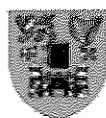




The University of Dublin
Trinity College



JUSTIFICATION FOR THE IMPLEMENTATION OF CITYWIDE GPS SYSTEM

BY
ADIL KHAN JADOON

UNDER SUPERVISION OF
DR. MARGARET O' MAHONY

SUBMITTED TO DEPARTMENT OF CIVIL, STRUCTURAL AND
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DEDICATION

*I dedicate this success to my respectable teacher
Prof. Ahmed Rafiq Akhtar who gave me the real sense
of knowledge and set my priorities.*

DECLARATION

This dissertation is submitted in partial fulfilment of the course requirement for the degree of Master of Science in Civil Engineering.

I declare that this thesis, in whole or in part, has not been submitted to any University as an exercise for a degree. I further declare that, except where reference is given in the text, it is entirely my own work.

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A handwritten signature in dark ink, appearing to read 'Adil Khan Jadoon', is written over a horizontal line.

Adil Khan Jadoon

October 2003.

ABSTRACT

Over the past few years, there has been an increase in the use of telematics in Demand Responsive Transport like taxis, so as to maximize the ever-increasing demand. To provide better customer service in the competitive taxi business, use of telematics becomes ever more important. In Dublin, National Radio Cabs uses satellite based Global Positioning System to dispatch and monitor its taxi fleet. The research work presented in this thesis looks at the Global Positioning System data provided by National Radio Cabs in terms of customer waiting times, effect on number of dispatches, travel time duration and customer waiting time ratio. The thesis looks at the improvements in these transport variables so as to justify the implementation of Global Positioning system on citywide basis. Average CWT varies between 5-34 minutes as compared to 20-45 minutes. Average travel time is approximately 21 minutes between 6 a.m. and 10 a.m. and average travel time in the evening is 25 minutes between 3 p.m. and 7 p.m. Average travel time is approximately 22 minutes at any time of the day. Average taxi dispatches are 1411 per day as compared to 700 before using GPS. Average CWT ratio is 0.37.

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ABBREVIATIONS

CAD	Computer Assisted Dispatching
CWT	Customer Waiting Time
DDS	Digital Dispatch Systems
DGPS	Differential Global Positioning System
DRT	Demand Responsive Transport
DOD	Department of Defence
DOP	Dilution of Precision
ESA	European Space Agency
FCD	Floating Car Data
GCC	Galileo Control Centres
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GSS	Galileo Sensor Stations
GSTB	Galileo System Test Bed
IVR	Interactive Voice Response
LBS	Location Based Services
MBH	Manganese Bronze Holdings
MEO	Medium Earth Orbit
MVPN	Mobile Virtual Private Network
NAVSTAR	NAVigation System With Time And Range
NRC	National Radio Cabs
PPS	Precise Position Service
RTL	Radio Taxis Limited
SA	Selective Availability
SAR	Search and Rescue
SMS	Short Message Service
SPS	Standard Position Service
TT	Travel Time
VHF	Very High Frequency
WAP	Wireless Access Protocol

CHAPTER ONE

INTRODUCTION

1 INTRODUCTION

1.1 BACKGROUND

Taxis and hackneys play an essential part in the economic development of any nation and provide an essential complement to the smooth operation of public transit services. The use of new and innovative technologies to maximise the output of the existing facilities with growing demand becomes important. By December 2001, there were 9900 cabs in all (Goodbody Economic Consultants, 2001) in Dublin. Due to the increase in number of cabs, National Radio Cabs (NRC) took a step forward and invested in satellite based GPS (Global Positioning System) technology for growth and development in late 2000. It currently operates a fleet of over 440 taxis (NRC, 2003). NRC uses GPS system to dispatch and monitor its taxi fleet.

1.2 OBJECTIVE AND THESIS STRUCTURE

Chapter 2 introduces with the scenario of taxis and hackneys in Dublin with light on NRC. The chapter further gives the description of Satellite Navigational Systems currently in use. Finally it provides examples from different countries on how different taxi companies are using GPS based taxi dispatch system.

The objective of this project was to analyse the GPS data provided by NRC. Originally the taxi operators (NRC) had promised GPS data so that routing, location, etc could be examined but the taxi operators did not provide with enough data that was necessary to analyse the demand for taxis and to investigate the variables driving that demand.

Moreover GPS based dispatch facility of NRC is also used by another cab operators called Trinity Cabs. Since Trinity Cabs used this facility, it benefited Trinity Cabs in terms of transfers of taxis within the companies, financial savings and savings in

administration cost; therefore, these benefits could have been extrapolated to justify the citywide use of GPS system.

But due to limited availability of data provided, the results obtained may not be strong. The objective of this project was then limited to analyse the GPS data in terms of customer waiting times, effect on number of dispatches, customer waiting time ratios and travel time duration. Chapter 3 describes the calculations of this data. Also included in this chapter are daily profiles of customer waiting time, number of dispatches and travel time duration. In Chapter 4, discussion of the results is described. Also included in this chapter are daily profiles of customer waiting time, number of dispatches and travel time duration.

Chapter 5 draws together the conclusions derived from the analysis undertaken. Results output from the data would indicate the variations before and after using GPS based taxi dispatch. This would conclude whether GPS based taxi dispatch system be used on citywide basis or not.

CHAPTER TWO

LITERATURE REVIEW

2. LITERATURE REVIEW

2.1 DEMAND RESPONSIVE TRANSPORT

Demand Responsive Transport (DRT) is based on demand for travel and then match the transport offer to that demand (CORDIS, 2003). It is an essential part in the economic development of any nation. Examples include taxis, hire-cars and other modes of transportation. They comprise an essential complement to the smooth operation of public transit services, whether urban or inter-urban, and for some groups of people are the only available means of transportation like disabled, elderly, tourists and rural dwellers. These transport services are also a back-up service for unplanned travel (business, emergencies, etc.). Largely because of their 24-hour availability and capacity to provide door-to-door service, efficient service is important.

In general, there is an increase in the use of telematics in these modes of transport services. In 1998 about 56,000 vehicles were equipped with telematics systems. By 2003, 1.2 million vehicles will have telematics systems (Reeds Business, 2003). It becomes increasingly important and meaningful to seek new and innovative means to maximise the use of the existing facilities to satisfy the ever-increasing demand. As a result, respective authorities bear a responsibility in ensuring the availability and proper operation of their transport mode and the use of telematics becomes ever more important. The failure of earlier demand-responsive transit systems stemmed from low passenger demands caused by excessive waiting time for patrons, poor coverage of the networks by demand-responsive vehicles, and poor computational algorithms and routing capabilities (PATH, 2003).

To provide better customer service in the competitive taxi business, fast and efficient dispatching is a critical factor. Taxi dispatching systems have traditionally relied on good staff and teamwork. But misunderstandings occur when bookings are transmitted by voice (Cheng, 1996). With the use of satellite-based taxi dispatching system that uses Global Positioning System (GPS) technology, the nearest taxi is located with the

help of GPS and then bookings and routings are transmitted to the taxi driver's display unit in digital form. Using this computerised satellite-based taxi dispatching and data network system, better service is provided to the customer, and the use of the driver's time and vehicle is optimised without causing misunderstandings (Cheng, 1996).

2.2 TAXIS AND HACKNEY IN DUBLIN

Existing legislation provides for two types of cab operation; taxis and hackney carriages (Faber, 1998). Taxis are entitled to engage generally in hire and reward services, including services contracted through standing or plying for hire in public places; they are subject to a maximum fare structure and are required to display a roof sign. Hackneys are restricted in the manner in which they provide hire and reward services. In particular they are prevented from plying or standing for hire and in effecting contracts for hire by means of telephones or radio communications within the vehicle in a public place, and are not permitted to carry a distinguishing sign on the exterior of the vehicle. However, they are not subject to a maximum fare structure. By December 2001, there were 6891 taxis and approximately 3000 hackneys licensed in Dublin making a total of 9900 cabs in all (Goodbody Economic Consultants, 2001). However, the number of cabs has since increased to 10,000.

In recent report, Minister for Transport, Mr. Séamus Brennan said,

"The number of taxis went to 10,000 in Dublin city in a period of just two years."
(Breaking News, June 10, 2003).

The majority of taxi operators are in possession of one license only and a significant proportion rent their license and vehicle to a driver. A minority of taxi operators have multiple licenses and use drivers to operate these vehicles (Faber, 1998).

Due to the increase in number of cabs, competition among the taxi operators increases, and telematics becomes ever more important to improve efficiency and customer

services. National Radio Cabs took a step forward and invested in satellite based GPS technology in line with its strategy for growth and development.

2.3 NATIONAL RADIO CABS

National Radio Cabs (NRC) was established in the 1970s. It grew rapidly from that time through the help of radio technology that allowed it to increase its customer management capacity, and consequently its taxi fleet. Today NRC defines itself as the largest and leading taxi company in Dublin. It currently operates a fleet of over 440 taxis (NRC, 2003).

NRC specialises in the provision of account taxi services, mostly for large companies, institutions, and government offices. Acting as a broker, NRC owns and operates an office, provides branding identity and manages the recruitment, co-ordination and distribution of jobs. Drivers are self-employed, and in the case of contract work, NRC carries the credit to the customer, finances the credit and charges the customer accordingly. Account customers amount to approximately 75% of National Radio Cab's business while the rest consists of non-regular cash customers.

In practice with account work, the company invoices clients on a fixed basis and pays a weekly cheque to the driver reflecting this amount, minus deductions for the fees and rental due. Cash jobs are paid directly to the driver. National Radio Cabs operates from a back office base that accommodates all technological, dispatch, accounting and management facilities. Customers contact National Radio Cabs exclusively via phone, fax or email.

In late 2000, the management of NRC decided to invest in new technology in line with its strategy for growth and development. In the view of its management, the prevailing system limited the efficiency of the company's operations. It required too much time to dispatch booking and resulted in the loss of customers. Following research into GPS systems in use in Australia, a Raywood system was chosen. This offered GPS driver

tracking and in addition to the integration and enhancement of existing dispatch systems. The ability to link the meter to the system was of particular interest as it provided a further source of data for the company. Under the old system, drivers provided details as to their status and location. This made NRC dependent on the drivers yet unable to control the accuracy of information that they provided. In contrast, the new system automatically records their activities and locations.

NRC's explicit goals for the new dispatch system can be summarised as increased work efficiency, improved customer service, expanded control over drivers, enhanced organizational data and the capacity to expand the customer base and provide service offers. A further goal was to reduce interaction with driver (Grampp et al, 2002), like interaction with radio as well as interaction with tele-operators and customers, as one dispatcher puts:

"In the old days you had a radio blare all the time. The noise level – it was deafening sometimes. You would come out at 4 o'clock and would just feel dizzy" (Grampp et al, 2002).

2.4 SATELLITE NAVIGATION

Satellite navigation is a system to determine the position anywhere on the surface of the earth. It can tell us where you are to the nearest 5 to 10 metres, whatever the weather conditions (ESA, 2002). Enhanced instruments can even pinpoint the position of a stationary object to within a few centimetres. The satellite navigation system has three parts, the space segment, the user segment, and the control segment (ESA, 2002). The space segment consists of 24 satellites, each in its own orbit at heights of about 20000 km above the Earth so that at least four are visible from any point on the Earth's surface at any time. The user segment consists of receivers, which you can hold in your hand or mount in your car. The control segment consists of ground stations that make sure the satellites are working properly. Figure 1 below describes the parts of navigation system.

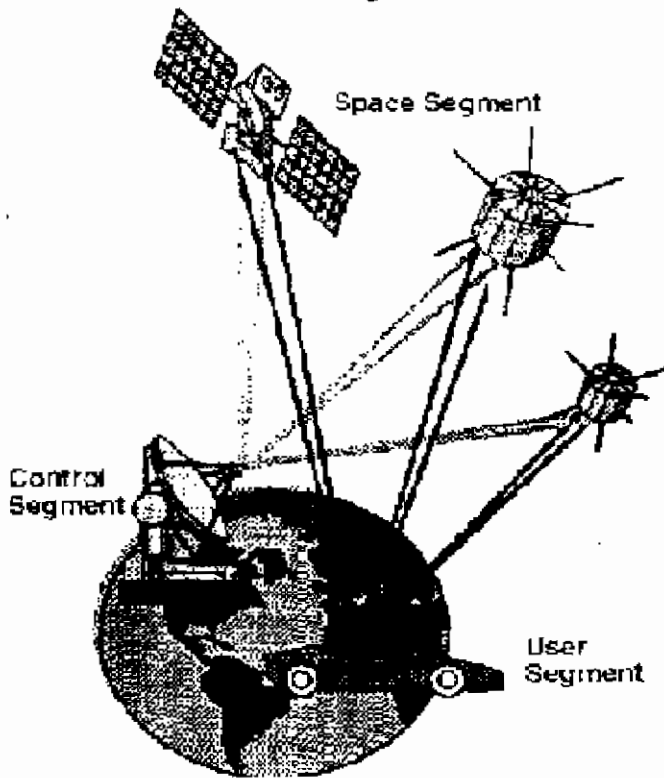


Figure 2.1 Satellite Navigation System and its components (Zito et al, 1995)

To pinpoint your location accurately, your receiver needs to receive signals from at least two navigational satellites. The receiver determines your distance from each of the satellites by measuring the time taken by the signal to travel from the satellite to your receiver antenna. These distance measurements tell you that you are situated somewhere on the circle where two spheres intersect. The spheres have each of the two satellites at their centres and their radii are the satellite-receiver distances. If you are standing on the surface of the Earth, you are standing on the surface of a third sphere. Your position must be one of two points where the Earth's surface touches the circle. It is usually obvious which of the two points is the one you are occupying as the other is far away. In practice, a third satellite is needed to synchronise your receiver's clock with a common standard time that is adhered to strictly by the clocks on board all the satellites.

If you want to determine your position in an aircraft above the surface of the Earth, however, you need to have a fourth satellite in view. In this case, the sphere, which has the fourth satellite at its centre and a radius equal to the distance between that satellite and your receiver, takes the place of the Earth in the example above. Three and four satellites are the minimum needed to determine positions on the surface of the Earth and above it. In general, the more satellites used the greater the positioning accuracy (ESA, 2002).

There are three satellite navigation systems in all. Russia and US provide the two global satellite navigation systems available at the moment. US department of defence operates GPS. Russia operates its satellite navigational system called GLONASS (ESA, 2002). A third system, Galileo, to be built and operated in Europe, is due to come on line between 2005-2008. The three systems will be fully interoperable, which means that a user on Earth will be able to determine a position with any receiver picking up signals from any combination of satellites belonging to any of the three systems.

2.4.1 THE IMPORTANCE OF MEASURING TIME

Determining precise location depends on measuring accurately the distances between receiver and satellite, and that depends on very accurate measurement of signal travel time. As signals travel at the speed of light, travel times are tiny fractions of a second. The receiver measures travel times by comparing 'time marks' imprinted on the satellite signals with the time recorded on the receiver's clock. The time marks are controlled by a highly accurate atomic clock on board each satellite. These clocks, however, are too expensive to incorporate into standard receivers, which have to make do with small quartz oscillators like those found in a wristwatch. Quartz oscillators are very accurate when measuring times of less than a few seconds, but inaccurate over longer periods. The solution is to re-set the receiver's time to the satellite's time continuously. The receiver processor using an approximation method involving signals

from at least four satellites does this. For this system of measurement to work, all satellites need to be synchronised so that they can start transmitting their signals at precisely the same time. This is achieved by continuously synchronising all on-board atomic clocks with a master clock on the ground. These super-accurate clocks can keep time to within one second in 100 million years (ESA, 2002).

2.4.2 ERRORS IN NAVIGATION

Numerous errors can degrade the accuracy of a positioning. For example, errors in satellite to receiver distances can occur if conditions within the ionosphere, the electrically charged outer layer of the atmosphere, slow down the signal. Conditions within the ionosphere are influenced by the level of activity on the surface of the Sun. Inaccurate distance measurements will also occur if the signal takes an unusually long path because it is reflected off many tall buildings or other surfaces before entering the receiver. It can suffer from signal blockage especially in city centres where high-rise buildings form concrete canyons, making it difficult for signals to reach the vehicle. There are various ways of overcoming such inaccuracies. The best known is called differential satellite navigation, which uses a fixed receiver in a known position as a reference. The time taken for the signal to travel from the satellite to the fixed receiver can be calculated precisely because the positions of the fixed receiver and the satellites (and hence the length of the travel path) are known precisely. Any difference between the calculated travel time and that actually measured reflects inaccuracies introduced by disturbances in the ionosphere (ESA, 2002).

2.4.3 PRACTICAL APPLICATIONS

Satellite navigation systems are changing the way in which we travel from place to place whether by land, sea or air and whether in remote areas or through congested city streets. Within a few years, mobile phones will incorporate global positioning receivers as standard. The combination of being able to send a text message by mobile phone together with your precise location will have far reaching implications. The day is

almost here, for example, when you will be able to use your mobile phone equipped with satellite navigation receiver to find your way when entering an unfamiliar city. You will be able to send your requirements (for example, nearest parking space, pizza restaurant or whatever) via text message to a service provider, who will use your position to determine the nearest facility to you. The service provider will check on availability - perhaps even book a table or parking space for you - before automatically sending a map for display on your phone that shows your position and how to get to what you want (ESA, 2002). Satellite navigation is already widely used to locate life rafts lost at sea or to keep tabs on explorers heading for isolated and little-known parts. A mobile phone equipped with standard navigation satellite receiver, however, could soon become an everyday item for the elderly or disabled (ESA, 2002).

Satellite navigation will help regulate road use and minimise traffic jams. If all vehicles are fitted with a navigation satellite receiver and a data transmitter, their position can be relayed automatically every few seconds to a central station. This information can then be used in a number of ways to control road usage. It could, for example, be used to charge motorists for using a stretch of road, to restrict access to congested roads, or to inform drivers of congestion and suggest alternative, quieter routes.

When planning aircraft routes and landing schedules at busy airports, it is essential to ensure that aircraft are always a safe distance from each other. The satellite navigation system provides a guaranteed service with sufficient accuracy to allow airlines and pilots to know their position reliably and precisely enough to make substantial efficiency savings. Satellite navigation can also help pilots to land planes safely, especially in poor weather. At present, this is possible only with differential satellite navigation in which an antenna close to the runway transmits a signal to the navigational satellites. Accuracy as high as 5 cm could be obtained when kinematic phase Differential GPS (DGPS) is used (GARMIN, 2003).

2.5 GLOBAL POSITIONING SYSTEM (GPS)

The GPS is a satellite positioning technology developed by the US Department of Defence (DOD). This technology is used both by military and public for marine and ground vehicle positioning (Cheng, 1996). The research and tests of the GPS technology have been conducted since 1978, and its development program can be considered as three phases as described in the follows:

The GPS satellites, which are professionally called NAVSTAR (NAVigation System with Time And Range), circle the earth in nominal 20,200-kilometer orbits. The orbital geometry is six, 55-degree inclined planes, with four satellites eventually in each planar orbit. Each satellite has an orbit period of 12 hours. The geometry of each constellation enables it to furnish direct line-of-sight navigation from at least four satellites to any point on or near the earth's surface 24 hours a day. GPS technology has developed rapidly. An important event that pushed this research forward was the Gulf War, in which more than 10,000 GPS receiver devices were used. Commercial products using GPS receivers are already widely available on the market, and many vehicles now are equipped with navigational devices using GPS. These receivers make it possible for two dimensional (2D) or three-dimensional (3D) positioning in many applications such as vehicle location and navigation. For 2D-position service, such as marine and ground vehicles, which need only latitude and longitude to determine their position, at least three GPS satellites are required, although frequently four to six GPS satellites are used for precise positioning results. For 3D-positioning application, such as that of missiles and aeroplanes, at least four satellites are needed; usually more satellites are used in military situations, for good positioning results. GPS location technology works as follows. Individual ground receivers use the various signals transmitted from GPS satellites to calculate the positions of the satellites in ground coordinates at the time of the signal transmission, and the ranges from receiver to each of the satellites. The ranges are professionally called pseudoranges since clock errors are involved in the process of range calculation (Cheng, 1996). As soon as the positions of

the satellites and the ranges from the receiver to the satellites are known, the position of the user's receiver can be easily calculated from triangle relation.

There are several levels of accuracy for GPS positioning: Precise Position Service (PPS) used by US military. Authorised users can obtain a position accuracy of 7-15 meters. The Standard Position Service (SPS) without Selective Availability (SA) for the general public gives a position accuracy of 10-30 meters, while the Standard Position Service with Selective Availability, gives 50-100 meters. Prior to midnight May 1, 2000, under conditions of SA, single point positioning had uncertainty of 100 meters. SA is the main reason for reduction of the accuracy of single point positioning. Single point positioning can be achieved 10 times more accurately with selective availability (Alkan, 2001). United States stopped the degradation of GPS signals i.e. SA on May 1, 2000.

2.5.1 GPS DATA APPLICATIONS

Heavy traffic is observed all over the world. In order to exploit existing networks more efficiently, number of telematics applications has grown rapidly over past few years. Conventional traffic data for mobility information are collected by stationary traffic volume measurements like inductive loops, video observation, infrared and laser vehicle detection etc (Wagner et al, 2002). The use of GPS data has become important in order to get real time picture of traffic conditions. Figure 1.2 describes the real time information of vehicles. GPS time, position and speed data can be usefully employed in traffic studies and in vehicle tracking.

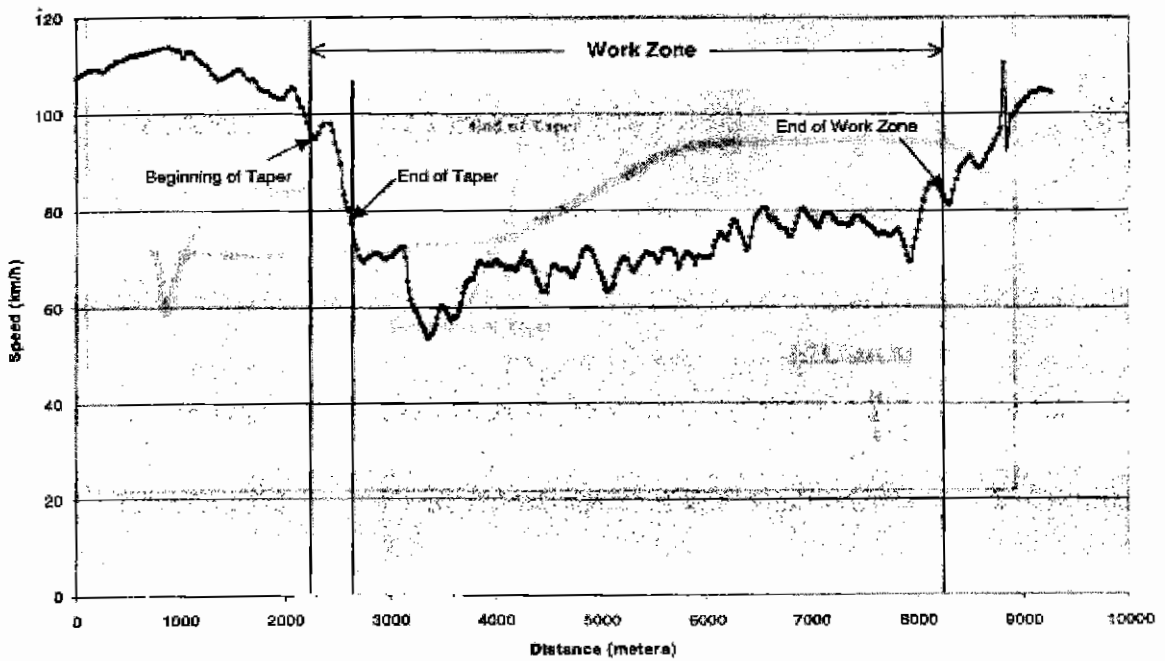


Figure 2.2 Real time information from GPS (Yi Jiang and Shou Li, 2001).

This data can be used for assessing vehicle and traffic system performance, especially in congested conditions (Taylor, 1992 cited Zito et al 1995). GPS travel time and delay data are important in assessing the performance of road traffic system, especially in urban areas. This GPS data can also be used to analyse freeway work zones to obtain precise profile of vehicle speed along roadway sections and work zones in terms of congestion, acceleration, deceleration and traffic delays (Jiang and Shou, 2001).

2.5.2 GPS IN TAXI DISPATCHING

To provide better customer service in the competitive taxi business, fast and efficient dispatching is a critical factor. Taxi dispatching systems have traditionally relied on good staff and teamwork. But misunderstandings occur when bookings are transmitted by voice. It is considered significant that taxi companies in many places around the world have successfully initiated a new application using GPS, a smart satellite-based system for tracking and dispatching taxis to commuters

2.5.3 YELLOW CHECKER CAB, CALIFORNIA, USA

According to Digital Dispatch Systems (DDS, 2003), Yellow Checker Cab Co., Inc. is a family-owned company in operation since 1938. It is the largest and oldest family-owned taxicab company in the Bay area, San Jose, California. With a current fleet of 330 cabs which is expected to grow to 450 in the near future, the Company offers a variety of services such as 24-hour service, guaranteed rides for car-poolers, messenger service, package delivery, pre-arranged time calls, and non-ambulatory wheelchair vans. An aggressive and rapidly developing company, Yellow Checker Cab Co.'s current first generation wireless dispatching system has gradually become inadequate and out-of-date for their existing and future needs. Seeking to increase fleet efficiency, improve customer service and enhance driver safety, Yellow Checker Cab Co. switched their entire dispatching system to Digital Dispatch that includes GPS Closest Cab Dispatching.

Larry Silva, President and General Manager of Yellow Checker Cab Co., comments, "We have reduced the number of 'call-backs' and shortened customer wait times, thereby significantly improving our level of service and efficiency to our customers".

2.5.4 COMFORT TAXI, SINGAPORE

Comfort Taxi is the largest taxi fleet operator in the world, with more than 11,000 taxis. In 1996, Comfort introduced a fully automated, satellite-based booking and dispatching system known as Comfort CabLink, which redefined the state-of-art for the industry. Prior to implementing CabLink, Comfort dispatched about 3,500 jobs per day. Today, CabLink dispatches more than 30,000 jobs per day, an astounding achievement for both Comfort Taxi and ST Mobile Data (STMobiledData, 2003). Limited voice channels, jammed phone lines, dispatch system not optimised. These are just a handful of problems Comfort encountered in the past. The new dispatch system uses a unique feature of Mobitex network to solicit GPS (Global Positioning System) location of taxis nearest to the pickup point. Job orders are then dispatched to these

taxis within the zone, and a bidding process allows drivers to enter approximate arrival time. The computer-assisted dispatching (CAD) module will automatically determine the winner of the bid (i.e. the taxi nearest to the passenger) and inform both the driver and the customer of the match. As compared to the old analogue radio broadcast system, taxis are not bombarded with inappropriate job orders with pickup points that are too far from their location. With the new system, taxis only receive job orders that are in close proximity, therefore ensuring drivers a continuous flow of jobs with a system that sends jobs to the closest driver as soon as the driver is available. Digital text display eliminates errors in voice communication and ensures that the drivers receive correct addresses from the call centre. Since the inception of the service, many enhancements have been added to the system. For example, cashless payments using credit cards and NETS are made possible to offer customers alternative payment modes. These enhancements helped anchor Comfort as one of the leading mobile data users in Singapore. For a city of more than 3.5 million inhabitants, that prides itself as a leading-edge telecommunications hub, CabLink allows one to get a taxi easily, and quickly. So successful was it that Comfort expanded the system from the initial 500 taxis to 5,000 taxis by the end of 1996. CabLink's fully automated, mobile data-based booking and dispatching system is an excellent example of how fully leveraging the latest communications technology can bring efficiency and service to a new level. By automating the entire order process, from the time the customer calls from a taxi to the moment of pick-up, Comfort Transportation is able to significantly increase efficiency (STMobilityData, 2003).

