Reducing Waiting Time for Transportation using GIS

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Abstract

Nobody denies that the vehicles are requirements of life. Especially, when students and employees going to their work and school, so they must be waiting at the assembling bus location for this waiting, time depends on a several factors (Traffic, streets status, and Population). This study presents the design of a system called Waiting at Home (W@H) to helping users to arrive at time and spending there waiting time at home. it has been used the Geographic Information Systems (GIS), Global Positioning System (GPS), General Packet Radio Service (GPRS) to configure the architecture of the W@H, as well as the advantage of the integration between the transmitter techniques and GIS, it has been used the GPS as an essential element in determining the bus location, in addition to pre-determine the locations of waiting stations and the location of habitation waiting. Thus, the W@H will be sending alert messages to waiting people before the arrival of the bus by enough time in order to be reaching the waiting stations in appropriate time for the arrival of the bus and they are not waiting for long periods.

Keywords

GIS Network, GPS, GPRS, SMS, GSM,W@H.

I. Introduction

Traffic congestion in our communities has become a major threat which we cannot ignore it, because it threatens our future that it is prevent people especially students and employee to reach their place at the specific time which leads to wasting of waiting time. That is a general phenomenon in all countries of the world because of many reasons which led to this horrible problem. One of this reason is that the increasing of the population, and this leads to increase the numbers of the vehicles. So people waiting for their buses for long time in the station because of this traffic which leads to wasting of waiting time .also, some people violates of traffic laws and regulations, many people do not respect the rules which lead to many accident its produce the traffic jams . The problem of traffic jams which lead to wasted time is the most serious problems in this time. employee and students are suffering from waiting for long time because of the delay of the employee's buses transfer that the cities will be crowded in the early morning when they goes to their workplaces or school. Countries can be reduce the phenomenon of lost time that caused by congestion, especially after the great technological development of the world in the field of computer science, especially in the range of geographic information, communication technologies systems and the emergence of mobile, which help people to exceeded a lot of obstacles such as, traffic jam in the street by receiving an aerial photographs via satellite to avoid the crowded streets to reduce the lost time. In conclusion, the traffic congestion a major Problem need to be a great effort, so that we concerned our study to keep People's time away from lost when they are in their home before they leaving.

A. Geographic Information Systems

The first person who put the meaning of geographic information systems is a Canadian man in 1962, the first person who effective the geographic information systems in Canada at the time. It's called Canadian GIS (CGIS). Information can be divided depiction different from the map that Offers only what has been presented. it is integration of computers hardware , software and geographical data together to capture, analysis , presentation, achieve and manage all kinds of geographic information [1]. GIS

is computer tool that based on the analysis, storage, processing and the perception of geographical information on the map [2]. GIS A tool used by persons, organizations, governments, schools and Companies that are looking for new solutions to resolve their crisis [3]. GIS have the ability to spatial analysis, the classification of the target to the personal theme and the ability to deal with these various aims. The ability to store base data spatial on internet: where the control system can be more easily [4]. For several decades, one of the most activity fields by the IT industry is the development of Geographical Information Systems (GIS). A GIS is a software system for the capture, storage, analysis and display of geographical information where the element id location is an important changing. GIS find applications in all sciences fields not only have a spatial content (geography, archaeology geology, ecology and social science). But also have applications in the service industry. In retail sale etc.. In summary. GIS is a Reaching a total of concepts and methods and perceptions at a specific time [5]. GIS consists of several tools as: Model Builder, Buffer and ArcGis Editor [26-36].

1. Model Builder

Model Builder is a visible programming language for building geo processing track, that it depends to documenting and analyzing spatial data, so the user can be created and adjusting geographical processing models in model builder, it will be like a diagrammatic drawing for geographical processing tools using the output through input from one process to the other. [6]

2. Buffer

A buffer in GIS, it's the area around a maps characteristics by units of measure either the distance or the time. It's an important feature for analyze the proximity [7]. A buffer is an area defined by the bounding region determined by a set of points at a specified maximum distance from all nodes along segments of an object [8]. A buffer is a zone of memory that it used to input and output data temporary. While in Geographical Information Systems, buffers units are points, polygons, and lines. so that buffer operation can create a region in a specific width about either a points , a line or a polygon, there are two kind of buffers : a fixed width buffers

and a changeable width buffers , and both of them can be created an encasement feature depend on each feature character values. These region or buffer can be used for information to select the entities that happen inside or outside the buffer zone set. So similar to buffering in GIS is distance analysis [9]. There are two ways to make the buffer analysis in ARCGIS , the first way it let you chose Target layer which are in a particular distance around source layer features, the second way it let you to establishing the buffer in a polygon shape that can be used for additional geo processing like clip functions. You can use both ways, but in the end you use the first way for this project [10].

