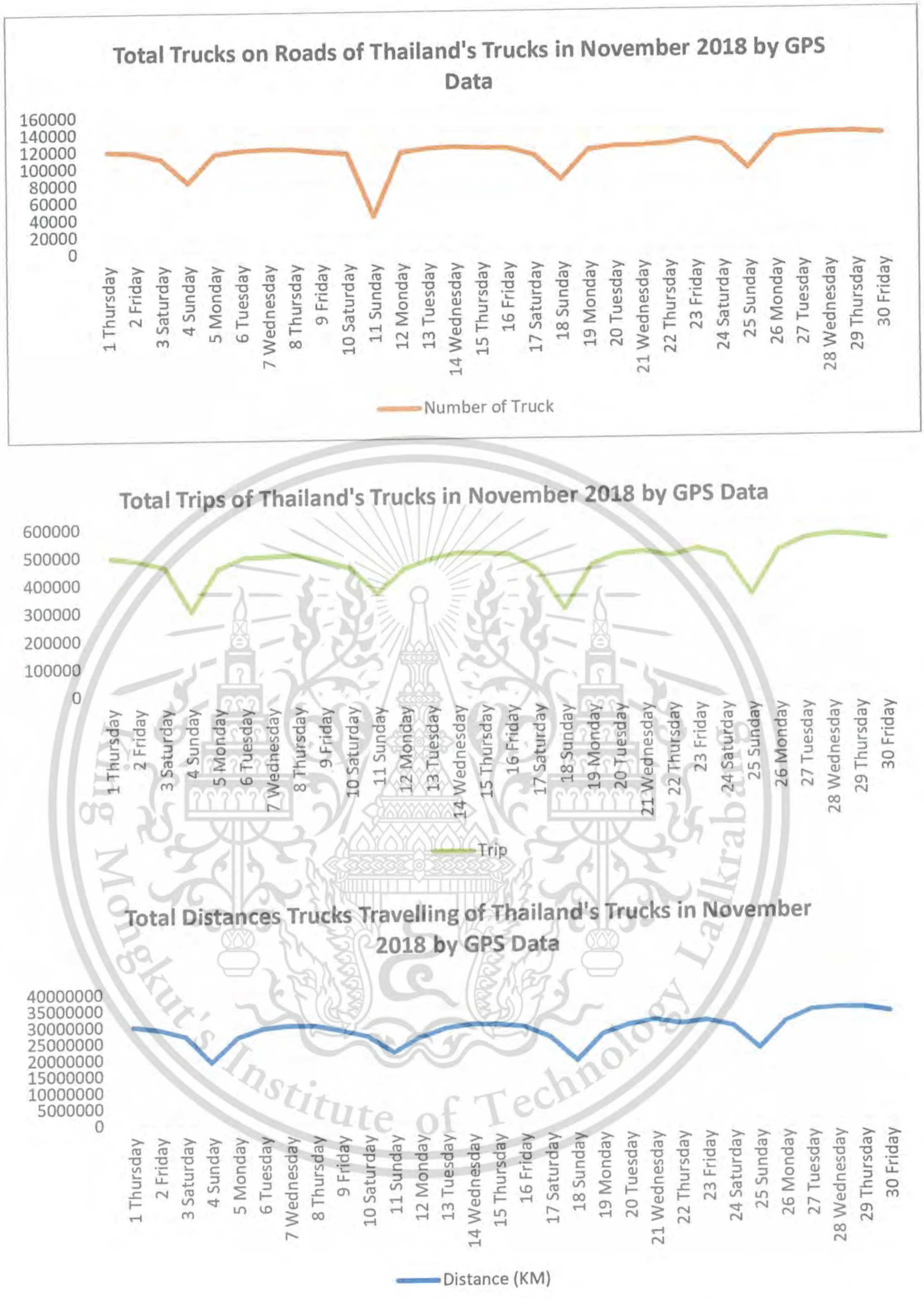

Figure 4.1-1 Total Numbers of Trucks, Trips, and Distances of Thailand Trucks in November 2018 by GPS Data

4.2 Regression Model Development

Regression analysis is a set of statistical processes for estimating the relationships among variables and prediction and forecasting, where its use has substantial overlap with the field of machine learning. Most typically, regression analysis estimates the conditional expectation of the dependent variable given the independent variables, that is, the average value of the dependent variable when the independent variables are fixed. Less commonly, the focus is other location parameter, or on a quantile of the conditional distribution of the dependent variable given the independent variables. In all cases, a function of the independent variables called the regression function is to be estimated. In regression analysis, it is also of interest to characterize the variation of the dependent variable around the prediction of the regression function using a probability distribution (Kuiper S., 2017).

