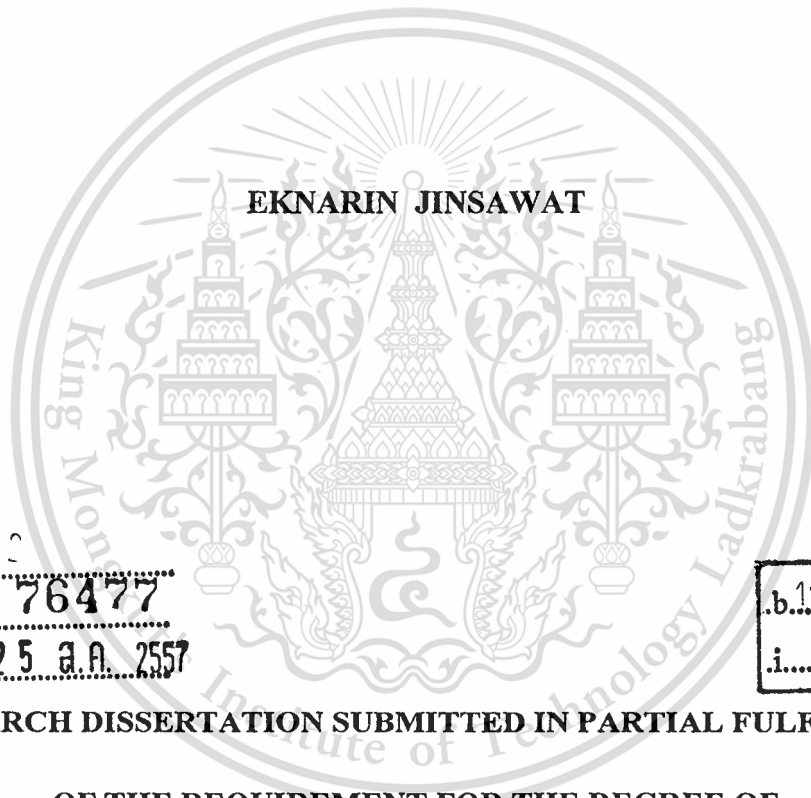


**FACTORS AFFECTING GPS IMPLEMENTATION FOR
TRUCK TRACKING OF SAMUTPRAKARN SMEs**



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**A RESEARCH DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENT FOR THE DEGREE OF
MASTER OF SCIENCE IN LOGISTICS AND SUPPLY CHAIN
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INTERNATIONAL COLLEGE
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ABSTRACT

The objectives of this independent study were to explore opinions of small and medium entrepreneurs towards the adoption of Global Positioning System (GPS) in their trucks transportation work. The Research sample group was designed to study 30 SME's Entrepreneurs in Samutprakarn District. After the data had been collected, it was analyzed by descriptive analysis and statistics analysis i.e. frequency, percentage, mean, standard deviation and t-test.

The results have shown that most SME entrepreneurs run businesses of food and drinks and industrial machinery and equipment for 8 companies or 26.67 percent.

The research results have shown that most SME entrepreneurs have monthly income about 200,001 to 300,000 per month for 17 companies or 56.67 percent. Most SME entrepreneurs have installed GPS for their trucks about 1-2 trucks for 16 companies or 53.33 percent. Most SME entrepreneurs used delivery routes within Bangkok and outbound area for 19 companies or 63.33 percent. Most SME entrepreneurs found a direct benefit of GPS for reducing the cost in term of time and safety governance for 22 companies or 73.33 percent .

About the test of hypothesis, results show that production cost and time cost has reduction was directly related to the use of GPS, significant at 0.05 level. About work safety, the results have not found the relationship using of GPS significant at 0.05 level. The results also have shown that GPS can actually reduce costs. The SME entrepreneurs can use GPS data as alternative to reduce costs by comparing it with their competitors and partners in the same industry in terms of the business value gained from GPS usage.



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Mr.Eknarin Jinsawat

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Chapter 1

Introduction

1.1 Project Background

The traffic problem in Thailand is causing vehicle accidents or risk of accidents to increase each year, this is effecting the economy by 1% of GDP policies are required to address this problem. The traffic problem causes economical loss because the majority of oil imports are from the foreign countries. Thailand uses approximately 42,324 million litres of oil per year or about 117.6 million litres per day, majority in Bangkok and the surrounding area. At the same time Thailand can only produce by 24.1 million litres per day. This results in Thailand paying to import more than 93.5 million litres of oil per day. Not only the national energy problem all other resources still gradually disappear with empty dilapidation in the shipping and the traffic, with environmental problems such as the pollution in the air, dirty water, disturbance sound and other pollution affects directly with existence quality (Department of Energy Business, 2011).

Nowadays, logistics and goods delivery are very important for business. From the competition, each a company must try to deliver goods and the serve arrive at consumer hand very quickly and have to control their capital, make the customer satisfied. If, one company can control other companies, they will have the advantage in this competition.

The majority of goods delivery in Thailand is by road. (land and road mean the same, so use only one)The consumer thought that this is an easy way to deliver goods or services to customers. The number of goods delivered by road is higher every year if compared with the other ways of delivery to customers. (see Table 1.1).

Table 1.1 The Quantity of Goods Delivery in Thailand (Ton)

Mode of Delivery	2007	2008	2009	2010	2011
By Land	428,123	424,456	423,677	420,449	406,538
By Rail	12,419	13,172	11,517	11,288	10,667
By Inland Waterway	47,229	47,687	41,561	48,185	46,932
By Coasting Shipping	34,429	35,982	35,692	36,731	41,273
By Air	110	106	104	121	131
Total	522,310	521,403	512,551	561,774	505,540

Source: The Ministry of Transportation, 2011

As shown in Table 1.1 the majority of goods delivery in Thailand is by road because it is the fast way to service the customer and more convenient than other transportation for example the goods delivery by rail, there is the area services to limit, the period time is not stable and always slowly. It makes the goods delivery by road very important for Thailand transportation. The problems of the administration and goods delivery can be divided into 3 levels, (Boonkajornkul, 2010).

1. A problem in Strategy level, be the making decision that make the effect to the company in the long run such as the problem from the place stands of a company.
2. A problem in Tactical level is the administration and plans to allocate the difference resource of the organization for make the efficiency in using the resource topmost such as the problem from vehicle.
3. A problem in Operational level is the problem in the level manages in each day such as the problem from manage the way, select the car size for load goods, control the time, control cost for the customer and company.

In traffic remedy and the goods delivery can do many the way, by the focusing emphasizes public utility foundation construction gives can support travel requirement more and more in every year. But this way is inappropriate to suit with the situation of the country and no the advantage as expected and not the settlement in the long time. In nowadays have the system that can solve the traffic and the goods delivery by use a few investment extremely and have to prove from many country that, can solve well is Global Positioning System (GPS)

Goods deliveries in Thailand have both of by land, by rail, by sea and by air. Many a company in nowadays lead the civilizations of the Information Technology especially information side comes to apply in delivery remedy. Both of the government sector and private take an interest in system development because of the advantage of genius system. In Thailand, the goods delivery system by land, the majority way for delivery or shipping is by a truck. The delivery could be carried by many sorts of vehicle such as 4 wheel pickup truck, 6 or 10 wheel rigid truck, and 18 and 22 wheel semi-trailer truck. The Intelligent Transportation System that has to develop the delivery is the global positioning system or GPS (Putthapornmognkol, 2010).

Since the government first launched a satellite navigation system known as the global positioning system (GPS) in 1978, the system's ability to pinpoint the location of an object has steadily improved. Already, GPS navigation is being built into cars and cell phones to enable people to figure out where they can find the nearest restaurants or locate someone in need of 191 assistance. Tens of millions of people track their locations today.

The Global Positioning System (GPS) consists of a constellation of satellites orbiting the earth. The satellites are approximately 20,000 kilometers above the earth and complete 2 orbits per day. The orbits are aligned at 55 degrees to the equator and there are six orbits used by the system. A total of 24 GPS satellites make up the constellation and they are positioned to provide 24 hour GPS coverage anywhere on earth. The GPS system is operated by the US military and signals are available, at no cost, to all users (Boonkajornkul, 2010).

Using GPS to locate a position on the earth can help make tasks that were once difficult much easier and in some cases, previously impossible tasks are now possible with the help of GPS. GPS technology is applicable to applications that involve:

- Location-determining a basic position
- Navigation- getting from one location to another
- Tracking- monitoring the movement of people and things
- Mapping- creating maps of the world
- Timing- bringing precise timing to the world

Nowadays vehicle navigation systems are the most interesting field of vehicle electronics. The objective of vehicle navigation systems is to provide various information for driver. Global position system (GPS) is the most important components in the development of the vehicle navigation system.

Thus, most transportation business in Thailand would be run by family style and they do not really have an idea about benefit from technology so it might be difficult to convince them to apply GPS to their business. The company believes that in the future technology would be one of the most important tools to improve work and transportation of the company.

As such , this research is performed to set up GPS for SMEs in order to serve customer satisfaction, reduce time consuming and saving cost. The company has a good serve to customer both in Bangkok, all area around Bangkok and other provinces.

1.2 Objectives of the study

To study factors affecting GPS implementation for truck tracking of Samutprakarn SMEs.

1.3 Scope of the study

The research was studied by interviewing and collecting data from questionnaire. After the data had been collected, it was analyzed by descriptive analysis and statistics analysis. The respondents are SMEs enterprise in Samutprakarn area who work in part of transportation and used GPS everyday for collect information and consider information about GPS by analyzing statistics method. The research will study and conclude that how GPS solve problem and make benefits to SME's business.

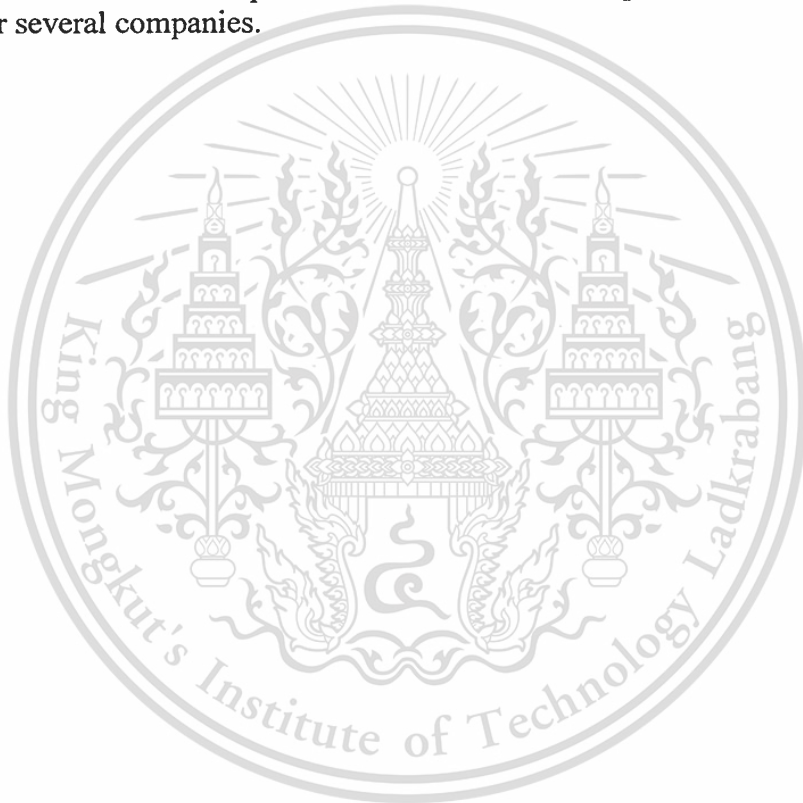
1.4 Benefits Expected

1. To understand the advantages of installation GPS in business and how it helps business performance.
2. To recommend SMEs that GPS installation will help the company in future site map for competitiveness in logistic system.

1.5 Definitions

GPS : The Global Positioning System (GPS) is a technical marvel made possible by a group of satellites in earth orbit that transmit precise signals, allowing GPS receivers to calculate and display accurate location, speed, and time information to the user. With the addition of computing power, and data stored in memory such as road maps, points of interest, topographic information, and much more, GPS receivers are able to convert location, speed, and time information into a useful display format.

SMEs : SME is classified in three groups including medium, small and micro enterprises. Its definition is based on the number of paid employees, turnover, balance sheet total, and independence. Independence is the ultimate criterion to justify enterprises to be a SME. Independence means less than a quarter owned by one large company or several companies.



Chapter 2

Literature Review

This chapter provides a general overview of the basic operating principles and theory of the GPS.

2.1 Overview of GPS

2.1.1 History of GPS

The Global Positioning System (GPS) is a U.S.-owned utility that provides users with positioning, navigation, and timing (PNT) services. This system consists of three segments: the space segment, the control segment, and the user segment. The U.S. Air Force develops, maintains, and operates the space and control segments.

Throughout time people have developed a variety of ways to figure out their position on earth and to navigate from one place to another. Early mariners relied on angular measurements to celestial bodies like the sun and stars to calculate their location. The 1920s witnessed the introduction of a more advanced technique radio navigation based at first on radios that allowed navigators to locate the direction of shore-based transmitters when in range. Later, the development of artificial satellites made possible the transmission of more-precise, line-of-sight radio navigation signals and sparked a new era in navigation technology. Satellites were first used in position-finding in a simple but reliable two-dimensional Navy system called Transit. This laid the groundwork for a system that would later revolutionize navigation forever the Global.