2.5.5 LONDON TAXIS

London taxis were licensed more than 350 years ago. Zingo, a division of Manganese Bronze Holdings (MBH), manufacturer of the world famous London taxis, has created a revolutionary service for London taxis that uses patent pending technology to match passengers, who want to find a taxi, with nearby drivers searching for fares even if they are out of sight. Zingo has worked with three of the UK's major mobile networks, Vodafone, T-Mobile and O₂, to create a unique solution that makes use of the

operators' advanced location-based services (LBS) and Global Positioning System (GPS) technology employed in thousands of licensed London taxis. After dialling, passengers are first connected with Zingo's Interactive Voice Response (IVR) system – which manages the call for a few seconds while the caller's location is identified using the network operator's LBS technology. The LBS data provides the caller's location as an approximate longitude and latitude. Using the approximate passenger location, the nearest available taxi is selected from a pool of vehicles. The taxi's location information is periodically sent through the Vodafone Paknet data network to provide Zingo with the driver's position, using GPS. This information ensures that caller is connected to the appropriate driver with minimum delay. Zingo's patent pending technology then automatically connects the mobile call to the driver's hands-free mobile phone through a mobile virtual private network (MVPN). This allows passengers to talk directly with the driver rather than an intermediary call centre and provide their precise location, such as a building or street name, and confirm the pick-up point. The driver will then collect them as agreed. In line with modern-day consumer trends that see plastic replacing cash for transactions, Zingo also fits a credit card terminal in the driver's cab, which means no more searching for cash points before or during the journey. The on-board credit card payment facility allows transactions to be made in as little as six seconds – the fastest of its kind in a taxi. For security purposes, this data is protected using vehicle specific encryption before being sent through Paknet to be processed. Various security components will prevent stolen terminal use. Using this technology, location-based services provides us with the opportunity to deliver real customer benefits - as it helps ensure that customers are inside a licensed London taxi within a few minutes of their initial call to Zingo and are able to hail a taxi without venturing outside until they know their taxi is on its way. Feedback from user trials has shown that drivers also love Zingo because it means less empty cab time and ultimately more fares. Zingo plans to take this world first to other cities across the UK very soon (Zingo, 2003).

2.5.6 OSLO TAXI, NORWAY

Oslo Taxi of Oslo, Norway, is one of the first major taxi companies in the world to begin fully automating the monitoring of its entire fleet of vehicles. With the implementation of a fleet wide monitoring system based on GIS and GPS technology and used in conjunction with a sophisticated radio transmission network, system provides customers with a significant improvement in service and efficiency. In addition, many of the day-to-day security concerns of the taxi driver can be easily resolved (Al-Khabar, 1996).

After extensive testing, Oslo Taxi chose ArcView Version 2 from the Environmental Systems Research Institute, Inc. (ESRI) of Redlands, California, for its GIS and Trimble Navigation of Sunnyvale, California, to supply its GPS. The system also includes a custom-built radio unit from TP Radio, a company owned by Oslo Taxi. The unit includes the GPS receiver as well as a special device allowing the transmission of both voice and digital signals on the same band. The radio system uses antennas that have been installed around Oslo and transmission to and from the taxis is performed over a very high frequency (VHF) band. Radio transmission automatically switches from VHF to a cellular system when the taxi travels outside the coverage area, which includes Oslo and its suburbs.

After a successful pilot study, 100 vehicles were fitted with the equipment. Oslo Taxi began the process of installing tracking systems in all of the 1,800 vehicles in its fleet. In 1995 800 taxis were fitted with the system and the entire fleet had the system installed by the summer of 1996. Upon the completion of the full installation, the exact locations of the vehicles are monitored at all times by the Oslo Taxi dispatchers. While the emergency response aspect of the system is of critical importance to the drivers, the customer response features are of equal importance in managing and maintaining a smooth flowing, time-critical taxi fleet (Al-Khabar, 1996).

2.5.7 RADIO TAXIS LIMITED, LONDON (RTL)

Radio Taxis Limited (RTL) was formed in 1953 by a group of six independent Licensed Taxi drivers in London. Today, a Co-operative of black taxi drivers own the company, with a fleet of over 2,500 licensed taxis and employing some 200 staff. The company specializes in providing transportation services to many of London's large businesses (Capscan Limited, 2003).

RTL was the first licensed black taxi firm in London to integrate Global Positioning System (GPS) technology into its dispatch system. The GPS ensures the closest available taxi is dispatched to the pickup address given by the customer, reducing waiting time and dramatically improving the service. Jonathan Visser, Project Manager at Radio Taxis comments, "RTL has always been committed to maintaining the highest possible service for all of its corporate and personal clients, as well as its drivers, and it was for this reason that we integrated GPS technology into the dispatch system."

As part of this commitment, RTL has also recently initiated an Internet Booker project to further improve the service it offers. This innovation was partly due to client demand, but reflects the company's emphasis on customer service. The Internet Booking system is expected to take 25% of the company's business online. Visitors to a website simply need to enter a postcode or partial address to return a full and valid address, which can then be used to register as a customer, as a delivery address for goods or as a pick up point for a taxi. The Matchcode Webnet address management and data-capture software gives RTL's Internet Booker a fast and effective address validation system. It automatically chooses the best search method - quick browsing, rapid addressing, or cross matching, based upon the details entered by the customer.

For the future, RTL are now looking at adding a telephone number dataset to Matchcode Webnet. This will allow customers to validate addresses from their mobile phones using a location's telephone number. This functionality will be used for SMS and WAP versions of the Internet Booker (Capscan Limited, 2003).

2.5.8 TAXIS IN BERLIN, NUREMBERG AND VIENNA

The Institute of Transport Research of the German Aerospace Centre (DLR) have used Floating Car Data (FCD) from GPS based fleet, exploiting position data of several hundred vehicles of taxi companies in Berlin, Nuremberg and Vienna. In order to manage the client order, each taxi has to send the GPS position to the taxi headquarters at least once per minute, acting as a FCD probe vehicle. This lead to an almost complete data coverage of all major roads in the above mentioned urban areas. Since May 2001, several millions of position data from the associated taxi fleets have been collected. After the successful transfer of the data from taxi data base server to DLR server, this data has been used to compare the travel times and daily variations on different types of roads. The travel time calculation for particular road is done with map-matching algorithm, where the GPS positions are linked to the network layer. The analysis of the GPS data in terms of velocities and the daily variations show a great difference between cities. Especially in the Vienna inner city regions with centralized road structure and many narrow roads, the mean speed is quite lower, especially during the rush hours. This data helps to manage the fleets more efficiently (Wagner et al, 2002).

2.6 GALILEO

Satellite navigation users in Europe today have no alternative other than to take their positions from US GPS or Russian GLONASS satellites. Satellite positioning has already become the standard way of navigating on the high seas, air and land. In a few years' time, when the use of satellite positioning has spread, the implications of a signal failure will be even greater, jeopardizing not only the efficient running of transport systems, but also human safety.

As far back as the early 1990s, the European Union saw the need for Europe to have its own global satellite navigation system. The conclusion to build one was taken in similar spirit to decisions in the 1970s to embark on other well-known European

endeavours, such as the Ariane launcher and the Airbus. The European Commission and European Space Agency joined forces to build GALILEO, an independent system under civilian control which will be guaranteed to operate at all times, bar the direst emergency. GALILEO is now at the point of moving from definition to full-scale development.

European independence is the chief reason for taking this major step. However, other subsidiary reasons include:

- By being inter-operable with GPS and GLONASS, GALILEO will be a cornerstone of the Global Navigation Satellite System (GNSS). This system will be under civilian control and will allow positions to be determined accurately for most places on Earth, even in high rise cities where buildings obscure signals from satellites low on the horizon. This is because the number of satellites available from which to take a position more than double (ESA, 2002).
- By placing satellites in orbits at a greater inclination to the equatorial plane than GPS, Galileo will achieve better coverage at high latitudes. This will make it particularly suitable for operation over northern Europe, an area not well covered by GPS.
- With Galileo, Europe will be able to exploit the opportunities provided by satellite navigation to the full extent. GNSS receiver and equipment manufacturers, application providers and service operators will benefit from novel business opportunities. Under request from the European Commission, PricewaterhouseCoopers (PwC) prepared a study on the business plan for the Galileo programme.

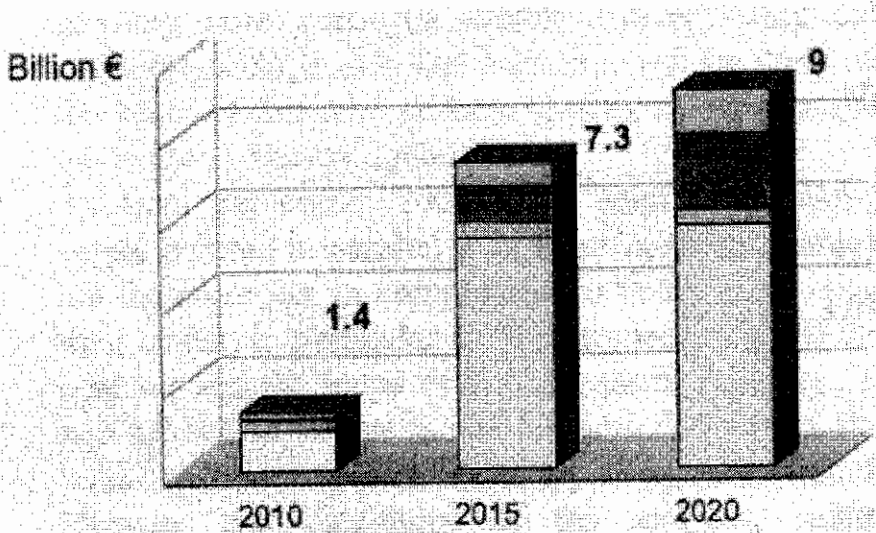


Figure 2.3 Worldwide revenues for GALILEO (Onidi, 2002).

The first experimental satellite, part of the so-called Galileo System Test Bed (GSTB) will be launched in late 2004. The objective of this experimental satellite is to characterize the critical technologies, which are already under development under ESA contracts. Thereafter up to four operational satellites will be launched in the timeframe 2005-2006 to validate the basic Galileo space and related ground segment. Once this In-Orbit Validation (IOV) phase has been completed, the remaining satellites will be installed to reach the Full Operational Capability (FOC) in 2008.

The fully deployed Galileo system consists of 30 satellites (27 operational + 3 active spares), positioned in three circular Medium Earth Orbit (MEO) planes in 23616 km altitude above the Earth, and at an inclination of the orbital planes of 56 degrees with reference to the equatorial plane. Once this is achieved, the Galileo navigation signals will provide a good coverage even at latitudes up to 75 degrees north, which corresponds to the North Cape, and beyond. The large number of satellites together with the optimisation of the constellation, and the availability of the three active spare satellites, will ensure that the loss of one satellite has no discernible effect on the user. Two Galileo Control Centres (GCC) will be implemented on European ground to provide for the control of the satellites and to perform the navigation mission

management. The data provided by a global network of twenty Galileo Sensor Stations (GSS) will be sent to the Galileo Control Centres through a redundant communications network. The GCC's will use the data of the Sensor Stations to compute the integrity information and to synchronize the time signal of all satellites and of the ground station clocks. The exchange of the data between the Control Centres and the satellites will be performed through so-called up-link stations. Five S-band up-link stations and 10 C-band up-link stations will be installed around the globe for this purpose. As a further feature, Galileo will provide a global Search and Rescue (SAR) function, based on the operational Cospas-Sarsat system (Europa, 2002). To do so, each satellite will be equipped with a transponder, which is able to transfer the distress signals from the user transmitters to the Rescue Co-ordination Centre, which will then initiate the rescue operation. At the same time, the system will provide a signal to the user, informing him that his situation has been detected and that help is under way. This latter feature is new and is considered a major upgrade compared to the existing system, which does not provide a feedback to the user.

2.7 WORKING TOGETHER

The benefits of more GNSS signals in space include improved availability, particularly in urban canyons and steep terrain in which signals can be blocked, as well as greater accuracy. Gains in accuracy are usually associated with the improved satellite geometry of combined GNSS constellations, which reduces the dilution of precision (DOP) and the latter factor's multiplicative effect on ranging errors. Comparison between GPS and GALILEO is shown in the table below (Lachapelle et al, 2002).

	GPS	GALILEO
Number of Satellites	27	30
Number of Planes	6	3
Spacing in Planes	Uneven	Evenly spaced
Inclination of Planes	53-56 degrees	54 degrees
Radius of Orbits	26561.75 km	29378.137 km
Frequencies used herein	L1 (1575.42 MHz)	E1 (1575.42 MHz)

Table 2.1 **Comparison between GPS and GALILEO (Lachapelle et al, 2002).**

The performance of the combined system i.e. GPS and GALILEO is about 10 percent better than that of GPS alone. With roughly twice as many satellites as GPS, a combined system is better able to reject incorrect ambiguity sets (Lachapelle et al, 2002).

CHAPTER THREE

ANALYSIS OF GPS DATA

3. ANALYSIS OF GPS DATA

Cab use is mainly for social and recreational purposes here in Dublin as compared to business use (Goodbody Economic Consultants, 2001). As demand for taxis has increased in the recent periods (Kenny & McNutt, 1998), it becomes increasingly important and meaningful to provide with regular availability and proper operation of taxis to satisfy the ever-increasing demand. At the same time, level and characteristics of transport demand need to be analysed.

Originally the taxi operators (NRC) had promised GPS data that could have been comprehensive enough to analyse transport characteristics like routing, origin and destination patterns in addition to other characteristics like travel time variations, customer waiting time etc. This limited to analyse the GPS data in terms of customer waiting time, effect on number of dispatches and travel time duration. Furthermore, customer waiting time ratio was also analysed.

3.1 CUSTOMER WAITING TIME

Customer waiting time is subject to availability of taxis, location, congestion etc. By looking at each day of the week in terms of customer waiting time in the month of June, the following points could be extrapolated. On Sundays, being a weekend, by looking at Figure C.22, we can see that the customer waiting time (CWT) form a usual pattern. It can be observed that the CWT for all Sundays is less then 15 minutes till 8 a.m. in the morning. Between 8 a.m. and 3 p.m., the CWT increases. It means that demand for the taxis in this time of the day is high. The demand for the cabs during these hours is high so customers have to wait at taxi ranks or other places. Apart from 1st June, when CWT reached 45 minutes in the peak hours, CWT is less than 29 minutes between 8 a.m. and 3 p.m., for other Sundays in the month of June. After 3 p.m. till midnight, it can be observed from figure 3.1 that CWT is less than 20 minutes. Overall average CWT for Sundays in the month of June is 12.23 minutes (Table B.7).

When looking at Figure C.23, for CWT patterns, there is an increase between 7 a.m. and 12 p.m. People after a weekend break, go back to their usual works. So there is an increase in the early office hours in the morning, as people have to wait for the taxis at their usual places. During the early morning office hours, congestion on the roads can also be factor for increase in CWT, apart from increase in the demand of taxis. The figure tells us that overall CWT on Mondays during the month of June is less than 22 minutes and the average CWT during these days is 14.45 minutes (Table B.8).

On Tuesdays, there is a usual pattern. It can be observed from Figure C.24 that CWT is high in the morning office hours till 10 a.m., showing demand for taxis. At the same time, this increase can be due to congestion as well. CWT is less than 22 minutes before 10 a.m. and after 10 a.m., CWT falls to less than 15 minutes. Average CWT for Tuesdays in the month of June is 11.94 minutes (Table B.9).

When looking at the patterns of CWT of Wednesdays in Figure C.25, a usual pattern can be observed. In the early office hours, before 8 a.m., CWT increase and it is less than 15 minutes. Again between 3 p.m. and 6 p.m., increase in CWT can be observed where CWT is again less than 22 minutes. The average CWT for Wednesdays is 11.64 minutes (Table B.10).

When looking at the CWT pattern of Thursdays in Figure C.26, it increases in the morning office hours and evening office hours. At both of these time intervals, again it is due to more taxi demand. The average CWT on Thursdays is 12.73 minutes (Table B.11).

For Fridays, the CWT patterns can be observed in Figure C.27. Between 6 a.m. and 9 a.m., demand for taxis is high so there is an increase in CWT, which almost reaches 29 minutes at peak as compared to 16 minutes for the rest of time in a particular Friday. The average CWT for Fridays is 11.75 minutes (Table B.12).

Figure C.28 shows the CWT patterns for Saturdays in the month of June. It can be observed that there is increase in demand between 7 a.m. and 10 a.m. in the morning,

resulting in high CWT reaching upto 22 minutes. Furthermore, between 4 p.m. and 6 p.m., again demand for taxis is high resulting an increase in CWT. During this time of the day, it is because people tend to head towards night-clubs, cinemas and other social places. The average CWT for Saturdays is 12.07 minutes (Table B.13)

When we look at the trend-lines in Figure C.22, C.23, C.26 and C.28, CWT variations by particular time of the day form a general pattern. In the early hours of the morning, between 7 a.m. and 1 p.m., CWT increases because of more people on the road and increase in demand for the taxis.

3.2 TRAVEL TIME

Travel time or commuting time is influenced by areas like metropolitan (Gordon et al, 1989 cited O' Mahony & O' Regan, 2002). The transport demand problems in Dublin are increasing so travel time of commuters to Dublin are also increasing. The travel time depends on location from central business district. As ones location is farther from central district, high is the travel time duration. . By looking at each day of the week in terms of travel time in the month of June, the following points could be extrapolated.

Travel time (TT) variations of Sundays in the month of June Figure C.1 reveal a similar pattern in general. It can be seen from the figure that till 7 a.m. in the morning, TT reaches less than 15 minutes, as there is less traffic on the roads. But from 7 a.m. onward, TT starts increasing and reaches 36 minutes at maximum till 1 o' clock. From 1 p.m. onward it moves with slight decrease and again reaches to minimum TT of 14 minutes. On the average, TT for Sundays in the month of June is 23.55 minutes (Table B.7).

When looking at the TT variations for Monday in Figure C.2, again TT starts increasing from 7 a.m. But when compared to Sunday, TT reaches 22 minutes before 7 a.m. on Mondays. From 7 a.m. onward, TT again increases to a maximum of 37 minutes till 1 o' clock in the afternoon. Between 4 p.m. and 10 p.m. TT again increases at reaches maximum to 36 minutes. On the average, TT for Mondays is 19.52 minutes (Table B.8).

Figure C.3 shows the TT variations of Tuesdays in the month of June. Again the pattern is similar to previous days. TT at minimum is almost 14 minutes before 7 a.m. and then it starts increasing as one can expect more traffic on the roads. Similarly TT variations for the other days of the week can be seen in Figures C.4-C.7 in Appendix C. It can be observed that maximum TT is almost 36 minutes (between 7 a.m. and 1 p.m.) and minimum TT in general is 14 minutes before 7 a.m. in the morning.

When looking at the trend-lines in Figure C.5, C.6 and C.7, we come to see a general pattern in TT variations. It can be extrapolated that travel time varies with particular time of the day. This variation can be divided into three portions. These are time between 1 a.m. and 7 a.m., time between 7 a.m. and 6 p.m. and time between 7 p.m. and midnight. Accordingly the general variations in TT form a similar pattern. It decrease till 7 a.m., then it increases between 7 a.m. and 6 p.m. and again it declines after 7 p.m.

3.3 TAXI DISPATCHES VS CUSTOMER WAITING TIME

When we look at Figure C.8, which shows variations in CWT and the number of taxi dispatches, of all Sundays in the month of June. From Table B.1, it can be seen that maximum CWT on Sundays is almost 46 minutes related to Figure. Similarly the maximum number of taxis dispatched on Sundays is 88 in an hour (Table B.3) related to Figure C.8. Similarly, minimum taxis dispatched on Sundays are 18 (Table B.4) and minimum CWT on Sundays is approximately 7 minutes (Table B.2). It can be seen from figure that CWT is dependent on the number of taxis dispatched. On the whole, looking at the figure shows that when the number of taxis dispatched increase so does the CWT. Similarly CWT decrease with decrease in number of taxi dispatches.

When we look for variations in CWT and the number of taxi dispatches for Mondays in Figure C.9, it can be observed that CWT varies with number of taxis dispatched. As the number of taxis dispatched increase so does the CWT and vice versa. The variations of both CWT and taxi dispatches show that maximum CWT on Mondays is approximately

43 minutes (Table B.1) and the maximum taxis dispatched are 73 in an hour (Table B.3). Similarly minimum taxis dispatched are 12 (Table B.4) and minimum CWT is approximately 6 minutes (Table B.2).

When we look for variations in CWT and the number of taxi dispatches for Tuesdays in Figure C.10, it can be observed that CWT varies with number of taxis dispatched. As the number of taxis dispatched increase so does the CWT and vice versa. The variations of both CWT and taxi show that maximum CWT on Tuesdays is approximately 25 minutes (Table B.1) and the maximum taxis dispatched are 145 in an hour (Table B.3). Similarly minimum taxis dispatched on Tuesdays are 9 (Table B.4) and minimum CWT is approximately 7 minutes (Table B.2).

When we look for variations in CWT and the number of taxi dispatches for Wednesdays in Figure C.11, it can be observed that CWT varies with number of taxis dispatched. As the number of taxis dispatched increase so does the CWT and vice versa. The variations of both CWT and taxi show that maximum CWT on Wednesdays is approximately 25 minutes (Table B.1) and the maximum taxis dispatched are 155 (Table B.3). Similarly minimum taxis dispatched are 5 (Table B.4) and minimum CWT is approximately 4 minutes (Table B.2).

When we look for variations in CWT and the number of taxi dispatches for Thursdays in Figure C.12, it can be observed that CWT varies with number of taxis dispatched. As the number of taxis dispatched increase so does the CWT and vice versa. The variations of both CWT and taxi show that maximum CWT on Thursdays is approximately 26 minutes (Table B.1) and the maximum taxis dispatched are 159 (Table B.3). Similarly minimum taxis dispatched are 5 (Table B.4) and minimum CWT is approximately 5 minutes (Table B.2).

When we look for variations in CWT and the number of taxi dispatches for Fridays in Figure C.13, it can be observed that CWT varies with number of taxis dispatched. As the number of taxis dispatched increase so does the CWT and vice versa. The variations of

both CWT and taxi show that maximum CWT on Fridays is approximately 30 minutes (Table B.1) and the maximum taxis dispatched are 154 (Table B.3). Similarly minimum taxis dispatched are 5 (Table B.4) and minimum CWT is approximately 5 minutes (Table B.2).

When we look for variations in CWT and the number of taxi dispatches for Saturdays in Figure C.14, it can be observed that CWT varies with number of taxis dispatched. As the number of taxis dispatched increase so does the CWT and vice versa. The variations of both CWT and taxi show that maximum CWT on Saturdays is approximately 27 minutes (Table B.1) and the maximum taxis dispatched are 153 (Table B.3). Similarly minimum taxis dispatched are 10 (Table B.4) and minimum CWT is approximately 7 minutes (Table B.2).

When looking at trend-lines in Figure C.8 to Figure C.14, we can see that CWT is proportional to the number of taxis dispatched. As the number of taxis dispatched decreases or increases, CWT also increases or decreases.

3.4 CUSTOMER WAITING TIME RATIO

Customer waiting time ratio can be defined as

“Ratio of customer waiting time to summation of travel time and customer waiting time”.

Mathematically

$$\tau = T_a / (T_a + T_b) \quad (1)$$

In this equation, T_a is the customer waiting time and T_b is travel time. This waiting time ratio is based on concept of travel time ratio (Dijst and Schwanen, 2001). The duration of CWT and travel time are taken together in the denominator. The values fall between zero and one.

The graphs for CWT ratio reveal the following.

When we look at Figure C.15, that shows the variations of both CWT and CWT Ratio for Sundays, it can be seen that both are directly proportional to each other. It can be observed that maximum CWT ratio is 0.75 for Sundays in June (Table B.5). Similarly minimum CWT ratio for Sundays is 0.17 (Table B.6). Average CWT ratio on Sundays is 0.378 (Table B.7). When we look at CWT, it can be observed that maximum and minimum waiting time are approximately 46 minutes (Table B.1) and 7 minutes respectively (Table B.2) and the average CWT is approximately 12 minutes (Table B.7).

When we look at Figure C.16, that shows the variations of both CWT and CWT Ratio for Mondays, it can be seen that both are directly proportional to each other. It can be observed that maximum CWT ratio is 0.72 (Table B.5) for Mondays in June. Similarly minimum CWT ratio for Mondays is 0.14 (Table B.6). Average CWT ratio on Mondays is 0.43 (Table B.8). When we look at CWT, it can be observed that maximum and minimum waiting time are approximately 42 minutes (Table B.1) and 6 (Table B.2) minutes respectively and the average CWT is approximately 15 minutes (Table B.8).

When we look at Figure C.17, that shows the variations of both CWT and CWT Ratio, it can be seen that both are directly proportional to each other. It can be observed that maximum CWT ratio is 0.61 (Table B.5) for Tuesdays in June. Similarly minimum CWT ratio for Tuesdays is 0.22 (Table B.6). Average CWT ratio on Tuesdays is 0.365 (Table B.9). When we look at CWT, it can be observed that maximum and minimum waiting time are approximately 25 (Table B.1) minutes and 7 minutes (Table B.2) respectively and the average CWT is approximately 12 minutes (Table B.9).

When we look at Figure C.18, that shows the variations of both CWT and CWT Ratio, it can be seen that both are directly proportional to each other. It can be observed that maximum CWT ratio is 0.74 (Table B.5) for Wednesdays in June. Similarly minimum CWT ratio for Wednesdays is 0.17 (Table B.6). Average CWT ratio on Wednesdays is 0.36 (Table B.10). When we look at CWT, it can be observed that maximum and

minimum waiting time are approximately 25 (Table B.1) minutes and 4 minutes respectively (Table B.2) and the average CWT is approximately 12 minutes (Table B.10).

When we look at Figure C.19, that shows the variations of both CWT and CWT Ratio, it can be seen that both are directly proportional to each other. It can be observed that maximum CWT ratio is 0.63 (Table B.5) for Thursdays in June. Similarly minimum CWT ratio for Thursdays is 0.20 (Table B.6). Average CWT ratio on Thursdays is 0.37 (Table B.11). When we look at CWT, it can be observed that maximum and minimum waiting time are approximately 26 (Table B.1) minutes and 5 minutes respectively (Table B.2) and the average CWT is approximately 13 minutes (Table B.11).

When we look at Figure C.20, that shows the variations of both CWT and CWT Ratio, it can be seen that both are directly proportional to each other. It can be observed that maximum CWT ratio is 0.67 (Table B.5) for Fridays in June. Similarly minimum CWT ratio for Fridays is 0.18 (Table B.6). Average CWT ratio on Fridays is 0.343 (Table B.12). When we look at CWT, it can be observed that maximum and minimum waiting time are approximately 30 minutes (Table B.1) and 5 minutes respectively (Table B.2) and the average CWT is approximately 12 minutes (Table B.12).

When we look at Figure C.21, that shows the variations of both CWT and CWT Ratio, it can be seen that both are directly proportional to each other. It can be observed that maximum CWT ratio is 0.59 (Table B.5) for Saturdays in June. Similarly minimum CWT ratio for Saturdays is 0.18 (Table B.6). Average CWT ratio on Saturdays is 0.345 (Table B.13). When we look at CWT, it can be observed that maximum and minimum waiting time are approximately 27 minutes (Table B.1) and 7 minutes respectively (Table B.2) and the average CWT is approximately 12 minutes (Table B.13).

CHAPTER FOUR

DISCUSSION

4. DISCUSSION

4.1 CUSTOMER WAITING TIME

Customer waiting time is subject to availability of taxis, location, congestion etc. The analysis of customer waiting time from GPS data graphs are given in tabular form that reveals the following points.