In this study, MLR was conducted to investigate whether there is a relationship between trip per day in each province and factors effected such as destination, number of trips per day, population, gross population product, population surrounding, areas, population density, human development index (HDI), number of accommodations, number of factories, amount of horsepower, gross population growth, and number of registered transportation companies in. There are four models of MLR. They are MLR results included and excluded Bangkok calculating, which trip-per-day and numbers of destination are dependent factors in relationship with effected factors.

The MLR results from four models are shown as per Table 4.2-1 to Table 4.2-4.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.922[a]	.849	.839	1642.965

a. Predictors: (Constant), TransCo

b. Predictors: (Constant), TransCo, HP_10000, GPPSur_bill, Factories, PopSur_1000

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-371.537	417.126		-.891	.376
	TransCo	4.345	.634	.762	6.854	.000
	HP_10000	2.880	.525	.348	5.489	.000
	GPPSur_bill	1.085	.325	.233	3.335	.001
	Factories	-.523	.192	-.312	-2.726	.008
	PopSur_1000	.199	.096	.115	2.063	.043

a. Dependent Variable: TripDay

Excluded Variables[a]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
1	Pop_1000	-.095[b]	-.649	.519	-.078	.101
	GPP_bill	-.128[b]	-.773	.442	-.093	.079
	Areasqkm	-.058[b]	-1.046	.299	-.125	.707
	PopulationDensity	-.087[b]	-1.118	.267	-.133	.287
	HDI	.053[b]	.943	.349	.113	.673
	Accommodation	.094[b]	1.082	.283	.129	.286

a. Dependent Variable: TripDay

b. Predictors in the Model: (Constant), TransCo, HP_10000, GPPSur_bill, Factories, PopSur_1000

Table 4.2-1 MLR Result Included Bangkok Calculating (Trip-per-Day and Effected Factors)

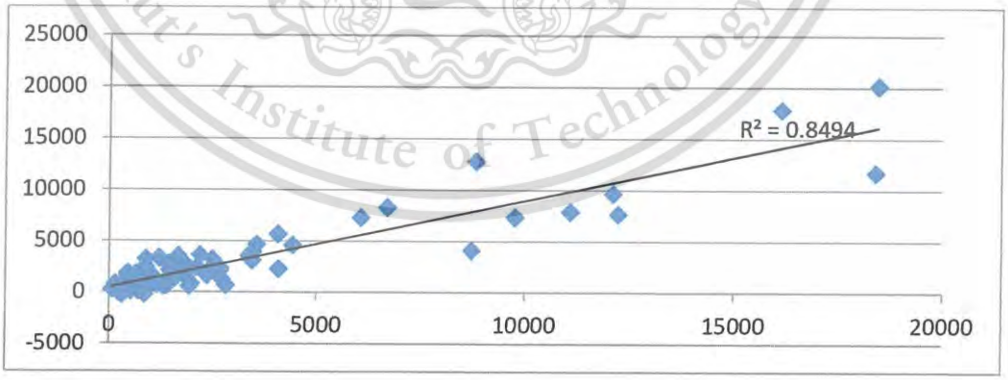

Figure 4.2-1 Comparison between Actual and Prediction

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.931[a]	.866	.858	1390.887

a. Predictors: (Constant), GPP_bill, TransCo, PopSur_1000, Pop_1000

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-556.277	376.376		-1.478	.144
	GPP_bill	16.700	2.567	.551	6.505	.000
	TransCo	3.765	.869	.413	4.333	.000
	PopSur_1000	.266	.074	.170	3.601	.001
	Pop_1000	-.965	.448	-.123	-2.154	.035