The design of GPS is based partly on similar ground-based radio navigation systems, such as LORAN and the Decca Navigator developed in the early 1940s, and used during World War II. In 1956 Friedwardt Winterberg, (*Astronautica Acta* II, 1996) proposed a test of general relativity using accurate atomic clocks placed in orbit in artificial satellites. To achieve accuracy requirements, GPS uses principles of general relativity to correct the satellites' atomic clocks. Additional inspiration for the GPS came when the Soviet Union launched the first man-made satellite, Sputnik in 1957. 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 continued away from them. They realized that since they knew their exact location on the globe, they could pinpoint where the satellite was along its orbit by measuring the Doppler distortion.

The first satellite navigation system, Transit, used by the United States Navy, was first successfully tested in 1960. It used a constellation of five satellites and could provide a navigational fix approximately once per hour. In 1967, the U.S. Navy developed the Timation satellite which proved the ability to place accurate clocks in space, a technology that GPS relies upon. In the 1970s, the ground-based Omega Navigation System, based on phase comparison of signal transmission from pairs of stations, became the first worldwide radio navigation system. However, limitations of these systems drove the need for a more universal navigation solution with greater accuracy.

While there were wide needs for accurate navigation in military and civilian sectors, almost none of those were seen as justification for the billions of dollars it would cost in research, development, deployment, and operation for a complex constellation of navigation satellites. However during the Cold War arms race, the nuclear threat to the very existence of the United States was the one need that did justify this cost in the view of the US Congress. And this deterrent effect is why GPS was funded. The nuclear triad consisted of the US Navy's submarine-launched ballistic missiles (SLBMs) along with the US Air Force's strategic bombers and intercontinental ballistic missiles (ICBMs). Considered vital to the nuclear deterrence posture, accurate determination of the SLBM launch position was a force multiplier. Precise navigation would enable US submarines to get an accurate fix of their positions prior to launching their SLBMs. The US Air Force with two-thirds of the nuclear triad also had requirements for a more accurate and reliable navigation system. The Navy and Air Force were developing their own technologies in parallel to solve what was essentially the same problem. To increase the survivability of ICBMs, there was a proposal to use mobile launch platforms so the need to fix the launch position had similarity to the SLBM situation. In 1960, the Air Force proposed a radio-navigation system called MOSAIC (Mobile System for Accurate ICBM Control) that was essentially a 3-D LORAN. A follow-on study called Project 57 was worked in 1963 and it was "in this study that the GPS concept was born." That same year the concept was pursued as Project 621B, which had "many of the attributes that you now see in GPS" (and promised increased accuracy for Air Force bombers as well as ICBMs. Updates from the Navy Transit system were too slow for the high speeds that the Air Force operated at. The Navy Research Laboratory continued advancements with their Timation (Time Navigation) satellites, first launched in 1967, and with the third one in 1974 carrying the first atomic clock put into orbit (Steven, 2002).

With these parallel developments out of the 1960s, it was realized that a superior system could be developed by synthesizing the best technologies from 621B, Transit, Timation and SECOR in a multi-service program. Over the Labor Day weekend in 1973, a meeting of about 12 military officers at the Pentagon discussed the creation of a Defense Navigation Satellite System (DNSS). It was at this meeting that "the real synthesis that became GPS was created." Later that year, the DNSS program was named Navstar. With the individual satellites being associated with the name Navstar (as with the predecessors Transit and Timation), a more fully encompassing name was used to identify the constellation of Navstar satellites. This more complete name was Navstar-GPS which was later shortened simply to GPS (Michael and James, 2002: 65).

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After Korean Air Lines Flight 007, carrying 269 people, was shot down in 1983 after straying into the USSR's prohibited airspace, in the vicinity of Sakhalin and Moneron Islands, President Ronald Reagan issued a directive making GPS freely available for civilian use, once it was sufficiently developed, as a common good. The first satellite was launched in 1989, and the 24th and last satellite was launched in 1994 (Cheryl, 2006).

Initially, the highest quality signal was reserved for military use, and the signal available for civilian use was intentionally degraded ("Selective Availability", SA). This changed with U.S. President Bill Clinton ordering Selective Availability turned off at midnight May 1, 2000, improving the precision of civilian GPS from 300 meters (about 1000 feet) to 20 meters (about 65 feet). The U.S. military by then had the ability to deny GPS service to potential adversaries on a regional basis (GPS and Selective Availability, 2010).

Positioning, Navigation, and Timing Policy : U.S. law and policy on GPS emphasize continuity of service, open access to civil signals, and technological leadership. In 1996, the United States issued a national policy statement on the management and use of space-based positioning, navigation and timing services, which include GPS and augmentations. It underscored the dual use (civilian military) nature of GPS and established a joint civil-military national management structure to oversee its operation.

U.S. policy was expanded in 2004 in response to changing international conditions and the incredible growth in the types and complexities of GPS applications. This policy reaffirms the United States commitment to provide reliable civil space-based positioning, navigation, and timing services through GPS on a continuous, worldwide basis – freely available to all. The policy also calls for improving the performance of GPS and cooperating with other nations.

2.1.2 The Structure of Global Positioning System (GPS)

GPS stands for "Global Positioning System" and the name which was identified by the committee of enacting Information technology terms,. The Royal Institute on May BE 2541 has enacted the full name of GPS as the NAVSTAR Global Positioning System.

NAVSTAR stands for Navigation Satellite Timing and Ranging, term of Navigation Satellite means System used for the identification of any location on Earth by 24 satellites that has been orbited around the earth at the high level and far from any radio signal interference with the accuracy process to indicate any locations on the earth for 24 hours.



Figure 2.1 NAVSTAR satellites of the United States
Source : Courtesy of the Lockheed Martin Corporation, 2009

2.1.3 Elements of GPS satellite system

It can be divided into three components as follows.

2.1.3.1 The Control Station Segment is the command and control center.

The performance of GPS included the complete monitoring system which has been located at the U.S. Air Force Base of Colorado Spring, USA and the combined with

- 5 Monitor Station that scattered around the world as followed
 - Hawaiian Islands in the Pacific Ocean.
 - Ascension Islands in the Atlantic Ocean.
 - Diego Garcia Islands in the Indian Ocean.
 - Kwajalein Islands at Philippines.
 - Colorado Springs City at USA.
- Ground Antennas combined with 3 locations.
 - Kwajalein Islands.
 - Diego Garcia Islands.
 - Ascension Islands.
- Master Control Station located in the US Air Force Base, Schriever AFB. State , Colorado.

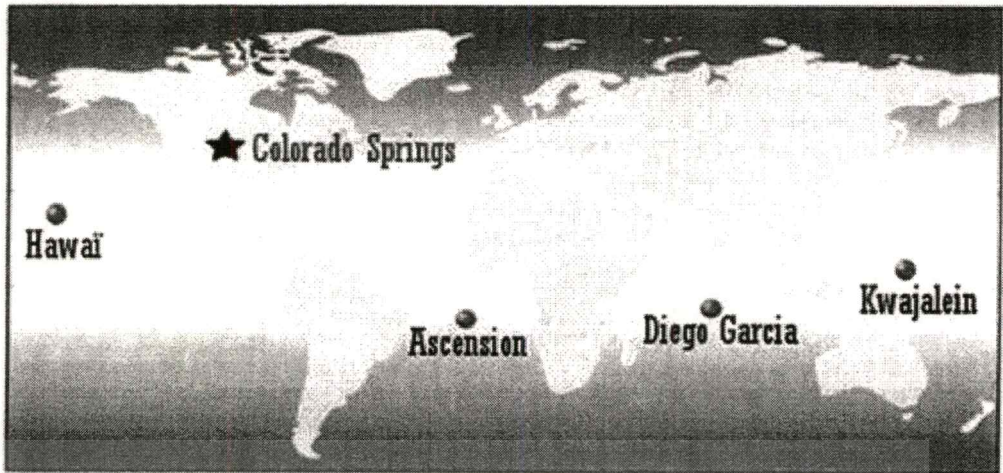


Figure 2.2 GPS Monitoring Station
Source : Earthmap NASA, 2008

The control segment consists of worldwide monitor and control stations that maintain the satellites in their proper orbits through occasional command maneuvers, and adjust the satellite clocks. It tracks the GPS satellites, uploads update navigational data, and maintains health and status of the satellite constellation.

2.1.3.2 Space Segment Combined With

- 24 satellites which has orbited around the earth for 12 hours.
- The orbit height is about 11,000 miles from Earth.
- Each satellite has 4 Atomic Clocks which provides the most accurate time.
- There are six orbital planes with 4 satellites on each orbital plane and has the angle with Equator about 55-degree. The space segment consists of a nominal constellation of 24 operating satellites that transmit one-way signals that give the current GPS satellite position and time.

2.1.3.3 User Segment consisted of two major parts: Military and Civilian. The Civilian part will received free service. But users have to prepare and arrange their own GPS Antenna and Receiver by themselves.

The user segment consists of the GPS receiver equipment, which receives the signals from the GPS satellites and uses the transmitted information to calculate the user's three – dimensional position and time.

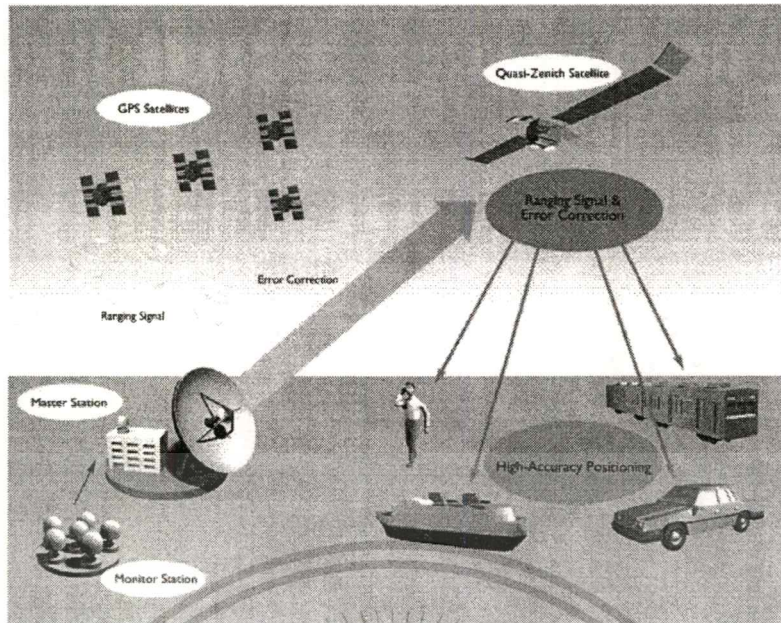


Figure 2.3 The Working Principle of GPS
Source: GPS Locator, 2009

The working principle of the GPS is to calculate the distance between satellite and GPS machine. This requires the minimum distance from at least three satellites to obtain the correct location. When GPS machine receives a signal from those 3 satellites, it will calculate the distance between a GPS machine to satellite with physics formula as the following

$$\text{Speed} \times \text{time} = \text{distance} \quad (2.1)$$

Those 3 satellites will transmit the same signal to GPS machine with the same speed at 186,000 miles per second). But the duration of the signal transmit from the satellites is not equal and varies by the different distance.

Data of the position shown on map can be identified by software application that came with the GPS machine to locate the correct position on map and our location. The accuracy of location is dependent on the accuracy of map information.

Some machines may not came with a map therefore users need to purchase separately from the GPS machine manufacture.

There have been some usages of GPS within Thailand for several years but only in the particular group. Because GPS which has been used for navigation purpose only or called " Stand alone " has only one function. Now Thailand has many manufacturers of GPS machines, some of them may provide only rough details as we compared with the GPS manufacturers from Europe or U.S.A or even some countries in Asia such as Japan, Hong Kong. Fortunately GPS machines from Thai manufactures are usable.

Users can select GPS Receiver in many styles while the most popular one is GPS Navigator with Bluetooth. It is suited to use in cars or any vehicles which is in transit on land, sea and air as well as being portable and free of charge.

There are 2 types of GPS which has been use in Thailand as follows :

1. GPS is used as a navigator : It provides great benefit to guide us to go anywhere we need and can show our correct location on Thailand. The first model of GPS navigator had only black and white screen display with tough design. At that time, GPS Navigator was the brand new technology with high price therefore it had limited users. Now the technology is widely available with better prices, from some GPS manufacturers such as Garmin, Magelland etc. The manufacturers have added more function into GPS navigator such as music player etc. This kind of GPS has been used only for navigation.

2. GPS has been used for other functions such as note pad, voice recorder, game player or even mobile phone. Its function has been designed similar to PDA, Palm, Pocket PC and Pocket PC Phone which has been complied with the abilities for navigation of GPS.

At the beginning, Garmin was the pioneer of PDA installed with GPS Receiver or well known as Palm PC on that time. Since the technology has advanced more, Gammin has produced a Pocket PC installed with GPS Receiver. There are some manufacturers of GPS in form of Pocket PC such as Speed Navi (Mio), ASUS, Eten, Fujitsu – Seimens and etc. In the future many more manufacturers will show their intension to share GPS market as well.

GPS Services

GPS satellites provide service to civilian and military users. The civilian service is freely available to all users on a continuous, worldwide basis. The military service is available to U.S. and allied armed forces as well as approved Government agencies.

A variety of GPS augmentation systems and techniques are available to enhance system performance to meet specific user requirements. These improve signal availability, accuracy, and integrity, allowing even better performance than is possible using the basic GPS civilian service.

The outstanding performance of GPS over many years has earned the confidence of millions of civil users worldwide. It has proven its dependability in the past and promises to be of benefit to users, throughout the world, far into the future.

2.2 Basic of GPS

Global Positioning System (GPS) has three components, (NAVSTAR GPS, 1996:13-16), namely

The space segment (SS) is composed of the orbiting GPS satellites or Space Vehicles (SV) in GPS parlance. The GPS design originally called for 24 SVs, eight each in three circular orbital planes, (Daly, 1993:349-357) but this was modified to six planes with four satellites each. The orbital planes are centered on the Earth, not rotating with respect to the distant stars. The six planes have approximately 55° inclination (tilt relative to Earth's equator) and are separated by 60° right ascension of the ascending node (angle along the equator from a reference point to the orbit's intersection)(NAVSTAR GPS, 2006). The orbits are arranged so that at least six satellites are always within line of sight from almost everywhere on Earth's surface.