Maximum waiting time on Sundays is approximately 46 minutes (Table B.1) and the minimum CWT on Sundays is approximately 7 minutes (Table B.2). There is a big variation in CWT. But, the average CWT from the GPS data for Sundays is 12 minutes (Table B.7). Maximum waiting time on Mondays is approximately 42 minutes (Table B.1) and the minimum CWT on Mondays is approximately 6 minutes (Table B.2). The average CWT from the GPS data for Mondays is 15 minutes (Table B.8). Maximum waiting time on Tuesdays is approximately 25 minutes (Table B.1) and the minimum CWT on Tuesdays is approximately 7 minutes (Table B.2) and the average CWT from the GPS data for Tuesdays is 12 minutes (Table B.9). Maximum waiting time on Wednesdays is approximately 25 minutes (Table B.1) and the minimum CWT on Wednesdays is approximately 4 minutes (Table B.2). But, the average CWT from the GPS data for Wednesdays is 12 minutes (Table B.10). Maximum waiting time on Thursdays is approximately 26 minutes (Table B.1) and the minimum CWT on Thursdays is approximately 5 minutes (Table B.2). The average CWT from the GPS data for Thursdays is 13 minutes (Table B.11). Maximum waiting time on Fridays is approximately 30 minutes (Table B.1) and the minimum CWT on Fridays is approximately 5 minutes (Table B.2). But, the average CWT from the GPS data for Fridays is 12 minutes (Table B.12). Maximum waiting time on Saturdays is approximately 27 minutes (Table B.1) and the minimum CWT on Saturdays is approximately 7 minutes (Table B.2). The average CWT from the GPS data for Saturdays is 12 minutes (Table B.13).

From the above points about the daily variations in CWT during all the days of the week show that average customer waiting time is 12 minutes. Moreover average variations in maximum and minimum CWT vary between 5-34 minutes. A study by Trinity College's Centre for Urban and Regional Studies in April 2000 show that people wait for 20-45 minutes on average for taxis. The survey revealed that on weekends, many passengers even had to wait for 90 minutes to get a cab. This shows that customer waiting time for taxis using GPS on ranks and other places have improved considerably. The GPS data provided does not on the other hand information about routing, origins and destinations. Therefore it is not possible to show here that how the customer waiting time changes with places of origin and destination.

4.2 TRAVEL TIME

Travel time or commuting time is influenced by areas like metropolitan (Gordon et al, 1989 cited O' Mahony & O' Regan, 2002). The transport demand problems in Dublin are increasing so travel time of commuters to Dublin are also increasing.

The analysis of customer travel time from GPS data graphs are given in tabular form in Appendix B that reveals the following points.

The average TT for weekends is 24 minutes approximately (B.7 & B.13). Similarly the average TT for weekdays between Mondays and Fridays is between 20-22 minutes (Table B.8-B-12). The analysis from GPS data show that average travel time is approximately 22 minutes. But it does not show TT origin and destination. On the whole average travel time using GPS dispatch is 22 minutes (within Dublin) at any time of the day. From the Tables (B.14-B.20) in Appendix B, the average travel time between 6 a.m. and 10 a.m. in the morning is 21 minutes. From the Tables (B.21-B.27) in Appendix B, the average travel time between 3 p.m. and 7 p.m. in the morning is 25 minutes. Again this average in the morning hours and evening hours from data does not give information about origin, destination and routing.

4.3 TAXI DISPATCHES

It can be seen from Figure C.8 to Figure C.14 that CWT is dependent on the number of taxis dispatched. On the whole, figures show that when the number of taxis dispatched increase, so does the CWT. Similarly CWT decrease with decrease in number of taxi dispatches. The maximum number of taxis dispatched on Sundays is 88 in an hour (Table B.3) related to Figure C.8 and minimum taxis dispatched on Sundays are 18 (Table B.4) in an hour. For Mondays, the maximum taxis dispatched are 73 in an hour (Table B.3) and minimum taxis dispatched are 12 (Table B.4). The maximum taxis dispatched on Tuesdays are 145 in an hour (Table B.3) and minimum taxis dispatched on Tuesdays are 9 (Table B.4). When looking for number of taxi dispatches on Wednesdays, maximum taxis dispatched are 155 (Table B.3). Similarly minimum taxis dispatched are 5 (Table B.4). Maximum taxis dispatched on Thursdays are 159 (Table B.3) in an hour. Similarly minimum taxis dispatched are 5 (Table B.4). Maximum taxis dispatched are 154 (Table B.3) for Fridays in an hour and minimum taxis dispatched are 5 (Table B.4). When we sum up the number of taxis dispatched in June, the figure for dispatches is 42342 that gives us average of 1411 taxis dispatched per day in June. According to NRC, the numbers of calls received daily are 2400 per day. But all of these calls are not relayed for taxi dispatches because of cancellations (Appendix A) or no show by customers.

A case study done by Raywood Communications for NRC show that the number of taxi dispatches for NRC has increased by 91% since the installation of this system. According to NRC director Mr. Liam Brady, the company handled 700 jobs on average before using GPS dispatch system. The average number of dispatches in June is eventually higher than the previous jobs.

4.4 CUSTOMER WAITING TIME RATIO

The customer waiting time ratio is based on concept of travel time ratio by Dijkstra and Schwanen (2001). It can be seen from Figure C.15 to C.21 that CWT Ratio is directly proportional to CWT. Increase or decrease in CWT ratio depends on CWT. Average CWT ratio on Sundays is 0.378 (Table B.7). Average CWT ratio on Mondays is 0.43 (Table B.8). Similarly, the average CWT ratio for other days can be observed in Tables B.9-B.13. The average CWT ratio for the month of June is 0.37.

CHAPTER FIVE

CONCLUSIONS

5. CONCLUSIONS

The objective of this project was to analyse the GPS data provided by NRC. Originally the taxi operators (NRC) had promised GPS data so that routing etc could be examined but the taxi operators did not provide with enough data that was necessary to analyse the demand for taxis and to investigate the variables driving that demand. Due to limited availability of data provided, the results obtained may not be strong. Thus the objective of this project was then limited to analyse the GPS data in terms of customer waiting times, effect on number of dispatches, customer waiting time ratios and travel time duration. Hence following conclusions can be extrapolated from the analysis.

- ◆ Average CWT vary between 5-34 minutes as compared to study by Trinity College's Centre for Urban and Regional Studies that show that people wait for 20-45 minutes on average for taxis. Moreover average customer waiting time is 12 minutes. This shows that GPS based taxi dispatch is effective in reduction of customer waiting time.
- ◆ Average travel time is approximately 22 minutes at any time of the day.
- ◆ Average travel time is approximately 21 minutes between 6 a.m. and 10 a.m. and the average travel time in the evening is 25 minutes between 3 p.m. and 7 p.m.
- ◆ The numbers of average taxi dispatches using GPS per day are 1411 as compared to 700 before using GPS based taxi dispatch.
- ◆ The average CWT ratio is 0.37.

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APPENDIX A

GPS DATA

1-Jun	Time	CWT Ratio	Jobs Entered	Templates	Dispatched	Canceled	Msgs	Pick-up	Custwait	Duration	% Called In
Sunday											
	00- 01hr	0.42	12	25	33	0	0	07:59	09:09	12:45	36.36
	01 - 02hr	0.42	9	19	31	1	1	08:18	13:33	18:57	29.03
	02 - 03hr	0.42	10	26	34	0	0	08:59	13:12	18:14	29.41
	03 - 04hr	0.40	3	20	25	0	0	08:23	11:09	16:29	12.00
	04 - 05hr	0.40	11	11	44	0	0	09:33	10:07	15:00	25.00
	05 - 06hr	0.48	2	10	42	0	0	10:44	14:18	15:26	4.76
	06 - 07hr	0.51	5	11	63	0	0	10:17	12:12	11:31	7.94
	07 - 08hr	0.44	2	3	35	2	2	07:28	13:12	16:28	5.71
	08 - 09hr	0.46	3	27	32	0	0	11:30	20:50	24:00	9.38
	09 - 10hr	0.54	3	34	39	0	0	12:04	17:03	14:27	7.69
	10 - 11hr	0.75	6	28	48	0	0	06:33	45:46	15:39	12.50
	11 - 12hr	0.46	4	30	34	0	0	09:23	17:53	21:24	11.76
	12 - 13hr	0.33	10	22	36	0	0	08:24	10:58	22:45	27.78
	13 - 14hr	0.41	11	30	42	0	0	10:34	15:48	22:19	26.19
	14 - 15hr	0.41	6	23	31	0	0	09:59	14:50	21:10	19.35
	15 - 16hr	0.38	6	18	18	0	0	08:32	14:30	23:55	33.33
	16 - 17hr	0.52	12	23	39	5	5	09:32	18:56	17:19	30.77
	17 - 18hr	0.38	3	30	29	0	0	10:25	13:56	23:09	10.34
	18 - 19hr	0.40	7	33	42	4	4	07:12	13:07	19:37	16.67
	19 - 20hr	0.51	12	43	61	0	0	10:29	18:54	18:18	19.67
	20 - 21hr	0.47	12	34	63	2	2	08:29	15:40	17:59	19.05
	21 - 22hr	0.43	9	36	46	0	1	09:09	10:09	13:26	19.57
	22 - 23hr	0.43	25	42	56	1	0	08:28	12:55	17:17	44.64
	23 - 00hr	0.46	24	30	72	0	0	08:28	15:18	18:08	33.33
Average		0.45							15:34	18:09	

Table A.1 GPS Data for Sunday 1st, June 03

2-Jun	Time	CWT Ratio	Jobs Entered	Templates	Dispatched	Canceled	Msgs	Pick-up	Custwait	Duration	% Called In
Monday											
	00- 01hr	0.44	27	44	55	0	0	08:41	12:06	15:25	49.09
	01 - 02hr	0.51	40	46	73	1	0	08:09	17:42	16:55	54.79
	02 - 03hr	0.57	20	30	66	0	0	09:45	22:13	16:38	30.30
	03 - 04hr	0.60	18	31	47	1	0	08:56	24:00	15:55	38.30
	04 - 05hr	0.56	11	14	50	2	0	10:27	20:38	16:00	22.00
	05 - 06hr	0.40	4	14	29	1	0	08:41	09:39	14:29	13.79
	06 - 07hr	0.49	6	12	35	0	0	07:09	08:52	09:04	17.14
	07 - 08hr	0.63	7	10	39	0	0	11:56	17:19	10:19	17.95
	08 - 09hr	0.39	5	7	30	0	0	09:42	10:41	16:27	16.67
	09 - 10hr	0.35	9	16	29	0	0	07:09	09:19	17:37	31.03
	10 - 11hr	0.34	5	15	22	0	0	07:33	14:48	28:52	22.73
	11 - 12hr	0.72	5	14	25	0	0	12:44	42:28	16:11	20.00
	12 - 13hr	0.37	8	10	17	0	0	40:38	08:02	13:45	47.06
	13 - 14hr	0.32	7	15	27	2	0	06:48	09:19	19:59	25.93
	14 - 15hr	0.39	8	21	32	1	0	07:13	11:20	17:34	25.00
	15 - 16hr	0.34	6	17	27	3	0	08:02	10:31	19:59	22.22
	16 - 17hr	0.52	14	10	27	1	0	10:00	15:48	14:48	51.85
	17 - 18hr	0.42	7	19	21	0	0	07:41	13:00	18:05	33.33
	18 - 19hr	0.37	0	23	28	0	0	11:43	12:07	20:20	0.00
	19 - 20hr	0.45	5	26	27	0	0	09:04	11:56	14:31	18.52
	20 - 21hr	0.37	8	21	34	0	0	08:27	13:00	22:07	23.53
	21 - 22hr	0.45	7	23	37	1	0	08:25	12:07	14:58	18.92
	22 - 23hr	0.43	3	27	32	0	1	09:25	12:55	17:10	9.38
	23 - 00hr	0.50	9	23	31	0	0	10:32	15:32	15:23	29.03
Average		0.46							14:48	16:46	

Table A.2 GPS Data for Monday 2nd, June 03

3-Jun	Time	CWT Ratio	Jobs Entered	Templates	Dispatched	Canceled	Msgs	Pick-up	Custwait	Duration	% Called In
Tuesday											
	00-01hr	0.40	18	30	34	0	0	07:21	11:43	17:45	52.94
	01-02hr	0.46	13	22	35	0	0	08:33	14:28	17:18	37.14
	02-03hr	0.51	9	16	27	0	0	08:13	15:37	15:06	33.33
	03-04hr	0.47	3	19	21	0	0	09:07	14:46	16:40	14.29
	04-05hr	0.50	7	11	31	0	0	08:48	14:07	13:51	22.58
	05-06hr	0.55	5	11	29	1	0	11:37	16:31	13:38	17.24
	06-07hr	0.52	4	12	40	1	0	11:04	14:25	13:20	10.00
	07-08hr	0.55	5	15	58	0	0	11:07	19:45	16:22	8.62
	08-09hr	0.61	5	9	50	0	0	09:10	22:43	14:34	10.00
	09-10hr	0.24	7	20	28	0	1	07:45	08:12	25:48	25.00
	10-11hr	0.40	5	20	20	1	1	08:31	10:35	16:08	25.00
	11-12hr	0.35	2	17	14	0	0	09:49	11:18	20:59	14.29
	12-13hr	0.51	4	15	23	1	2	16:34	17:16	16:27	17.39
	13-14hr	0.41	8	8	21	1	0	10:18	11:26	16:23	38.10
	14-15hr	0.37	5	17	19	1	2	10:30	12:31	21:25	26.32
	15-16hr	0.43	4	14	20	0	2	10:43	14:57	19:46	20.00
	16-17hr	0.37	5	9	23	1	1	08:49	11:13	19:02	21.74
	17-18hr	0.40	1	17	15	0	2	08:37	13:00	19:45	6.67
	18-19hr	0.53	2	29	36	0	3	09:55	15:49	14:14	5.56
	19-20hr	0.29	2	22	25	1	0	07:15	09:18	22:35	8.00
	20-21hr	0.39	2	16	22	0	2	07:38	09:13	14:33	9.09
	21-22hr	0.35	7	24	29	0	1	07:11	09:46	18:30	24.14
	22-23hr	0.35	4	10	19	0	4	08:53	09:23	17:16	21.05
	23-00hr	0.46	4	19	25	1	0	09:26	18:30	22:03	16.00
Average		0.43								13:36 17:39	

Table A.3 GPS Data for Tuesday 3rd, June 03

4-Jun	Time	CWT Ratio	Jobs Entered	Templates	Dispatched	Canceled	Msgs	Pick-up	Custwait	Duration	% Called In
Wednesday											
	00-01hr	0.47	11	31	24	1	0	08:37	13:47	15:44	45.83
	01-02hr	0.53	7	16	18	0	0	07:43	17:02	14:58	38.89
	02-03hr	0.54	1	6	6	0	0	12:41	16:39	14:23	16.67
	03-04hr	0.38	2	8	10	0	0	07:23	07:52	13:05	20.00
	04-05hr	0.59	0	6	18	1	0	10:02	18:44	13:05	0.00
	05-06hr	0.50	2	6	42	0	0	11:15	19:12	18:51	4.76
	06-07hr	0.50	1	5	35	0	0	09:26	09:58	10:02	2.86
	07-08hr	0.27	7	17	48	0	0	07:35	08:01	21:23	14.58
	08-09hr	0.39	4	64	99	6	2	13:01	15:03	23:45	4.04
	09-10hr	0.31	5	98	122	1	1	09:45	12:29	27:49	4.10
	10-11hr	0.29	2	89	96	2	1	09:08	10:55	26:24	2.08
	11-12hr	0.28	1	82	75	1	0	10:02	10:54	27:49	1.33
	12-13hr	0.29	4	81	91	4	4	09:24	12:24	29:44	4.40
	13-14hr	0.33	1	80	96	1	3	11:31	12:13	24:57	1.04
	14-15hr	0.29	3	98	118	1	1	09:06	10:38	26:37	2.54
	15-16hr	0.29	3	92	121	2	5	08:12	09:36	23:44	2.48
	16-17hr	0.27	7	71	91	2	2	10:50	14:58	40:27	7.69
	17-18hr	0.29	5	51	75	2	2	10:02	13:18	32:13	6.67
	18-19hr	0.31	1	60	63	2	3	09:08	11:39	26:12	1.59
	19-20hr	0.30	2	44	58	0	4	09:27	10:46	24:41	3.45
	20-21hr	0.24	1	38	43	0	0	06:04	07:13	22:51	2.33
	21-22hr	0.23	0	39	40	0	0	06:12	07:29	24:49	0.00
	22-23hr	0.39	3	45	53	1	0	08:20	10:24	15:56	5.66
	23-00hr	0.37	4	22	31	1	0	08:48	11:28	19:53	12.90
Average		0.36							12:12	22:28	

Table A.4 GPS Data for Wednesday 4th, June 03

5-Jun	Time	CWT Ratio	Jobs Entered	Templates	Dispatched	Canceled	Msgs	Pick-up	Custwait	Duration	% Called In
Thursday											
	00- 01hr	0.34	9	39	28	3	0	04:47	07:56	15:17	32.14
	01 - 02hr	0.43	8	24	28	0	2	06:28	11:22	14:46	28.57
	02 - 03hr	0.54	4	17	18	0	0	11:47	15:30	13:27	22.22
	03 - 04hr	0.45	3	8	15	0	0	06:00	13:15	16:22	20.00
	04 - 05hr	0.29	2	8	21	2	0	07:00	08:29	21:13	9.52
	05 - 06hr	0.51	3	8	52	0	3	08:58	19:24	18:26	5.77
	06 - 07hr	0.33	2	12	54	1	0	08:22	09:51	20:24	3.70
	07 - 08hr	0.36	3	29	80	1	0	11:29	12:41	22:58	3.75
	08 - 09hr	0.37	3	46	99	1	0	12:40	14:03	23:33	3.03
	09 - 10hr	0.31	5	118	147	4	0	09:59	12:11	26:58	3.40
	10 - 11hr	0.28	3	129	128	1	2	09:35	11:53	31:15	2.34
	11 - 12hr	0.31	3	101	118	4	0	08:28	13:49	30:48	2.54
	12 - 13hr	0.59	1	63	60	1	0	09:17	26:09	18:12	1.67
	13 - 14hr	0.47	0	37	50	4	0	06:26	20:00	22:57	0.00
	14 - 15hr	0.51	1	75	102	4	0	09:56	19:11	18:05	0.98
	15 - 16hr	0.42	6	79	124	7	2	10:23	14:50	20:12	4.84
	16 - 17hr	0.32	3	85	102	2	2	09:07	12:30	26:21	2.94
	17 - 18hr	0.29	4	63	75	2	1	08:30	12:36	31:05	5.33
	18 - 19hr	0.41	1	43	61	0	3	08:25	16:13	23:29	1.64
	19 - 20hr	0.30	12	60	74	0	2	07:56	10:22	23:58	16.22
	20 - 21hr	0.35	11	43	61	0	2	07:31	12:17	22:36	18.03
	21 - 22hr	0.42	8	51	74	3	0	09:36	13:46	19:14	10.81
	22 - 23hr	0.44	15	32	56	0	0	06:39	13:59	17:51	26.79
	23 - 00hr	0.41	14	38	38	1	1	06:46	12:25	17:38	36.84
Average		0.39								13:57 21:33	

Table A.5 GPS Data for Thursday 5th, June 03

6-Jun	Time	CWT Ratio	Jobs Entered	Templates	Dispatched	Canceled	Msgs	Pick-up	Custwait	Duration	% Called In
Friday											
	00- 01hr	0.36	18	33	27	0	2	05:30	12:56	22:56	66.67
	01 - 02hr	0.54	18	28	53	0	0	09:57	18:02	15:29	33.96
	02 - 03hr	0.38	9	20	24	2	0	05:16	08:41	14:16	37.50
	03 - 04hr	0.32	4	4	11	0	1	06:57	09:16	19:25	36.36
	04 - 05hr	0.54	5	6	25	0	0	06:57	14:54	12:31	20.00
	05 - 06hr	0.41	2	6	45	1	1	09:36	14:28	20:43	4.44
	06 - 07hr	0.48	4	1	73	2	1	08:03	17:08	18:43	5.48
	07 - 08hr	0.35	9	35	88	2	1	09:53	14:18	27:08	10.23
	08 - 09hr	0.33	5	67	125	1	5	42:51	09:58	19:54	4.00
	09 - 10hr	0.30	12	97	132	3	5	09:08	10:49	24:48	9.09
	10 - 11hr	0.26	16	106	131	1	1	09:43	09:35	27:12	12.21
	11 - 12hr	0.35	11	113	111	2	22	12:59	11:31	21:16	9.91
	12 - 13hr	0.39	4	100	107	4	3	08:13	16:04	24:53	3.74
	13 - 14hr	0.39	8	85	103	2	2	08:21	15:48	25:08	7.77
	14 - 15hr	0.35	10	110	139	0	2	08:30	14:56	28:04	7.19
	15 - 16hr	0.23	10	104	148	3	4	09:42	10:16	34:55	6.76
	16 - 17hr	0.27	3	92	118	3	1	09:24	08:35	23:11	2.54
	17 - 18hr	0.21	5	62	81	2	0	10:45	04:35	17:22	6.17
	18 - 19hr	0.31	6	56	80	1	0	09:34	08:56	19:40	7.50
	19 - 20hr	0.28	3	40	54	0	0	08:13	08:41	21:53	5.56
	20 - 21hr	0.36	2	49	55	1	2	07:27	09:45	17:40	3.64
	21 - 22hr	0.38	5	41	38	0	0	04:19	09:24	15:23	13.16
	22 - 23hr	0.31	6	41	59	1	1	07:32	07:34	17:00	10.17
	23 - 00hr	0.39	9	20	31	2	0	07:12	08:56	14:05	29.03
Average		0.35								11:28 20:59	

Table A.6 GPS Data for Friday 6th, June 03

7-Jun	Time	CWT Ratio	Jobs Entered	Templates	Dispatched	Canceled	Msgs	Pick-up	Custwait	Duration	% Called In
Saturday											
	00- 01hr		6	39	34	0					17.65
	01 - 02hr	0.25	5	24	32	0		04:45	06:35	20:17	15.63
	02 - 03hr	0.31	4	16	14	0		07:51	09:28	20:50	28.57
	03 - 04hr	0.39	1	6	13	0		07:01	11:45	18:17	7.69
	04 - 05hr	0.36	2	3	21	0		08:06	12:07	21:11	9.52
	05 - 06hr	0.59	6	11	46	1		09:03	13:16	09:21	13.04
	06 - 07hr	0.58	6	18	72	0		08:09	20:42	15:07	8.33
	07 - 08hr	0.41	7	30	69	1		06:40	10:37	15:24	10.14
	08 - 09hr	0.33	7	70	109	1		11:15	13:38	27:37	6.42
	09 - 10hr	0.38	1	107	134	2		09:51	18:49	30:31	0.75
	10 - 11hr	0.29	3	98	100	3		15:50	12:27	30:35	3.00
	11 - 12hr	0.30	3	109	121	3		10:50	12:36	29:32	2.48
	12 - 13hr	0.30	10	114	116	1		10:47	11:10	26:15	8.62
	13 - 14hr	0.29	2	83	96	2		09:22	10:31	26:23	2.08
	14 - 15hr	0.32	5	115	127	2		07:44	13:39	28:38	3.94
	15 - 16hr	0.38	18	113	147	2		10:46	17:20	28:08	12.24
	16 - 17hr	0.40	21	68	141	5		10:53	20:57	31:45	14.89
	17 - 18hr	0.32	12	54	74	1		10:42	16:56	35:16	16.22
	18 - 19hr	0.50	15	52	73	4		08:09	26:45	26:28	20.55
	19 - 20hr	0.35	10	65	95	2		15:14	16:44	31:22	10.53
	20 - 21hr	0.43	15	51	77	1		09:47	13:49	18:34	19.48
	21 - 22hr	0.24	13	53	65	0		10:51	08:23	26:26	20.00
	22 - 23hr	0.36	14	35	57	0		07:35	09:46	17:12	24.56
	23 - 00hr	0.39	4	33	42	1		09:19	11:31	17:49	9.52
Average		0.37							13:54	24:03	

Table A.7 GPS Data for Saturday 7th, June 03

8-Jun	Time	CWT Ratio	Jobs Entered	Templates	Dispatched	Canceled	Msgs	Pick-up	Custwait	Duration	% Called In
Sunday											
	00- 01hr	0.30	8	46	39	1	1	06:55	08:13	19:32	20.51
	01 - 02hr	0.42	14	64	70	2	0	07:31	11:06	15:14	20.00
	02 - 03hr	0.35	7	31	39	2	0	06:19	08:25	15:32	17.95
	03 - 04hr	0.46	3	45	46	1	0	07:41	13:33	15:44	6.52
	04 - 05hr	0.49	2	17	47	0	0	06:59	11:47	12:09	4.26
	05 - 06hr	0.45	2	4	38	0	2	07:00	11:05	13:18	5.26
	06 - 07hr	0.38	3	16	40	0	0	07:42	09:38	15:39	7.50
	07 - 08hr	0.32	2	15	35	0	1	08:36	10:04	21:23	5.71
	08 - 09hr	0.36	8	13	31	0	0	07:15	09:39	16:57	25.81
	09 - 10hr	0.32	5	39	47	1	0	13:35	15:41	34:03	10.64
	10 - 11hr	0.32	4	29	33	0	0	09:16	09:48	20:33	12.12
	11 - 12hr	0.01	2	35	43	0	0	07:25	10:27	36:00	4.65
	12 - 13hr	0.44	4	35	42	3	0	23:30	27:39	34:54	9.52
	13 - 14hr	0.30	7	36	43	1	0	07:05	10:01	23:33	16.28
	14 - 15hr	0.35	9	32	48	2	0	08:36	11:59	22:14	18.75
	15 - 16hr	0.41	5	27	33	1	0	11:05	15:27	22:14	15.15
	16 - 17hr	0.19	6	19	24	1	0	07:04	07:40	32:46	25.00
	17 - 18hr	0.33	16	25	27	0	0	10:15	11:39	23:38	59.26
	18 - 19hr	0.36	14	33	42	0	0	09:33	14:37	25:56	33.33
	19 - 20hr	0.30	19	63	88	0	0	07:57	10:27	24:52	21.59
	20 - 21hr	0.34	14	47	85	1	0	07:28	09:45	19:02	16.47
	21 - 22hr	0.31	19	40	67	3	0	08:57	11:05	24:43	28.36
	22 - 23hr	0.45	16	33	47	1	0	09:11	11:23	14:09	34.04
	23 - 00hr	0.44	11	28	51	1	0	08:06	10:58	14:00	21.57
Average		0.35						11:45	39:05		

Table A.8 GPS Data for Sunday 8th, June 03

9-Jun	Time	CWT Ratio	Jobs Entered	Templates	Dispatched	Canceled	Msgs	Pick-up	Custwait	Duration	% Called In
Monday											
	00- 01hr		5	59	55	1					9.09
	01 - 02hr	0.38	14	48	54	1	0	09:04	10:56	17:40	25.93
	02 - 03hr	0.42	7	33	44	0	0	08:42	13:31	18:51	15.91
	03 - 04hr	0.51	5	25	28	2	0	11:45	14:50	14:20	17.86
	04 - 05hr	0.35	3	35	48	1	0	07:39	12:38	23:08	6.25
	05 - 06hr	0.54	6	36	62	0	0	13:09	17:51	15:00	9.68
	06 - 07hr	0.53	4	22	45	0	2	08:01	13:41	12:03	8.89
	07 - 08hr	0.56	4	24	44	0	0	08:30	19:03	14:51	9.09
	08 - 09hr	0.47	1	21	52	0	0	07:12	11:55	13:26	1.92
	09 - 10hr	0.36	4	19	33	0	0	07:02	13:54	25:08	12.12
	10 - 11hr	0.39	2	21	22	0	0	10:22	12:32	19:25	9.09
	11 - 12hr	0.46	3	20	27	1	0	12:46	17:07	19:47	11.11
	12 - 13hr	0.47	5	28	29	0	0	09:26	15:45	17:57	17.24
	13 - 14hr	0.43	0	31	33	1	0	16:09	19:21	25:18	0.00
	14 - 15hr	0.42	4	26	22	0	0	11:14	13:06	18:05	18.18
	15 - 16hr	0.37	0	22	29	0	0	09:10	12:57	21:45	0.00
	16 - 17hr	0.46	7	26	31	1	1	19:54	21:14	25:08	22.58
	17 - 18hr	0.42	4	19	38	1	0	11:52	12:49	17:28	10.53
	18 - 19hr	0.45	5	32	23	0	0	08:44	13:06	15:46	21.74
	19 - 20hr	0.46	1	12	31	0	0	11:10	13:32	15:48	3.23
	20 - 21hr	0.14	11	26	29	0	1	08:01	12:06	#####	37.93
	21 - 22hr	0.32	4	20	23	1	0	07:06	10:42	22:23	17.39
	22 - 23hr	0.30	3	16	25	0	0	05:59	09:48	22:50	12.00
	23 - 00hr	0.38	2	21	16	2	1	10:14	12:28	20:28	12.50
Average		0.42							14:07	21:19	