a. Dependent Variable: TripDay

Excluded Variables[a]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
1	GPPSur_bill	-.020[b]	-.228	.820	-.027	.251
	Areasqkm	-.044[b]	-.713	.478	-.085	.616
	PopulationDensity	-.028[b]	-.553	.582	-.066	.728
	HDI	.001[b]	.019	.985	.002	.690
	Accommodation	-.002[b]	-.035	.972	-.004	.655
	Factories	.000[b]	.002	.999	.000	.237
	HP_10000	.042[b]	.486	.628	.058	.265

a. Dependent Variable: TripDay

b. Predictors in the Model: (Constant), GPP_bill, TransCo, PopSur_1000, Pop_1000

Table 4.2-2 MLR Result Excluded Bangkok Calculating (Trip-per-Day and Effected Factors)

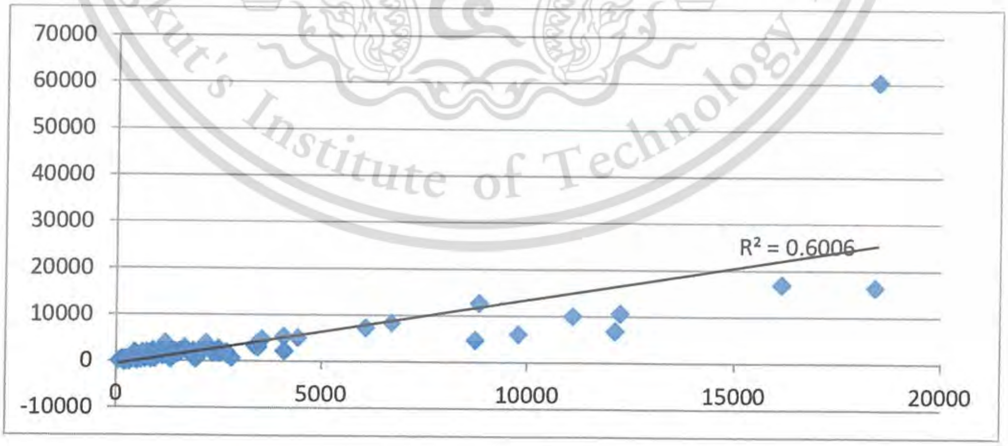

Figure 4.2-2 Comparison between Actual and Prediction

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.730[c]	.532	.513	8.921

a. Predictors: (Constant), TransCo, PopSur_1000, HP_10000

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	15.279	2.159		7.078	.000
	TransCo	.008	.002	.353	3.767	.000
	PopSur_1000	.002	.000	.426	5.168	.000
	HP_10000	.008	.002	.228	2.438	.017

a. Dependent Variable: Destination

Excluded Variables[a]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
1	Pop_1000	-.197[d]	-1.267	.209	-.149	.267
	GPP_bill	-.402[d]	-1.602	.114	-.187	.101
	GPPSur_bill	.040[d]	.328	.744	.039	.445
	Areasqkm	-.001[d]	-.009	.993	-.001	.984
	PopulationDensity	-.196[d]	-1.412	.162	-.165	.332
	HDI	.123[d]	1.264	.210	.148	.684
	Accommodation	-.170[d]	-1.130	.262	-.133	.287
	Factories	-.357[d]	-1.830	.071	-.212	.165

a. Dependent Variable: Destination

b. Predictors in the Model: (Constant), TransCo, PopSur_1000, HP_10000

Table 4.2-3 MLR Result Included Bangkok Calculating (Destination and Effected Factors)