Orbiting at an altitude of approximately 20,200 kilometers (about 12,550 miles or 10,900 nautical miles; orbital radius of approximately 26,600 km (about 16,500 mi or 14,400 NM)), each SV makes two complete orbits each sidereal day, repeating the same ground track each day. This was very helpful during development, since even with just four satellites, correct alignment means all four are visible from one spot for a few hours each day (Agnew and Larson, 2007:71-76). For military operations, the ground track repeat can be used to ensure good coverage in combat zones.

As of March 2008, there are 31 actively broadcasting satellites in the GPS constellation, and two older, retired from active service satellites kept in the constellation as orbital spares. The additional satellites improve the precision of GPS receiver calculations by providing redundant measurements. With the increased number of satellites, the constellation was changed to a non uniform arrangement. Such an arrangement was shown to improve reliability and availability of the system, relative to a uniform system, when multiple satellites fail. About eight satellites are visible from any point on the ground at any one time

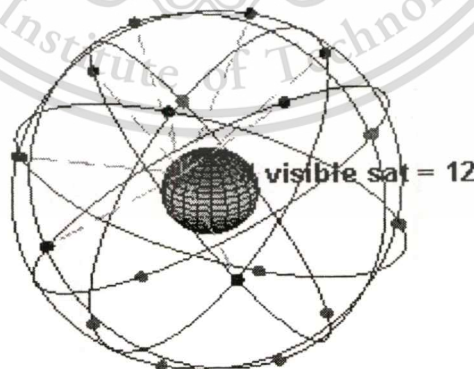


Figure 2.4 A Visual Example of the GPS Constellation in Motion with The Earth Rotating.

Source: NAVSTAR GPS User Equipment Introduction.(1996).US Coast Guard

The control segment is composed of

1. a master control station (MCS),
2. an alternate master control station,
3. four dedicated ground antennas and
4. Six dedicated monitor stations.

The MCS can also access U.S. Air Force Satellite Control Network (AFSCN) ground antennas (for additional command and control capability) and NGA (National Geospatial-Intelligence Agency) monitor stations. The flight paths of the satellites are tracked by dedicated U.S. Air Force monitoring stations in Hawaii, Kwajalein, Ascension Island, Diego Garcia, Colorado Springs, Colorado and Cape Canaveral, along with shared NGA monitor stations operated in England, Argentina, Ecuador, Bahrain, Australia and Washington DC (Slater, 2005). The tracking information is sent to the Air Force Space Command's MCS at Schriever Air Force Base 25 km (16 miles) ESE of Colorado Springs, which is operated by the 2nd Space Operations Squadron (2 SOPS) of the United States Air Force (USAF). Then 2 SOPS contacts each GPS satellite regularly with a navigational update using dedicated or shared (AFSCN) ground antennas (GPS dedicated ground antennas are located at Kwajalein, Ascension Island, Diego Garcia, and Cape Canaveral). These updates synchronize the atomic clocks on board the satellites to within a few nanoseconds of each other, and adjust the ephemeris of each satellite's internal orbital model. The updates are created by a Kalman filter which uses inputs from the ground monitoring stations, space weather information, and various other inputs (USNO, 2006).

Satellite maneuvers are not precise by GPS standards. So to change the orbit of a satellite, the satellite must be marked unhealthy, so receivers will not use it in their calculation. Then the maneuver can be carried out, and the resulting orbit tracked from the ground. Then the new ephemeris is uploaded and the satellite marked healthy again.

The user segment is composed of hundreds of thousands of U.S. and allied military users of the secure GPS Precise Positioning Service, and tens of millions of civil, commercial and scientific users of the Standard Positioning Service. In general, GPS receivers are composed of an antenna, tuned to the frequencies transmitted by the satellites, receiver-processors, and a highly stable clock (often a crystal oscillator). They may also include a display for providing location and speed information to the user. A receiver is often described by its number of channels: this signifies how many satellites it can monitor simultaneously. Originally limited to four or five, this has progressively increased over the years so that, as of 2007, receivers typically have between 12 and 20 channels (GPS Technology Reviews, 2007).

GPS receivers may include an input for differential corrections, using the RTCM SC-104 format. This is typically in the form of an RS-232 port at 4,800 bit/s speed. Data is actually sent at a much lower rate, which limits the accuracy of the signal sent using RTCM. Receivers with internal DGPS receivers can outperform those using external RTCM data. As of 2006, even low-cost units commonly include Wide Area Augmentation System (WAAS) receivers.

Many GPS receivers can relay position data to a PC or other device using the NMEA 0183 protocol, or the newer and less widely used NMEA 2000. Although these protocols are officially defined by the NMEA, (National Marine Electronics Association, 2008) references to these protocols have been compiled from public records, allowing open source tools like gps to read the protocol without violating intellectual property laws. Other proprietary protocols exist as well, such as the SiRF and MTK protocols. Receivers can interface with other devices using methods including a serial connection, USB, or Bluetooth.

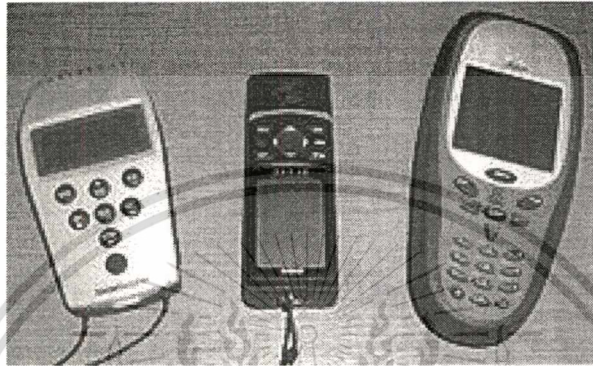


Figure 2.5 GPS Receivers
Source: GPS Technology Reviews, 2007



Figure 2.6 A Typical OEM GPS Receiver Module Measuring 15×17 mm.
Source: GPS Technology Reviews, 2007



Figure 2.7 A Typical GPS Receiver with Integrated Antenna

Source: GPS Technology Reviews, 2007

2.2.1 The Evolution of GPS in the Civilian World

This section examines the U.S. government's public responses to the growing number of civil users, the role of government agencies and other private-sector agents in fostering commercial GPS markets, and present GPS governance and management. With the proliferation of civil government and private-sector users and the widening array of commercial GPS applications, the U.S. government has to juggle a growing set of civilian demands on the system along with the military demands.

The United States Opens GPS Up to Civilians The first U.S. pronouncement regarding civil use of GPS came in 1983 following the downing of Korean Airlines Flight 007 after it strayed over territory belonging to the Soviet Union. At this time, President Reagan announced that the Global Positioning System would be made available for international civil use once the system became operational. In 1987 DoD formally requested the Department of Transportation to establish and provide an office to respond to civil users' needs and to work closely with the DoD (Department of Defense) to ensure proper implementation of GPS for civil use. Two years later, the U.S. Coast Guard became the lead agency for this project.

The Reagan announcement was followed by a U.S. offer to make available the Standard Positioning Service of GPS, which was announced at the International Civil Aviation Organization's (ICAO) Tenth Air Navigation Conference, September 5, 1991. The Federal Aviation Administration's (FAA) Administrator, James Busey, promised that GPS would be available free of charge to the international community beginning in 1993 on a continuous, worldwide basis for at least 10 years. This offer was extended the following year at the 29th ICAO Assembly, when the United States offered SPS to the world for the foreseeable future and pledged to provide at least six years notice prior to termination of GPS operations or elimination of the GPS SPS.

Both offers were formally reiterated in a 1994 letter from the FAA's chief, David Hinson, to ICAO, reaffirming the U.S. government's intention to provide GPS SPS free of charge for at least 10 years (Hinson, 1994). In 1995, President Clinton once again confirmed the government's commitment to provide GPS signals to international civil users in a statement that was released at an ICAO meeting in Montreal in March (Clinton, 1995).

The U.S. Government's Role in Fostering Commercial GPS Markets. The birth of one of the first GPS markets surveying was influenced by a 1984 decision by the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) to publish the first draft standards in the Federal

Register that allowed for the use of GPS data. This seal of approval of GPS data by a civil government agency helped jump start the expansion of the surveying market even while the GPS system was still in development.

By the mid-1980s, commercial GPS equipment aimed at the surveying profession appeared on the market even though only a small number of operating GPS satellites were in orbit. Surveying and time transfer were logical entry points into the market because their applications could accept the limited availability of satellite

signals (Kuznik, 1992). Surveyors did not need to use their data in real time, but could make observations whenever sufficient satellite signals were available, day or night. GPS surveying offered greater productivity and cost savings over traditional survey methods. Tasks that normally required several weeks or months to finish could now be completed in a fraction of the time using GPS at one-fifth to one-tenth of the cost of conventional surveying. Satellite surveying also helped sustain the commercial market for GPS equipment after the Challenger disaster shut down operations and delayed satellite launches for several years.

The money generated by the survey market boom was also important to the overall development of GPS applications because it enabled U.S. manufacturers to invest in research and development (R&D) on GPS technology. The added R&D investment helped accelerate the development of GPS applications faster than would have been possible had the DoD been left to carry out this task on its own. In fact, surveyors were the first to employ some of the more advanced differential GPS techniques being used today, such as kinematic surveying and real-time carrier phase tracking. Now, ten years after the first standards were published, almost all geodetic standards are based on GPS data (United States GPS Industry Council (USGIC), 1994).

The growth in the GPS survey market opened the way for a number of GPS niche markets such as aviation. Even in these smaller markets, government agencies have contributed to their expansion. For example, the FAA issued performance standards for GPS receivers (Technical Standard Order C129) in 1992. This action allowed manufacturers to build GPS receivers as supplemental navigation aids for aircraft, thereby broadening the range of market opportunities for GPS suppliers. As evidence of this, Trimble, the first company to be awarded the GPS Technical Standard Order certification, signed an agreement with Honeywell in 1995 to cooperate in developing GPS products for the commercial, space, and military aviation markets. This alliance will allow both companies to tap into new GPS markets.

Government export controls have also affected GPS markets. Prior to 1991, most GPS user equipment shipped abroad required individual validated licenses to ensure compliance with various Department of Commerce (DoC) Bureau of Export Administration export control programs. On September 1, 1991, the DoC revised its export list of electronic equipment requiring licenses for shipment abroad. What the DoC essentially did was to make a clear delineation between military and civil GPS user equipment. Under the revised regulations, civilian GPS receivers, other satellite equipment, and telecommunications systems were freed of restrictions and were allowed to be shipped as "general destination items," although military receivers, GPS null steerable antennas, encryption devices, and certain other components were still treated as "munitions" with strict export restrictions (United States GPS Industry Council (USGIC), 1994). This liberalization of export controls helped speed up the U.S. industry's entry into foreign markets. Today, export markets are important to U.S. GPS manufacturers, making up an average of 45 to 50 percent of overall sales (United States GPS Industry Council (USGIC), 1994).

GPS Management Today

The Global Positioning System management structure is currently undergoing a transition. Until recently, DoD was solely responsible for the management and operations of GPS as well as for policy formulation regarding the system and its uses. Although DoD and the Department of Transportation cooperated on those aspects of GPS policy affecting civil access to the system, much of the decision authority rested with DoD, and ultimately with the National Command Authority. However, now the civil government sector—primarily DoT—has been given a more active role in GPS management.

The Future of GPS

The United States committed to an extensive modernization program, including the implementation of a second and a third civil signal on GPS satellites. The second civil signal will improve the accuracy of the civilian service and supports some safety-of-life applications. The third signal will further enhance civilian capability and is primarily designed for safety-of-life applications, such as aviation.

2.3 Applications of GPS System

2.3.1 Timing

In addition to longitude, latitude, and altitude, the Global Positioning System (GPS) provides a critical fourth dimension – time. Each GPS satellite contains multiple atomic clocks that contribute very precise time data to the GPS signals. GPS receivers decode users to determine the time to within 100 billionths of a second, without the cost of owning and operating atomic clocks.

Precise time is crucial to a variety of economic activities around the world. Communication systems, electrical power grids, and financial networks all rely on precision timing for synchronization and operational efficiency. The free availability of GPS time has enabled cost saving for companies that depend on precise time and has led to significant advances in capability.

For example, wireless telephone and data networks use GPS time to keep all of their base stations in perfect synchronization. This allows mobile handsets to share limited radio spectrum more efficiently. Similarly, digital broadcast radio service use GPS time to ensure that the bits from all radio stations arrive at receivers in lockstep. This allows listeners to tune between stations with a minimum of delay.

Companies worldwide use GPS to time – stamp business transactions, providing a consistent and accurate way to maintain records and ensure their traceability. Major investment banks use GPS to synchronize their network computers located around the world. Large and small business are turning to automated systems that can track, update, and manage multiple transactions made by a global network of customers, and these require accurate timing information available through GPS.

The U.S. Federal Aviation Administration (FAA) uses GPS to synchronize reporting of hazardous weather from its 45 Terminal Doppler Weather Radars located throughout the United States.

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Instrumentation is another application that requires precise timing. Distributed networks of instruments that must work together to precisely measure common events require timing sources that can guarantee accuracy at several points. GPS-based timing works exceptionally well for any application in which precise timing is required by devices that are dispersed over wide geographic areas. For example, integration of GPS time into seismic monitoring networks enables researchers to quickly locate the epicenters of earthquakes and other seismic events.