Table A.9 GPS Data for Mondayday 9th, June 03

10-Jun	Time	CWT Ratio	Jobs Entered	Templates	Dispatched	Canceled	Msgs	Pick-up	Custwait	Duration	% Called In
Tuesday											
	00- 01hr	0.39	4	56	27	2	0	06:44	09:57	15:34	14.81
	01 - 02hr	0.42	3	15	22	0	0	06:23	12:15	16:37	13.64
	02 - 03hr	0.39	1	13	14	0	0	04:27	06:42	10:33	7.14
	03 - 04hr	0.43	5	11	9	0	0	07:46	13:32	18:18	55.56
	04 - 05hr	0.40	1	3	21	0	1	10:08	11:29	17:06	4.76
	05 - 06hr	0.58	1	9	60	0	0	10:33	21:10	15:01	1.67
	06 - 07hr	0.45	1	17	67	0	1	07:25	09:55	12:12	1.49
	07 - 08hr	0.36	4	32	67	0	0	08:05	12:30	22:34	5.97
	08 - 09hr	0.26	5	71	107	1	3	08:15	10:47	29:55	4.67
	09 - 10hr	0.32	2	91	145	1	10	07:39	11:56	24:50	1.38
	10 - 11hr	0.29	3	82	88	3	1	07:33	10:46	25:56	3.41
	11 - 12hr	0.28	7	87	89	1	1	07:51	08:27	21:58	7.87
	12 - 13hr	0.27	5	95	100	2	0	07:04	09:02	23:57	5.00
	13 - 14hr	0.29	12	62	99	7	2	08:32	09:31	23:43	12.12
	14 - 15hr	0.23	13	99	122	1	1	07:13	07:56	26:45	10.66
	15 - 16hr	0.24	12	81	127	1	3	09:35	11:52	38:17	9.45
	16 - 17hr	0.28	7	67	93	3	0	10:01	11:55	30:09	7.53
	17 - 18hr	0.45	4	47	58	2	0	11:22	16:02	19:13	6.90
	18 - 19hr	0.39	6	41	50	2	2	11:06	14:37	22:48	12.00
	19 - 20hr	0.34	0	43	52	1	1	07:14	10:50	21:28	0.00
	20 - 21hr	0.27	2	32	30	5	0	06:21	07:35	20:20	6.67
	21 - 22hr	0.32	3	26	33	0	1	07:09	08:00	16:49	9.09
	22 - 23hr	0.34	2	34	40	0	0	08:09	08:51	17:28	5.00
	23 - 00hr	0.37	3	25	33	0	1	09:21	14:14	23:50	9.09
Average		0.35								11:15 21:28	

Table A.10 GPS Data for Tuesday 10th, June 03

11-Jun	Time	CWT Ratio	Jobs Entered	Templates	Dispatched	Canceled	Msgs	Pick-up	Custwait	Duration	% Called In
Wednesday											
	00 - 01hr	0.41	9	32	33	1	0	08:58	10:57	15:56	27.27
	01 - 02hr	0.45	3	25	22	0	0	09:05	11:55	14:42	13.64
	02 - 03hr	0.42	1	7	7	0	0	07:40	08:31	11:52	14.29
	03 - 04hr	0.50	3	6	10	0	1	06:18	09:56	10:00	30.00
	04 - 05hr	0.74	1	4	25	0	1	06:16	20:12	07:04	4.00
	05 - 06hr	0.57	1	9	52	0	0	08:37	16:42	12:30	1.92
	06 - 07hr	0.29	6	12	52	1	0	05:39	06:44	16:28	11.54
	07 - 08hr	0.27	2	13	75	0	1	09:21	10:40	28:27	2.67
	08 - 09hr	0.39	10	49	98	2	0	10:24	11:26	17:54	10.20
	09 - 10hr	0.30	10	95	126	2	2	08:31	10:05	23:55	7.94
	10 - 11hr	0.26	16	115	119	2	2	07:07	08:24	23:18	13.45
	11 - 12hr	0.34	13	86	98	5	2	08:02	13:54	26:30	13.27
	12 - 13hr	0.51	2	45	65	3	5	07:35	22:05	20:58	3.08
	13 - 14hr	0.44	1	33	42	1	3	08:42	18:31	23:41	2.38
	14 - 15hr	0.29	5	56	76	4	1	08:18	09:18	22:38	6.58
	15 - 16hr	0.29	1	80	120	0	4	07:54	11:10	27:03	0.83
	16 - 17hr	0.29	15	48	94	2	0	08:54	12:19	29:47	15.96
	17 - 18hr	0.35	13	49	68	1	2	10:06	14:03	25:32	19.12
	18 - 19hr	0.30	7	46	53	0	1	08:47	13:26	31:59	13.21
	19 - 20hr	0.39	16	43	69	1	0	08:39	12:21	19:22	23.19
	20 - 21hr	0.55	6	29	37	0	1	22:08	25:14	20:30	16.22
	21 - 22hr	0.34	4	32	36	0	0	06:25	09:28	18:21	11.11
	22 - 23hr	0.40	4	31	44	1	0	07:27	11:09	16:43	9.09
	23 - 00hr	0.43	7	31	40	1	1	07:43	12:16	16:28	17.50
Average		0.40							12:57	20:04	

Table A.11 GPS Data for Wednesday 11th, June 03

12-Jun	Time	CWT Ratio	Jobs Entered	Templates	Dispatched	Canceled	Msgs	Pick-up	Custwait	Duration	% Called In
Thursday											
	00 - 01hr	0.52	17	55	38	0	0	08:50	14:18	13:17	44.74
	01 - 02hr	0.50	14	18	46	1	1	07:16	16:06	16:19	30.43
	02 - 03hr	0.33	3	10	14	0	0	06:45	10:50	22:30	21.43
	03 - 04hr	0.38	0	13	15	1	0	05:12	07:38	12:39	0.00
	04 - 05hr	0.41	1	4	15	0	1	08:26	14:48	21:26	6.67
	05 - 06hr	0.46	1	8	37	1	0	14:09	17:09	19:49	2.70
	06 - 07hr	0.41	3	10	49	0	2	09:36	14:04	20:06	6.12
	07 - 08hr	0.36	6	30	72	2	1	08:46	10:53	19:08	8.33
	08 - 09hr	0.41	13	62	121	4	2	10:44	16:47	23:56	10.74
	09 - 10hr	0.44	8	85	137	3	5	09:01	17:37	22:29	5.84
	10 - 11hr	0.29	4	126	126	7	8	08:43	10:45	26:25	3.17
	11 - 12hr	0.31	4	104	114	2	4	10:02	11:12	24:53	3.51
	12 - 13hr	0.28	5	99	105	6	1	09:50	11:42	29:55	4.76
	13 - 14hr	0.22	4	64	82	0	0	08:14	09:32	34:10	4.88
	14 - 15hr	0.26	4	126	114	4	10	07:04	08:46	24:50	3.51
	15 - 16hr	0.33	3	124	159	3	6	09:18	13:20	26:40	1.89
	16 - 17hr	0.36	3	93	119	2	0	09:35	17:12	30:26	2.52
	17 - 18hr	0.47	4	62	93	0	0	09:56	18:48	21:18	4.30
	18 - 19hr	0.48	6	50	66	0	1	08:10	17:49	19:06	9.09
	19 - 20hr	0.40	3	47	56	1	0	07:31	14:46	22:10	5.36
	20 - 21hr	0.30	0	56	57	0	0	07:55	09:59	23:15	0.00
	21 - 22hr	0.39	2	42	52	0	0	07:49	10:04	15:48	3.85
	22 - 23hr	0.22	4	21	38	0	0	07:28	10:04	35:50	10.53
	23 - 00hr	0.34	6	29	39	0	0	09:07	12:07	23:56	15.38
Average		0.37								13:11 22:56	

Table A.12 GPS Data for Thursday 12th, June 03

13-Jun	Time	CWT Ratio	Jobs Entered	Templates	Dispatched	Canceled	Msgs	Pick-up	Custwait	Duration	% Called In
Friday											
	00 - 01hr	0.32	9	46	26	0	0	09:46	11:56	25:44	34.62
	01 - 02hr	0.56	2	19	26	0	0	17:43	22:39	17:55	7.69
	02 - 03hr	0.34	1	19	21	0	1	05:57	08:38	16:40	4.76
	03 - 04hr	0.40	1	4	5	0	0	04:24	09:09	13:30	20.00
	04 - 05hr	0.28	1	2	13	0	2	04:35	05:29	13:59	7.69
	05 - 06hr	0.43	5	8	49	3	1	08:08	10:27	13:55	10.20
	06 - 07hr	0.23	0	8	64	0	2	05:01	05:34	18:29	0.00
	07 - 08hr	0.53	9	29	71	1	0	28:39	29:54	26:31	12.68
	08 - 09hr	0.29	12	62	126	2	1	08:29	10:17	24:52	9.52
	09 - 10hr	0.25	6	97	133	5	7	08:22	09:01	26:43	4.51
	10 - 11hr	0.20	11	89	111	4	9	08:18	08:27	33:42	9.91
	11 - 12hr	0.29	10	94	93	1	16	07:53	10:46	26:55	10.75
	12 - 13hr	0.27	5	108	112	3	1	09:21	11:49	31:31	4.46
	13 - 14hr	0.30	3	68	77	4	0	09:35	11:50	26:59	3.90
	14 - 15hr	0.28	12	98	131	2	2	08:30	13:05	33:52	9.16
	15 - 16hr	0.32	17	105	153	0	8	08:50	14:09	30:33	11.11
	16 - 17hr	0.41	6	100	134	2	0	10:08	17:11	24:47	4.48
	17 - 18hr	0.33	5	51	82	1	1	10:46	10:36	21:21	6.10
	18 - 19hr	0.43	2	67	65	0	0	06:48	14:28	19:15	3.08
	19 - 20hr	0.34	9	78	94	2	1	09:37	12:43	24:22	9.57
	20 - 21hr	0.40	5	63	77	2	0	08:58	16:33	25:08	6.49
	21 - 22hr	0.47	4	37	51	0	0	12:51	12:34	14:23	7.84
	22 - 23hr	0.24	7	53	60	0	0	10:52	08:24	25:55	11.67
	23 - 00hr	0.34	5	24	36	1	0	07:51	12:28	24:11	13.89
Average		0.34							12:25	23:23	

Table A.13 GPS Data for Friday 13th, June 03

14-Jun	Time	CWT Ratio	Jobs Entered	Templates	Dispatched	Canceled	Msgs	Pick-up	Custwait	Duration	% Called In
Saturday											
	00-01hr	0.36	11	49	50	2	0	07:11	09:40	16:51	22.00
	01-02hr	0.41	2	40	39	0	0	07:04	10:36	15:10	5.13
	02-03hr	0.39	5	15	20	0	0	07:22	08:47	13:57	25.00
	03-04hr	0.18	2	6	15	0	0	15:15	15:51	13:41	13.33
	04-05hr	0.40	2	8	21	0	0	07:01	12:01	18:12	9.52
	05-06hr	0.25	4	9	50	0	2	06:00	07:44	23:22	8.00
	06-07hr	0.38	3	13	73	1	0	05:28	09:23	15:28	4.11
	07-08hr	0.45	4	28	65	2	1	16:27	17:52	21:47	6.15
	08-09hr	0.36	1	82	122	0	6	10:12	13:54	24:41	0.82
	09-10hr	0.45	2	128	153	9	5	16:41	20:36	25:35	1.31
	10-11hr	0.27	6	124	132	3	0	08:28	09:36	26:34	4.55
	11-12hr	0.27	3	111	97	3	1	10:23	10:52	28:40	3.09
	12-13hr	0.30	9	99	114	4	8	09:17	11:19	26:20	7.89
	13-14hr	0.31	6	82	115	6	0	08:32	09:51	22:10	5.22
	14-15hr	0.26	9	119	135	3	1	09:22	10:35	30:54	6.67
	15-16hr	0.30	7	112	151	1	0	08:28	12:32	28:34	4.64
	16-17hr	0.28	5	80	114	1	0	07:44	12:10	30:55	4.39
	17-18hr	0.36	6	48	69	3	0	09:45	14:50	26:31	8.70
	18-19hr	0.31	10	97	93	0	0	08:17	12:01	26:53	10.75
	19-20hr	0.39	13	106	128	4	2	07:36	11:51	18:25	10.16
	20-21hr	0.35	9	64	88	2	0	08:57	10:23	18:56	10.23
	21-22hr	0.33	9	44	71	4	0	10:13	12:28	24:57	12.68
	22-23hr	0.40	8	37	45	2	0	08:50	10:19	15:40	17.78
	23-00hr	0.32	9	38	51	2	0	07:56	09:17	19:55	17.65
Average		0.34								11:51 24:45	

Table A.14 GPS Data for Saturday 14th, June 03

15-Jun	Time	CWT Ratio	Jobs Entered	Templates	Dispatched	Canceled	Msgs	Pick-up	Custwait	Duration	% Called In
Sunday											
	00-01hr	0.28	9	60	42	0	0	07:33	08:44	23:01	21.43
	01-02hr	0.36	7	46	61	0	0	07:47	10:11	17:57	11.48
	02-03hr	0.40	1	26	27	0	0	07:40	11:09	16:41	3.70
	03-04hr	0.37	7	22	34	0	0	07:03	12:10	20:21	20.59
	04-05hr	0.38	3	14	30	0	0	07:16	09:39	15:46	10.00
	05-06hr	0.34	3	11	55	1	1	06:08	07:22	14:26	5.45
	06-07hr	0.47	6	11	42	1	0	07:29	13:49	15:23	14.29
	07-08hr	0.23	7	10	34	1	0	06:56	07:18	24:38	20.59
	08-09hr	0.35	7	12	31	0	0	06:43	07:28	13:54	22.58
	09-10hr	0.37	13	19	43	0	0	08:42	10:36	17:51	30.23
	10-11hr	0.33	6	36	50	1	0	08:55	11:04	22:11	12.00
	11-12hr	0.40	7	31	37	0	0	07:35	15:31	23:34	18.92
	12-13hr	0.31	8	22	31	0	0	09:58	10:38	23:36	25.81
	13-14hr	0.28	11	18	36	0	0	08:47	09:42	25:11	30.56
	14-15hr	0.32	6	16	27	0	0	08:32	07:55	16:58	22.22
	15-16hr	0.37	13	11	21	0	0	06:53	12:51	22:17	61.90
	16-17hr	0.35	2	26	22	0	0	07:28	10:34	20:02	9.09
	17-18hr	0.31	4	36	30	1	0	08:43	09:17	21:00	13.33
	18-19hr	0.35	6	50	50	0	0	08:09	11:44	21:49	12.00
	19-20hr	0.26	10	53	62	1	0	08:37	10:48	29:58	16.13
	20-21hr	0.28	8	48	82	0	0	08:24	06:51	17:46	9.76
	21-22hr	0.36	6	29	45	1	0	05:59	10:21	18:03	13.33
	22-23hr	0.41	5	35	41	0	0	08:37	10:00	14:26	12.20
	23-00hr	0.39	17	12	35	1	0	07:03	10:25	16:07	48.57
Average		0.34								10:15 19:42	

Table A.15 GPS Data for Sunday 15th, June 03

16-Jun	Time	CWT Ratio	Jobs Entered	Templates	Dispatched	Canceled	Msgs	Pick-up	Custwait	Duration	% Called In
Monday											
	00- 01hr	0.35	34	26	50	1	1	09:49	11:37	21:39	68.00
	01 - 02hr	0.42	27	57	67	0	0	07:19	10:56	15:21	40.30
	02 - 03hr	0.44	10	34	48	3	1	08:17	12:50	16:22	20.83
	03 - 04hr	0.49	13	25	33	1	0	09:49	14:49	15:15	39.39
	04 - 05hr	0.62	6	17	39	2	0	14:40	24:15	14:42	15.38
	05 - 06hr	0.60	4	11	42	1	0	11:12	23:25	15:55	9.52
	06 - 07hr	0.63	6	10	37	0	1	13:18	19:37	11:37	16.22
	07 - 08hr	0.46	6	20	61	0	2	08:03	10:43	12:30	9.84
	08 - 09hr	0.51	2	18	36	0	0	09:44	12:50	12:07	5.56
	09 - 10hr	0.45	3	25	38	0	8	12:50	15:44	18:53	7.89
	10 - 11hr	0.48	8	32	43	3	0	14:51	17:26	19:12	18.60
	11 - 12hr	0.37	0	24	30	3	1	10:31	14:36	24:25	0.00
	12 - 13hr	0.46	0	17	18	0	0	09:36	22:31	26:09	0.00
	13 - 14hr	0.47	2	7	12	2	0	09:30	13:46	15:24	16.67
	14 - 15hr	0.29	1	11	14	1	0	04:38	10:52	26:09	7.14
	15 - 16hr	0.52	4	22	37	1	0	10:42	16:26	15:24	10.81
	16 - 17hr	0.31	12	48	46	3	0	09:09	15:18	33:19	26.09
	17 - 18hr	0.56	4	36	46	0	0	12:11	22:38	17:34	8.70
	18 - 19hr	0.46	10	30	38	1	0	07:34	21:08	25:18	26.32
	19 - 20hr	0.33	12	47	65	2	1	08:20	17:50	35:30	18.46
	20 - 21hr	0.49	6	33	51	1	0	06:45	16:40	17:15	11.76
	21 - 22hr	0.48	10	25	37	0	0	10:36	18:39	20:15	27.03
	22 - 23hr	0.51	12	23	39	2	0	08:04	18:01	17:35	30.77
	23 - 00hr	0.49	21	26	43	1	0	10:01	19:09	19:36	48.84
Average		0.47							16:44	19:29	

Table A.16 GPS Data for Monday 16th, June 03

17-Jun	Time	CWT Ratio	Jobs Entered	Templates	Dispatched	Canceled	Msgs	Pick-up	Custwait	Duration	% Called In
Tuesday											
	00 - 01hr	0.44	22	38	36	0	0	08:42	23:06	29:34	61.11
	01 - 02hr	0.60	12	24	31	0	0	09:08	21:40	14:30	38.71
	02 - 03hr	0.48	7	11	23	0	0	04:44	13:05	14:13	30.43
	03 - 04hr	0.50	6	5	13	0	0	10:24	15:52	15:57	46.15
	04 - 05hr	0.41	2	7	17	0	0	05:49	10:25	15:13	11.76
	05 - 06hr	0.42	1	4	50	0	0	02:33	08:35	11:41	2.00
	06 - 07hr	0.37	12	6	74	0	0	07:15	09:53	16:51	16.22
	07 - 08hr	0.37	14	28	62	1	0	12:48	14:55	25:14	22.58
	08 - 09hr	0.30	14	57	98	3	0	07:50	10:34	24:27	14.29
	09 - 10hr	0.34	15	113	145	5	2	09:50	14:08	27:31	10.34
	10 - 11hr	0.28	17	80	121	6	2	08:23	11:06	28:32	14.05
	11 - 12hr	0.22	8	82	72	1	3	07:35	08:22	30:03	11.11
	12 - 13hr	0.33	4	76	83	4	0	10:56	13:17	27:11	4.82
	13 - 14hr	0.31	2	57	104	2	3	09:24	10:22	23:12	1.92
	14 - 15hr	0.33	10	78	128	0	0	09:07	11:42	23:54	7.81
	15 - 16hr	0.30	10	90	94	1	2	07:46	11:02	25:31	10.64
	16 - 17hr	0.30	7	56	62	6	1	09:48	11:29	27:19	11.29
	17 - 18hr	0.36	11	50	52	1	1	10:27	15:06	27:20	21.15
	18 - 19hr	0.35	7	43	48	2	0	08:19	13:17	25:08	14.58
	19 - 20hr	0.33	7	34	32	1	0	06:18	08:19	16:52	21.88
	20 - 21hr	0.23	0	35	25	0	0	07:09	08:40	28:26	0.00
	21 - 22hr	0.22	0	29	29	1	0	06:57	09:58	35:26	0.00
	22 - 23hr	0.37	0	21	25	0	1	07:05	09:44	16:43	0.00
	23 - 00hr	0.31	3	17	28	1	0	06:43	09:10	20:39	10.71
Average		0.35							12:14	22:59	

Table A.17 GPS Data for Tuesday 17th, June 03

18-Jun	Time	CWT Ratio	Jobs Entered	Templates	Dispatched	Canceled	Msgs	Pick-up	Custwait	Duration	% Called In
Wednesday											
	00-01hr	0.30	9	38	31	0	0	05:33	09:11	21:13	29.03
	01-02hr	0.46	1	27	32	0	0	05:40	11:24	13:17	3.13
	02-03hr	0.37	0	8	7	0	0	06:19	09:36	16:37	0.00
	03-04hr	0.44	2	4	8	0	0	04:09	07:20	09:28	25.00
	04-05hr	0.56	1	10	21	1	0	10:18	16:15	12:41	4.76
	05-06hr	0.48	4	13	55	0	3	09:01	13:31	14:47	7.27
	06-07hr	0.21	0	14	36	0	1	03:29	03:49	14:28	0.00
	07-08hr	0.23	1	20	73	0	0	07:42	07:58	27:14	1.37
	08-09hr	0.33	18	44	109	1	1	08:57	12:24	25:09	16.51
	09-10hr	0.27	15	81	125	1	1	09:35	09:41	26:36	12.00
	10-11hr	0.29	19	83	101	2	0	08:39	09:53	24:09	18.81
	11-12hr	0.25	22	79	84	2	1	09:05	09:32	28:26	26.19
	12-13hr	0.30	18	79	91	3	9	09:46	09:53	23:08	19.78
	13-14hr	0.23	13	79	101	3	1	09:47	09:31	31:21	12.87
	14-15hr	0.30	28	63	104	2	1	09:08	12:47	29:20	26.92
	15-16hr	0.32	23	89	155	4	1	06:24	13:00	27:29	14.84
	16-17hr	0.37	24	74	123	0	0	10:04	18:39	31:20	19.51
	17-18hr	0.42	13	40	77	3	1	08:05	19:06	26:13	16.88
	18-19hr	0.49	8	42	69	3	2	06:27	17:01	17:36	11.59
	19-20hr	0.17	7	29	44	1	0	08:27	07:38	37:05	15.91
	20-21hr	0.35	3	34	44	0	0	06:59	13:14	24:38	6.82
	21-22hr	0.32	4	40	43	0	0	10:04	11:14	23:41	9.30
	22-23hr	0.43	6	38	52	1	0	08:05	10:05	13:13	11.54
	23-00hr	0.32	7	27	37	0	0	06:27	11:49	25:09	18.92
Average		0.34								11:26 22:41	

Table A.18 GPS Data for Wednesday 18th, June 03

19-Jun	Time	CWT Ratio	Jobs Entered	Templates	Dispatched	Canceled	Msgs	Pick-up	Custwait	Duration	% Called In
Thursday											
	00- 01hr	0.41	5	76	68	1	0	06:07	10:04	14:46	7.35
	01 - 02hr	0.42	6	16	29	0	0	06:11	10:44	15:05	20.69
	02 - 03hr	0.41	2	14	9	1	0	10:50	13:28	19:17	22.22
	03 - 04hr	0.20	2	2	5	0	0	04:45	05:33	21:55	40.00
	04 - 05hr	0.24	2	6	20	1	0	03:58	04:42	14:35	10.00
	05 - 06hr	0.30	0	7	44	1	0	05:58	09:04	21:11	0.00
	06 - 07hr	0.44	7	17	52	0	3	08:00	09:06	11:33	13.46
	07 - 08hr	0.40	1	25	76	0	0	11:24	13:32	20:37	1.32
	08 - 09hr	0.20	11	54	107	0	1	08:08	09:58	39:04	10.28
	09 - 10hr	0.40	19	83	151	4	2	09:39	14:09	20:59	12.58
	10 - 11hr	0.37	17	77	102	3	2	09:49	11:46	19:56	16.67
	11 - 12hr	0.31	18	97	101	3	12	09:51	10:54	24:42	17.82
	12 - 13hr	0.28	11	91	103	0	2	10:46	11:36	29:29	10.68
	13 - 14hr	0.29	3	77	93	1	0	08:57	10:22	25:33	3.23
	14 - 15hr	0.32	13	114	142	7	1	09:39	12:50	27:03	9.15
	15 - 16hr	0.31	2	100	137	5	1	08:59	11:51	26:11	1.46
	16 - 17hr	0.26	3	95	105	4	1	08:38	11:38	32:45	2.86
	17 - 18hr	0.40	5	54	75	2	0	11:28	19:45	29:48	6.67
	18 - 19hr	0.39	3	46	67	2	0	08:41	14:24	22:56	4.48
	19 - 20hr	0.37	1	54	63	1	0	10:04	13:04	21:55	1.59
	20 - 21hr	0.35	8	57	71	1	0	08:17	10:11	18:37	11.27
	21 - 22hr	0.24	7	41	49	0	0	07:17	08:57	28:07	14.29
	22 - 23hr	0.34	0	26	43	0	0	07:58	09:32	18:37	0.00
	23 - 00hr	0.29	5	29	36	0	1	06:06	07:20	17:37	13.89
Average		0.33							11:01	22:36	

Table A.19 GPS Data for Thursday 19th, June 03

20-Jun	Time	CWT Ratio	Jobs Entered	Templates	Dispatched	Canceled	Msgs	Pick-up	Custwait	Duration	% Called In
Friday											
	00 - 01hr	0.34	4	47	38	1	0	08:37	11:02	21:07	10.53
	01 - 02hr	0.41	6	21	25	0	0	08:41	09:50	13:59	24.00
	02 - 03hr	0.37	2	14	14	0	0	06:17	09:30	16:24	14.29
	03 - 04hr	0.30	1	7	12	1	0	04:36	06:09	14:38	8.33
	04 - 05hr	0.29	0	3	20	0	1	04:45	05:59	14:23	0.00
	05 - 06hr	0.63	1	8	48	1	3	10:28	25:11	14:35	2.08
	06 - 07hr	0.24	0	10	47	0	3	05:41	06:27	20:55	0.00
	07 - 08hr	0.42	8	21	70	1	1	16:18	18:32	26:04	11.43
	08 - 09hr	0.39	1	56	103	1	0	14:11	14:53	23:08	0.97
	09 - 10hr	0.31	2	109	128	2	0	09:55	12:52	28:06	1.56
	10 - 11hr	0.24	3	102	114	0	0	06:55	08:14	26:37	2.63
	11 - 12hr	0.28	1	101	104	1	0	10:11	11:22	28:54	0.96
	12 - 13hr	0.27	7	91	94	3	0	07:58	08:42	23:28	7.45
	13 - 14hr	0.32	2	80	92	0	8	08:01	11:45	25:24	2.17
	14 - 15hr	0.29	3	96	102	6	2	10:50	11:33	28:30	2.94
	15 - 16hr	0.33	5	107	154	7	0	10:04	12:53	25:59	3.25
	16 - 17hr	0.38	2	82	112	4	1	11:43	16:24	26:24	1.79
	17 - 18hr	0.32	1	63	74	0	0	10:23	15:15	32:41	1.35
	18 - 19hr	0.36	2	53	66	3	0	09:34	13:39	24:17	3.03
	19 - 20hr	0.41	6	40	65	1	1	12:06	13:53	20:10	9.23
	20 - 21hr	0.29	1	52	54	1	0	06:41	08:09	20:26	1.85
	21 - 22hr	0.21	1	50	44	1	0	06:23	08:23	32:28	2.27
	22 - 23hr	0.35	1	34	48	0	0	08:18	10:17	18:47	2.08
	23 - 00hr	0.36	7	37	52	0	1	09:06	11:01	19:54	13.46
Average		0.34								11:45 22:48	