3. ArcGIS Editor

ArcGIS Editor allows us to create and edit various styles of data. feature data that saved in shape files and geodatabases , however, many table formats including points , lines , text , polygons can be editing ,and shared edges and coincident geometry can be edited by using geometric networks and topologies [11]. ArcGIS Editor can be used to build geodatabase for study region. That contains a number of layers which represents the most feature of study zone. you might be need to use ArcMap, in order to make your own feature from the scratch, or you might be need to change or add to the data that may not have been updated newly because the data that you need might be not ready for you , that some spatial feature is found only in Printed maps or you might be try to specific how some characteristic affect the landscape of the some building that not built yet , Arc Map is a educational program help you to develop your skills you need it to moving forward [12].

B. General Packet Radio Service:

General Packet Radio System is also called GPRS is a third-generation step toward internet access. Its known as GPRS- IP which means a Global- system mobile communications internet protocol its make the users of this system online, so they can make voice call, and access internet anywhere. Even Time -Division Multiple Access (TDMA) users can get the useful from this system, as it reception packet radio access [13]. GPRS is selected as the major method of communication between the tracking unit and the server. GPRS is a 2.5G mobile technology, it is obtainable in the country , and also it is perfect appropriate for data transfer through on -line connection between a central location and mobile devices[14]. GPRS is a packet-turning technology which is a Stretching of GSM, but it is more advantage of GSM that it has an ability to transfer data faster [15]. GPRS can be used as the support of SMS .if SMS is used through GPRS, a 30 SMS sending in a minute, and this is more faster than using the ordinary SMS, that can send 6 to 10 SMS messages in a minute. GPRS modem is necessary to send and receive SMS through GPRS. Notes that some wireless carriers do not support sending and receiving SMS through GPRS [16].

C. Short Message Services:

SMS (Short Message Services): is an important technology that has an effect in our life. it is one of GSM terminal services in which data can send by SMS to the listener server [17]. Short message service (SMS) is the major communications technology for mobile data transfer and it can be differentiated by the interchange of short text message between digital line and mobile devices. SMS messaging main influence element is affordability. SMS messages hold up to 140 bytes (1,120 bits) of data, which can 160- character alphanumeric message in the default 7-bit

alphabet or a 70-character message in a non-Latin language, like Chinese language. SMS is also called text messaging [18]. SMS represent for Short Message Service. It is a technology that can sending and receiving the message between mobile phones. At the beginning it's appeared in Europe in 1992. Where it was from the beginning within the system or GSM standards (Global System for Mobile Communications). And later it became to be within wireless technology systems. Originally ، ETSI (European Telecommunications Standards Institute) has put SMS and GSM standards. For this time the development and maintenance has become by the 3GPP (Third Generation Partnership Project) [19].

D. Global System for Mobile Communications:

Global System for Mobile Communications (GSM) it is a mobile phone that is being used all over the world. In the 80s and 90s of the last century, the scientists put a convention in order to improve the standards of mobile phone among European countries. That GSM had an identity card and one known as (SIM), that it is important to perform the functions of communication and have the advantage that allows the user to switch phone easily [20]. In this research, the use of GSM data transfer via SMS and GPRS by a wireless modem works just like a landline modem, but the difference between them that is that the phone modem sends and receives data through fixed telephone, while wireless modem sends and receives data from through radio waves, this system is based on the commands of GSM modem [21]. It has been previously mentioned that GSM is a protocol of mobile phones all over the world. Scientists have established a standard for mobile phones service between European countries before the 1980s and 90s. Where used GSM phones (SIM card) which is the basis to make the connection and the user can change the phone simply. In this study, can transfer the data by GSM using either SMS or GPRS [22]. The short message service(SMS) is offer by GSM, it help user to sends and receives data by alphanumeric messages in few bytes, that the GSM is a system digital mobile communications, it's the second generation (2G) in the world[23].