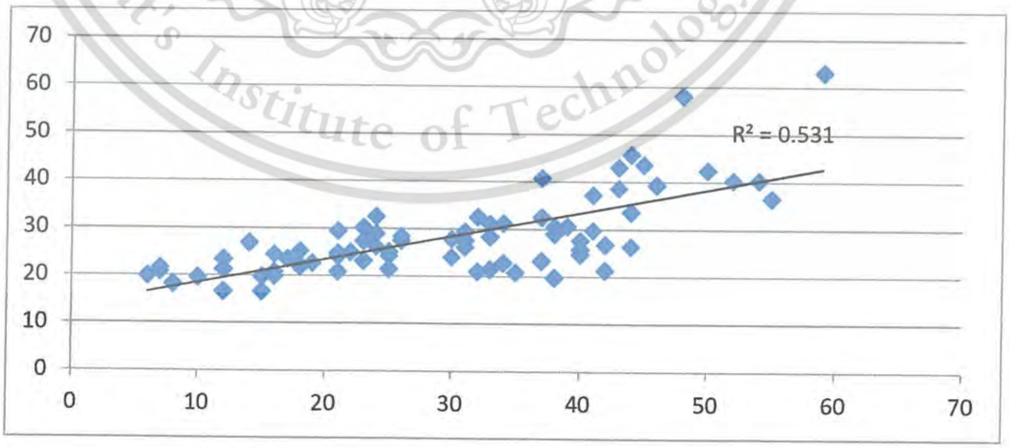

Figure 4.2-3 Comparison between Actual and Prediction

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.724[b]	.524	.511	8.674

a. Predictors: (Constant), TransCo, PopSur_1000

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	13.810	2.150		6.422	.000
	TransCo	.015	.003	.497	5.898	.000
	PopSur_1000	.002	.000	.414	4.914	.000

a. Dependent Variable: Destination

Excluded Variables[a]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
1	Pop_1000	-.112[c]	-1.141	.258	-.134	.677
	GPP_bill	.067[c]	.452	.653	.054	.307
	GPPSur_bill	.078[c]	.747	.457	.088	.610
	Areasqkm	-.043[c]	-.522	.603	-.062	.994
	PopulationDensity	-.032[c]	-.358	.721	-.042	.819
	HDI	.064[c]	.661	.511	.078	.722
	Accommodation	-.127[c]	-1.289	.202	-.151	.678
	Factories	-.159[c]	-1.213	.229	-.143	.381
	HP_10000	.056[c]	.438	.663	.052	.406

a. Dependent Variable: Destination

b. Predictors in the Model: (Constant), TransCo, PopSur_1000

Table 4.2-4 MLR Result Excluded Bangkok Calculating (Destination and Effected Factors)

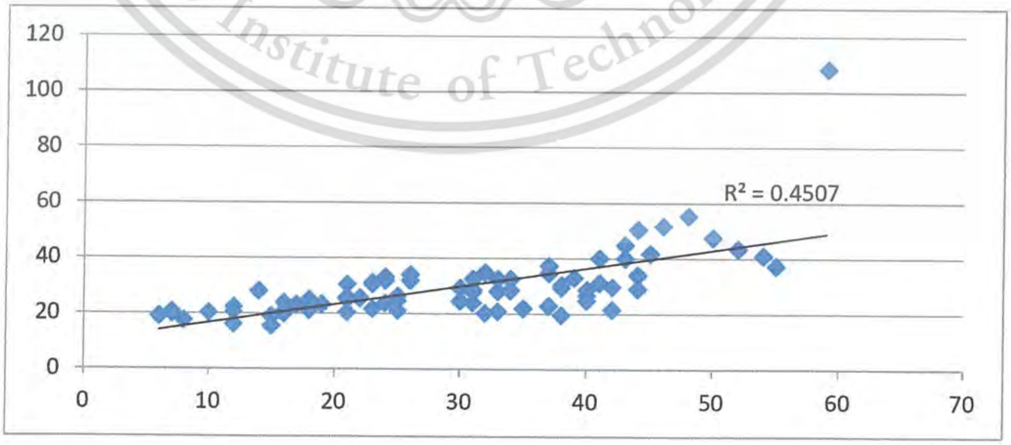

Figure 4.2-4 Comparison between Actual and Prediction

All steps have achieved statistically significant results. The regression equation is shown below:

$$y = \text{Constant} + (B_1)x_1 + (B_2)x_2 + (B_3)x_3 + (B_4)x_4 + (B_5)\,x_5 \qquad (4.2)$$

Table 4.2.1 to Table 4.2-4 illustrate the correlations result of the trip-per-day and numbers of destination and all variables. Additionally, there is a significant correlation between the trip-per-day and all variables.