Table A.20 GPS Data for Friday 20th, June 03

21-Jun	Time	CWT Ratio	Jobs Entered	Templates	Dispatched	Canceled	Msgs	Pick-up	Custwait	Duration	% Called In
Saturday											
	00 - 01hr	0.26	4	56	46	0	0	05:48	08:54	25:11	8.70
	01 - 02hr	0.32	1	26	31	0	1	05:48	07:29	16:09	3.23
	02 - 03hr	0.39	1	18	15	0	0	05:13	10:34	16:46	6.67
	03 - 04hr	0.43	1	7	10	0	0	08:56	12:02	15:45	10.00
	04 - 05hr	0.34	13	10	24	0	2	07:44	08:48	17:28	54.17
	05 - 06hr	0.34	2	12	50	7	2	07:38	08:39	17:08	4.00
	06 - 07hr	0.43	14	15	69	0	0	07:35	09:38	12:35	20.29
	07 - 08hr	0.31	24	37	72	2	3	08:16	12:18	27:42	33.33
	08 - 09hr	0.32	10	59	116	4	1	09:24	13:07	27:21	8.62
	09 - 10hr	0.50	4	78	131	4	7	11:39	22:08	21:53	3.05
	10 - 11hr	0.34	8	119	121	3	2	12:42	14:46	29:14	6.61
	11 - 12hr	0.26	13	124	110	3	6	11:04	12:14	35:07	11.82
	12 - 13hr	0.28	12	100	116	5	0	10:58	13:38	34:55	10.34
	13 - 14hr	0.35	6	89	113	4	0	10:37	14:07	25:42	5.31
	14 - 15hr	0.30	6	99	121	2	4	08:49	12:39	28:50	4.96
	15 - 16hr	0.37	7	124	142	2	5	10:36	15:43	27:11	4.93
	16 - 17hr	0.37	4	68	117	0	0	08:49	18:13	31:14	3.42
	17 - 18hr	0.32	6	65	80	2	0	10:36	12:55	27:58	7.50
	18 - 19hr	0.31	16	78	92	1	0	08:48	10:57	24:21	17.39
	19 - 20hr	0.31	10	54	95	8	0	08:42	11:43	25:58	10.53
	20 - 21hr	0.29	6	57	70	1	0	07:44	10:18	25:35	8.57
	21 - 22hr	0.27	10	32	49	1	0	08:07	08:07	22:07	20.41
	22 - 23hr	0.35	6	29	40	1	0	07:54	12:05	22:32	15.00
	23 - 00hr	0.39	9	34	47	1	0	07:47	10:04	16:00	19.15
Average		0.34						12:08	23:57		

Table A.21 GPS Data for Saturday 21st, June 03

22-Jun	Time	CWT Ratio	Jobs Entered	Templates	Dispatched	Canceled	Msgs	Pick-up	Custwait	Duration	% Called In
Sunday											
	00- 01hr	0.33	9	54	53	1	0	07:46	09:05	18:11	16.98
	01 - 02hr	0.36	5	47	58	0	1	10:34	12:43	22:26	8.62
	02 - 03hr	0.36	12	25	35	1	0	08:27	10:31	19:06	34.29
	03 - 04hr	0.36	4	24	32	1	0	08:34	12:13	21:52	12.50
	04 - 05hr	0.37	4	23	35	0	1	07:44	10:01	17:25	11.43
	05 - 06hr	0.44	3	16	32	0	1	06:58	09:28	12:16	9.38
	06 - 07hr	0.48	1	13	35	1	0	09:59	11:28	12:36	2.86
	07 - 08hr	0.28	7	12	50	0	0	06:23	07:53	20:10	14.00
	08 - 09hr	0.40	3	24	32	1	0	05:22	09:18	13:48	9.38
	09 - 10hr	0.26	4	32	37	0	0	08:06	09:27	26:16	10.81
	10 - 11hr	0.27	5	24	35	0	0	08:16	12:51	35:07	14.29
	11 - 12hr	0.43	1	27	37	0	1	14:12	17:57	23:29	2.70
	12 - 13hr	0.17	2	24	41	0	0	06:07	06:33	31:40	4.88
	13 - 14hr	0.27	6	19	34	0	0	08:15	10:13	27:42	17.65
	14 - 15hr	0.57	6	24	27	1	0	23:09	25:17	18:46	22.22
	15 - 16hr	0.46	1	33	31	0	0	10:47	13:29	16:09	3.23
	16 - 17hr	0.38	0	32	31	0	0	12:56	16:51	27:52	0.00
	17 - 18hr	0.35	5	39	31	0	0	09:14	11:10	20:25	16.13
	18 - 19hr	0.28	3	62	39	1	0	08:18	10:39	27:11	7.69
	19 - 20hr	0.37	13	54	28	3	0	08:57	10:14	17:11	46.43
	20 - 21hr	0.33	7	28	44	0	0	09:26	12:04	24:17	15.91
	21 - 22hr	0.36	8	35	81	1	0	10:13	11:46	21:05	9.88
	22 - 23hr	0.50	2	40	54	3	0	09:57	13:54	13:43	3.70
	23 - 00hr	0.44	13	36	57	2	0	10:53	14:04	17:52	22.81
Average		0.37								12:03 21:06	

Table A.22 GPS Data for Sunday 22nd, June 03

23-Jun	Time	CWT Ratio	Jobs Entered	Templates	Dispatched	Canceled	Msgs	Pick-up	Custwait	Duration	% Called In
Monday											
	00 - 01hr	0.40	13	48	51	0	0	08:53	11:13	16:29	25.49
	01 - 02hr	0.47	12	37	47	1	0	09:56	13:04	14:34	25.53
	02 - 03hr	0.40	7	34	36	0	0	07:56	12:32	18:43	19.44
	03 - 04hr	0.37	15	26	34	0	1	07:09	10:34	18:08	44.12
	04 - 05hr	0.42	3	28	43	2	0	08:07	11:58	16:34	6.98
	05 - 06hr	0.43	2	17	40	0	0	09:03	13:10	17:17	5.00
	06 - 07hr	0.33	3	15	38	0	0	10:34	07:41	15:18	7.89
	07 - 08hr	0.30	1	11	35	0	0	08:48	05:49	13:48	2.86
	08 - 09hr	0.17	4	23	42	0	0	06:53	08:01	37:59	9.52
	09 - 10hr	0.31	0	19	21	0	0	05:21	11:23	25:43	0.00
	10 - 11hr	0.61	4	9	19	0	0	05:58	36:08	23:30	21.05
	11 - 12hr	0.27	1	33	26	0	1	09:13	10:17	27:23	3.85
	12 - 13hr	0.34	3	35	32	0	0	33:57	15:01	29:24	9.38
	13 - 14hr	0.39	8	28	49	1	0	07:54	17:03	26:09	16.33
	14 - 15hr	0.53	3	25	27	1	0	10:50	18:53	16:55	11.11
	15 - 16hr	0.43	5	24	33	2	0	09:22	16:18	21:38	15.15
	16 - 17hr	0.41	11	25	33	1	0	13:03	11:01	15:37	33.33
	17 - 18hr	0.36	4	27	38	0	0	08:34	14:05	24:54	10.53
	18 - 19hr	0.38	4	24	39	0	0	08:25	11:08	18:15	10.26
	19 - 20hr	0.18	4	23	28	0	0	10:22	05:51	26:42	14.29
	20 - 21hr	0.49	2	21	26	0	0	08:06	15:00	15:46	7.69
	21 - 22hr	0.38	5	11	13	0	0	04:53	11:11	17:58	38.46
	22 - 23hr	0.42	8	14	25	0	0	11:40	13:07	17:46	32.00
	23 - 00hr	0.38	9	17	26	1	0	07:49	12:27	19:57	34.62
Average		0.38							13:02	20:41	

Table A.23 GPS Data for Monday 23rd, June 03

24-Jun	Time	CWT Ratio	Jobs Entered	Templates	Dispatched	Canceled	Msgs	Pick-up	Custwait	Duration	% Called In
Tuesday											
	00-01hr	0.44	4	45	28	1	0	08:05	13:36	17:26	14.29
	01-02hr	0.54	10	27	33	1	0	08:24	17:38	15:01	30.30
	02-03hr	0.47	3	13	16	0	0	06:50	13:32	15:27	18.75
	03-04hr	0.28	2	11	13	0	1	06:03	08:23	21:59	15.38
	04-05hr	0.33	3	12	29	0	0	05:40	07:21	14:41	10.34
	05-06hr	0.48	1	6	53	0	0	08:08	17:25	18:42	1.89
	06-07hr	0.39	0	12	57	1	0	10:12	15:02	23:37	0.00
	07-08hr	0.38	7	24	59	1	0	13:25	13:40	22:40	11.86
	08-09hr	0.27	3	62	106	2	0	09:12	10:41	29:03	2.83
	09-10hr	0.27	6	89	121	2	0	09:55	14:05	37:44	4.96
	10-11hr	0.25	5	76	96	1	6	07:46	08:17	24:17	5.21
	11-12hr	0.25	5	86	81	4	0	08:51	10:01	30:07	6.17
	12-13hr	0.24	3	91	102	6	0	08:43	08:29	26:48	2.94
	13-14hr	0.30	4	90	85	1	1	08:20	10:55	25:08	4.71
	14-15hr	0.28	4	57	112	0	0	07:12	10:36	27:06	3.57
	15-16hr	0.28	9	56	111	2	0	09:16	11:01	28:58	8.11
	16-17hr	0.23	1	45	97	1	8	08:25	10:10	34:59	1.03
	17-18hr	0.28	10	41	61	0	3	08:47	08:42	22:56	16.39
	18-19hr	0.26	5	31	63	0	3	07:41	06:49	19:22	7.94
	19-20hr	0.29	1	25	56	3	0	06:26	08:10	20:09	1.79
	20-21hr	0.32	2	34	30	0	0	05:21	09:01	19:30	6.67
	21-22hr	0.46	1	38	27	0	0	06:23	12:48	14:52	3.70
	22-23hr	0.34	2	33	47	1	0	05:49	10:41	20:33	4.26
	23-00hr	0.24	1	27	39	0	0	08:42	10:28	34:01	2.56
Average		0.33						11:09	23:33		

Table A.24 GPS Data for Tuesday 24th, June 03

25-Jun	Time	CWT Ratio	Jobs Entered	Templates	Dispatched	Canceled	Msgs	Pick-up	Custwait	Duration	% Called In
Wednesday											
	00- 01hr	0.29	8	38	33	0	0	05:33	07:46	19:19	24.24
	01 - 02hr	0.37	5	16	26	0	0	06:59	09:29	16:03	19.23
	02 - 03hr	0.18	1	3	5	1	0	05:35	07:13	32:30	20.00
	03 - 04hr	0.29	1	5	9	1	0	04:39	06:46	16:29	11.11
	04 - 05hr	0.39	0	4	19	2	1	05:17	07:11	11:13	0.00
	05 - 06hr	0.42	1	5	41	0	12	07:35	08:08	11:14	2.44
	06 - 07hr	0.38	2	15	44	0	1	08:51	09:34	15:25	4.55
	07 - 08hr	0.30	3	26	64	2	0	06:50	07:59	18:37	4.69
	08 - 09hr	0.30	10	50	114	0	0	08:37	11:40	27:28	8.77
	09 - 10hr	0.39	10	96	152	2	3	08:42	15:50	25:06	6.58
	10 - 11hr	0.31	5	96	103	1	14	09:47	11:52	26:48	4.85
	11 - 12hr	0.31	8	81	95	2	1	09:30	10:40	24:02	8.42
	12 - 13hr	0.30	4	100	92	4	5	08:38	09:36	22:15	4.35
	13 - 14hr	0.31	3	64	79	0	1	07:18	10:02	22:47	3.80
	14 - 15hr	0.26	7	81	127	0	2	09:19	08:56	25:44	5.51
	15 - 16hr	0.33	6	100	124	6	4	09:41	11:34	23:43	4.84
	16 - 17hr	0.35	5	83	62	4	1	11:00	14:12	26:40	8.06
	17 - 18hr	0.33	2	53	61	2	0	11:40	15:56	33:05	3.28
	18 - 19hr	0.49	4	66	69	1	0	08:50	20:53	21:19	5.80
	19 - 20hr	0.41	2	45	36	7	1	06:47	13:41	20:03	5.56
	20 - 21hr	0.27	2	36	30	0	0	07:31	10:54	29:58	6.67
	21 - 22hr	0.32	0	31	43	0	0	07:34	08:49	18:55	0.00
	22 - 23hr	0.38	4	33	45	1	0	10:19	09:36	15:47	8.89
	23 - 00hr	0.42	17	31	41	2	1	08:52	15:21	22:00	41.46
Average		0.34						10:59	21:56		

Table A.25 GPS Data for Wednesday 25th, June 03

26-Jun	Time	CWT Ratio	Jobs Entered	Templates	Dispatched	Canceled	Msgs	Pick-up	Custwait	Duration	% Called In
Thursday											
	00 - 01hr	0.51	17	42	33	1	0	07:45	15:46	15:14	51.52
	01 - 02hr	0.45	13	21	40	1	0	06:40	12:38	15:37	32.50
	02 - 03hr	0.58	5	11	6	0	0	14:39	19:17	14:04	83.33
	03 - 04hr	0.63	4	5	10	0	0	12:35	16:27	09:44	40.00
	04 - 05hr	0.43	4	2	19	0	2	14:02	15:23	20:10	21.05
	05 - 06hr	0.61	4	12	53	4	3	06:46	20:50	13:27	7.55
	06 - 07hr	0.41	42	16	58	0	0	08:39	11:11	15:55	72.41
	07 - 08hr	0.46	7	20	64	0	1	12:45	16:46	19:37	10.94
	08 - 09hr	0.34	8	68	124	1	0	14:00	16:54	32:59	6.45
	09 - 10hr	0.39	9	80	127	2	0	09:00	15:33	24:04	7.09
	10 - 11hr	0.30	5	98	110	0	0	09:31	11:51	27:25	4.55
	11 - 12hr	0.27	11	101	112	3	0	08:01	08:38	23:46	9.82
	12 - 13hr	0.30	9	84	94	2	0	08:21	09:17	21:54	9.57
	13 - 14hr	0.30	1	76	86	0	1	08:12	09:43	22:40	1.16
	14 - 15hr	0.26	4	82	120	5	11	07:39	08:37	24:46	3.33
	15 - 16hr	0.25	6	84	126	5	2	08:24	09:14	27:50	4.76
	16 - 17hr	0.38	6	90	63	5	0	12:25	16:03	26:18	9.52
	17 - 18hr	0.39	7	61	59	2	2	09:52	15:31	24:12	11.86
	18 - 19hr	0.37	6	48	75	1	0	09:06	13:24	23:06	8.00
	19 - 20hr	0.43	9	52	51	1	1	09:03	14:01	18:29	17.65
	20 - 21hr	0.37	4	38	58	0	0	08:56	12:12	21:08	6.90
	21 - 22hr	0.30	3	50	41	0	0	08:54	10:43	24:44	7.32
	22 - 23hr	0.38	4	31	47	0	1	09:37	11:33	18:45	8.51
	23 - 00hr	0.30	14	30	34	0	0	07:47	10:14	23:34	41.18
Average		0.39							13:24	21:14	

Table A.26 GPS Data for Thursday 26th, June 03

27-Jun	Time	CWT Ratio	Jobs Entered	Templates	Dispatched	Canceled	Msgs	Pick-up	Custwait	Duration	% Called In
Friday											
	00- 01hr	0.46	30	45	42	0	0	10:02	14:02	16:31	71.43
	01 - 02hr	0.51	12	20	36	0	0	07:50	16:00	15:36	33.33
	02 - 03hr	0.30	6	10	16	0	0	06:25	08:21	19:34	37.50
	03 - 04hr	0.52	6	8	18	0	4	07:49	15:48	14:25	33.33
	04 - 05hr	0.44	4	3	25	0	0	09:05	11:33	14:40	16.00
	05 - 06hr	0.67	3	4	57	0	1	10:59	27:20	13:34	5.26
	06 - 07hr	0.29	6	14	56	0	1	06:10	06:39	16:22	10.71
	07 - 08hr	0.37	17	20	87	3	1	10:14	13:26	22:38	19.54
	08 - 09hr	0.34	3	62	113	2	7	09:59	15:50	30:20	2.65
	09 - 10hr	0.34	6	83	126	2	5	09:00	12:12	24:04	4.76
	10 - 11hr	0.27	4	97	122	5	0	09:01	09:29	25:19	3.28
	11 - 12hr	0.29	8	107	116	1	0	11:00	11:13	27:56	6.90
	12 - 13hr	0.26	7	113	109	1	0	08:33	10:39	29:34	6.42
	13 - 14hr	0.26	9	77	92	4	0	10:20	11:19	31:45	9.78
	14 - 15hr	0.36	2	122	135	2	7	09:02	12:17	21:32	1.48
	15 - 16hr	0.33	10	98	137	1	19	09:29	13:36	27:51	7.30
	16 - 17hr	0.25	5	75	113	5	2	08:43	08:45	26:07	4.42
	17 - 18hr	0.28	5	55	66	2	1	10:33	13:29	34:32	7.58
	18 - 19hr	0.25	7	63	80	2	0	06:57	08:41	26:11	8.75
	19 - 20hr	0.29	6	46	66	3	0	09:53	07:50	19:14	9.09
	20 - 21hr	0.18	2	37	46	0	0	07:18	08:30	37:49	4.35
	21 - 22hr	0.32	7	36	37	0	0	06:41	10:04	21:19	18.92
	22 - 23hr	0.34	11	31	50	1	0	06:07	12:00	22:58	22.00
	23 - 00hr	0.34	15	30	49	0	0	08:42	08:49	17:04	30.61
Average		0.34							12:00	23:12	

Table A.27 GPS Data for Friday 27th, June 03

28-Jun	Time	CWT Ratio	Jobs Entered	Templates	Dispatched	Canceled	Msgs	Pick-up	Custwait	Duration	% Called In
Saturday											
	00- 01hr	0.29	15	52	60	1	0	06:16	07:31	18:00	25.00
	01 - 02hr	0.34	25	48	59	1	0	07:51	09:18	17:49	42.37
	02 - 03hr	0.30	17	23	39	0	0	05:02	07:52	18:18	43.59
	03 - 04hr	0.37	5	21	32	0	0	06:27	10:14	17:06	15.63
	04 - 05hr	0.32	4	9	25	0	8	08:39	09:01	19:16	16.00
	05 - 06hr	0.31	1	13	60	2	0	05:49	06:45	15:06	1.67
	06 - 07hr	0.40	7	12	49	0	2	07:53	09:15	14:04	14.29
	07 - 08hr	0.36	10	23	62	2	1	09:26	10:45	19:05	16.13
	08 - 09hr	0.32	4	65	110	1	1	10:06	13:00	28:05	3.64
	09 - 10hr	0.44	4	102	136	0	0	09:53	20:50	26:32	2.94
	10 - 11hr	0.25	5	113	126	3	2	08:46	11:06	32:30	3.97
	11 - 12hr	0.34	2	117	106	3	9	11:57	13:13	25:51	1.89
	12 - 13hr	0.33	9	84	101	2	14	10:32	12:46	25:34	8.91
	13 - 14hr	0.27	8	92	117	2	1	08:47	10:41	28:15	6.84
	14 - 15hr	0.33	4	108	128	1	2	12:11	13:31	27:49	3.13
	15 - 16hr	0.31	7	90	119	2	1	08:56	13:38	29:49	5.88
	16 - 17hr	0.32	2	98	133	4	0	09:34	12:05	25:51	1.50
	17 - 18hr	0.31	4	65	78	0	0	09:24	11:50	26:32	5.13
	18 - 19hr	0.27	6	62	68	1	1	06:41	08:22	22:22	8.82
	19 - 20hr	0.37	7	63	79	1	0	09:56	11:20	19:28	8.86
	20 - 21hr	0.32	4	60	81	4	0	08:20	11:15	23:51	4.94
	21 - 22hr	0.36	5	48	52	0	0	12:18	14:32	25:24	9.62
	22 - 23hr	0.40	6	38	50	0	0	09:58	11:34	17:23	12.00
	23 - 00hr	0.33	11	49	62	1	0	06:37	09:51	19:38	17.74
Average		0.33								11:16 22:39	

Table A.28 GPS Data for Saturday 28th, June 03

29-Jun	Time	CWT Ratio	Jobs Entered	Templates	Dispatched	Canceled	Msgs	Pick-up	Custwait	Duration	% Called In
Sunday											
	00-01hr	0.36	10	58	65	0	0	07:33	09:57	17:42	15.38
	01-02hr	0.38	14	39	55	1	0	08:30	12:00	19:28	25.45
	02-03hr	0.35	7	43	42	0	0	05:50	08:55	16:23	16.67
	03-04hr	0.35	6	22	35	1	6	07:06	11:36	21:50	17.14
	04-05hr	0.46	7	19	37	2	0	09:33	13:10	15:39	18.92
	05-06hr	0.42	5	17	45	0	0	06:06	11:27	15:37	11.11
	06-07hr	0.45	3	13	34	0	0	08:58	12:22	14:49	8.82
	07-08hr	0.37	5	21	40	0	0	07:53	12:01	20:35	12.50
	08-09hr	0.37	1	20	38	0	0	08:02	10:37	18:26	2.63
	09-10hr	0.44	5	38	50	0	1	10:57	14:06	17:51	10.00
	10-11hr	0.35	6	33	40	1	0	09:07	10:25	19:26	15.00
	11-12hr	0.47	2	33	35	0	2	16:00	18:05	20:35	5.71
	12-13hr	0.39	3	29	40	2	2	12:02	16:47	26:38	7.50
	13-14hr	0.30	1	25	39	1	0	08:05	09:33	22:07	2.56
	14-15hr	0.34	2	22	23	1	1	13:02	13:50	26:50	8.70
	15-16hr	0.34	0	27	27	0	1	07:42	09:31	18:44	0.00
	16-17hr	0.24	4	32	30	0	0	09:12	11:10	34:47	13.33
	17-18hr	0.38	7	42	31	2	0	09:10	14:19	23:00	22.58
	18-19hr	0.38	7	46	45	1	1	09:36	13:28	22:16	15.56
	19-20hr	0.45	12	55	61	2	0	08:43	13:21	16:14	19.67
	20-21hr	0.29	14	53	77	0	1	08:12	10:19	25:28	18.18
	21-22hr	0.38	6	31	68	2	0	09:19	11:44	18:59	8.82
	22-23hr	0.50	8	30	47	3	0	10:43	14:52	14:46	17.02
	23-00hr	0.40	1	29	40	1	3	08:16	10:41	16:12	2.50
Average		0.38								12:16 20:11	

Table A.29 GPS Data for Sunday 29th, June 03

30-Jun	Time	CWT Ratio	Jobs Entered	Templates	Dispatched	Canceled	Msgs	Pick-up	Custwait	Duration	% Called In
Monday											
	00-01hr	0.39	2	60	50	2	1	07:45	10:42	16:40	4.00
	01-02hr	0.35	10	41	49	3	1	07:24	11:17	21:12	20.41
	02-03hr	0.46	13	39	56	0	0	08:01	13:41	16:17	23.21
	03-04hr	0.41	11	34	36	2	0	08:34	13:41	19:36	30.56
	04-05hr	0.43	9	26	49	1	0	07:34	13:24	17:39	18.37
	05-06hr	0.55	6	17	43	0	0	09:33	16:01	13:21	13.95
	06-07hr	0.41	2	21	36	3	1	09:05	14:05	20:39	5.56
	07-08hr	0.42	2	18	55	0	0	08:22	12:16	17:10	3.64
	08-09hr	0.42	4	14	33	0	0	10:27	11:42	16:16	12.12
	09-10hr	0.57	5	21	31	3	1	17:47	15:29	11:42	16.13
	10-11hr	0.49	6	37	37	1	0	15:52	18:57	19:56	16.22
	11-12hr	0.32	8	46	50	1	1	09:35	17:12	36:52	16.00
	12-13hr	0.30	5	27	37	2	0	09:46	13:21	31:37	13.51
	13-14hr	0.53	5	18	31	1	1	11:13	19:01	16:36	16.13
	14-15hr	0.35	3	31	34	1	1	07:39	14:16	26:42	8.82
	15-16hr	0.42	5	19	35	0	0	08:27	14:35	20:04	14.29
	16-17hr	0.43	10	26	36	2	0	21:22	14:54	19:34	27.78
	17-18hr	0.41	3	34	41	0	0	08:09	22:44	32:46	7.32
	18-19hr	0.31	4	27	34	0	0	13:58	10:13	22:51	11.76
	19-20hr	0.56	3	24	33	1	0	09:58	18:12	14:26	9.09
	20-21hr	0.26	6	19	29	1	0	08:12	12:31	35:55	20.69
	21-22hr	0.46	2	27	23	0	0	09:51	12:31	14:45	8.70
	22-23hr	0.52	7	17	30	1	0	07:52	13:40	12:37	23.33
	23-00hr	0.43	9	25	34	3	0	07:28	11:05	14:41	26.47
Average		0.42							14:24	20:25	

Table A.30 GPS Data for Monday 30th, June 03

APPENDIX B

RESULTS FROM GPS DATA

	Sundays	Mondays	Tuesdays	Wednesdays	Thursdays	Fridays	Saturdays
	0:45:46	42:28	22:43	19:12	26:09	18:02	26:45
	27:39	21:14	25:14	25:14	18:48	29:54	20:36
	15:31	24:15	23:06	19:06	19:45	25:11	22:08
	25:17	36:08	17:38	20:53	20:50	27:20	20:50
	18:05	22:44					
Maximum	0:45:46	42:28	25:14	25:14	26:09	29:54	26:45

Table B.1 Maximum Customer Waiting Time each day (June, 03)

	Sundays	Mondays	Tuesdays	Wednesdays	Thursdays	Fridays	Saturdays
	09:09	08:02	08:12	07:13	07:56	04:35	08:23
	07:40	09:48	06:42	06:44	07:38	05:29	07:44
	06:51	10:43	08:19	03:49	04:42	05:59	07:29
	06:33	05:49	06:49	06:46	08:37	06:39	06:45
	08:55	10:13					
Minimum	06:33	05:49	06:42	03:49	04:42	04:35	06:45

Table B.2 Minimum Customer Waiting Time each day (June, 03)

	Sundays	Mondays	Tuesdays	Wednesdays	Thursdays	Fridays	Saturdays
	72	73	58	122	147	148	147
	88	62	145	126	159	153	153
	82	67	145	155	151	154	142
	81	51	121	152	127	137	136
	77	56					
Maximum	88	73	145	155	159	154	153

Table B.3 Maximum taxis dispatched each day per hour (June, 03)

	Sundays	Mondays	Tuesdays	Wednesdays	Thursdays	Fridays	Saturdays
	18	17	14	6	15	11	13
	24	16	9	7	14	5	15
	21	12	13	7	5	12	10
	27	13	13	5	6	16	25
	23	23					
Minimum	18	12	9	5	5	5	10

Table B.4 Minimum taxis dispatched each day per hour (June, 03)

	Sundays	Mondays	Tuesdays	Wednesdays	Thursdays	Fridays	Saturdays
	0.75	0.72	0.61	0.59	0.59	0.54	0.59
	0.49	0.56	0.58	0.74	0.52	0.56	0.45
	0.47	0.63	0.6	0.56	0.44	0.63	0.5
	0.57	0.61	0.54	0.49	0.63	0.67	0.44
	0.5	0.57					
Maximum	0.75	0.72	0.61	0.74	0.63	0.67	0.59

Table B.5 Maximum Customer Waiting Time Ratio (June, 03)