II. System Preparation

A. Hardware Devices

In our Project, those two kinds of hardware devices were used: GPS Tracker and Server Establish.

1. GPS Tracker

GPS is used to tracking the bus's location anywhere on the earth's surface. The GPS device consist of two key elements, they are GPS sender and GPS Receiver. simply, the GPS device can measures the spending time of the signals transmitted from the satellites, then speed of light multiplies by this time to locate exactly how far this device from every satellites. A 2D (two-dimensional) positional fix can calculate by GPS receiver that consisting of your latitude and longitude.the bus's location can triangulate by using the GPS device. GPS Receiver receives the bus coordinates from satellite through GPS Antenna [24](Figure1).

2. Server Establish:

Is a computer program that gives a helpful services to another computer programs (and users) in the same or different computers., and must be linked to the World Wide Web to taken advantage of it whole world[25]. In our system, We have prepared a computer and

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we have installed of Windows Server System as well as ArcGIS Desktop program, and it has been linked to the internet directly and available on the length of time. Even the server can provide 24-hour service must contain:

- Permanent power: keeps the server running continuously.
- Customize an unique and special IP address does not repeat for our system's computer, it is called Static IP, which always consists of four digit separated by a dot between them, Through this the unique address, the GPS can see and deal with the system or computer via Internet network.
- So be the GPS is able to send geographic data from Satellite to our System, It has to be a special port for that, We have allocated a specific defined port by the internet and computer, So that the system can receive geographic information about the position of the bus (latitude and longitude, speed, date, time, and other information) Which is equipped for the system by GPS is installer in a bus car, And this data is transferred through that port which configured by socket program to execute on the startup Listener's server.

B. Software Collection

In this paper, we used: ArcGIS10.1 Desktop, Listener Server and Data Set.

1. ArcGIS10.1 Desktop

One of the main programs and vital in the issuance of maps and processing, analysis and tracking objects on its, and drawing features such as roads, buildings and other parameters that we need in our project, and stores all information in the form of organization databases to make it easier to deal with them from within the program and outside, as well as the ArcGIS10.1 Desktop contains many tools For example (Buffer, intersection, selection, Models, etc) to resolve the problem that we are discussing this in our research.

2. Listener Server

Is a program that contains a set of commands, which work several important operations, from this commands, the program contains commands Socket System which open a special port and take Static IP in order to make the system is capable of receiving data from the GPS Tracker for the coordinates of the bus Location and others of its own data. The program also contains commands working to convert these data received, which are usually in the form Message up to the server and it portable through the GPRS signals, As Well that program analyzes this Message and converted from the data in the form of a list of strings to a variety of data in the form of a set of fields within the Organization of tables in a special database called (GPS Database)(figure3) that contains the coordinates of the bus after converting from Geographic Coordinate System(GCS) to Projected Coordinate system (UTM). Which is required in order to track of the bus from on the map that is on the Coordinate System latter.

C. Data Set

the geodatabase in our system consist of :Bus Data, Stations Data and People Data.

1. Bus Data

The position of bus on the ground can be obtained by using GPS where GPS Tracker device is installed inside the bus where this device to send the location of the bus to the server and are receiving these messages and be converted from DMS format (Digit, Minute, Seconds) in GCS system to DD format (Decimal Degree) in UMT system, and store this data within a database in order to integrate with databases GIS own, and then it can represent on the city map directly (Figure2).

2. Stations Data

It is a waiting points where the bus stops, have been identified these points according to the number of people who will be transferred by this bus, and has been calculated the time for each of the bus to waiting point, as well as the time it takes for a person to get to the waiting point, and we have been identified these points using GIS Editor.

3. People Data

They represent the people sites who will be transported by bus, it has been calculating the time it takes them to arrive from their home sites to the waiting point, and taking into consideration the speed of the person to reach, as well as the speed of the bus, and it account that, also calculate the difference between speed of the bus and people in order to get rid of the waiting time, it has been stored telephone number for each person In order to send messages to them and notification them of approaching arrival time of their bus.