As can be seen from the results, the MLR model of the four models gives r^2 value of 84.9, 86.6, 53.2, and 52.4 percent respectively. The value of r^2 (coefficient of determination) is indicated on how well model fits the data. Thus, the value of r^2 that is closer to 1, the better fit. (Grant, Kenton ,2017). Consequently, the MLR model of only the trip-per-day as a criterion variable is used for further analysis of the study.

One key objective of the study is to examine the relationship between trip-per -day, destination and factor effected. Therefore, multiple regression modeling technique is chosen to investigate the relationship among these variables. With the historical data gathered, the model has been developed to predict the trip-per-day. On the contrary, the other models or techniques can be used for a future work of this study.

As a result, the variables that influence the calculation are presented as follows:

Table 4.2-1: MLR Result Included Bangkok Calculating (Trip-per-Day and Effected factors) - Transportation company, horsepower, Gross Provincial Product of surrounding factories, and population surrounding.

Table 4.2-2: MLR Result Excluded Bangkok Calculating. (Trip-per-Day and Effected factors) - Gross Provincial Product ,transportation company, population surrounding, and population.

Table 4.2-3: MLR Result Included Bangkok Calculating. (Destination and Effected factors) - Transportation company, horsepower and population surrounding.

Table 4.2-4: MLR Result Excluded Bangkok Calculating. (Destination and Effected factors) - Transportation company, and population surrounding.

Criticizing the result of each table shows the impact of each variables as follows:

Table 4.2-1 MLR Result included Bangkok calculating (Trip-per-Day and Effected Factors), the multiple regression is shown below:

$$y = -371.537 + 4.345x_1 + 2.880x_2 + 1.085x_3 - .523x_4 + .199x_5 \qquad (4.2.1)$$

We find that the adjusted R^2 = .849. This means that the linear regression explains 84.9 percent of the variance in the data, as we set trip-per-day as a dependent variable. If we force all variables to multiple linear regression, transportation company, horse power, GPP surrounding and population surrounding are significant predictors. We can also see that transportation company has the highest impact than other factors by comparing the standardized coefficients which transportation company has beta equals to .762, and the model is significant as p is less than 0.05. The significant variables which p-values are less than alpha level of 0.05. Whereas it is a surprise that factories lead to negative relation to trip-per-day dependent variable.

Table 4.2-2 MLR Result Without Bangkok Calculating (Trip-per-Day and Effected Factors), the multiple regression is shown below:

$$y = -556.277 + 16.700x_1 + 3.765x_2 + .266x_3 - .965x_4 \qquad (4.2.2)$$

When we exclude bangkok from calculation, $R^2 = .866$ or 86.6 percent variance in the data. GPP seems to be the most effected factors comparing to transportation companies and poppulation surrounding (beta are .552, .413, and .17) while poppulation also negative factor.

Table 4.2-3 MLR Result Included Bangkok Calculating (Destination and Effected Factors), the multiple regression is shown as follow :

$$y = 15.279 + .006x_1 + .002x_2 + .006x_3 \qquad (4.2.3)$$

The $R^2 = .532$ or 53.2 percent of the varience which mean the model does not quite fit the data. But population surrounding, transportation company, horsepower which its Beta is .426, .353, and .228 respectively involving with significant as p is less than 0.05.

Table 4.2-4 MLR result without Bangkok calculating (Destination and Effected Factors), the multiple regression is shown as follow :

$$y = 13.810 + .015x_1 + .002x_2 \qquad (4.2.4)$$

The $R^2 = .524$ or 52.4 percent of the varience means the model does not quite fit the data.The significant factor as significant variables which p-values are less than alpha level of 0.05. are transporation companies and poppulation surrounding variable which beta equal to .497 and .414 and p-values are 0.000.

Figure 4.2-1 to Figure 4.2-4 show the chart comparing actual data and prediction results from the model. The prediction results of Figure 4.2-1 and 4.2-2, which has trip-per-day as a dependent variable, is found fit the data. Figure 4.2-3 and 4.2-4, with the numbers of destinations play dependent variable, are not quite sufficiently fit for the study.