	Sundays	Mondays	Tuesdays	Wednesdays	Thursdays	Fridays	Saturdays
	0.33	0.32	0.24	0.23	0.28	0.21	0.24
	0.19	0.14	0.23	0.26	0.22	0.2	0.18
	0.23	0.29	0.22	0.17	0.2	0.21	0.26
	0.17	0.17	0.23	0.18	0.25	0.18	0.25
	0.24	0.26					
Minimum	0.17	0.14	0.22	0.17	0.2	0.18	0.18

Table B.6 Minimum Customer Waiting Time Ratio (June, 03)

Sundays			
	Avg. Customer Waiting Time	Avg. Travel Time	Avg. CWT Ratio
1st June	15.34	18.09	0.45
8th June	11.45	39.05	0.35
15th June	10.15	19.42	0.34
22nd June	12.03	21.06	0.37
29th June	12.16	20.11	0.38
Average	12.226	23.546	0.378

Table B.7 Averages for Transport Variables for Sundays

Mondays			
	Avg. Customer Waiting Time	Avg. Travel Time	Avg. CWT Ratio
2nd June	14.48	16.46	0.46
9th June	14.07	21.19	0.42
16th June	16.44	19.29	0.47
23rd June	13.02	20.41	0.38
30th June	14.24	20.25	0.42
Average	14.45	19.52	0.43

Table B.8 Averages for Transport Variables for Mondays

Tuesdays			
	Avg. Customer Waiting Time	Avg. Travel Time	Avg. CWT Ratio
3rd June	13.36	17.39	0.43
10th June	11.15	21.28	0.35
17th June	12.14	22.59	0.35
24th June	11.09	23.33	0.33
Average	11.935	21.1475	0.365

Table B.9 Averages for Transport Variables for Tuesdays

Wednesdays			
	Avg. Customer Waiting Time	Avg. Travel Time	Avg. CWT Ratio
4th June	12.12	22.28	0.36
11th June	12.57	20.04	0.4
18th June	11.26	22.41	0.34
25th June	10.59	21.56	0.34
Average	11.635	21.5725	0.36

Table B.10 Averages for Transport Variables for Wednesdays

Thursdays			
	Avg. Customer Waiting Time	Avg. Travel Time	Avg. CWT Ratio
5th June	13.57	21.33	0.39
12th June	13.11	22.56	0.37
19th June	11.01	22.36	0.33
26th June	13.24	21.14	0.39
Average	12.7325	21.8475	0.37

Table B.11 Averages for Transport Variables for Thursdays

Fridays			
	Avg. Customer Waiting Time	Avg. Travel Time	Avg. CWT Ratio
6th June	11.28	20.59	0.35
13th June	12.25	23.23	0.34
20th June	11.45	22.48	0.34
27th June	12	23.12	0.34
Average	11.745	22.355	0.343

Table B.12 Averages for Transport Variables for Fridays

Saturdays			
	Avg. Customer Waiting Time	Avg. Travel Time	Avg. CWT Ratio
7th June	13.54	24.03	0.37
14th June	11.51	24.45	0.34
21st June	12.08	23.57	0.34
28th June	11.16	22.39	0.33
Average	12.0725	23.61	0.345

Table B.13 Averages for Transport Variables for Saturdays

Time	1st June	8th June	15th June	22nd June	29th June	T. Avg
06 - 07hr	11:31	15:39	15:23	12:36	14:49	
07 - 08hr	16:28	21:23	24:38	20:10	20:35	
08 - 09hr	24:00	16:57	13:54	13:48	18:26	
09 - 10hr	14:27	34:03	17:51	26:16	17:51	
Avg.	16:37	22:01	17:57	18:13	17:55	18:32

Table B.14 Average Travel Time on Sunday mornings in June

Time	2nd June	9th June	16th June	23rd June	30th June	T. Avg
06 - 07hr	09:04	12:03	11:37	15:18	20:39	
07 - 08hr	10:19	14:51	12:30	13:48	17:10	
08 - 09hr	16:27	13:26	12:07	37:59	16:16	
09 - 10hr	17:37	25:08	18:53	25:43	11:42	
Avg.	13:22	16:22	13:47	23:12	16:27	16:38

Table B.15 Average Travel Time on Monday mornings in June

Time	3rd June	10th June	17th June	24th June	T. Avg
06 - 07hr	13:20	12:12	16:51	15:25	
07 - 08hr	16:22	22:34	25:14	18:37	
08 - 09hr	14:34	29:55	24:27	27:28	
09 - 10hr	25:48	24:50	27:31	25:06	
Avg.	17:31	22:23	23:31	21:39	21:16

Table B.16 Average Travel Time on Tuesday mornings in June

Time	4th June	11th June	18th June	25th June	T. Avg
06 - 07hr	10:02	16:28	14:28	15:25	
07 - 08hr	21:23	28:27	27:14	18:37	
08 - 09hr	23:45	17:54	25:09	27:28	
09 - 10hr	27:49	23:55	26:36	25:06	
Avg.	20:45	21:41	23:22	21:39	21:52

Table B.17 Average Travel Time on Wednesday mornings in June

Time	5th June	12th June	19th June	26th June	T. Avg
06 - 07hr	20:24	20:06	11:33	15:55	
07 - 08hr	22:58	19:08	20:37	19:37	
08 - 09hr	23:33	23:56	39:04	32:59	
09 - 10hr	26:58	22:29	20:59	24:04	
Avg.	23:28	21:25	23:03	23:09	22:46

Table B.18 Average Travel Time on Thursday mornings in June

Time	6th June	13th June	20th June	27th June	T. Avg
06 - 07hr	18:43	18:29	20:55	16:22	
07 - 08hr	27:08	26:31	26:04	22:38	
08 - 09hr	19:54	24:52	23:08	30:20	
09 - 10hr	24:48	26:43	28:06	24:04	
Avg.	22:38	24:09	24:33	23:21	23:40

Table B.19 Average Travel Time on Friday mornings in June

Time	7th June	14th June	21st June	28th June	T. Avg
06 - 07hr	15:07	15:28	12:35	14:04	
07 - 08hr	15:24	21:47	27:42	19:05	
08 - 09hr	27:37	24:41	27:21	28:05	
09 - 10hr	30:31	25:35	21:53	26:32	
Avg.	22:10	21:53	22:23	21:56	22:05

Table B.20 Average Travel Time on Saturday mornings in June

Time	1st June	8th June	15th June	22nd June	29th June	T. Avg
06 - 07hr	23:55	22:14	22:17	22:17	18:44	
07 - 08hr	17:19	32:46	20:02	20:02	34:47	
08 - 09hr	23:09	23:38	21:00	21:00	23:00	
09 - 10hr	19:37	25:56	21:49	21:49	22:16	
Avg.	21:00	26:09	21:17	21:17	24:42	22:53

Table B.21 Average Travel Time on Sunday evenings in June

Time	2nd June	9th June	16th June	23rd June	30th June	T. Avg
06 - 07hr	19:59	21:45	15:24	21:38	20:04	
07 - 08hr	14:48	25:08	33:19	15:37	19:34	
08 - 09hr	18:05	17:28	17:34	24:54	32:46	
09 - 10hr	20:20	15:46	25:18	18:15	22:51	
Avg.	18:18	20:02	22:54	20:06	23:49	21:02

Table B.22 Average Travel Time on Monday evenings in June

Time	3rd June	10th June	17th June	24th June	T. Avg
06 - 07hr	19:46	38:17	25:31	28:58	
07 - 08hr	19:02	30:09	27:19	34:59	
08 - 09hr	19:45	19:13	27:20	22:56	
09 - 10hr	14:14	22:48	25:08	19:22	
Avg.	18:12	27:37	26:19	26:34	24:40

Table B.23 Average Travel Time on Tuesday evenings in June

Time	4th June	11th June	18th June	25th June	T. Avg
06 - 07hr	23:44	27:03	27:29	23:43	
07 - 08hr	40:27	29:47	31:20	26:40	
08 - 09hr	32:13	25:32	26:13	33:05	
09 - 10hr	26:12	31:59	17:36	21:19	
Avg.	30:39	28:35	25:39	26:12	27:46

Table B.24 Average Travel Time on Wednesday evenings in June

Time	5th June	12th June	19th June	26th June	T. Avg
06 - 07hr	20:12	26:40	26:11	27:50	
07 - 08hr	26:21	30:26	32:45	26:18	
08 - 09hr	31:05	21:18	29:48	24:12	
09 - 10hr	23:29	19:06	22:56	23:06	
Avg.	25:17	24:22	27:55	25:22	25:44

Table B.25 Average Travel Time on Thursday evenings in June

Time	6th June	13th June	20th June	27th June	T. Avg
06 - 07hr	34:55	30:33	25:59	27:51	
07 - 08hr	23:11	24:47	26:24	26:07	
08 - 09hr	17:22	21:21	32:41	34:32	
09 - 10hr	19:40	19:15	24:17	26:11	
Avg.	23:47	23:59	27:20	28:40	25:57

Table B.26 Average Travel Time on Friday evenings in June

Time	7th June	14th June	21st June	28th June	T. Avg
06 - 07hr	28:08	28:34	27:11	29:49	
07 - 08hr	31:45	30:55	31:14	25:51	
08 - 09hr	35:16	26:31	27:58	26:32	
09 - 10hr	26:28	26:53	24:21	22:22	
Avg.	30:24	28:13	27:41	26:09	28:07