Power companies and utilities have fundamental requirements for time and frequency to enable efficient power transmission and distribution. Repeated power blackouts have demonstrated to power companies the need for improved time synchronization throughout the power grid. Analyses of these blackouts have led many companies to place GPS-based time synchronization devices in power plants and substations. By analyzing the precise timing of an electrical anomaly as it propagates through a grid, engineers can trace back the exact location of a power line break.

Some users, such as national laboratories, require the time at a higher level of precision than GPS provides. These users routinely use GPS satellites not for direct time acquisition, but for communication of high-precision time over long distance. By simultaneously receiving the same GPS signal in two places and comparing the results, the atomic clock time at one location can be communicated to the other. National laboratories around the world use this “common view” technique to compare their time scales and establish Coordinated Universal Time (UTC). They use the same technique to disseminate their time scales to their own nations.

New applications of GPS timing technology appear every day. Hollywood studios are incorporating GPS in their movie slates, allowing for unparalleled control of audio and video date, as well as multi-camera sequencing. The ultimate applications for GPS, like the time it measures, are limitless.

As GPS becomes modernized, further benefits await users. The addition of the second and third civilian GPS signals will increase the accuracy and reliability of GPS time, which will remain free and available to the entire world.

2.3.2 Roads & Highways

It is estimated that delays from congestion on highways, streets, and transit systems throughout the world result in productivity losses in the hundreds of billions of dollars annually. Other negative effects of congestion this include property damage, personal injuries, increased air pollution, and inefficient fuel consumption.

The availability and accuracy of the Global Positioning System (GPS) offers increased efficiencies and safety for vehicles using highways, streets, and mass transit systems. Many of the problems associated with the routing and dispatch of commercial vehicle is significantly reduced or eliminated with the help of GPS. This is also true for the management of mass transit systems, road maintenance crews, and emergency vehicles, GPS enables automatic vehicle location and in-vehicle navigation systems that are widely used throughout the world today. By combining GPS position technology with systems that can display geographic information or

with systems that can automatically transmit data to display screens or computers, a new dimension in surface transportation is realized.

A geographic information system (GIS) stores, analyzes, and displays geographically referenced information provided in large part by GPS. Today GIS is used to monitor vehicle location, making possible effective strategies that can keep transit vehicles on schedule and inform passengers of precise arrival times. Mass transit systems use this capability to track rail, bus, and other services to improve on-time performance.

Many new capabilities are made possible with the help of GPS. Instant car pools are feasible since people desiring a ride can be instantly matched with a vehicle in a nearby area.

Using GPS technology to help track and forecast the movement of freight has made a logistical revolution, including an application known as time-definite delivery. In time-definite delivery, trucking companies use GPS for tracking to guarantee delivery and pickup at the time promised, whether over short distances or across time zones. When an order comes in, a dispatcher punches a computer function, and a list of trucks appears on the screen, displaying a full array of detailed information on the status of each of them. If a truck is running late or strays off route, an alert is sent to the dispatcher.

Many nations use GPS to help survey their road and highway networks, by identifying the location of features on, near, or adjacent to the road networks. These include service stations, maintenance and emergency services and supplies, entry and exit ramps, damage to the road system, etc. The information serves as an input to the GIS data gathering process. This database of knowledge helps transportation agencies to reduce maintenance and service costs and enhances the safety of drivers using the roads.

Research is underway to provide warnings to drivers of potential critical situations, such as traffic violations or crashes. Additional research is being conducted to examine the potential for minimal vehicle control when there is a clear need for action, such as the pre-deployment of air bags. The position information provided by GPS is an integral part of this research.

GPS is an essential element in the future of Intelligent Transportation Systems (ITS). ITS encompasses a broad range of communications-based information and electronics technologies. Research is being conducted in the area of advanced driver assistance systems, which include road departure and lane change collision avoidance systems. These systems need to estimate the position of a vehicle relative to lane and road edge with an accuracy of 10 centimeters.

With the continuous modernization of GPS, one can expect even more effective systems for crash prevention, distress alerts and position notification, electronic mapping, and in-vehicle navigation with audible instructions.

2.4 Advantage of GPS

There are a number of advantages to GPS Technology, and in many cases, they aren't often thought about.

Most people in industrialized countries, especially the US, are well aware of the use of global positioning for helping us find our way when we are on the road. It does this by an ingenious method. A signal is received from three global positioning satellites. Using a combination of location of the satellite and the amount of time it takes for the signal to get to the receiver, the unit can triangulate its position with astonishing accuracy. A fourth satellite can be used to also determine the location in three dimensions, in other words, altitude as well as location (Trulove, 2008).

Exactly the same technology is used in different ways, though. Global positioning may have been the first to use the idea, but it certainly isn't the only system that does. Note that most of these function without the GPS receiver, so it is done from the satellite, but the same technology is still the basis for the use.

Trulove (2008) stated that another system that uses this technology is science. Geologists can get very exact elevation readings of virtually any point by using global positioning. Scientists can determine nearly exact displacements during and immediately following earthquakes. Vulcanologists can use it to know by how much volcanic mountains are growing and where the mountain growth is occurring. Oceanographers even use it with a combination of sonar to map the ocean floor.

The United States Forest Service uses the same technology to pinpoint forest fire hot spots with their thermal infrared satellites. This allows them to send fire fighters to the areas they are most needed that might not be apparent from the ground or even aircraft. It also allows them to track the movement of fires (Trulove, 2008).

Missing people who have cell phones have been located using the same system, but with cell satellites acting as the locating sources for triangulation, and the signal that cell phones generate periodically as the beacon.

The same technology used in a slightly different way is responsible for allowing us to find missing pets that have a chip inserted under the skin.

GPS technology works well with other technologies, as all of this indicates. Either way, the GPS is a lot more than simply something made to give directions to find your destination. As valuable as that might be to many people, the technology is far more valuable for other uses that aren't often thought of (Trulove, 2008).

It is safe to say, though, that the Global Positioning System is definitely valuable, and that value is growing as new ways of using it are found.

2.5 The Factor of Fleet Management

Tracking of everything from people to packages can be expected to grow in significance as the price of tracking system decline along with the decline of electronic chip/board prices. In contrast to vehicle navigation, tracking is more passive function that is typically conducted from a central fixed site. Tracking allows for more efficient managements of a total transportation system inventory of cargo and vehicles, as well as reduced losses due to theft or accidents. Accuracy requirements vary depending on the specific application. In some cases, reliable sub-meter accuracy is required for tracking and controlling vehicles for collision avoidance (e.g., agriculture, construction, and rail). GPS is being considered for new tracking applications such as enhanced 911 services for mobile phone users. When dialing 911 from a fixed location, the address of the caller can be easily identified. This is not the case for mobile phone, whether they are cellular can be easily identified. As a result, emergency services have a more difficult time locating mobile 911 callers. Enhanced 911 services would address this problem, but doing so raises privacy concerns such as the possibility of a mobile phone being tracked without the owner's knowledge. Experiments have already been conducted on using GPS to track persons on parole or otherwise subject to other legal restrictions through tamper-resistant ankle bracelets. A key problem for GPS, however, is the very limited ability of the signal to penetrate buildings (Chu-ping Chi, 2004).

Other communications links, such as FM radio waves, may provide a substitute carrier for GPS-like signals in limited areas. Public safety also is benefiting from GPS through better resource management and Vehicle dispatch of emergency service, and should continue to grow. GPS tracking and Navigation reduces response times and enables more efficient utilization of expensive vehicles used by emergency services such as police, fire, and search and rescue. GPS can also be combined with communications to coordinate the actions of multiple grounds, sea, and air emergency vehicles. Differential GPS systems can also be deployed to emergency locations to guide individuals, such as firemen working inside a burning building.

The Federal Emergency management Agency uses GPS-bases geographic information systems for inventory damage from natural disasters such as hurricanes, earthquakes, floods, and tornadoes. The same information is then used to target relief services and monitor reconstruction efforts.

Truck Tracking is a new generation Fleet Management System. It is termed Intelligent Transport Management System because it combines all pertinent LBS (Location Based Services) technologies to form an integrated control and command platform.

These include the most advanced components of:

- Global Positioning System (GPS)
- Geographical Information System (GIS)
- General Packet Radio Services (GPRS)
- Mobile Data Computer (MDC)
- Relational DATA Base
- Web services
- Microsoft.Net Framework

Truck Tracking will be used as the core of the customer's control center; this may be in the form of a Control and Command Center (C2) or a customer-centric call center. It provides modules including G-CAD for daily track & trace operation, Trip Planner for fleet operation planning and Fleet Manager for data maintenance.

Using Global Positioning System (GPS) and in-built GPRS modem, every vehicle in the fleet is installed with a small black box which is hid in the vehicle. It allows the users to periodically retrieve real time GPS location of the vehicle. Anytime and anywhere is via the GPRS telecommunication network.

Using the fleet software and GPS, navigation to unfamiliar destinations will never take longer than it has to, no more flipping through outdated maps. Operator will be able to direct the drivers to their respective destination efficiently.

The other important feature is speed monitoring. Its purpose is to restrict the traveling speed of vehicles. Traffic fines, accidents rates and maintenance cost of our customers were reduced drastically since the implementation of the system.

Management of a Goods Truck Fleet essentially involved ensuring timely arrival and dispatch of trucks. To go a step further it also involves ensuring that the truck touches the destination as per schedule. Thus, by application of Intelligent Transportation Systems (ITS), would assist the transporter to have a closer monitoring and also actual record of the history of delivery that can be the benefit for acquiring the statistics for any further development of fleet management.

Furthermore, truck tracking by GPS could help control the driver behavior which related to transport operation and also generates the deliver report that includes the following:

- 1) Speed of the Trucks (minute by minute)
- 2) Working hours in one day (Star and Stop engines)
- 3) Idle of engine
- 4) Truck routing (Trip by Trip)
- 5) Positioning of Truck (meter by meter and minute by minute)
- 6) Trip reports

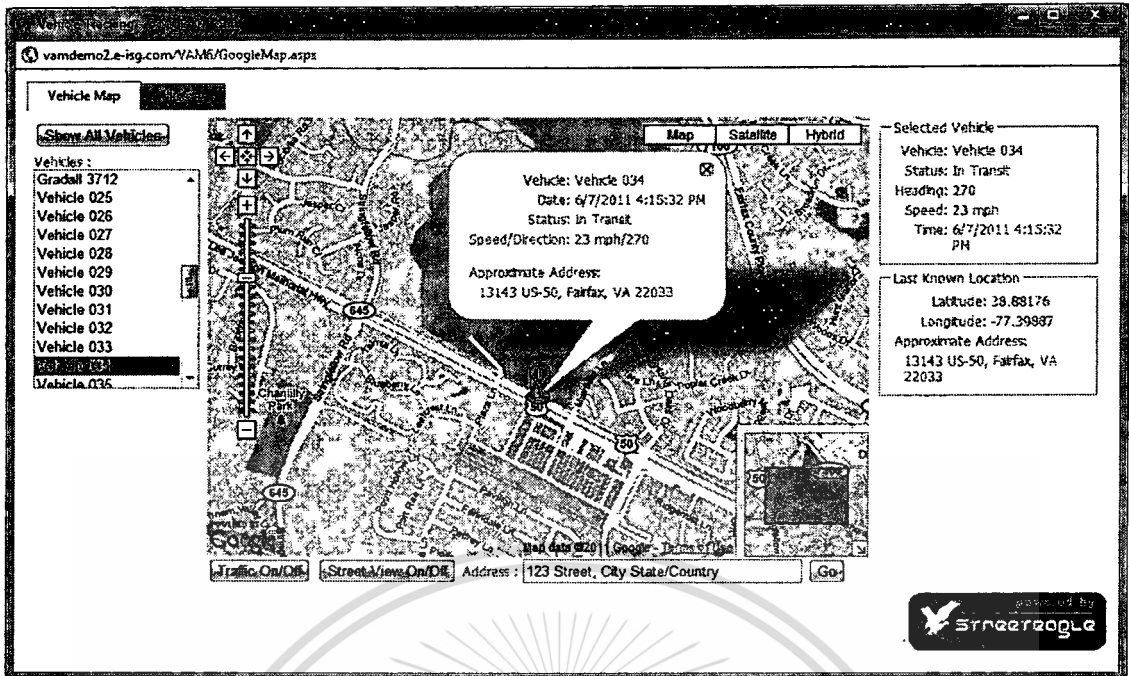


Figure 2.8 Example of Fleet Screen Shot
Source: E-isg Asset Intelligence GPS, 2008

From the items above, the system can be developed and add more functions as required by a transporter. We could say that the fleet management of Goods transportation needs to be monitored carefully because, the driver behavior could cause many problems from stealing to disaster if without any monitoring as conventional method of fleet management. It could be said that once the driver takes the truck for delivery, the owner or manager would not really know what the exact route that driver is going for and how he drives the truck. For example, refer to the case of accident on April 2002, the 36,000 liters truck tanker of SC Carrier Co., Ltd. Has smashed the high voltage pole inside the area of Maptaphut Industrial Estate Rayong. The driver had been burned dead in the accident and the plants in the industrial estate needed to shut down for 8 hours because of lack of electricity. The cost of shutting down from this accident is approximately THB 400,000 per hour for each plant. So, we cannot imagine how they could afford to compensate the damage cost. This is why we need to have a careful operation and monitoring of the goods transportation (Chu-ping Chi, 2010).

Moreover, one of the most serious classic problems of fleet management in Thailand is "Petrol Stealing" by driver. The system could help the manager to monitor and control truck parking during the delivery. Thus, we could design the system to alert the manager when truck has stopped longer than it should. So, the system could make the driver more disciplined, if they know that they are monitored or tracked by their manager.