III. The Proposed System

Figure 5; explain sources of data utilized in our work and the operations utilized in their manipulation, the Program Arc map 10.1 contains several Components, Such as layers (shapflies), classes, dataset, geodatabases, tables, models, tools, editor and Networks analysis, contains many tools that help to build strong systems help solve the problems of this world, and it is organized in a sophisticated form with the development of This modern technology age, as well as help in the exploitation of lost time eternal dilemma of the age and the reduction of it and eliminate it. We have used the program ArcCatalog10.1, ArcMap10.1 in the establishment and functioning of this system, which helps to reduce the time lost in transportation.

A. Layers System

In the beginning, we have created three major layers through the program ArcCatalog10.1; each layer contains its own. Our system consists of three layers (Figure2), and it is:

1. Bus Layer

We have created a shapfile of point type named Bus Location, when the GPS sends coordinates of the bus to Listener Server, the last is being to store coordinates after translated and analyzed to the private table of GPS Bus_Location(Figure2) and does the GIS to represent these coordinates in the form of points on the map by bus movement at each time, and are represented by these points by this Layer is responsible on Bus movement on the map.

2. Station Layer

So, we have created a shapfile of point type named Stations Location, it is consider as the most important layers in this system, it is as a link between the other layers, because it's Interfere in the calculation of time and the distance between it and the bus on one hand, and between it and the person's place on the other hand, so the system depends on it mainly to get the results, and it is contains its own table that consists of the following fields (name_id : the

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numbers of the stations on the road, SELECTION : that saving either (0) which means that the bus is not reach to the station yet, or (1) which means that the bus across this station.

3. People Layer

Also we created a shapefile of point type named (People_locations), this layer specifies the waiting people and their habitation place. This layer is used to calculate the taken Time for everyone to reach bus waiting station, by using the following equation:

$$Speed = \frac{Distance}{Time}$$

Where speed: is the average of normal human speed, and the distance: is the distance for every person from their habitation place to the station that follow this region and it is measured by the GIS program, while the time: is the taken time for every person to reach the station. So, the time can be calculated by the data that we have that it is the speed and distance and this is what we need. this layer contains a special table that consist of the following fields (name: names of the people , phone: Phone numbers of the people, message: this field saving two numbers either(0) which means the person didn't receive the an alert message when the bus nearing to arrive, or (1) which means the person receive the message, w-speed: the average of normal human speed, w-distance : distance , everyone housing place from the station , time_: the taken time for every person to reach the station .

B. System Engines

It consists of two stages or two models:

1. Create a model named (People_Selection) works to choose the names of the people and the names of the private stations for each person (each person and the number of its own station). At the beginning ; we input the station layer to **buffer** tool in a certain distance according to persons that they far away from the station which creating a circle around every station, and this is done by input the result of buffer to **intersection** tool with people layer, in order to get the intersecting points with the buffer ; this intersecting points is the location of the persons on the map , so we can select the persons who follow each station, then we input the result (the intersecting location of persons) to another tools to create a new table named (peopltable) consist of the persons who follow these selected station (Figure3).This models working only once at the beginning of Project execution to create the required table.

2. Also we create a second model which named (Bus_Selection) this is the major model and the basis of system work. Where its work all the day with the movement of the bus in each time that receive a new coordinates for the bus from the GPS, Constantly checking is the bus near the station? And so on to the last station. This model works as follows: We start to input the coordinates of the current bus to **buffer** tool, then this tool create a circle around the bus place, this circle radius difference with the car speed rate, so the relation will be as directly proportion Whenever the car speed rate increased; increased the radius of the circle, thus increase the distance between the bus and the station, this buffer result will be entered with another input ; it is a station layer to another tool known as **select layer by location**, so that we get a intersecting points with that buffer, it is the location of selected station of the **select** process after the bus approaches towards

the station which gets into the requested range. Then, notice is persons who follow the selected station, one after the other; according to far away of each person from the station and the time taken to arrive to it. After that we input the result to another tools to create new especial table (bustable) consist of the selected station (Figure4). And using loop with this model to works all the time.

C. System Implementation

Figure 6; shows the way the W@H works as follows: From the previous stage, we got two tables(bustable, peopletable), at the beginning; the system make checking for the first table(bustable) constantly. If it is empty it will be remains in the loop, if it is not empty make select for the table fields and that contains the selected stations. Then select the second table to choose the persons who follow these selected stations with their phone numbers and the time taken for every person to arrive to the station and this is done by loop according to the numbers of selected stations. the W@H make an remediation process; interference in the calculations of the distance and time taken for every person who follow that selected station from the housing location to the station location ; keep in mind if the person lives in the ground floor or upper , also the calculations of distance and time taken to reach the bus to the station, and through these information, the W@H sending messages to all persons who follow that selected station according to the priority from farthermost to the closest to next closest to the last person riding the bus from the station . The Figure 7, 8; shows the ordering messages system & messages sent.