CHAPTER 5
CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This chapter provides conclusion and recommendation from the findings throughout this study. The key findings are summarized as well as the results are evaluated. Additionally, the recommendations are provided for the improvement and problems solving related to GPS data of Thailand. Furthermore, limitation of the study and challenges are discussed. Lastly, the recommendations for further study or future works are also included.

Due to the fact that the data analyzed from GPS tracking system of GPS Department of Land Transport are between November 1-30. Predominantly, the highest numbers of trucks, trip, and distance belong to the middle of week. Moreover, the lower amount of trucks on the road, the less distance and trip will be. On the other hand, Saturday and Sunday have the least number of trucks consecutively. It is obvious that Sunday has the smallest number of trucks as it is holiday. There are 35 percent different between Wednesday and Sunday in all aspects. For November 2018, the higher numbers of trucks are at the end of the month and exposed in the data analysis.

According to the correlation analysis, the correlation report reveals the degree of association among variables in the study. Correlations exist between trip-per-day and all variables. The calculation by trip per day tends to fit the data more than destination.

Eventually, the relationship of Table 4.2-1 MLR Result included Bangkok calculating (Trip-per-Day and Effected Factors) and Table 4.2-2 MLR Result Without Bangkok Calculating. (Trip-per-Day and Effected Factors), or trip-per-day dependent variable based is used for further analysis of the study while the models of the destination are excluded. As the adjusted R^2 = .849. This means the linear regression explain 84.9 percent of the variance in the Table 4.2-1, and R^2 = .866 or 86.6 percent variance in the Table 4.2-2.

In MLR Result included Bangkok calculating (Trip-per-Day and Effected Factors), we can also see that transportation company has the highest impact than other factors by comparing the standardized coefficients. Also, horsepower, GPP surrounding and population surrounding are significant predictors. While factory leads to negative relation in this model.

When we exclude bangkok from calculation, GPP seems to be the most effected factors comparing to transportation companies and poppulation surrounding while poppulation is also a negative factor.

5.2 Recommendation and Future Study

5.2.1 Recommendation

From the study, there are several recommendations which can be done for the improvement and betterment of GPS system and the better traffic on the road. Even the GPS equipment is useful and practical, there are recommendations as the following:

1. The infrastructure for train and railway system should be implemented.
2. Backhauling should be more focused.
3. Networking on boarder system will be busier when AEC becomes officially effective.

5.2.2 Future Study

- A future study to account more data to cover a year-period
- A future study on analysing truck pattern based on truck types.
- A future study on analysing truck pattern based on cargo volume and goods characteristics
- A future study on analysing truck travel distance and stops pattern to define strategic location for logistics facilities, e.g. rest area facilities and public truck terminals

BIBLIOGRAPHIES

Ahmed S., Rahman S., & Costa S. E. (2015). Real- Time Vehicle Tracking System. Brac University, Dhaka, Bangladesh.

Anonymous. (2016). GPS on Dangerous goods-carrying truck. [Webblog]. Retrieved from http://www.tod.co.th/GPS%E0%B8%A3%E0%B8%96%E0%B8 %9A%E0%B8%A3%E0%B8%A3%E0%B8%97%E0%B8%B8%E0%B8%81%E0%B8%A7%E0%B8%B1%E0%B8%95%E0%B8%96%E0%B8%B8%E0%B8%AD%E0%B8%B1%E0%B8%99%E0%B8%95%E0%B8%A3%E0%B8%B%E0%B8%A2

Bishop C. M. (2006). Pattern Recognition and Machine Learning. Springer. (pp3). Willem W., Bernard D. B., & Luc B. (2008). ROC analysis in ordinal regression learning", Pattern Recognition Letters. 29, 1-9. Doi: http://10.1016/j.patrec.2007.07.019.

Cohen J. (1988). Set Correlation and Contingency Tables. Doi : http://10.1177/014662168801200410

Cook R. D., & Weisberg S. (1982). Criticism and Influence Analysis in Regression, Sociological Methodology (pp. 313–361). 13.