Furthermore, many such tracking systems can also feed information back to the drivers via an in-vehicle telecommunication, enabling dynamic course adjustment and en route pick-up delivery changes. In addition, stolen vehicles equipped with a tracking device can usually be located and recovered. The vehicle tracking system, for example, has helped the police to track and recover a 7.5 ton refrigerated heavy goods vehicle stolen in Bangkok, a truck taken from a car park and found ready to be stripped, as well as several other vehicles.

On the business side, new innovations for commercial vehicles are easing the trip for lorry drivers, with fleet management systems helping to optimize deployment, decrease empty runs and increase driver security. Transport operators have also benefited from these systems, which contributes to optimal scheduling and better customer service. Moreover, devices such as the GPS tracking system are helping to speed up the verification of a lorry driver's compliance with regulations.

2.6 Technology Solution for Transportation

New applications and technologies are being developed everyday. Better-known examples of ITS technologies include (Boonkajornkul, 2010):

- 1) On-board navigation systems
- 2) Crash notification systems
- 3) Electronic payment systems
- 4) Traffic control technologies
- 5) Weather information services
- 6) Variable message signs
- 7) Fleet tracking and weight in-motion technology

2.7 GPS Applied for ITS

In general, concepts of ITS that implemented by GPS, are normally integrated into a larger system. This larger system will be complicated and understanding of system engineering and an appreciation of the various components of the system. The ITS subsystem would include the human and machine interface, sensors, communications, control work stations and actuators (Boonkajornkul, 2010).

The components of the system could include the following:

- 1) A positioning system to determine the location of trucks (depicted in the figure by the satellites)
- 2) Human-machine interfaces in the form of information displays for the customers at the office and operator console
- 3) When the truck is back to the depot control, the computer would gather the data from the trucks, process it, and send it to customers' computer
- 4) A communication system to allow transfer of data from the control subsystems to the customer computer (depicted by the arrows)

On the other hand, a real time truck information system might have the following subsystems:

- 1) Wireless network Base station would have two-way communication link with the truck in order to detect the presence of truck.
- 2) Data would be sent to central control computer automatically.
- 3) A control computer to gather the data, process it and send to customer

The above examples demonstrate that positioning systems will be just one subsystem in many Intelligent Transport System applications. In order to ensure that all these subsystems work together smoothly and that the overall system satisfies the customer's requirements, careful systems engineering analysis and design is required. Moreover, as part of this analysis, it will be necessary to consider the attributes of the positioning system as well as those of the other system and subsystem components.

2.7.1 GIS, the Base for GPS

Geographical Information System (GIS) is a database system for capturing, storing, checking, integrating, manipulating, analyzing and displaying data, which are spatially referenced to Earth. In simple words GIS is computer based software capable of handling maps and various details given on the map. Data generated by the GPS is spatial data referring to Earth. In the other words this data is the coordinate of its own position expressed in latitude and longitude. This data needs to be positioned on a map of the area for any useful analysis. To be more precise a road map of the area, with important landmarks is required. On this map the GPS readings are superimposed for further processing.

2.7.2 Application of GPS for Land Navigation

It could be said that the promising market for GPS navigation in terms of sheer size is for land navigation products. Initial adaption of the technology is taking place in the fleet tracking applications. The value of current fleet information is evident for delivery, scheduled service fleet dispatch and control. Hence, the controller could monitor the progress of trucks that are transmitting their position to a central location.

2.7.3 Potential for Use

The potential for use of the reports generated was immense. 200 GPS units were mounted on all the buses of a depot. The readings were downloaded every three days and reports were generated. It now became possible to analyze the punctuality of the bus throughout the route. Cases of missed trips and short trips were brought to light immediately.

We could say by application of GPS, the distance delivered by the truck could be calculated accurately. Furthermore, the maximum speed of the truck could be informed by the system. Thus, GPS tracking system becomes a very useful tool for controlling the commercial trucks that have been taken on by transporters. Their billing can be made fully automatic without any chance of wrong billing on account of fake kilometers. The GPS readings could also be the base for scheduling of trucks, as now the actual time taken by a truck to cover a given distance was available. The system could also help in case of accidents by establishing the recklessness or otherwise of the driver (Boonkajornkul, 2010).

2.8 Benefit of Tracking

2.8.1 Enhance Security System

Tracking system can be incorporated to car anti-theft alarm system and if the alarm is triggered, warning will be send to the administrator via GPRS. For instance in the event of theft, vehicle started without using the ignition key or vehicles being moved without the engine being on could initiate a report to the administrator. It can also send an SMS message to the owner or insurance company.

2.8.2 Monitor Fuel Consumption

Using this system, the administrator is able to know the location of the vehicles, mileage traveled and this can help with the monitoring of petrol consumption. Proper routing will also assist in savings by using shorter route or avoiding certain location thereby enabling customers in lowering fuel consumption cost in the long run.

2.8.3 Idle Report Management

Idle report is created in alerting the administrator and take note of the driver leaving the engine running while in a stationery position. This profile will provide a report to the administrator the date, time, place and duration of the idling incident.

2.8.4 Petrol Saving Incentive

With the help of the system, best route plans can be plotted after a certain period of data collection and analysis. The data will provide the shortest/most effective route and then estimate the amount of petrol consumed for the particular route. From here, we can implement “a lump sum petrol budget” for the driver, example to give 9,000 bath for the whole month of petrol usage. If the driver consumed less than what is given for the route, he can keep the balance saving as an incentive. However if the cost is over the projected amount then a report has to be submitted as to why the usage is high.

2.8.5 Maintenance Report

The system is able to program the recorded mileage of the vehicle and provide a report for maintenance purpose. It enabled the company to monitor the amount of vehicles due for maintenance on a regular basis thus it can prevent major damages and can save on major repair cost in the long run. The fleet can then be managed more effectively as status report will show vehicle availability and those under maintenance currently.

2.8.6 Maximization of Vehicle

With the report generated from this system, the location of the vehicles is known and it can be deployed to achieve maximization in serving customers. It also assists in planning for ETD&ETA from or to customer around Thailand. In the event of an urgent call from customer, the nearest available vehicle can be dispatched to the customer thus help in saving cost and providing a faster service.

2.8.7 Emergency/Distress Button

A button can be fixed in the vehicle for case of any emergencies or distress that could happen to the driver. The button can be activated in an emergency sending a emergency or distress signal to the administrator and immediate action can be taken to assist the driver.

2.8.8 Prevent of Abuse by Drivers

When the drivers of the vehicles are aware that the company is able to generate reports of their activities, psychologically the possibility of abuse will be reduced and directly or indirectly it helps the company to save cost in long the run.

The principle objective of this system is to create a long term preventive measure with the aim of promoting good driving habit and enhancing effective vehicle maintenance. In achieving this, saving will increased as expense decreased thereby creating a “WIN WIN” situation for both the company and the drivers in due course.

1. Try to reduce the fixed costs (by renegotiating rent for example, or keeping better control of telephone bills or other costs)
2. Try to reduce variable costs (the price it pays for the tables by finding a new supplier)
3. Increase the selling price of their tables.

Any of these would reduce the break even point. In other words, the business would not need to sell so many tables to make sure it could pay its fixed costs

2.9 SME Definition

The Ministry of Industry's (MoI) Dept. of Industrial Promotion (DIP) defines three different categories of SMEs:

1. Production Sector SMEs (includes agricultural processing , manufacturing , and mining).
2. Service Sector SMEs.
3. Trading Sector SMEs (includes wholesale and retail).

The production and service sectors SMEs are under the responsibility of the DIP while trading sector SMEs are under the responsibility of the Ministry of Commerce.

What is the definition of SMEs in Thailand? In the past, many authors have noted that there was no single definition of SMEs in Thailand (Nattapongetal, 1994 ; Allal, 1999b). Various agencies used different criteria such as sales per annum, net fixed assets, number of employees and registered capital (Allal, 1999b). While the employment definitions for SMEs in Thailand have remained the same since the late 80s (i.e. fewer than 200 employees) the assets definition have been upgraded to reflect changing economic conditions. For example, Nattapong et al (1994) reported that the Industrial Finance Corporation of Thailand (IFCT) and the Small Industry Finance Office (SIFO) relied on the net fixed assets criterion. Small enterprises were defined as those having fixed assets less than 10 million baht (US\$0.39 million) and a medium enterprise as one having between 10 and 50 million baht (or US\$1.9 million) in the early 90s. Up until 1998, the DIP defined medium enterprises as having employment ranging from 50 to 200 and invested capital from more than 10 million to 100 million Baht. On the other hand small enterprises were defined as having employment not exceeding 50 workers and having invested capital (equity) not exceeding 10 million baht (Manu. No date). These classifications have been used by MoI based on an internal agreement concluded among its divisions on December 1987 (UNICO, 1995).

On December 8, 1998, an unofficial meeting was organized by the MoI to review the definition of SMEs. It was attended by representatives from other Ministries, banks , agencies and departments, private sector and technical experts to arrive at a classification of enterprises bases on the value of fixed assets (Allal, 1999b). The Cabinet approved the following definition on December 22, 1998 that uses the net fixed assets as the only classification criterion (Table 2.6.1). The DIP representative that we interviewed assured us that this definition is accepted by all other government offices. Although we have not confirmed the general awareness of this current classification by other government agencies, particularly those dealing in funding aspects, we are inclined to believe that over offices will comply since the MoI is the designated lead agency under the fourth program of the Industrial Restructuring Plan, "Incubation & Strengthening of Small and Medium Supporting Industries".

Table 2.1 : Definition of SMEs by Total Assets Value: (Million Baht)

Sector	Medium	Small
Production	Not more than 200	Not more than 50
Service Trading	Not more than 200	Not more than 50
- Wholesale	Not more than 100	Not more than 50
- Retail	Not more than 60	Not more than 30

Source: The Institute for Small and Medium Enterprises Development

2.10 Related Research Study

Boonkajornkul (2010) report studied the GPS for Truck Tracking Business online. From her study, we could found that it is necessary to have the drivers perform the goods delivery so it is difficult to avoid human errors. For example, they might park the truck in a prohibited area or drive at an unsafe speed. Moreover, external factors could cause serious incidents. For example, what would be the cost of damage if the chemical tanker truck was involved in a fatal accident. This would have an immediate effect of the death of people in an area of 20 square kilometers. Now, the transporter would not only be concerned about the fleet utilization but also the safety and security of goods transportation. Therefore, it is a necessary and effective method to support fleet management for monitoring and keeping records in order to update the status of delivery or alert the controller and give driver the feedback or warning for their driving behavior. The report has defined the number of equipments concerned which includes the software of digital mapping system, GPS receiver and memory module. The number of outputs includes, various kinds of reports generated to measure the performance of driver. For example, the system would generate speeding report, idle report and daily report. These reports would assist the manager to monitor their driver accurately. Therefore, it can be said that GPS is essentially a transport management system that applies information technology and telecommunication. GPS would be the resolution of transport problems, such as safety, congestion, pollution and even infrastructure deterioration, and in so doing may provide policy makers, government, operators, industry and the general public with tools that will help them to meet their transport objectives more efficiently, cost-effectively and safety.

Chulaluck Yongkietpanich and Chatawuth Wannisan (2010) studied the use of radio communicated system and GPS that complied with taxi service “ They found that service user of GPS has age between 30-40 years old, worked as taxi driver for 1-3 years, had average income from 10,000 to 15,000 baht per month. Most of them have rent taxi for service and work on day time. A comparison between the two communication channels (Radio and GPS), shown that most of taxi driver has preferred to communicate by radio communicated system than GPS due to user friendly functions of radio communicated system. . Those who had selected GPS as the communication channel because they believed that GPS can prevent taxi from theft. The accuracy of the information and the intervention while losing way, the radio communicated system can provide the better information and rapid help than GPS. The usage amount, most of taxi drivers had selected to use radio communicated system than GPS, while taxi with GPS can have more customers than radio channel.

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But the Taxi with GPS had higher cost than radio communicated system. The issue of the radio communicated system, was taxi driver had ignored to use the device, they lost time to drive and search for customers. The issue of GPS user cannot understand the advised routings from center and was confused how to use the system at the beginning. The reason for using radio communicated system because it was law enforcement and the reason for using GPS because it had been installed by taxi owner as well as law enforcement.

Chu-ping Chi (2010) report studied the GPS for Information Website. From his study we found that The Sharp Direction could be one of the most popular sites among GPS/GIS users. Because of the changing environment and competition, this company has formed a lot of strategies to attract the customers. After analysis, the company knows its own weakness and threat, so it will have to form new strategies to cover those threats and weaknesses. The company also has some opportunities and strengths, so it will be much easier to form the new strategies. The Sharp Direction found out that there is only one way to win over the competition and stop the price war and it is the technology innovation. The company also found out that they will have to use the technology to make it easier for the customers to either express of information searching online. Developing GPS in tracking web site is a new strategy that we want to introduce our business to people in other parts of the world. Not only for those, who are new customers, but the system is also beneficial for existing customer. The proposed system will make it easier for our customers to track the product information. They can check the availability of the product or finding out the nearest equipment dealers around them.

Chavalit Tipakonwong (2009) set up the research titled “ The service of taxi with GPS system for recording travel time within Bangkok area”. The result found that the average speed of taxi was about 489 km per day. The service routes for them were main roads, secondary roads, alleys and express way. But form the assessment of the ability of the GPS receiver, found most of them have used main road. Sample was 5 taxi drivers and period of data collection was 30 days. There were seven main roads chosen for the study. Wattana District was the area that can receive the best GPS signal, followed by Din Dang, Hauy Kwang . Rajthevee, Patumwan, Klong Toey and Phayathai Districts, respectively. The area with bad signal was roads that surrounded by high buildings, roads under the Mass Rapid Transit stations and roads inside the tunnels. The results showed traffic jams during rush hour on work days, morning and evening time and daytime on the holidays.