IV. Experimental Results

We calculate the waiting time after applying the (W@H) on a sample in Al-Mansoura city where the results show reducing the waiting time as follows: Table1 and Table2.

Table1: Calculate waiting time before applying W@H

Persons	Time Person arrive station	Time Bus arrive station	Waiting Time
P1	8:15am	8:30am	15
P2	8:20am	8:30am	10
P3	8:10am	8:30am	20
P4	8:20am	8:30am	10
Average of Waiting Time			13.75

Table2: Calculate waiting time after applying W@H

Persons	The message order	Time send message	Time Person arrive station	Time Bus arrive station	Waiting Time
P1	First message	8:22am	8:28am	8:30am	2
P2	Second message	8:24am	8:29am	8:30am	1
P3	Third message	8:24am	8:28am	8:30am	2
P4	Fourth message	8:26am	8:29am	8:30am	1
Average of Waiting Time					1.5

From the previous tables (Table1, Table2), we note that there is a vast difference in the percent ratio between the average waiting

time before applying the W@H and beyond (Figure 9), and so could the W@H reduce the waiting time to individuals in the waiting station by a very large ratio of the wasting time, and provides time for them to take advantage of it and they are in their homes.

The percentage rate of average wasting time of waiting and made available to individuals in their homes as follows:

Percentage available time for Waiting at home using the (W@H) = (13.75-1.5)/(13.75)=89%

Table 3: Percentage ratio of available time for each person for waiting at home.

Persons	Waiting Time without W@H	Waiting Time by W@H	Per. available Time
P1	15	2	87%
P2	10	1	90%
P3	20	2	90%
P4	10	1	90%

V. Conclusion

This paper presented this proposed system (W@H), which was applied the Geographic Information Systems (GIS), GPS Tracker, GSM Networks and GPRS Technique, to get for the bus location on the road network, in addition to specify previously the places for waiting people of this bus; it identify the location of persons who follow each waiting station when the bus approaching it , and sending an alert message for these waiting persons according to the primacy of people who far away from the station and the time taken to arrive to it, so that the person could moving at an appropriate speed before the arrival of the bus to the station, that our system could reduce the waiting time for persons which reach the rate of (1.5) in a minute only waiting in the station after they suffering from a big and unlimited waiting in the waiting station, thus the W@H has provided service to persons who involved with it, and they would be able to know when the bus would arrive to them in very short waiting time.