Department of Land Transport Committee. (2016). DLT Announcement on Defining GPS Modem and Tracker Characteristics and Types of Trucks Needed to Equip GPS Tracker, Retrieved from https://www.dlt.go.th/th/announce/view.php?_did=1396

Department of Land Transport Committee. (2017). Department of Land Transport Follows GPS Tracking Attached Government Policy on All Types and Routes of Public Buses and Trucks Since January 25, 2016. Retrieved from https://www.dlt.go.th/th/public-news/view.php?_did=1815

BIBLIOGRAPHIES

(Continued)

Final Report of Possibility and Management System on Truck Terminal. (2017). Bangkok: Department of Land Transport.

Freedman D. A. (2009). Statistical Models: Theory and Practice. Cambridge University Press. ISBN 978-1-139-47731-4.

Grant M., & Kenton W. (2017). Coefficient of Determination [Webblog]. Retrieved from https://www.investopedia.com/terms/c/coefficient-of-determination.asp

Iler E. (2016). How GPS Started. [Webblog]. Retrieved from https://www.fleetistics.com/resources/gps-history-benefits/

Kuiper S. (2017). Introduction to Multiple Regression: How Much Is Your Car Worth?. Doi : https://doi.org/10.1080/10691898.2008.11889579

Larsson R. (1993). Case Survey Methodology: Quantitative Analysis of Patterns Across Case Studies, Academy of Management Journal, 36(6), 1515-1546.

MathBits. (2014). Correlation Coefficient. [Online]. Retrieved from http://mathbits.com/MathBits/TISection/Statistics2/correlation.html

Mentzer J. T., & Kahn K. B. (1993). A Process Model for Logistics Research, 1993 Transportation and Logistics Educator's Conference Proceedings (pp. 141-160). Columbus: Ohio State University.

Northern Illinois University. (2005). Data Analysis. [Online]. Retrieved from http://ori.hhs.gov/education/products/n_illinois_u/datamanagement/datopic.html

Upadhayay A., Bothra S., Singh R., & Gupta S. (2014). Tracking System Using GSM, GPS & ARM7. Brac University, Dhaka, Bangladesh.

APPENDIX

Appendix A: Examples of Monthly Data Analysis between November 1-30, 2018 from DLT

ID	type_code	ts1	lat1	lon1	ts2	lat2	lon2	traveltime	km
28	7	1/11/2018 1:01	13.56829	100.28	1/11/2018 3:31	13.67204	100.7138	2:30:37	80.97
28	7	1/11/2018 11:48	13.67236	100.7127	1/11/2018 15:30	13.30057	99.73669	3:42:10	135.9
28	7	1/11/2018 17:53	13.30029	99.73893	1/11/2018 20:00	13.56366	100.2773	2:06:55	71.36
28	7	1/11/2018 20:49	13.57786	100.3029	1/11/2018 22:11	13.70836	100.5818	1:21:38	38.46
28	7	1/11/2018 22:27	13.70167	100.5833	1/11/2018 23:23	13.6883	100.7284	0:55:29	26.85
28	7	1/11/2018 23:48	13.67338	100.7216	1/11/2018 23:59	13.67032	100.7117	0:10:46	3.045
29	7	1/11/2018 1:08	13.70842	100.5649	1/11/2018 1:51	13.67244	100.7129	0:42:58	23.47
29	7	1/11/2018 14:48	13.66964	100.7115	1/11/2018 18:00	13.3011	99.73669	3:12:37	137
29	7	1/11/2018 19:20	13.30109	99.73661	1/11/2018 20:11	13.38808	99.99549	0:51:27	32.69
96	7	1/11/2018 3:48	13.12783	100.9853	1/11/2018 4:37	13.07552	100.9004	0:48:50	14.51
96	7	1/11/2018 6:17	13.08505	100.8962	1/11/2018 7:42	13.55241	100.9576	1:24:48	61.87
96	7	1/11/2018 8:40	13.56463	100.9461	1/11/2018 9:16	13.62748	100.7652	0:36:24	23.74
96	7	1/11/2018 10:45	13.6423	100.7775	1/11/2018 12:05	13.67204	100.7125	1:19:37	19.66
96	7	1/11/2018 12:26	13.67222	100.7135	1/11/2018 14:28	13.56655	100.271	2:01:49	61.1