Putthapornmongkol (2009) report studied the Application of Global Positioning System with Dangerous Goods Delivery. From his study, we could say that dangerous goods transportation needs serious management in order to provide the ultimate safe delivery. Many kinds of chemicals need a special and different method of handling. In the past, we had tried to monitor behavior of drivers by TACHOGRAPH but once delivery was completed it could not be done. However, currently, by the application of Global Positioning System (GPS) applied in business we have the solution for development of dangerous goods transportation management. Therefore, GPS will be major source of innovation in the positioning filed. The demand of GPS for accurate, precise, robust, wide area positioning will prompt many developments. Therefore GPS will be an important part of the project of GPS application.

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Qiu and Ran (2008) The paper attempts to provide real-time traffic states by analyzing information about hand-off or hand-over times of a cell phone and tries to estimate the speed of the mobile device by applying KF techniques. The method assumes the cell phones are already in “auto” mode and uses location determination method based on the locations of cell towers which generally produces unreliable speed information in its raw format. Instead of applying filtering techniques to the inaccurate information in order to improve the quality, the cell phone service providers can remotely activate the embedded GPS chips in cell phones and query the speed information directly to the chips instead of querying hand-off times

Tsui and Shalaby (2008) In order to use GPS data for traffic monitoring purpose, one needs to identify the mode of transportation first and use the data only if they are from the “auto” mode that refers to private automobiles. Tsui and Shalaby post-processed GPS trip data and they were able to identify the transportation mode the GPS data logger was in. They applied fuzzy-logic based mode identification algorithm against multiple days’ amount of GPS trip data. The challenge in real-time traffic monitoring is to achieve similar results from relatively short trace of GPS data in shorter amount of time.

Guo et al (2007) The paper recognizes that there are new approaches of traffic data collection (monitoring) methods emerging that can be grouped into one category known as “link monitoring systems”. Such systems “mine” location data from existing infrastructure (such as cellular telephone networks or fleet management systems) to estimate link speeds and travel times. However, they are generally developed and operated by private firms, who then seek to sell the data to transportation agencies. The paper presents a link monitoring system evaluation procedure in order to help transportation agencies make sound purchasing decisions. Authors contribute to the field by developing an evaluation scheme for traffic monitoring systems mainly focusing on the output data regardless of the specific technologies the data are produced from.

.From the all above mentioned research studies can be summarized that many organizations or businesses have GPS tracking devices placed on their vehicle to monitor. Using GPS has potential to shorten the period of time and time consuming, while at the same time improving data quality and reducing cost and expense. Also provide driving behavior information to decrease accident and road safety.

Chapter 3

Research Methodology

3.1 Research Methodology

In-depth interview and distribute questionnaire had been used in this study as follows :

3.1.1 Interview

Researcher had an in-depth-interview 3 SME entrepreneurs in order to gain understanding about GPS and bring information to design a questionnaire.

3.1.2 Questionnaire

Samples used for this research were 30 SME entrepreneurs, who had installed GPS machines in their trucks and have been used for logistic works. Researchers selected samples by using a convenience sampling method.

Tools used for the research

3.2 Tools

Researchers have checked and monitored researched tools with the following steps :

1. Designed questionnaire and its items combined with 2 parts, then sent to thesis advisors for verifying and corrected for an appropriated items.

Tools used in this research was a 30 set of questionnaire, consisted with two parts as follows:

Part 1: General data of Entrepreneur / operator.

Part 2: Factors that affect the buying decision for GPS machine used for truck of SME business.

2. An approved questionnaire has been rechecked by sending to qualified assistance to examine the Content validity and the language has been used for questionnaire for the final revision.

3. Fifteen Sets of Questionnaire have been distributed to respondent to test the reliability the result of reliability measurement was 0.78.

3.3 Data Collection

Researcher has distributed questionnaire to 30 SME entrepreneurs and got response back 100%

3.4 Data Analysis

Researchers have analyzed data by using SPSS program. This study is the descriptive analysis and collected data by using questionnaire. Data has been analyzed by using Statistics Package for Social Science or SPSS. Data has been analyzed and followed by the objectives of this study. The statistics used for data analysis were frequency distribution, percentage, mean, standard deviation. T-test has been used to test the difference of average variable. Research hypothesis has been tested with the statistical significance at 0.05 level

Researcher has used rating scale with 5 levels (Rating scale) as follows : Most importance , very important, average, less important and least important with the score range as follows:

Most important	5	rating score
Very important	4	rating score
Average	3	rating score
Less important	2	rating score
Least important	1	rating score

The score was calculated for Arithmetic Mean with the frequency of each score range formula

$$\bar{X} = \frac{\sum fx}{N}$$

Which

- \bar{X} = Weighted average.
- f = Frequency
- X = The important score
- n = Number of respondents.

Then researcher has used weighted means to identify the rank of score by using the criteria of opinion rating by calculating from the width of the interval from the following formula.

$$\begin{aligned} \text{The width of the interval} &= \frac{\text{the maximum score} - \text{the lowest score}}{\text{number of interval}} \\ &= \frac{(5 - 1)}{5} \\ &= 0.8 \end{aligned}$$

The average score rang as follows :

<u>Average score</u>	<u>Level of important</u>
4.21 to 5:00	Most importance
3.41 to 4.20	very important
2.61 to 3.40	Average
1.81 to 2.60	Less important
1.00 to 1.80	Least important

In addition, the researcher has used T-test for the statistical hypothesis test, the difference of the proportion of data from Quantitative statistics, to test the differences between the groups who has gained benefits from using GPS, the transit routes used for goods transportation has been tested by using T-test with statistically significant at the 0.05 level.

Researcher used t-test to analyze the statistical data because the researcher wanted to know the variables as follows: costs and expenses, work safety, time and product safety and how those factors effect to GPS installation and usage. Therefore T-test can help to find answer for the question specified in the research assumption.

3.4 Research Tools Measurement

The research has measured the questionnaire for its Validity and Reliability as follow :

1. Validity measurement by sending the questionnaire to 3 experts for evaluation and verification.

The calculation for IOC has been completed by using formula (Manee Boonyaditsai, 2548: page 79) as follow :

$$IOC = \frac{\sum R}{N}$$

IOC refer to Index of congruence

R refers to the opinion of experts by +1 refers to the item was valid, 0 refers to uncertain and - 1 refers the item was invalid.

N refers to the number of experts.

Researcher selected items with IOC more than 0.5 to be used as research items on questionnaire form the measurement with experts. The result has shown the validity of items and covered all aspects and objective of research. Researcher tested items from questionnaire to verify its validity by using IOC that must not under 0.5 on each item.

2. Reliability measurement

Researcher set up pretest with the respondent who has similar characteristic with sample group for 30 persons. Item Analysis has been used to determine the confidence level by formula (Manee Boonyaditsai, 2548: page 79) to clarify the items. The acceptance criteria was more than 0.70 to prove the sufficient confidence level of questionnaire by using Program SPSS to calculate the Reliability using order.

Analyze ⇒ Scale ⇒ Reliability Analysis

Table 3.1 The Reliability on Each Factor

Factor	Items amount	Reliability value
Transportation cost and expense	5	0.82
Time	8	0.78
Work safety	8	0.76
Total factor	21	0.79



Chapter 4

Results

4.1 Interview

The researcher has interviewed 3 SME entrepreneurs who installed GPS for their trucks. The result of interview as follows :

Case Study

4.1.1 Case 1

The researcher interviewed the SME entrepreneurs or called Company A who runs a food and beverage business with 30 employees

Company has been the SMEs business for 2-3 years company A has run its business by providing logistic service to their customers. Company has produced and delivered products such as snack, candy, cracker, biscuits and bun to the grocery shops of their customers within Bangkok . Company has income about 100,001 to 200,000 baht per month. Company has the authorized capital less than 10 million bath.

Company has 3-4 trucks used for delivery products in the morning to grocery shops which has located around Bangkok more than 10 branches per day. The reason that company decided to install GPS to their trucks because company need to know the vehicle performance for the calculation of the most economic distance. The issues that company has faced before GPS installation were the delay of products delivery, staff used vehicle for their private matters that made company loss of time and cost. Finally, the last issue was new driver has not recognized the delivery route to the grocery stores. After GPS installation to their trucks, company can solve all those issues.

It can be commented that the installation method of GPS at the most cost saving route for delivery goods by calculating the distance, amount of goods to delivery each time, goods arrangement by avoiding the damage of them, the cycle of fuel filling by saving time and cost.

4.1.2 Case 2

The researcher interviewed the SME entrepreneurs or called Company B who has run the SME business for 9-10 years. Company has income more than 300,000 baht per month. Company has run wholesale and retail furniture business. Company has produced and delivered products such as table, chair (office and household design) to their customers. Company has employed 40 employees. Company has the authorized capital less than 10 million bath. Company has 3 trucks used for delivery products to customers who have lived within the rural area as the retail shops. Customer who is wholesaler will receive products from company's factory. The reason for GPS installation and using were the company can protect the issue of misused vehicle, shorten time for coordinate with assistant team in case accident occurred, reduced the fraud occurred in transportation and reduced the cost and expense of transportation. GPS can help company to reduce the cost of fuel and other expenses.

The issues that company has faced before GPS installation were the delay of staff used vehicle for their private matters, used company fuel cost for their private cars, delay of product delivery due to driver cab not recognized the delivery routes. After GPS installation to their trucks, company can solve all those issues.

It can be suggested that the cash allowance system for fuel filling , rigidly check of GPS record on each month according to the delivery route therefore this can controlled driver not to use company's vehicle for private matter.

4.1.3 Case 3

The researcher interviewed the SME entrepreneurs or called Company C who runs SME business for 5 years as machinery tools and equipment importer and distributor. Company has income more than 300,000 baht per month. Company has the authorized capital less than 10 million bath.

Company has delivered their product to customer within Bangkok and rural area. .Company has employed 11 employees. Company has sold and distributed second handed machinery tools and equipment which has been imported from oversea. Those products are Steel pressing machine. Steal cutter, Industrial Drills and etc. Company has 3 trucks used for delivery products to customers who have lived within the rural area.

The reason for GPS installation were the company can protect the issue of misused vehicle, shorten time for coordinate with assistant team in case accident occurred, reduce the fraud occurred in transportation and reduced cost and expense of transportation. GPS can help company to reduce the cost of transit of empty vehicle (without products), reduced overtime cost. The use of GPS help to improve the effective transit routing, reduces cost of fuel and other expense.

The issues that company has faced before GPS installation were the delay of product delivery because the different direction of routing to company customers therefore company had to pay fines for late arrival. Moreover staff used vehicle for their private matters that made the severity of product delivery issues.

It can be commented that the entrepreneurs to install GPS with all company's cars such as truck received goods from supplier included the entrepreneurs should provide route checking on each truck per month.

From these interviews with the entrepreneur from all three companies, the results show GPS installation can help to reduce production cost and transit costs, saves transit time and reduce any loss or damage of products while transportation. Finally GPS increase the safety for products transportation.

4.2 Questionnaire

Data was collected from a questionnaire distributed to SMEs entrepreneur within Samut Prakan area who has installed GPS machines for their trucks. The survey data are as follows :

4.2.1 General Data of SMEs Operators

Table 4.1 The Percentage Frequency on Each Business

Business type	Amount	Percentage
Food and drink	8	26.67
Textile and apparel	4	13.33
Furniture	4	13.33
Chemical and chemical product	3	10.00
Construction tool and equipment	6	20.00
Electrical and electronic	3	10.00
Machinery and equipment	8	26.67
Others (Please specify).....	2	6.67

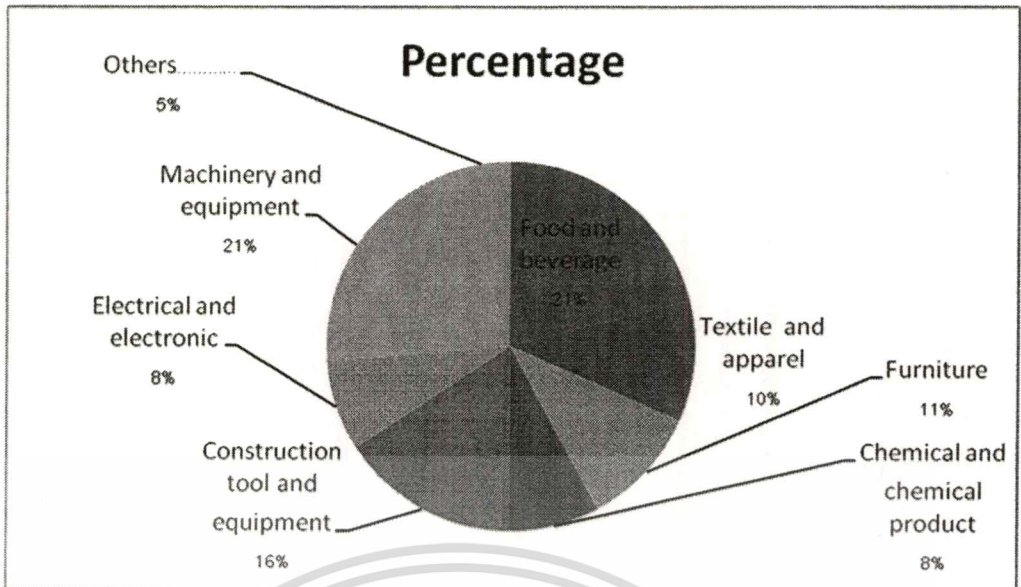


Figure 4.1 The Percentage Frequency on Each Business

The results from table 4.1 and figure 4.1 show that most SME entrepreneurs run a business of food and drink and industrial machinery and equipment for 8 companies or 26.67 percent, followed by the construction equipment and material for 6 persons or 20.00 percent.