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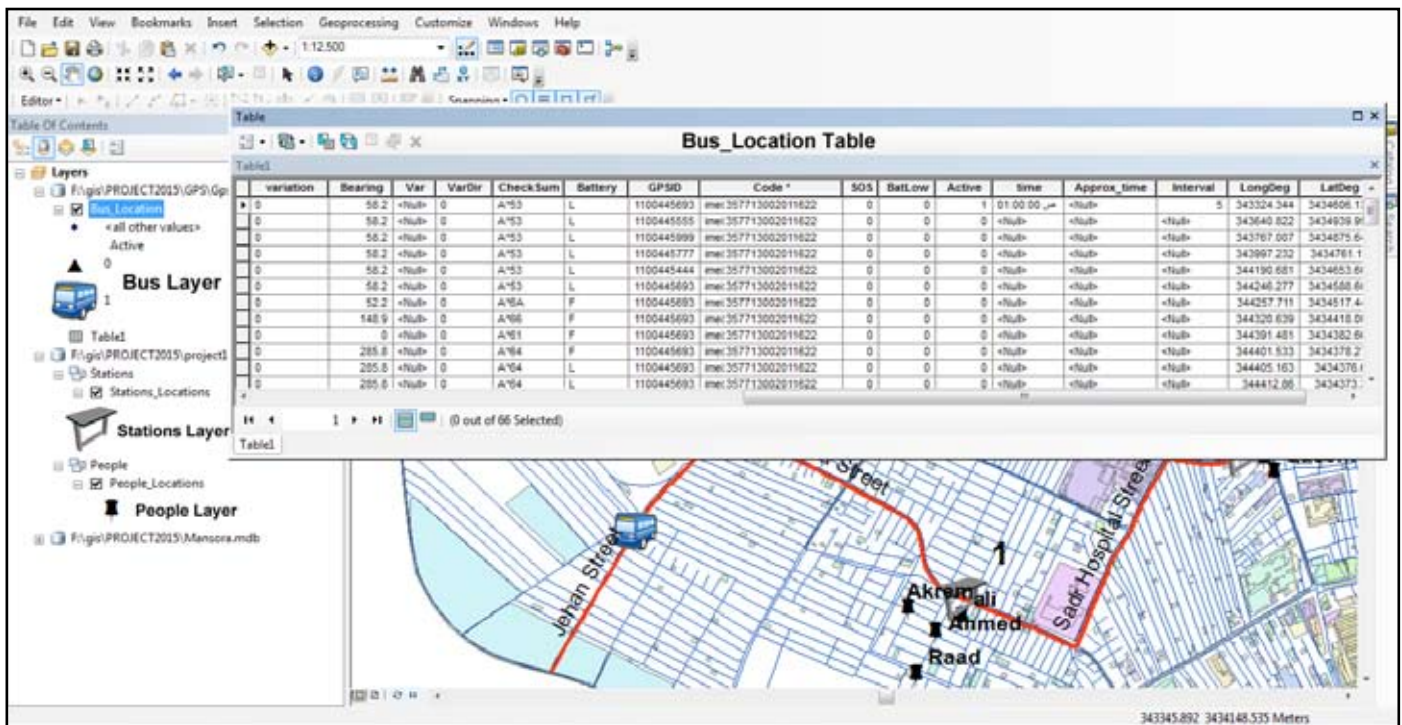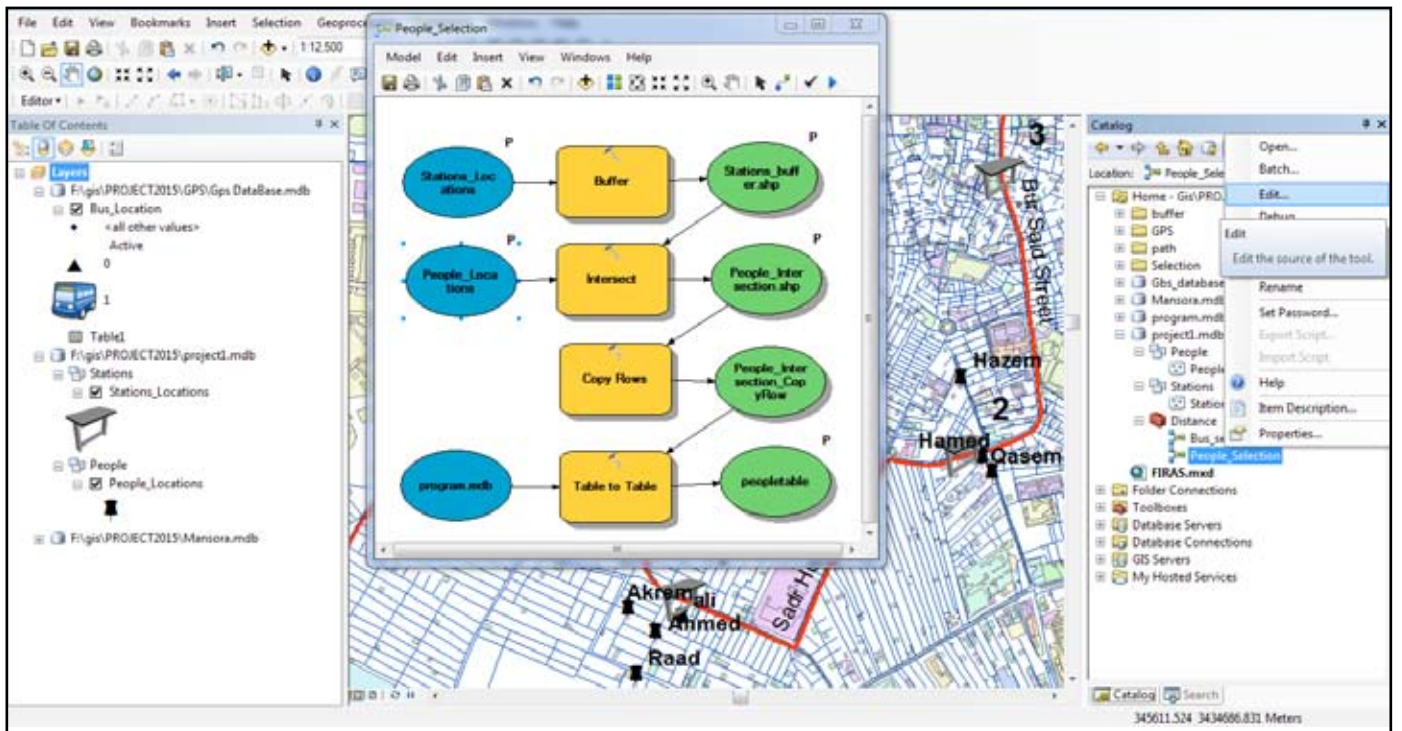
Fig. 1: GPS Tracker