Table B.27 Average Travel Time on Saturday evenings in June

APPENDIX C

TRANSPORT VARIABLES' FIGURES OF GPS DATA

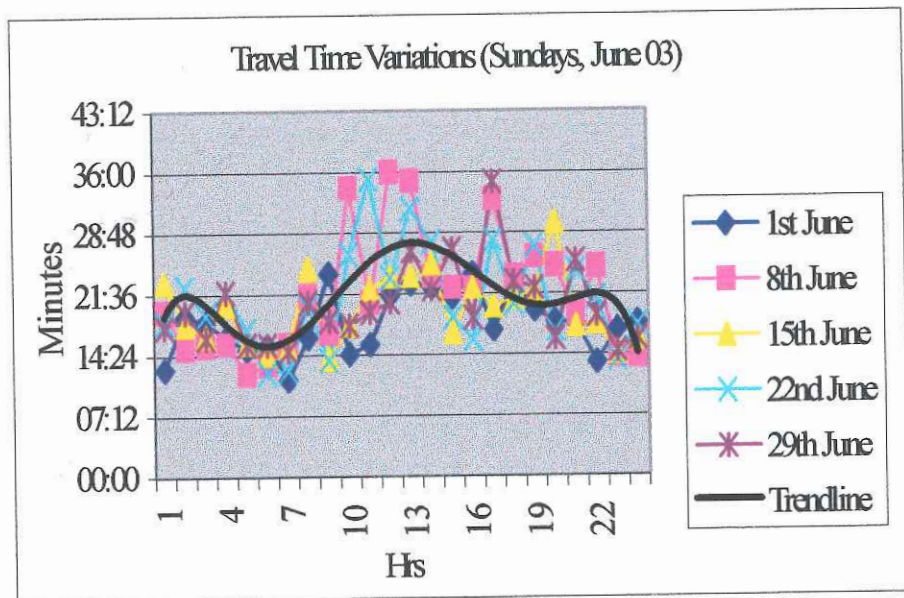


Figure C.1 Variations in Travel Time

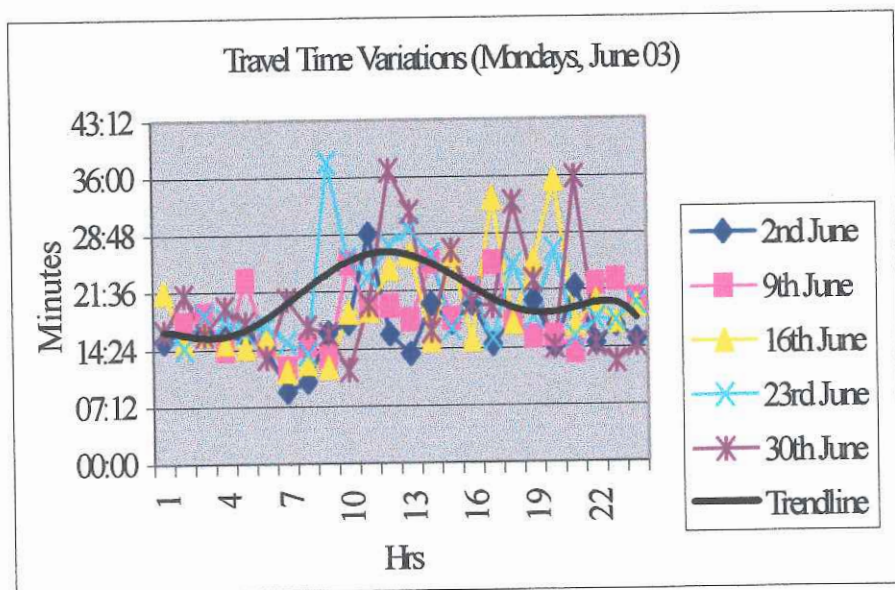


Figure C.2 Variations in Travel Time

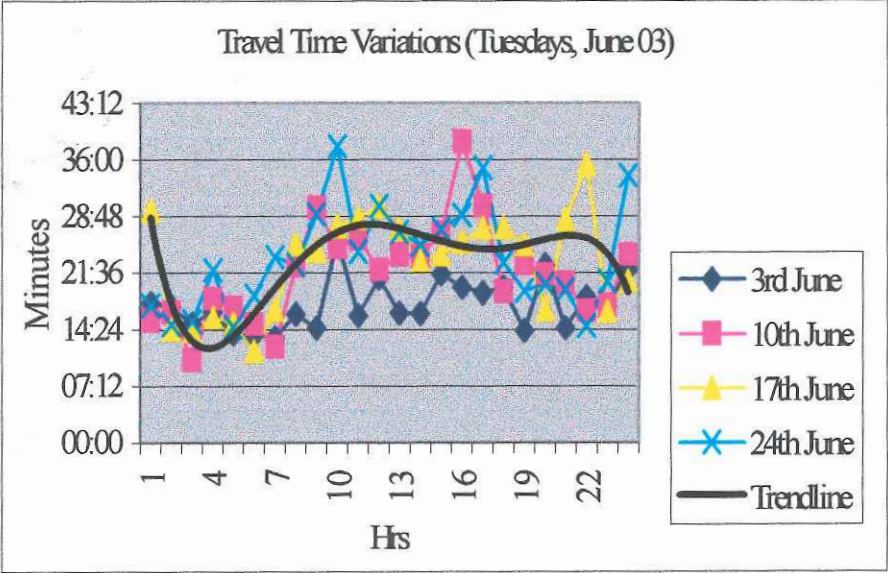


Figure C.3 Variations in Travel Time

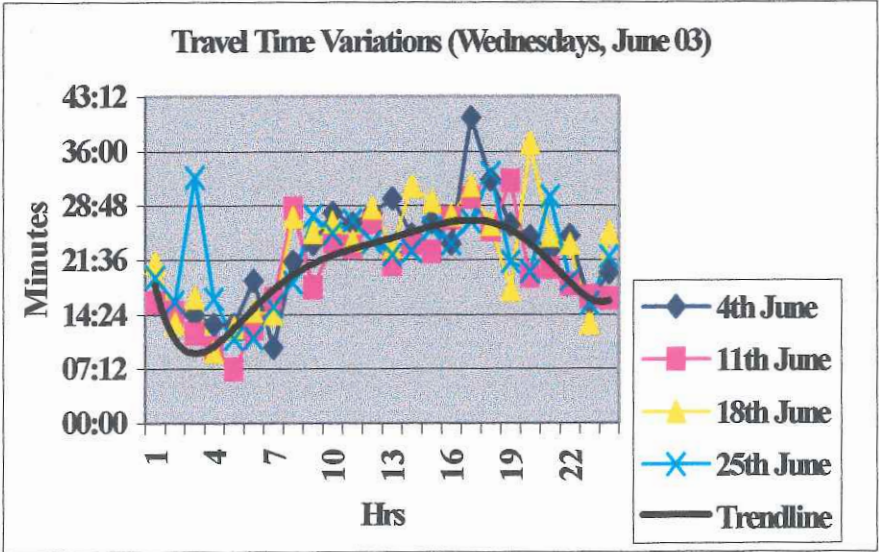


Figure C.4 Variations in Travel Time

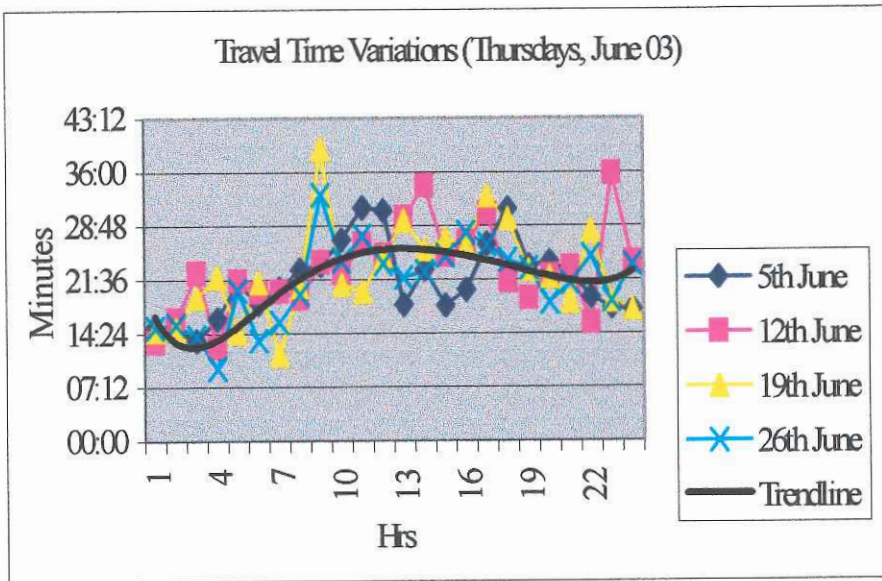


Figure C.5 Variations in Travel Time

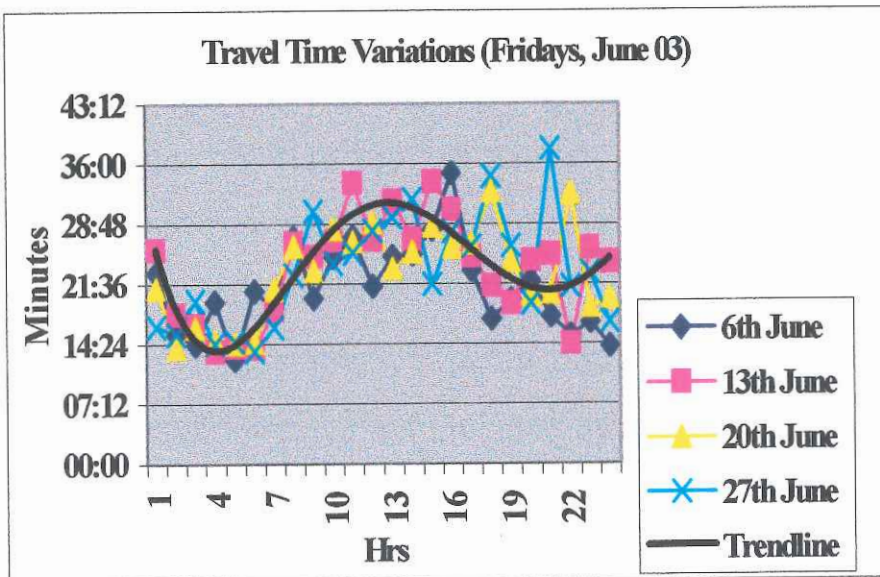


Figure C.6 Variations in Travel Time

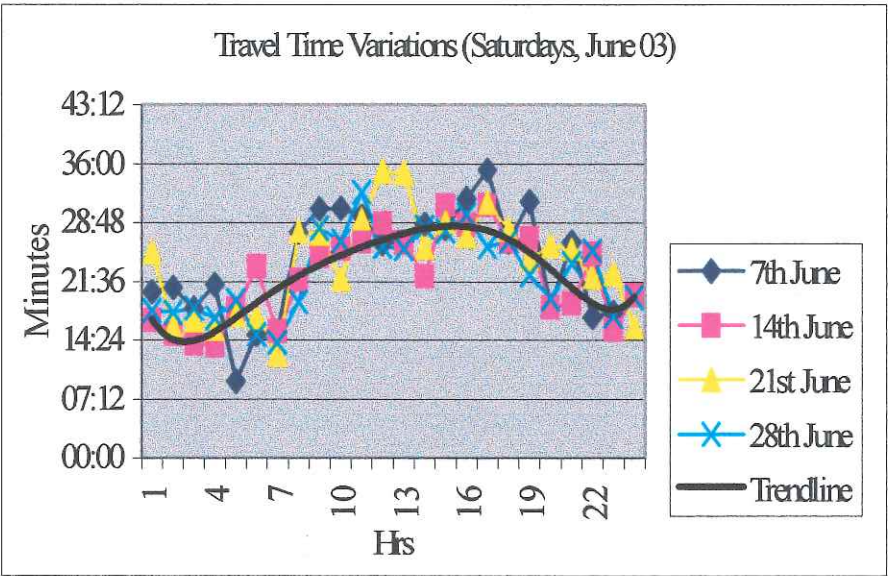


Figure C.7 Variations in Travel Time

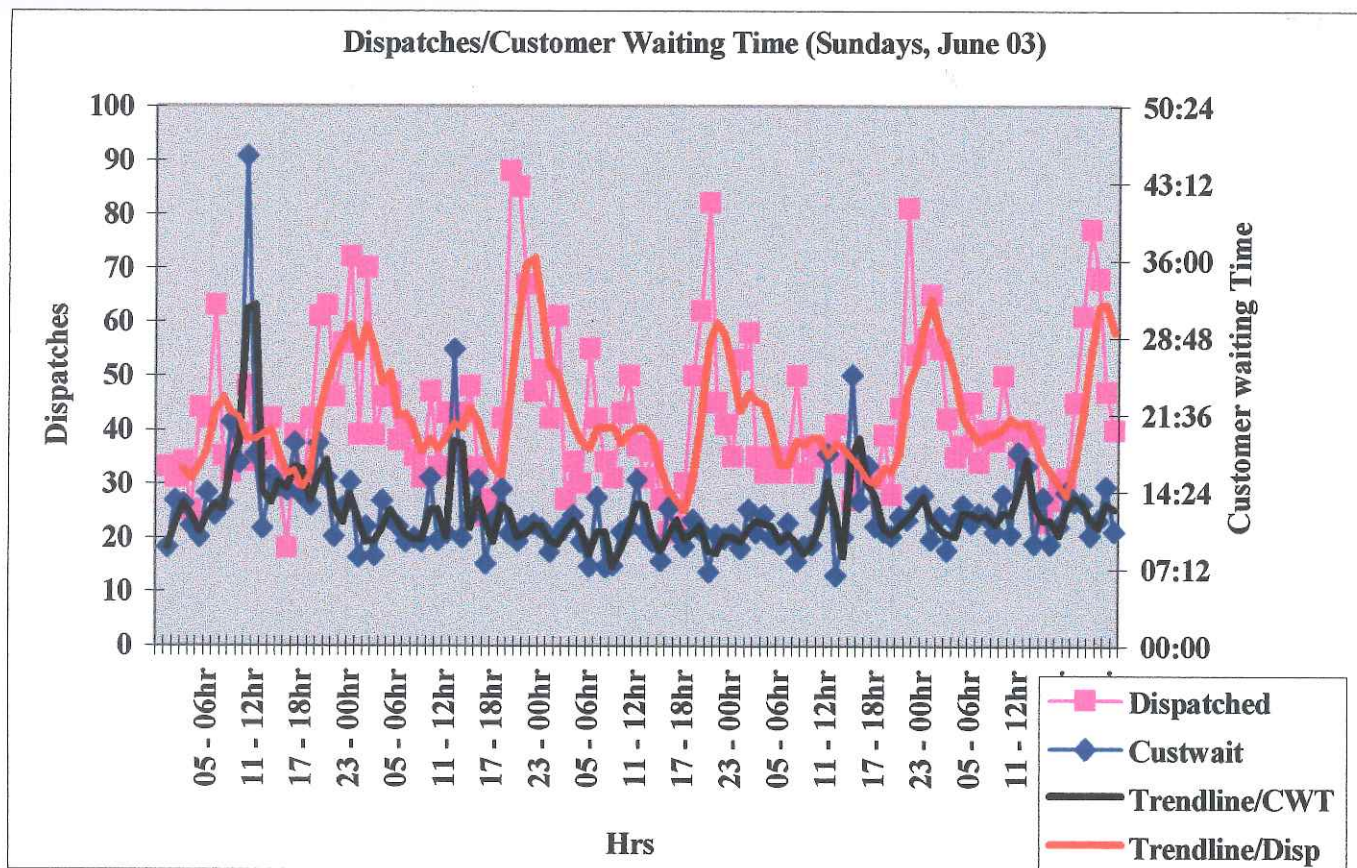


Figure C.8 Variations in Customer Waiting Time and Dispatches

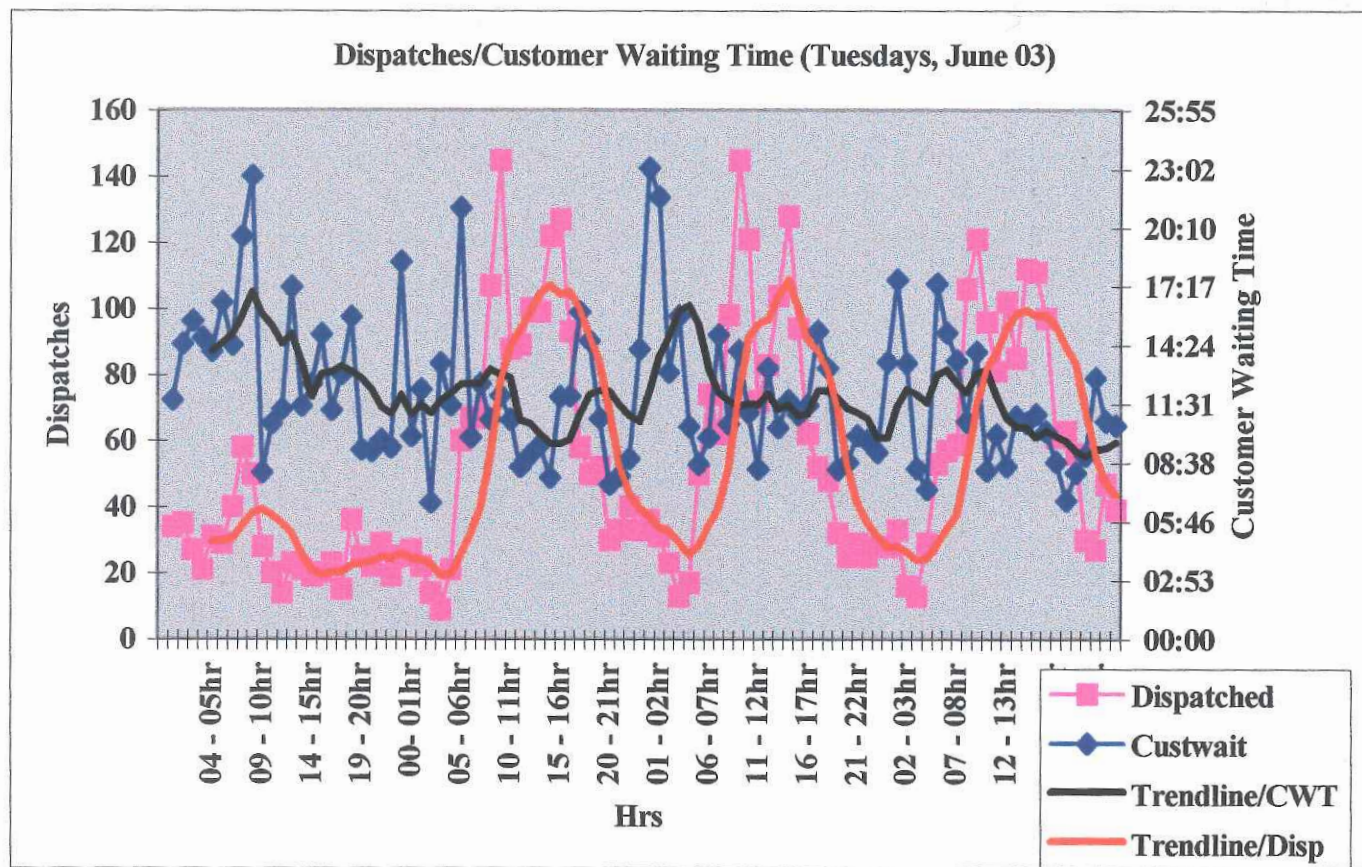


Figure C.10 Variations in Customer Waiting Time and Dispatches

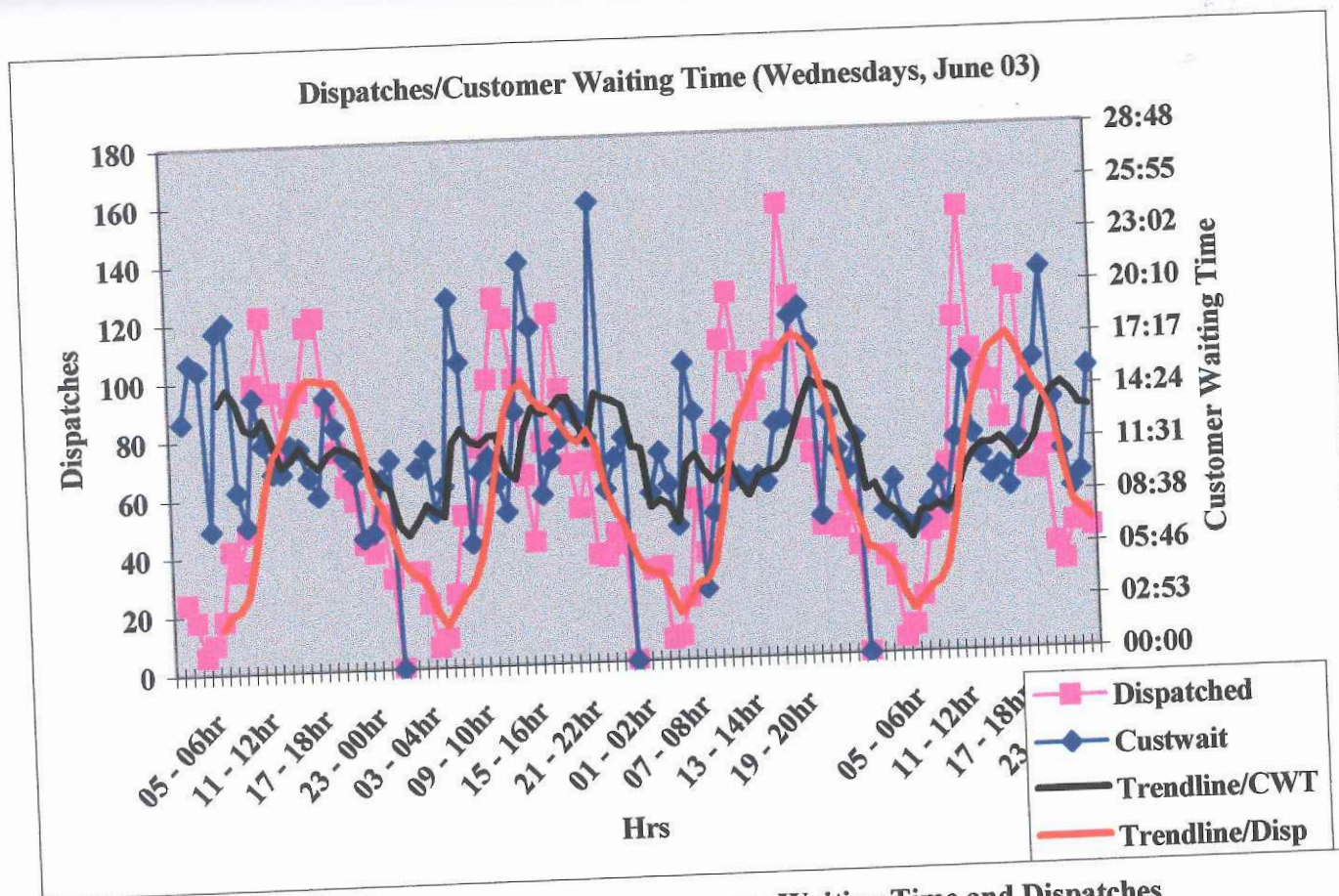


Figure C.11 Variations in Customer Waiting Time and Dispatches

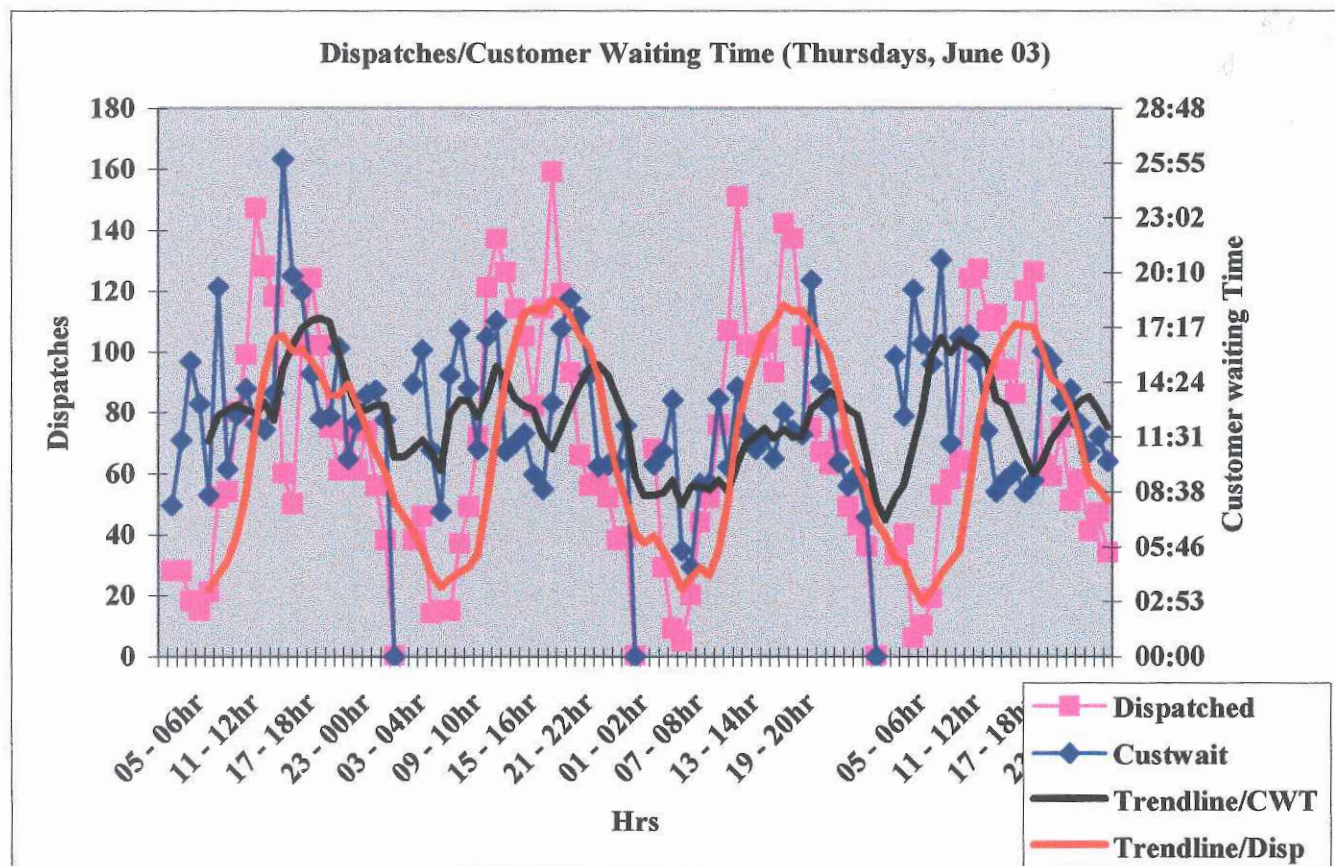


Figure C.12 Variations in Customer Waiting Time and Dispatches

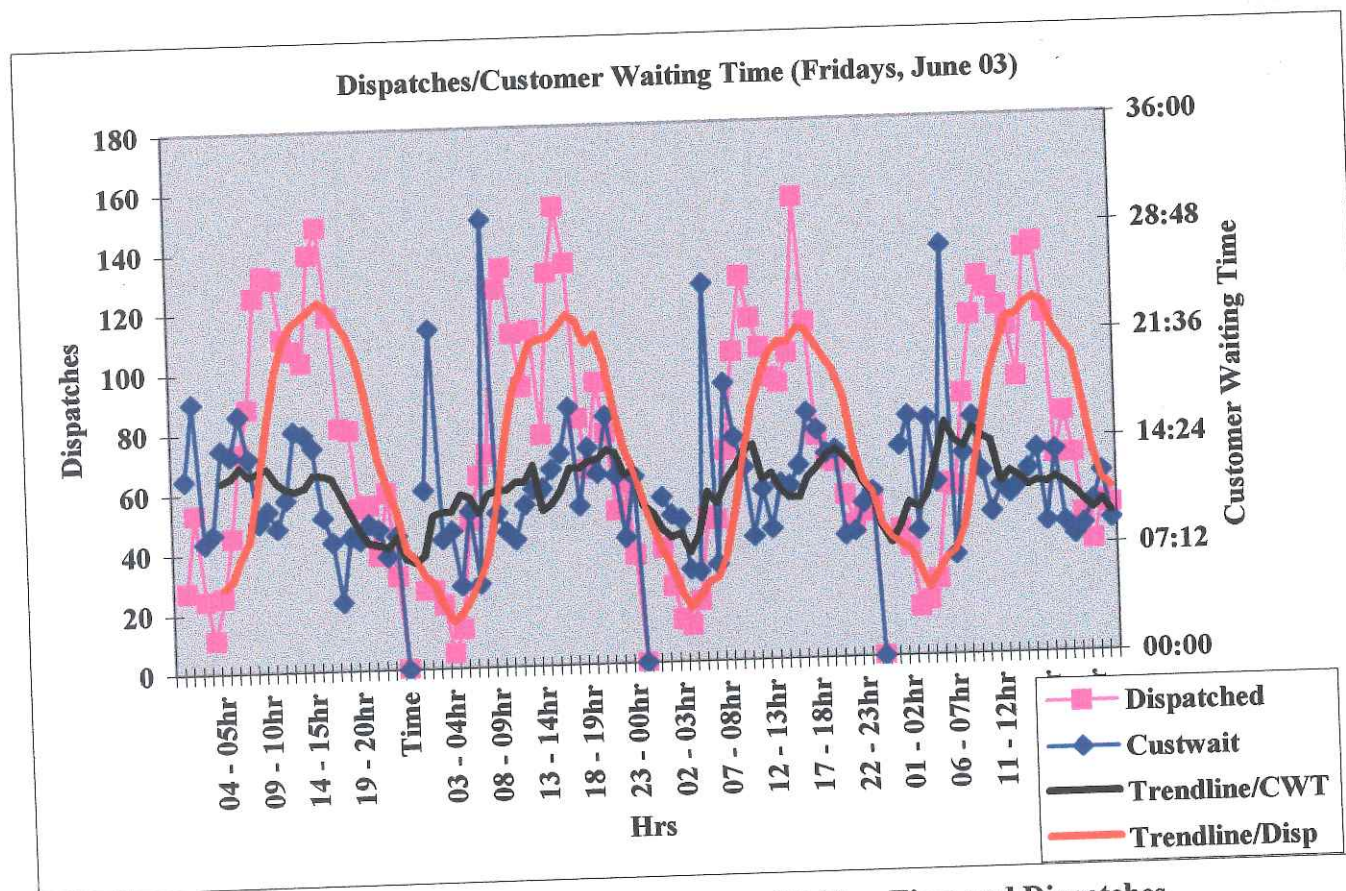


Figure C.13 Variations in Customer Waiting Time and Dispatches

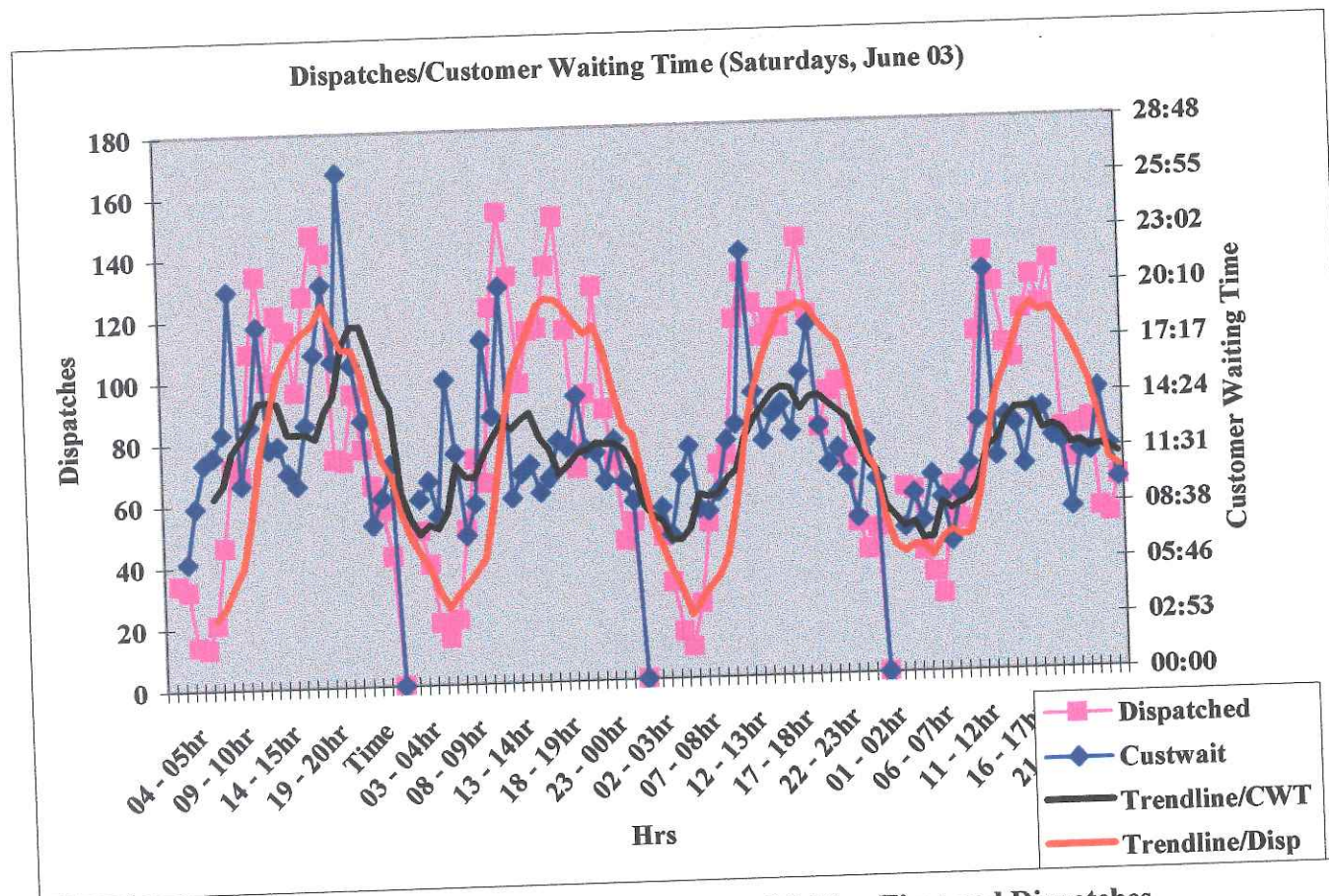


Figure C.14 Variations in Customer Waiting Time and Dispatches

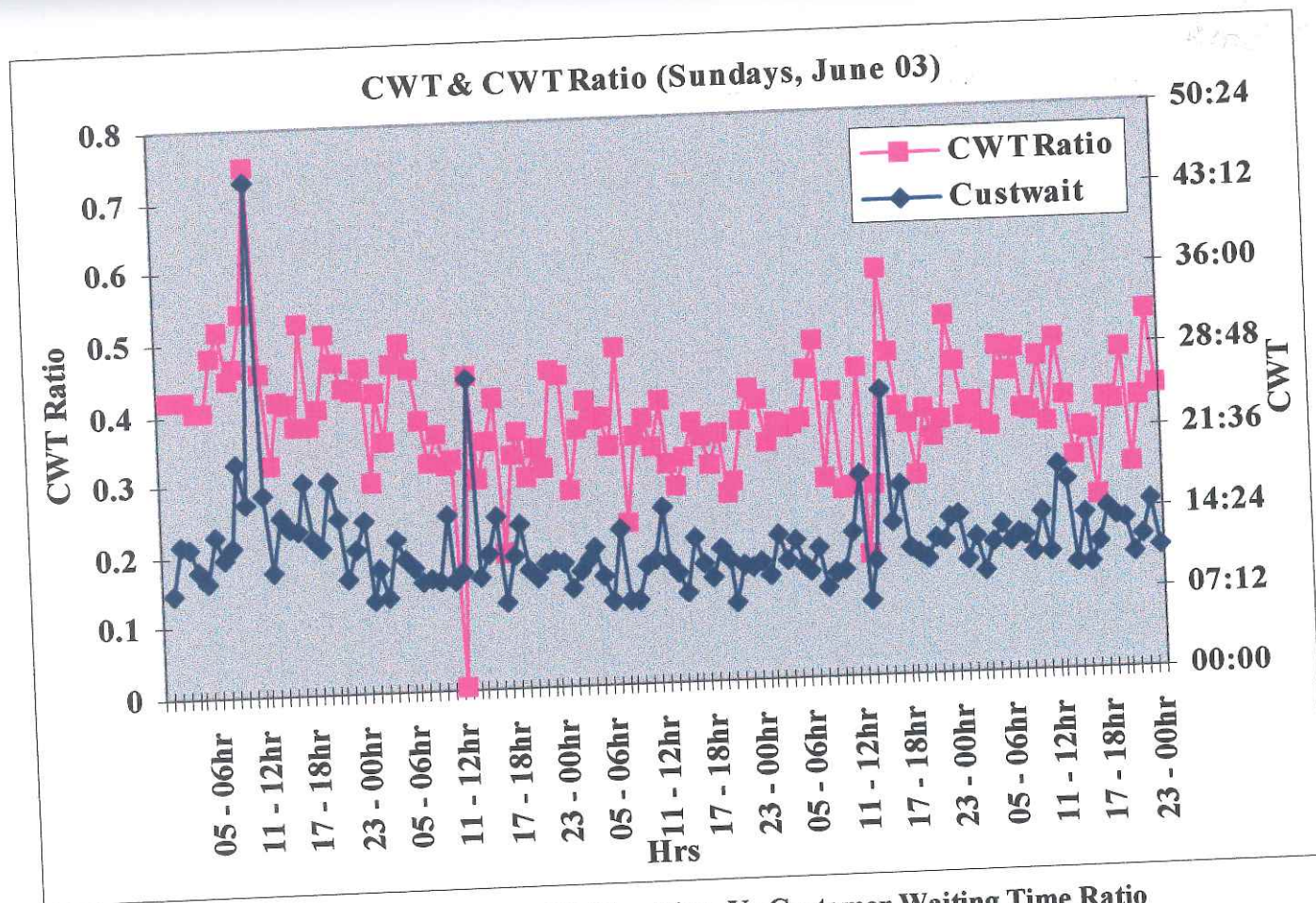


Figure C.15 Customer Waiting Time Vs Customer Waiting Time Ratio

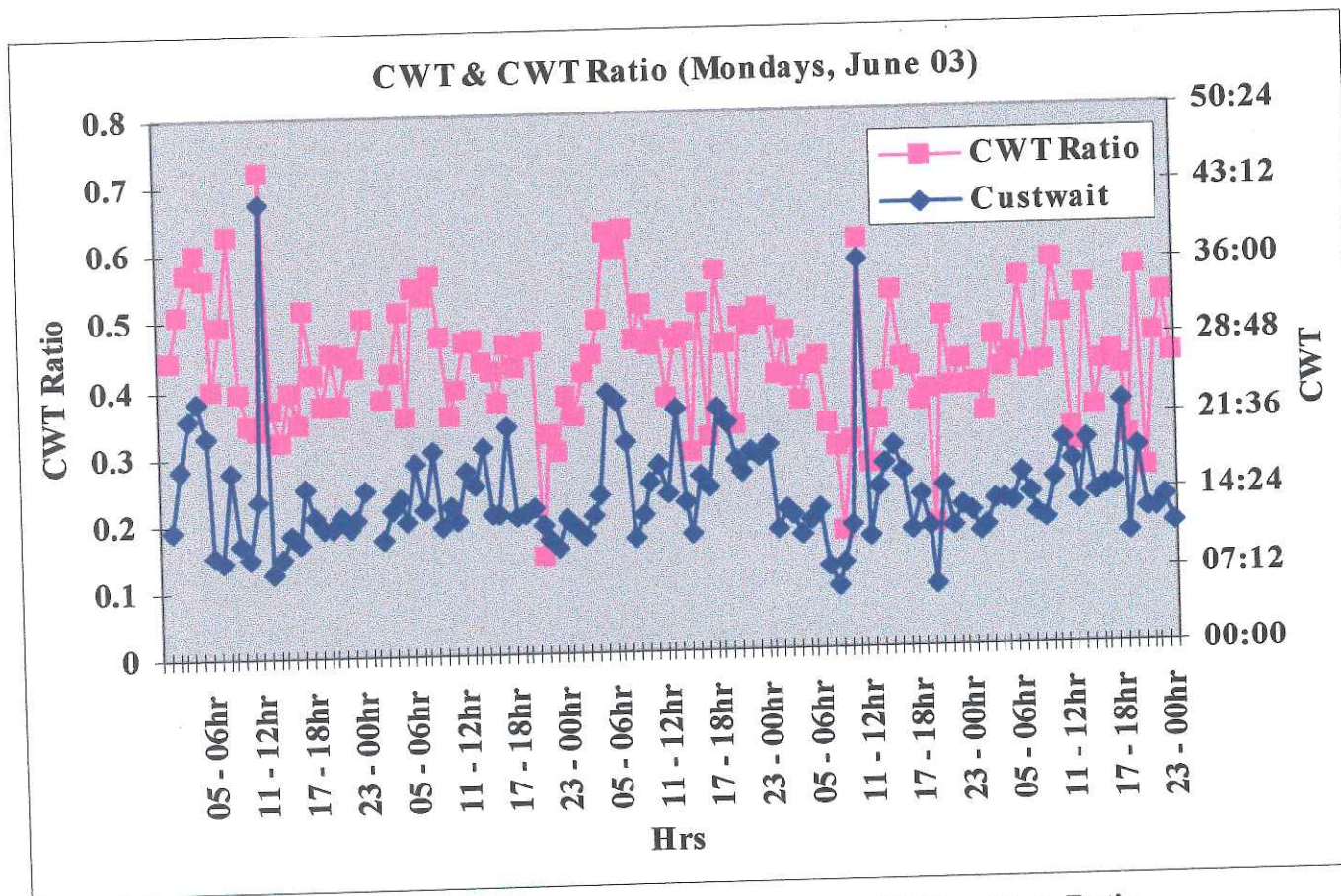
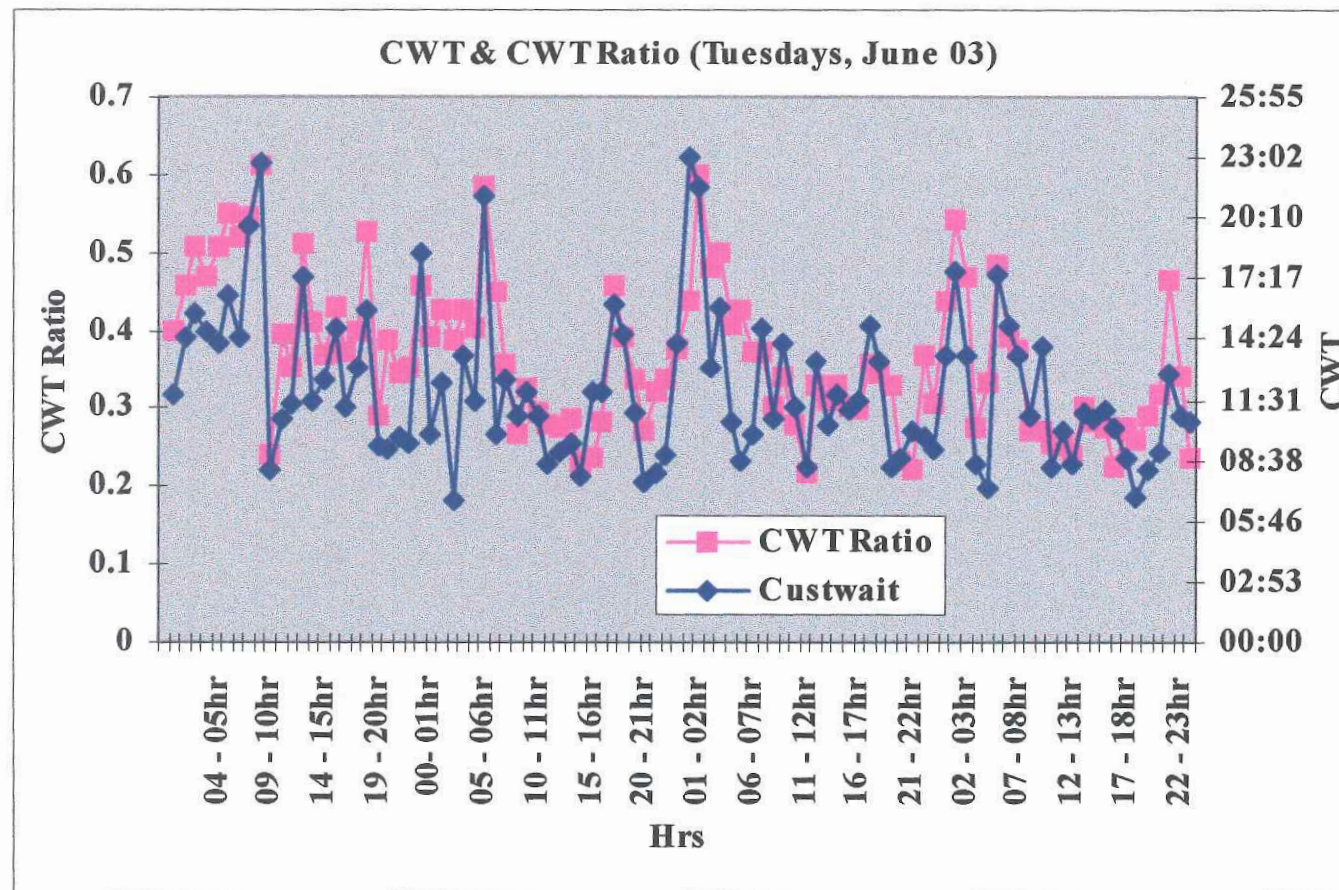