Table 4.2 Business's Revenue Per Month

Average revenue per month	Amount	Percentage
100,001 – 200,000 Bath	5	16.67
200,001 – 300,000 Bath	17	56.67
Over 300,000 Bath	8	26.67

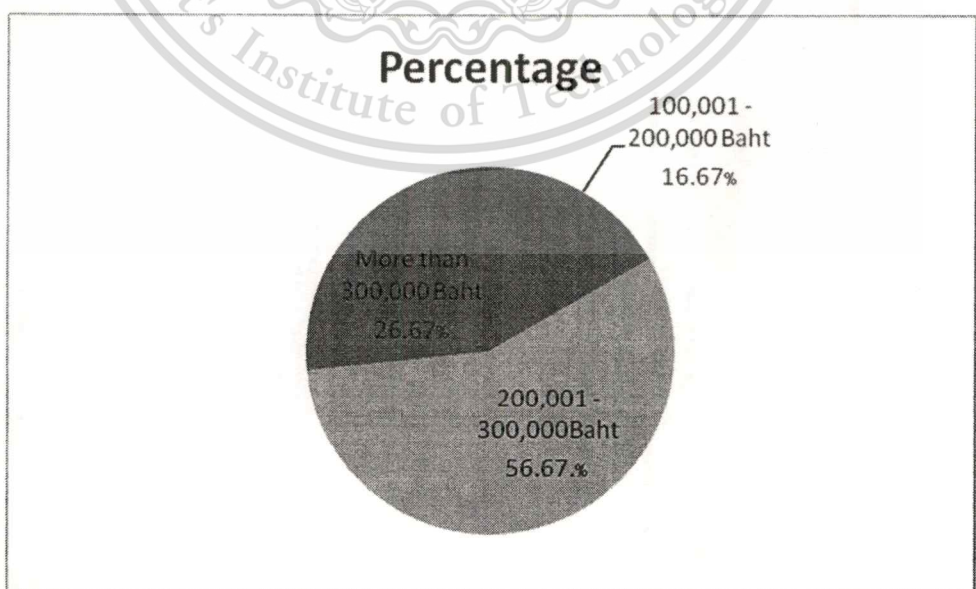


Figure 4.2 Business's Revenue Per Month

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The results from table4.2 and figure4.2 show that most households have a monthly income about 200,001 to 300,000 per month for 17 companies or 56.67 percent, followed by more than 300,000 bath for 8 companies or 26.67percent.

Table 4.3 The Authorized Capital of SMEs

authorized capital of SMEs	Amount	Percentage
Less than 10 million baht	30	100

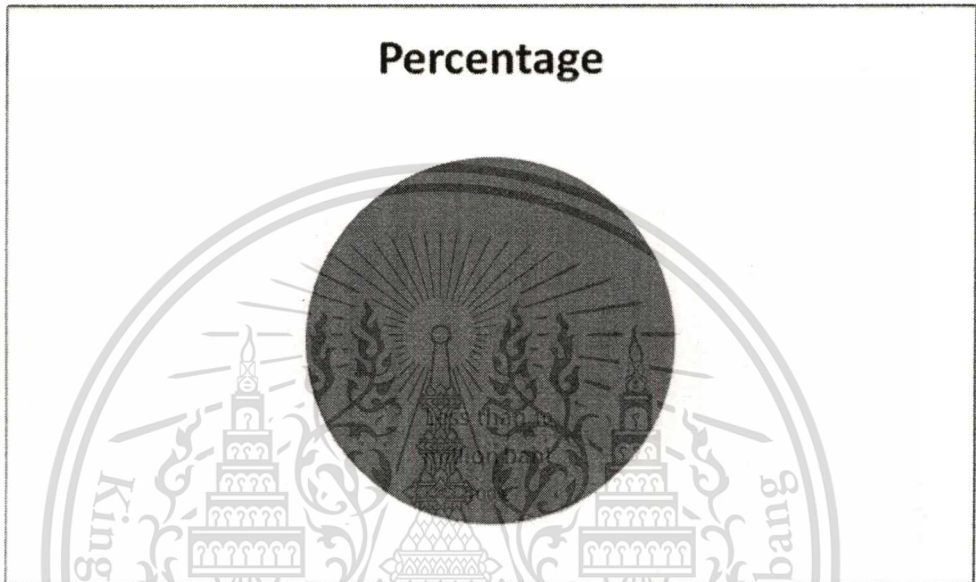


Figure 4.3 The Authorized Capital of SMEs

The results from table4.3 and figure4.3 show that SMEs with registered capital less than 10 million bath for 30 companies or 100 percent.

Table 4.4 The Number of Trucks Which Have GPS Installed for Their Delivery Service

the number of trucks which have GPS installed	Amount	Percentage
1 – 2 vehicles	16	53.33
3 – 4 vehicles	14	46.67

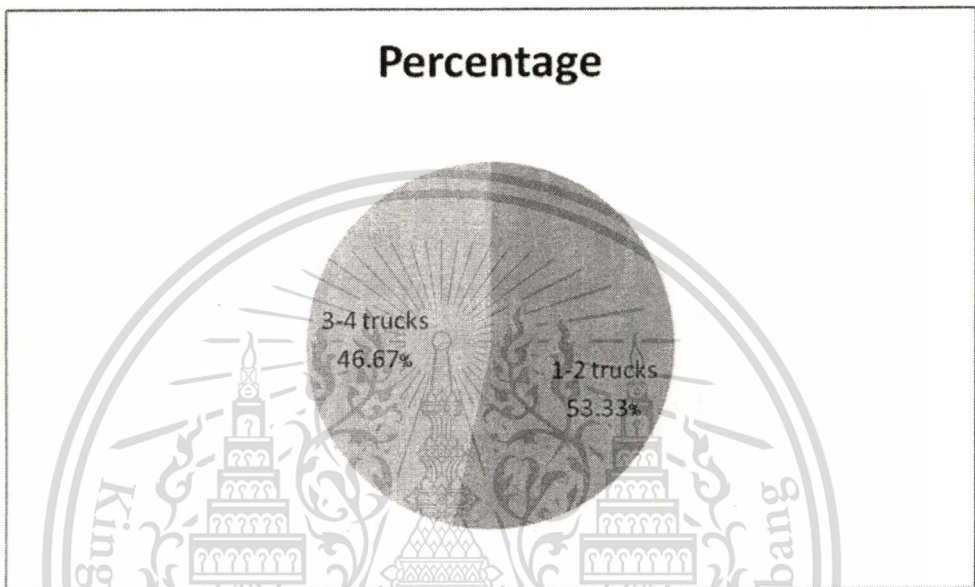
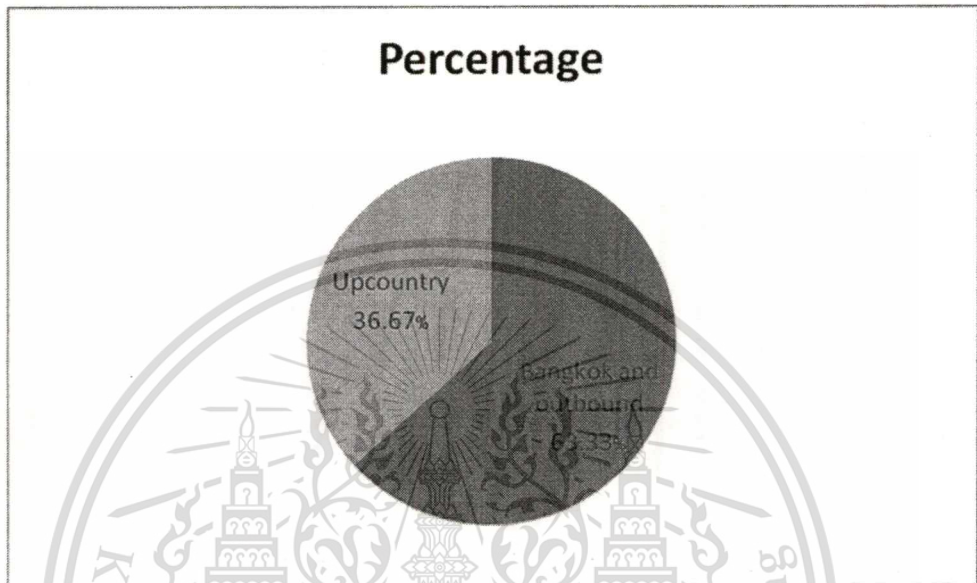


Figure 4.4 The Number of Trucks Which Have GPS Installed for Their Delivery Service

The study from table4.4 and figure4.4 found that SME operators of 16 companies have installed GPS in about 1-2 of their trucks or 53.33 percent followed by 3-4 trucks for 14 companies or 46.67 percent.

Table 4.5 The Products Delivery Routes

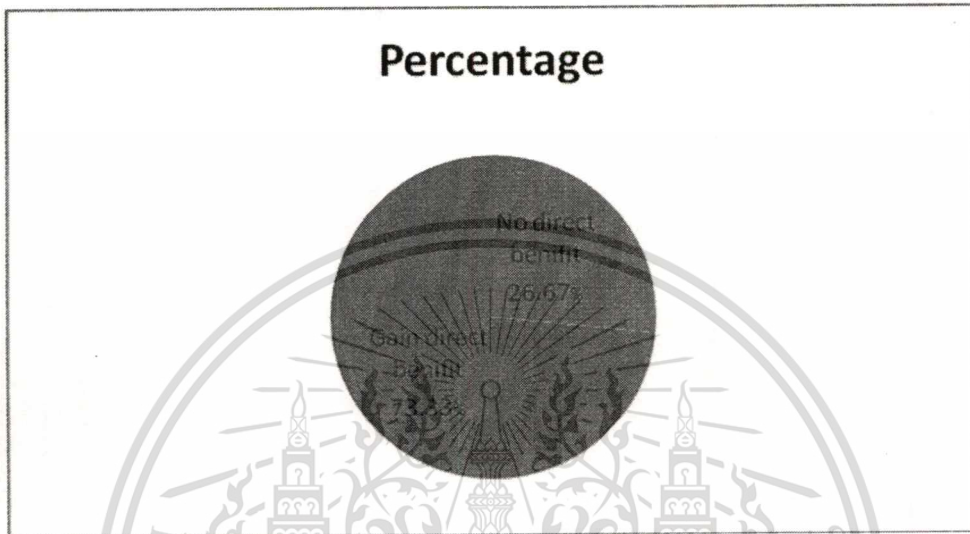
products delivery routes	Amount	Percentage
Bangkok and outbound	19	63.33
Upcountry	11	36.67

**Figure 4.5** The Products Delivery Routes

The results from table4.4 and figure4.4 show that most SME entrepreneurs used products delivery route within Bangkok and outbound for 19 companies or 63.33 percent, followed by the upcountry for 11 companies or 36.67 percent.

Table 4. 6 GPS Is Useful for Reducing The Cost in Term of Time and Safety

GPS is useful for reducing the cost in term of time and safety governance	Amount	Percentage
None of direct benefit	8	26.67
Direct benefit	22	73.33

**Figure 4.6** GPS is Useful for Reducing The Cost in Term of Time and Safety

The results from table4.6 and figure4.6 show that a SME entrepreneurs had found the direct benefit of GPS for reducing the cost in term of time and business safety for 22 companies or 73.33 percent followed by. SME entrepreneurs had not found the direct benefit of GPS for reducing the cost in term of time and business safety for 8 companies or 26.67 percent.

4.3 Factors Affecting GPS Implementation for Truck Tracking

H1: Factors such as cost, time, safety have associated with the GPS usage for the management or not ?

Table 4.7 Factors Effect to Cost Saving with GPS Usage in Term of Cost and Expense has Shown in Mean (\bar{x}) and The P-value for Testing The Differences of the Average Level.

Factors effect to cost saving with GPS usage	No direct benefit n = 8	Direct benefit n = 22	p-value
In term of cost and expense	2.8 (0.56)	3.78(0.88)	0.007*

* Significant at the 0.05 level.

The study found that factors such as cost and expense directly related to the use of GPS in gain benefit with the significant at 0.05 level.

Table 4.8 Factors Effect to Cost Saving with GPS Usage in Term of Time has Shown In Mean (\bar{x}) and The P-value for Testing The Differences of the Average Level.

Factors effect to cost saving with GPS usage	No direct benefit n = 8	Direct benefit n = 22	p-value
In term of time	3.09(0.48)	3.71(0.69)	0.029*

* Significant at 0.05 level

The study found that time directly related to the use of GPS in gain benefit with the significant at 0.05 level.

Table 4.9 Factors Effect to Cost Saving with GPS Usage in Term of Safety has Shown in Mean (\bar{x}) and the P-value for Testing the Differences of the Average Level.

Factors effect to cost saving with GPS usage	No direct benefit n = 8	Direct benefit n = 22	p-value
In term of safety	3.82(0.37)	3.85(0.36)	0.822

The study found that safety no directly related to the use of GPS in no direct benefit with the significant at the 0.05 level.