Appendix B: Data Gathering

Name	Description
ACC_1	Accomodation
PTRIP_1	Actual PRIVATE Trips Generated by Province in 2556
TTRIP_1	Actual TOUR Trips Generated by Province in 2556
WTRIP_1	Actual WORK Trips Generated by Province in 2556
AREA_1	Area of Province (km^2)
AVGFAC_1	Average Production Power by Factory
DIFAEC_1	Different between AEC and Non-AEC in 10 Years (2567)
FPRO57_1	Freight PRODUCTION by Model in 2557
FPRO62_1	Freight PRODUCTION by Model in 2562
FPRO67_1	Freight PRODUCTION by Model in 2567
FPRO77_1	Freight PRODUCTION by Model in 2577
GPP_1	GPP by Province (2557)
GPPINF_1	GPP in the Surrounding (2557)
ROOM_1	Hotel Room (2557)
HDI_1	Human Development Index (HDI)
AECIM_1	Impact from AEC to the GPP in 10 Years (2567)
TINC57_1	Income from Tourism Industry by Province in 2557

Appendix B: Data Gathering (Continued)

Name	Description
TINC62_1	Income from Tourism Industry by Province in 2562
TINC67_1	Income from Tourism Industry by Province in 2567
TINC77_1	Income from Tourism Industry by Province in 2577
MPT67X_1	Non-AEC PRIVATE Trips Generated by Trip Gen Model in 2567
MTT67X_1	Non-AEC TOUR Trips Generated by Trip Gen Model in 2567
MWT67X_1	Non-AEC WORK Trips Generated by Trip Gen Model in 2567
FACT_1	Number of Factories by Province
FPRGWH_1	Percentage of Freight PRODUCTION Growth by Annual in 10 Years (2567)
FPRGNA_1	Percentage of Freight PRODUCTION Growth by Annual in 10 Years (2567) without AEC Impact
GPPGWH_1	Percentage of GPP Growth by Annual in 10 Years (2567)
ROOGWH_1	Percentage of ROOM Growth by Annualin 10 Years (2567)
MSTGWH_1	Percentage of Total Trip Growth by Annual in 10 Years (2567)
POP_1	Population by Province (2557)
POPINF_1	Population in the Surrounding Provinces (2557)
MPTRIP_1	PRIVATE Trips Generated by Trip Gen Model in 2557
MPTR62_1	PRIVATE Trips Generated by Trip Gen Model in 2562
MPTR67_1	PRIVATE Trips Generated by Trip Gen Model in 2567
ROOM62_1	Projected Accommodation in 2562
ROOM67_1	Projected Accommodation in 2567
ROOM77_1	Projected Accommodation in 2577
FACT62_1	Projected Factories in 2562
FACT67_1	Projected Factories in 2567
FACT77_1	Projected Factories in 2577
GPP62_1	Projected GPP in 2562
GPP67_1	Projected GPP in 2567
GPP77_1	Projected GPP in 2577
NAME_1	Province's Name in EN
ID_1	Provincial ID

Appendix B: Data Gathering (Continued)

Name	Description
DENST_1	Provincial Population Density (2557) (person/km^2)
STRIP_1	SUMMARY of Actual Trips Generated by Province in 2556
MST67X_1	SUMMARY of Non-AEC Trips Generated by Trip Gen Model in 2567
MSTRIP_1	SUMMARY of Trips Generated by Trip Gen Model in 2557
MSTR62_1	SUMMARY of Trips Generated by Trip Gen Model in 2562
MSTR67_1	SUMMARY of Trips Generated by Trip Gen Model in 2567
POWER_1	Total Production Power by Province
MTTRIP_1	TOUR Trips Generated by Trip Gen Model in 2557
MTTR62_1	TOUR Trips Generated by Trip Gen Model in 2562
MTTR67_1	TOUR Trips Generated by Trip Gen Model in 2567
MWTRIP_1	WORK Trips Generated by Trip Gen Model in 2557
MWTR62_1	WORK Trips Generated by Trip Gen Model in 2562
MWTR67_1	WORK Trips Generated by Trip Gen Model in 2567

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