Figure C.16 Customer Waiting Time Vs Customer Waiting Time Ratio



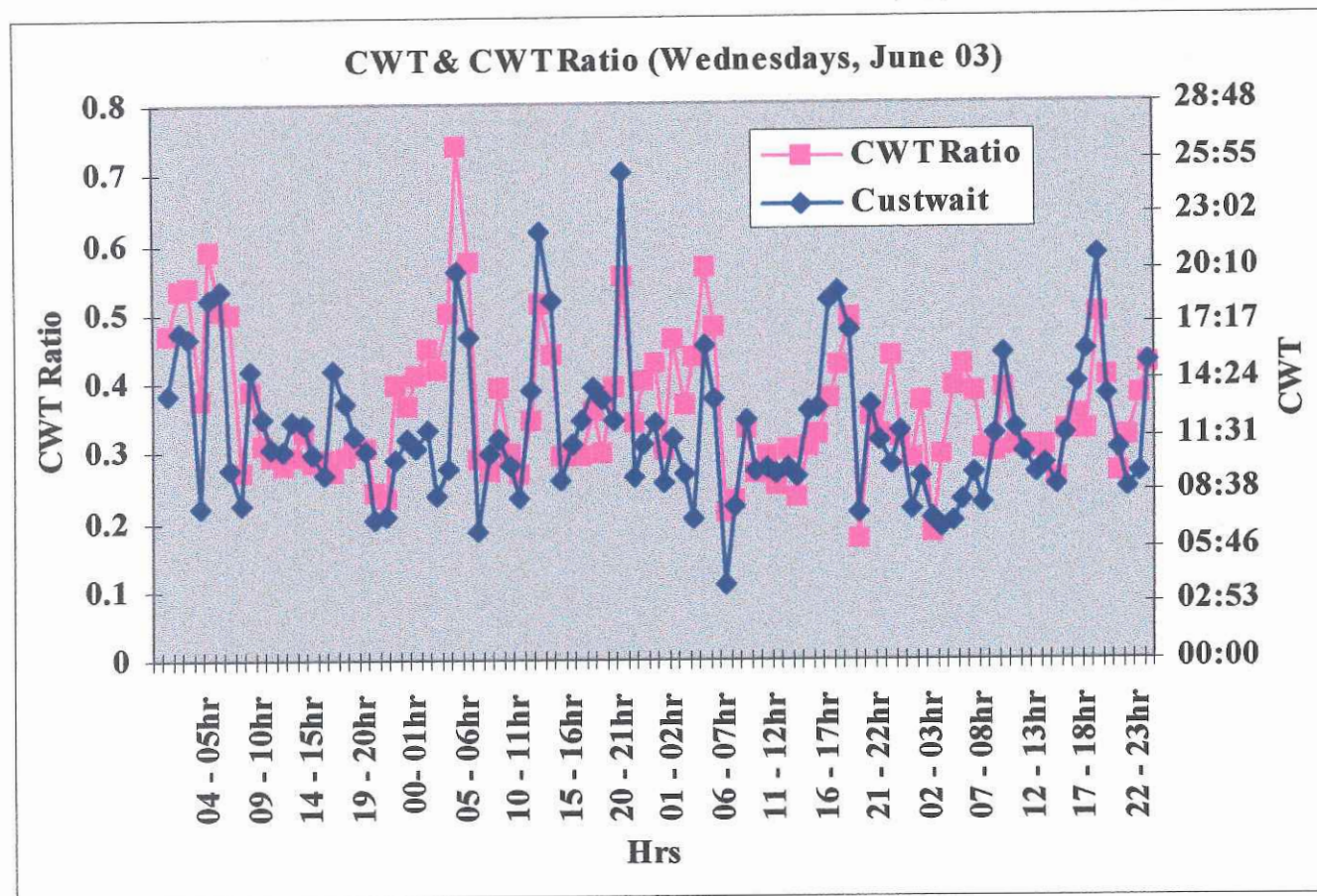


Figure C.18 Customer Waiting Time Vs Customer Waiting Time Ratio

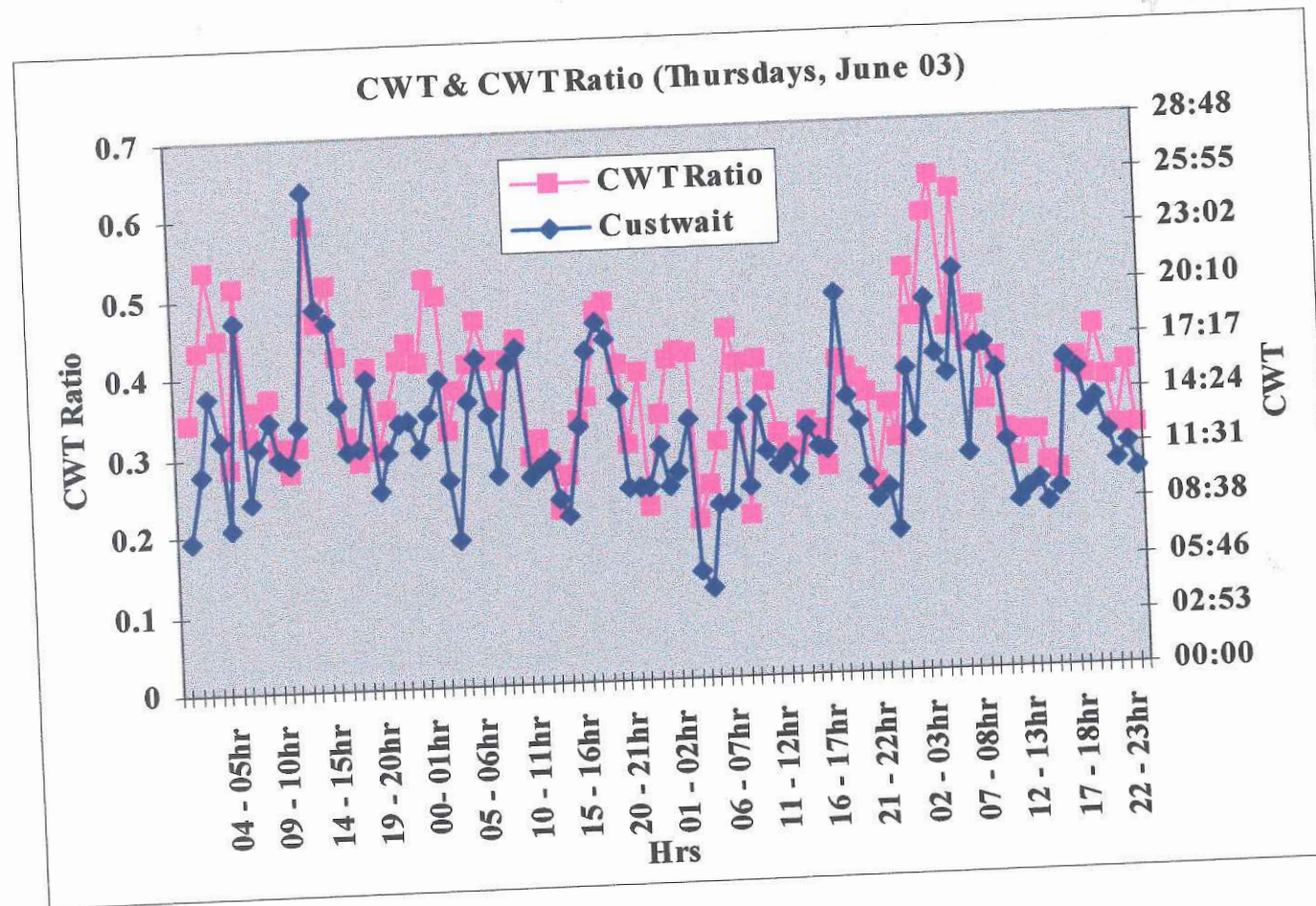


Figure C.19 Customer Waiting Time Vs Customer Waiting Time Ratio

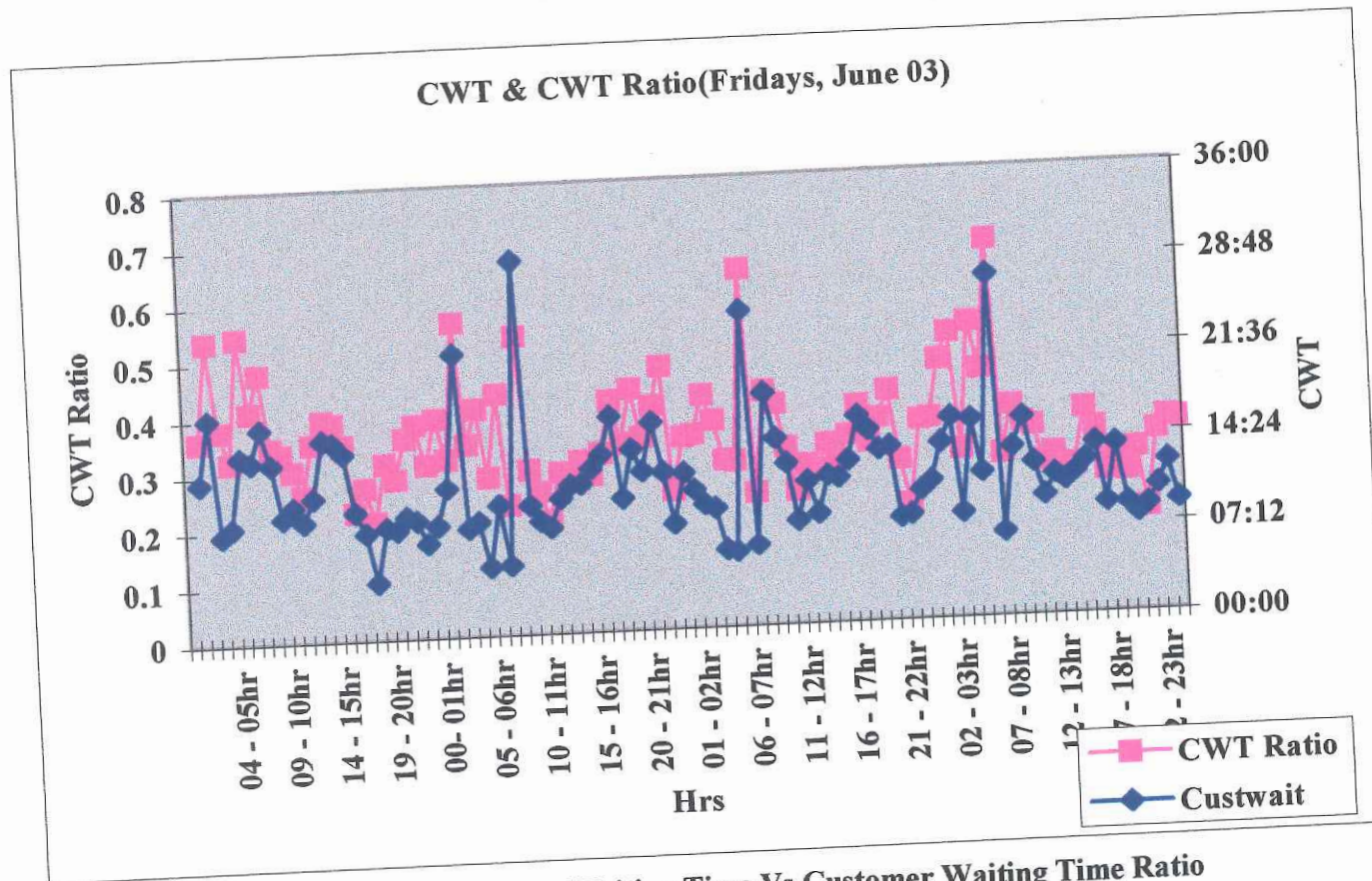


Figure C.20 Customer Waiting Time Vs Customer Waiting Time Ratio

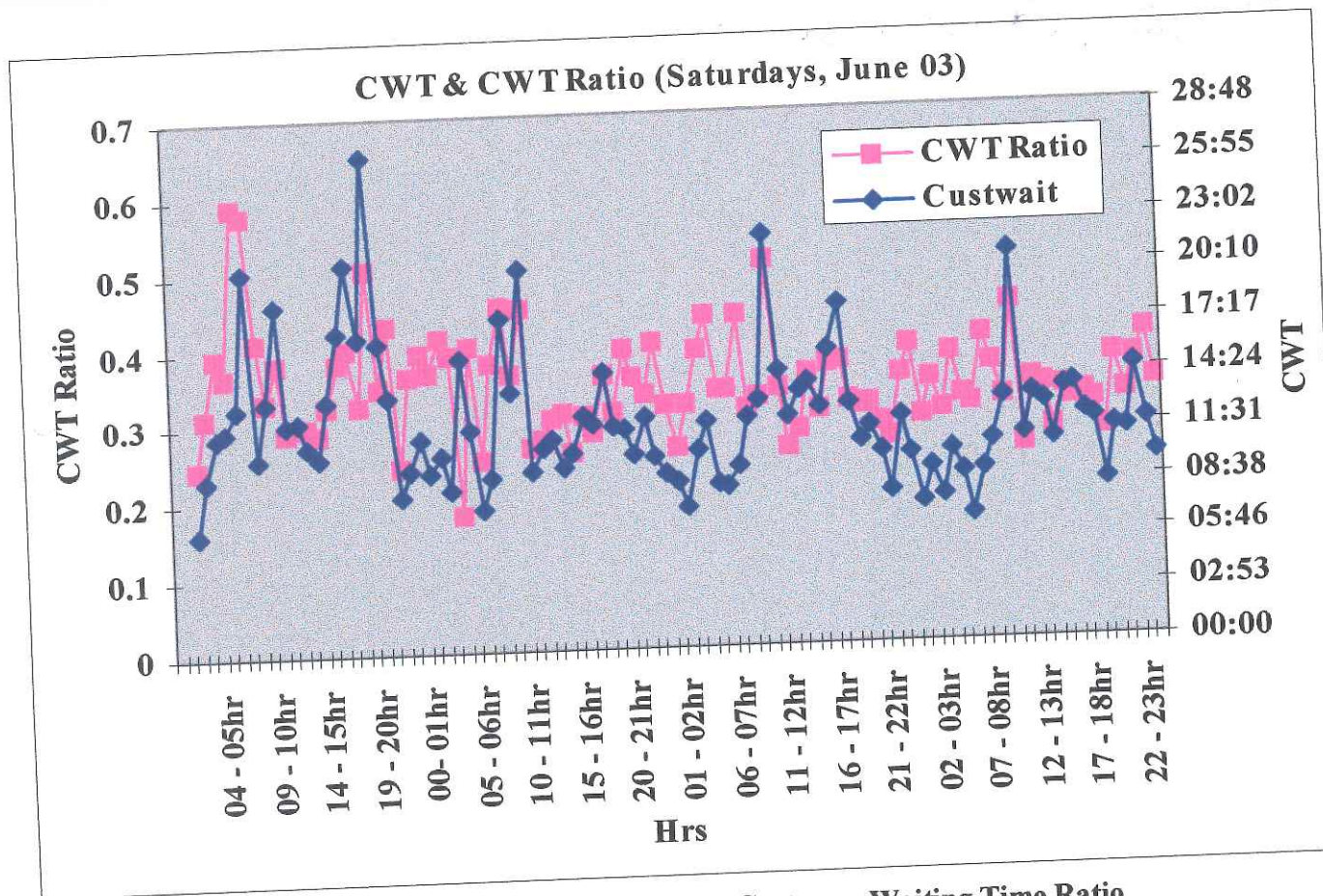


Figure C.21 Customer Waiting Time Vs Customer Waiting Time Ratio

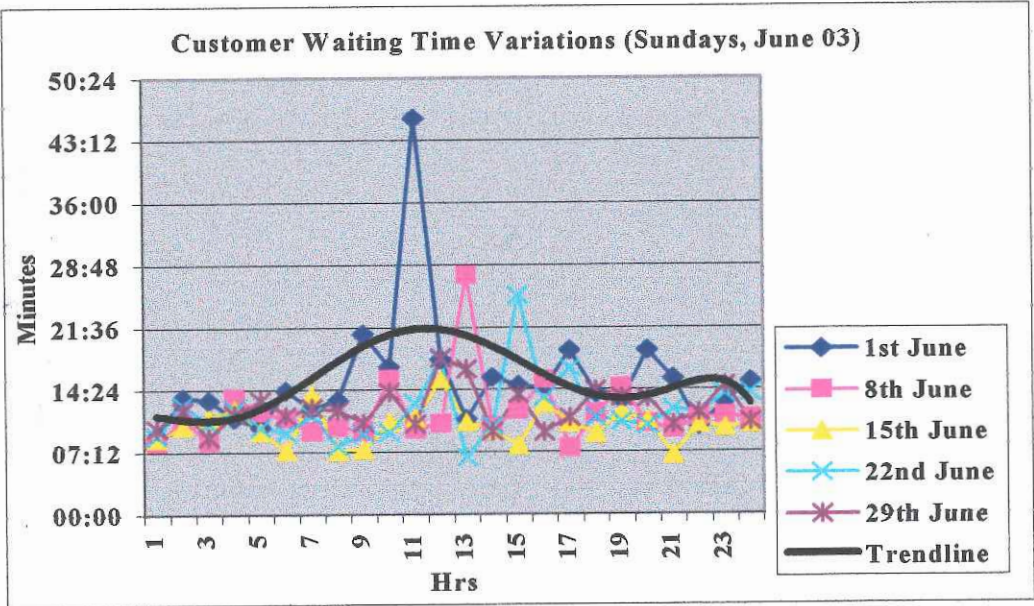


Figure C.22 Customer Waiting Time Variations

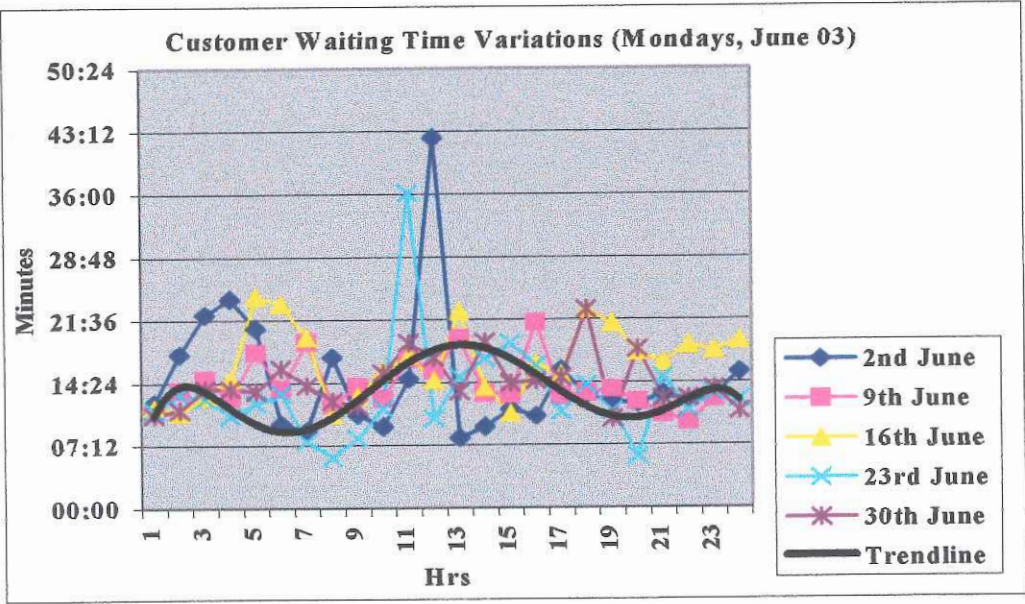


Figure C.23 Customer Waiting Time Variations

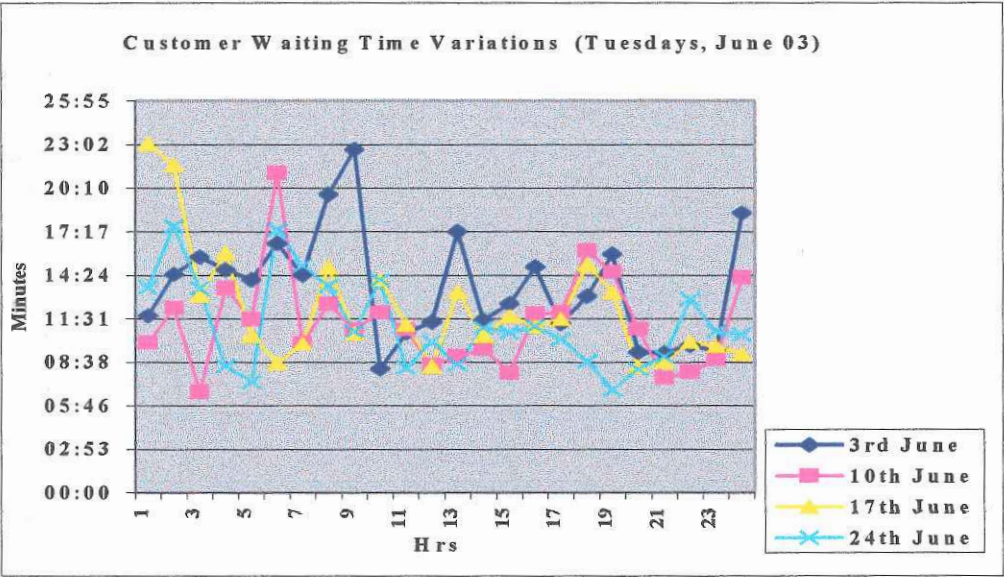


Figure C.24 Customer Waiting Time Variations

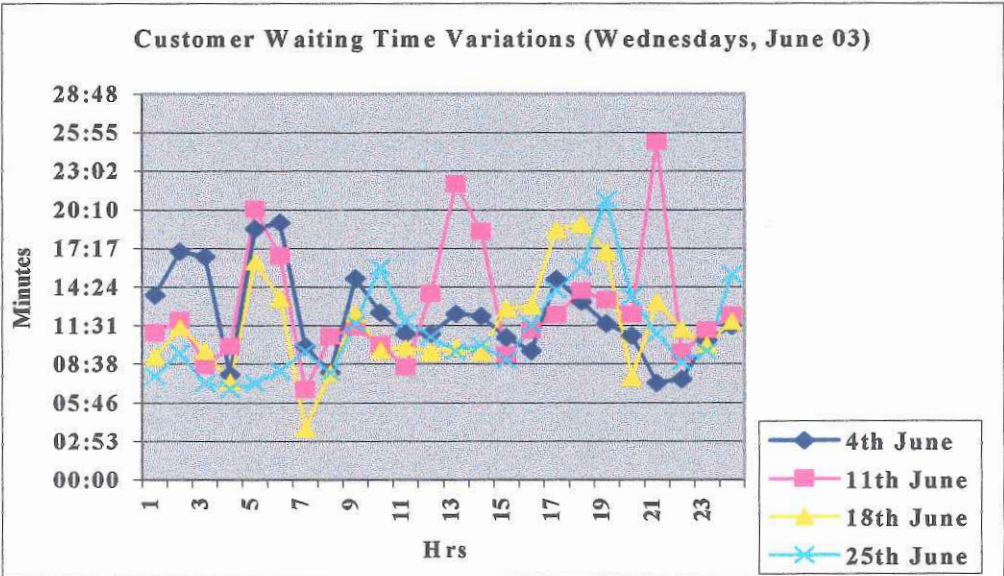


Figure C.25 Customer Waiting Time Variations

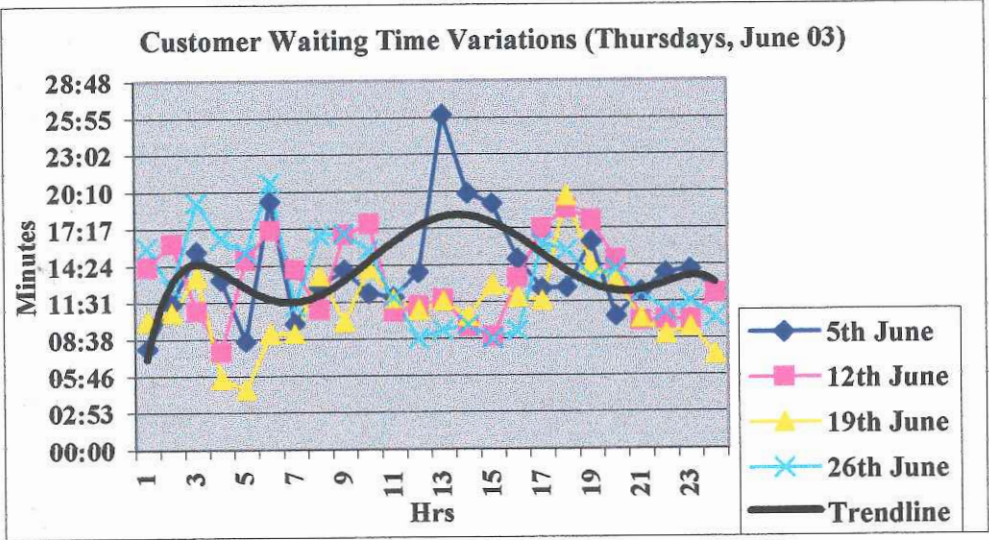


Figure C.26 Customer Waiting Time Variations

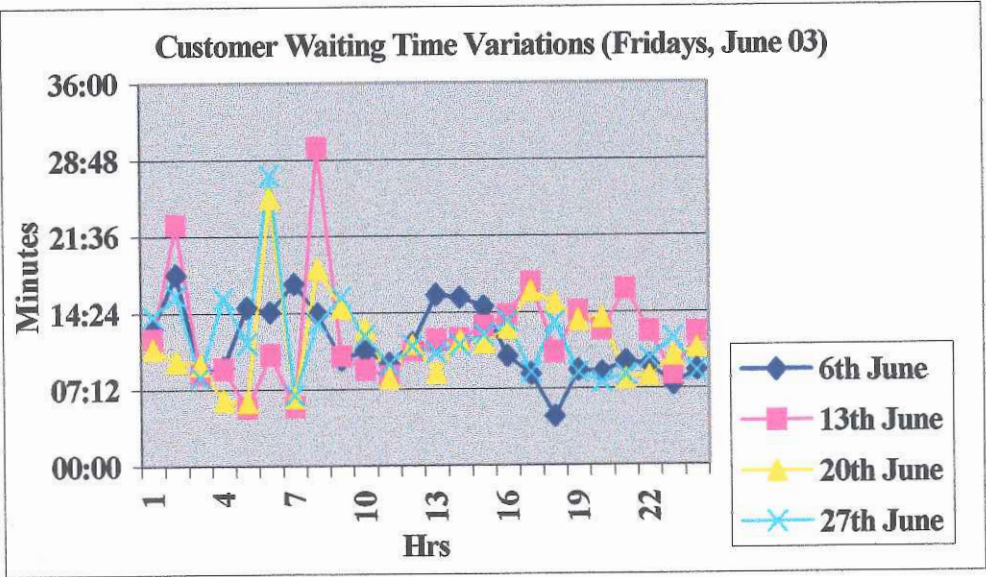


Figure C.27 Customer Waiting Time Variations

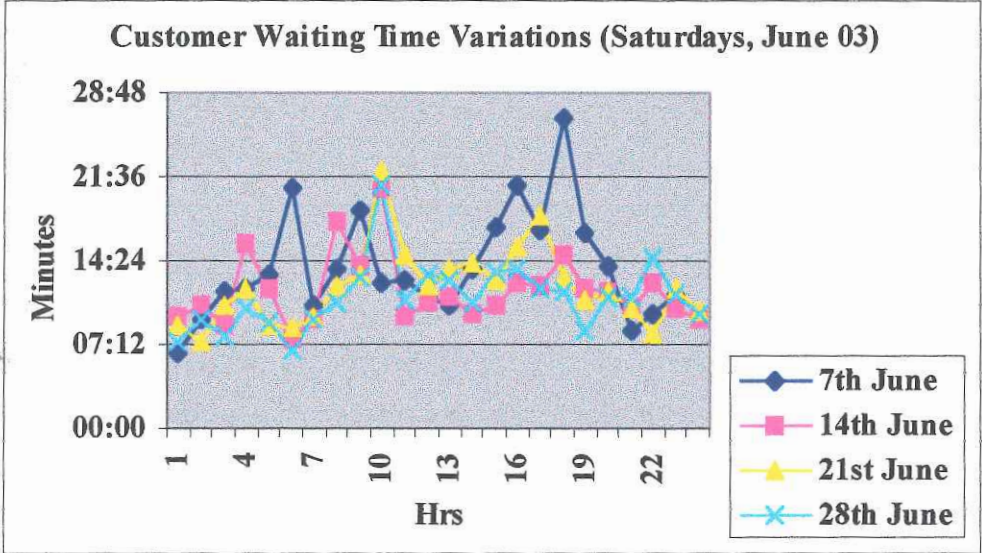


Figure C.28 Customer Waiting Time Variations