From the hypothesis test , the results show that GPS is useful for reducing the cost and expense , time including safety. The conclusion of hypothesis test (H_1) result displays in **Table 4.10**

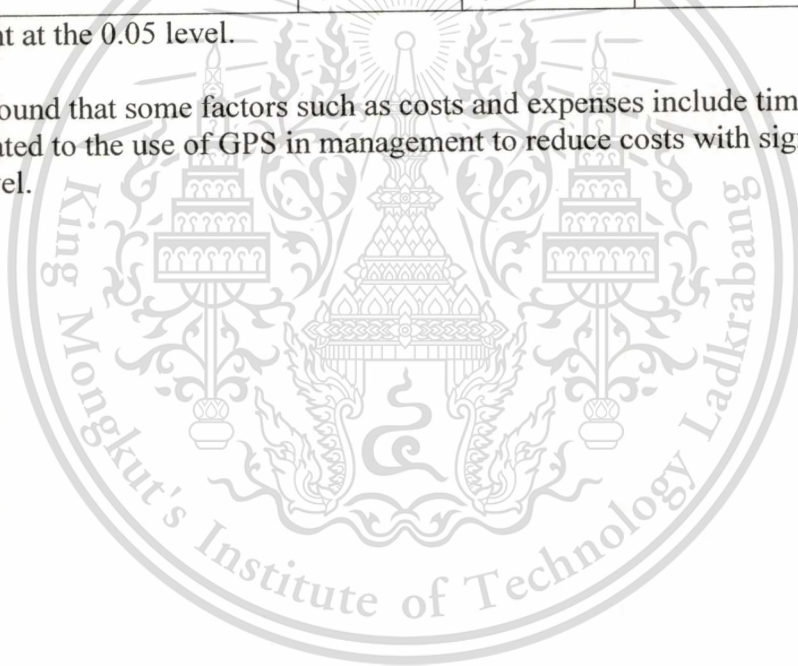
H_1 : factors such as time cost and safety business administration has associated with the use of GPS in the administration or not.

Table 4.10 Mean(\bar{x}) and the P-value for Testing the Difference of the Level Average

Factors affecting the reduction of costs by using GPS	No direct benefit n = 8	Direct benefit n = 22	p-value
Cost and expense	2.8 (0.56)	3.78(0.88)	0.007*
Time	3.09(0.48)	3.71(0.69)	0.029*
Safety	3.82(0.37)	3.85(0.36)	0.822
Total	3.24(0.47)	3.78(0.64)	0.286

* Significant at the 0.05 level.

The study found that some factors such as costs and expenses include time has directly related to the use of GPS in management to reduce costs with significant at the 0.05 level.



Chapter 5

Conclusions and Recommendations

GPS for truck tracking. The purpose of this research is to suggest way to set up and development the truck tracking management of Transportation for SMEs by using GPS(Global Positioning System) with the following goals for reduce the problem in goods transportation in one way transportation, reduce the period of time in one trip transportation, reduce the company's capital, arrangement real time in transportation and keep data record and improve road safety and security for Good delivery. Learning GPS using method will help the company in future site map for competitive and performance in Thailand logistic system.

Tools used in this research was a questionnaire for 30 sets consist of two parts as follow :

Part 1: General data of Entrepreneur / operator.

Part 2: Factors that affect to the buying decision for GPS machine used for truck of SME business.

The scope of the study, the researchers conducted a study by interviewing 30 SME entrepreneurs with 100% of methodology accuracy. Data has been analyzed by using descriptive statistics and statistical analysis has been made in form of frequency and percentage. Data has been tested by t-test.

5.1 Conclusion

The results show that most SME entrepreneurs run business of food and drinks and industrial machinery and equipment for 8 companies or 26.67 percent.

Most SME entrepreneurs have monthly income about 200,001 to 300,000 per month for 17 companies or 56.67 percent.

Most SME operators for 16 companies have installed GPS in about 1-2 of their trucks or 53.33 percent.

Most SME entrepreneurs used products delivery route within Bangkok and outbound for 19 companies or 63.33 percent.

Most SME entrepreneurs had found the direct benefit of GPS for reducing the cost in term of time and safety governance for 22 companies or 73.33 percent.

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From the interviews show that most SME entrepreneurs used the GPS for their commercial purpose because they cannot know that the drivers may use company vehicle for their own personal matters or not. Because the use of company truck for driver's personal purpose may increase the delivery cost, time and risk to product safety. Therefore the GPS installation with company trucks may control the unnecessary cost. GPS can report routing that cars / trucks have been deployed, however most SME entrepreneurs have an opinion about the high price of GPS installation. Small enterprises did not install GPS while the medium sized business require their commercial vehicles and realize the importance of the GPS usage as one function to control their operational cost. Therefore most of medium size business has installed GPS in the higher volume than before.

From Case 1 the company runs food and beverage business with income about 100,001 to 200,000 baht per month. Company has the authorized capital less than 10 million bath. Company has 3-4 trucks used for delivery products in the morning to grocery shops which has located around Bangkok more than 10 branches per day. The reason that company decided to install GPS to their trucks because company need to know the vehicle performance for the calculation of the most economic distance.

The issues that company has faced before GPS installation were the delay of products delivery, staff used vehicle for their private matters that made company loss of time and cost. Finally, the last issue was new driver has not recognized the delivery route to the grocery stores. After GPS installation to their trucks, company can solve all those issues. Researcher recommended the installation method of GPS at the most economic route for delivery goods by calculating the distance, amount of goods to delivery each time, goods arrangement by avoiding the damage of them, the cycle of fuel filling by saving time and cost.

Company from case 2 runs wholesale and retail furniture business. Company has 3 trucks used for delivery products to customers who have lived within the rural area as the retail shops. Customer who is wholesaler will receive products from company's factory. The reason for GPS installation and using were the company can protect the issue of misused vehicle, shorten time for coordinate with assistant team in case accident occurred, reduced the fraud occurred in transportation and reduced the cost and expense of transportation. GPS can help company to reduce the cost of fuel and other expenses.

The issues that company has faced before GPS installation were the delay of staff used vehicle for their private matters, used company fuel cost for their private cars, delay of product delivery due to driver cab not recognized the delivery routes. After GPS installation to their trucks, company can solve all those issues. Research suggested the cash allowance system for fuel filling ; rigidly check GPS record on each month according to the delivery route therefore this can controlled driver not to use company's vehicle for private matter.

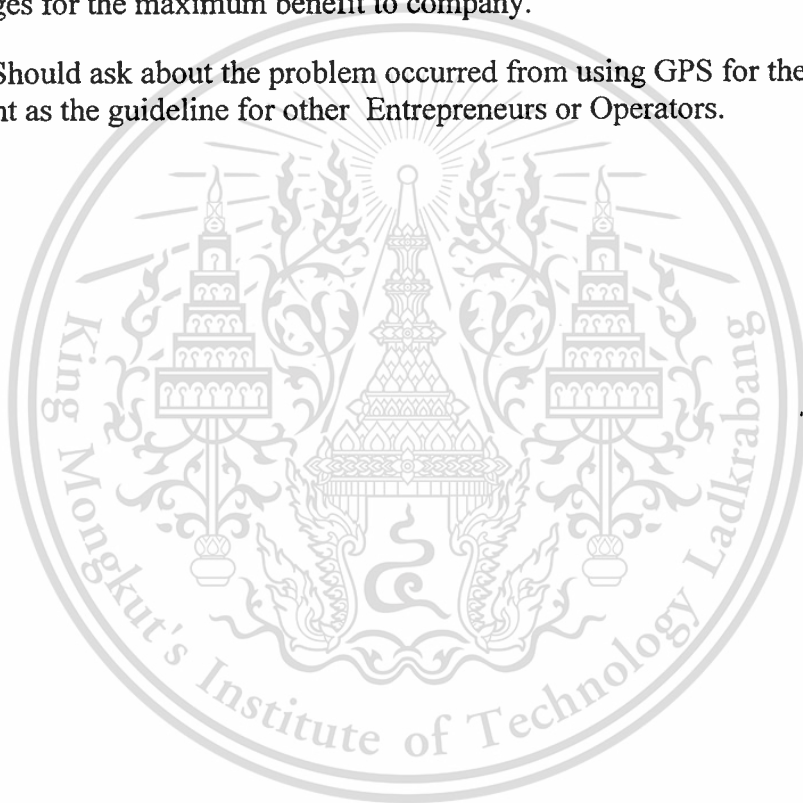
The company from case 3 runs SME business as machinery tools and equipment importer and distributor. Company has 3 trucks used for delivery products to customers who have lived within the rural area. The reason for GPS installation were the company can protect the issue of misused vehicle, shorten time for coordinate with assistant team in case accident occurred, reduce the fraud occurred in transportation and reduced cost and expense of transportation. GPS can help company to reduce the cost of transit of empty vehicle (without products), reduced overtime cost. The use of GPS help to improve the effective transit routing, reduces cost of fuel and other expense.

The issues that company has faced before GPS installation were the delay of product delivery because the different direction of routing to company customers therefore company had to pay much fine for late arrival. Moreover staff used vehicle for their private matters that made the severity of product delivery issues. Researcher recommended the entrepreneurs to install GPS with all company's cars such as truck received goods from supplier included the entrepreneurs should provide route checking on each truck per month.

About the test the of hypothesis, result shown that production cost and time cost has directly related to the use of GPS for reducing costs with significant at 0.05 level which supported Case1 (Company A). The company declared the reason for installation GPS because company need to know the vehicle performance for the calculation of the most economic distance. The issues that company has faced before GPS installation were the delay of products delivery, staff used vehicle for their private matters that made company loss of time and cost. Finally the last issue was new driver has not recognized the delivery route to the grocery stores. After GPS installation to their trucks, company can solve all those issues. The feedback from Company A has supported the result from Case 2 (company B). Company has trucks used for delivery products to customers who have lived within the rural area for retail shop. Customer who is wholesaler will receive products from company's factory. The reason for installation of GPS were the company can protect the issue of misused vehicle, shorten time for coordinate with assistant team in case accident occurred, reduce the fraud occurred in transportation and to reduce the cost and expense of transportation. GPS can help company to reduce the cost of fuel and other expenses.

5.2 Recommendations and Future Work

1. The study found that the GPS can help SMEs to actually reduce costs. Therefore, entrepreneurs can use GPS as an alternative method to reduce their costs which can help to save costs, expense and time.
2. Business has used GPS to reduce costs in many industries therefore entrepreneurs can reduce their costs by comparing with their competitors and partners at same industry in term of business value by using GPS for their trucks.
3. Should provide a comparative study between the cost of installing GPS with other approaches for cost management both in term of advantages and disadvantages for the maximum benefit to company.
4. Should ask about the problem occurred from using GPS for the transit cost management as the guideline for other Entrepreneurs or Operators.



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Questionnaire

The study of factors that affect to the decision of GPS (Global Positioning System) used by SMEs operators.

This questionnaire aimed to identify factors that affected to the Global Positioning System (GPS) installed in trucks of SMEs operators. This questionnaire has been compiled by a researcher who is a student of Master Degree, An International Program, Logistics and Supply Chain Management of King Mongkut's Institute of Technology Ladkrabang.

I would like to ask your participation to complete this questionnaire and certify that the information obtained here will be used only for educational purposes without other utilizations or disclosure under any circumstances. I would like to thank you for your participation.

Eknnarin Jinsawat

Please mark / into the () in front of the heading which best describes your business.

Part 1: Overview of the SMEs operator

1. Types of businesses.

- | | |
|--|---|
| <input type="checkbox"/> Food and beverage | <input type="checkbox"/> Textile and apparel |
| <input type="checkbox"/> Furniture | <input type="checkbox"/> Chemical and chemical product |
| <input type="checkbox"/> Construction tool and Equipment | <input type="checkbox"/> Electrical and Electronic |
| <input type="checkbox"/> Machinery and equipment | <input type="checkbox"/> Others (please specified): |

2. Average income of the business per month

- | | |
|---|---|
| <input type="checkbox"/> From 100,001 to 200,000 Baht | <input type="checkbox"/> From 200,001 to 300,000 Baht |
| <input type="checkbox"/> More than 300,001 Baht | |

3. Authorized capital of SMEs.

- | | |
|---|--|
| <input type="checkbox"/> Less than 10 million | <input type="checkbox"/> From 10 to 50 million |
| <input type="checkbox"/> More than 50 million | |

4. How many company trucks have been installed with GPS for transportation service ?

- | | |
|-------------------------------------|--|
| <input type="checkbox"/> 1-2 trucks | <input type="checkbox"/> 3 - 4 trucks |
| <input type="checkbox"/> 5-6 trucks | <input type="checkbox"/> More than 7 trucks. |

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5. Which is the main service route regularly used for delivery to your customers?

Bangkok and outbound

Upcountry

6. Would you agree that GPS is useful for reducing time, cost and can bring safety to your business?

No direct benefit

Gain direct benefit



Part 2: Please indicate the factors that would affect your decision to install a GPS system into your truck transportation of the SMEs business

The level of importance	Most important (5)	Very important (4)	Average (3)	Less important (2)	Least important (1)
Cost and expense					
1) GPS can reduce and control the cost of fuel and other expenses.					
2) GPS can define the effective transportation route.					
3) GPS reduces the overtime cost					
4) GPS can fix problem of non goods vehicle					
5) GPS reduces the damage of goods caused by the transportation.					
Time					
6) Operators can plan and calculate the most appropriated route to shorten the transit time					
7) GPS helps to identify the traffic intensity					
8) GPS helps to deliver goods on time					

The level of importance	Most important (5)	Very important (4)	Average (3)	Less important (2)	Least important (1)
9) GPS can track the location and current status of the truck					
10) GPS can ease the communication between staff and drivers					
11) GPS reduces the procedure for the documenting.					
12) GPS provides the full capacity of vehicle.					
13) GPS improves the quality of customer services and increase the business competitiveness.					
Security					
14) GPS can prevent car from being stolen.					
15) GPS can prevent the misuse of vehicle					
16) GPS can monitor the position and status of the truck					

The level of importance	Most important (5)	Very important (4)	Average (3)	Less important (2)	Least important (1)
17) GPS can investigate the behavior of the driver during service.					
18) GPS can coordinated and timely assistance as accident may be occurred .					
19) GPS can control and the limit the speed of trucks					
20) GPS can reduce fraud during transit					
21) GPS can store data and retrieve the stored data.					

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