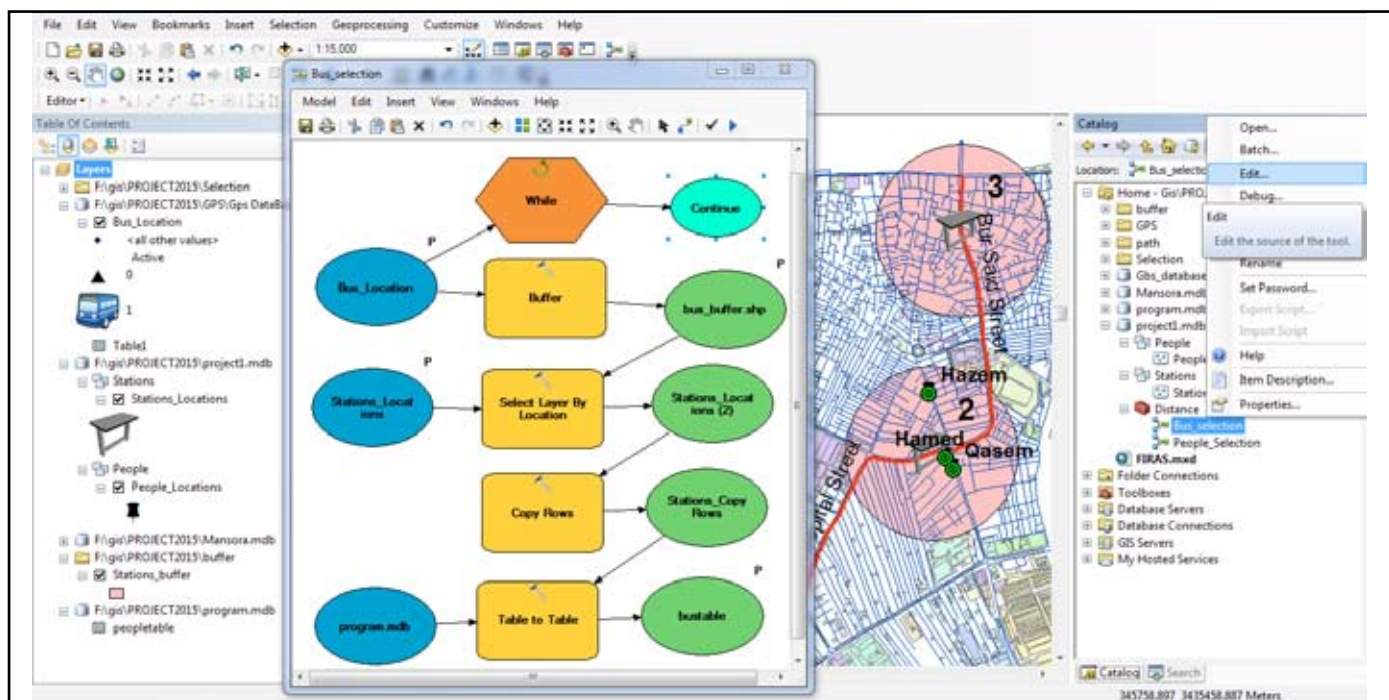Fig 2: GPS Database & Layers

Fig. 3: Design Model1 (People_Selection).

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Fig. 4: Design Model2 (Bus_Selection).

Fig. 5: Flowchart of W@H.

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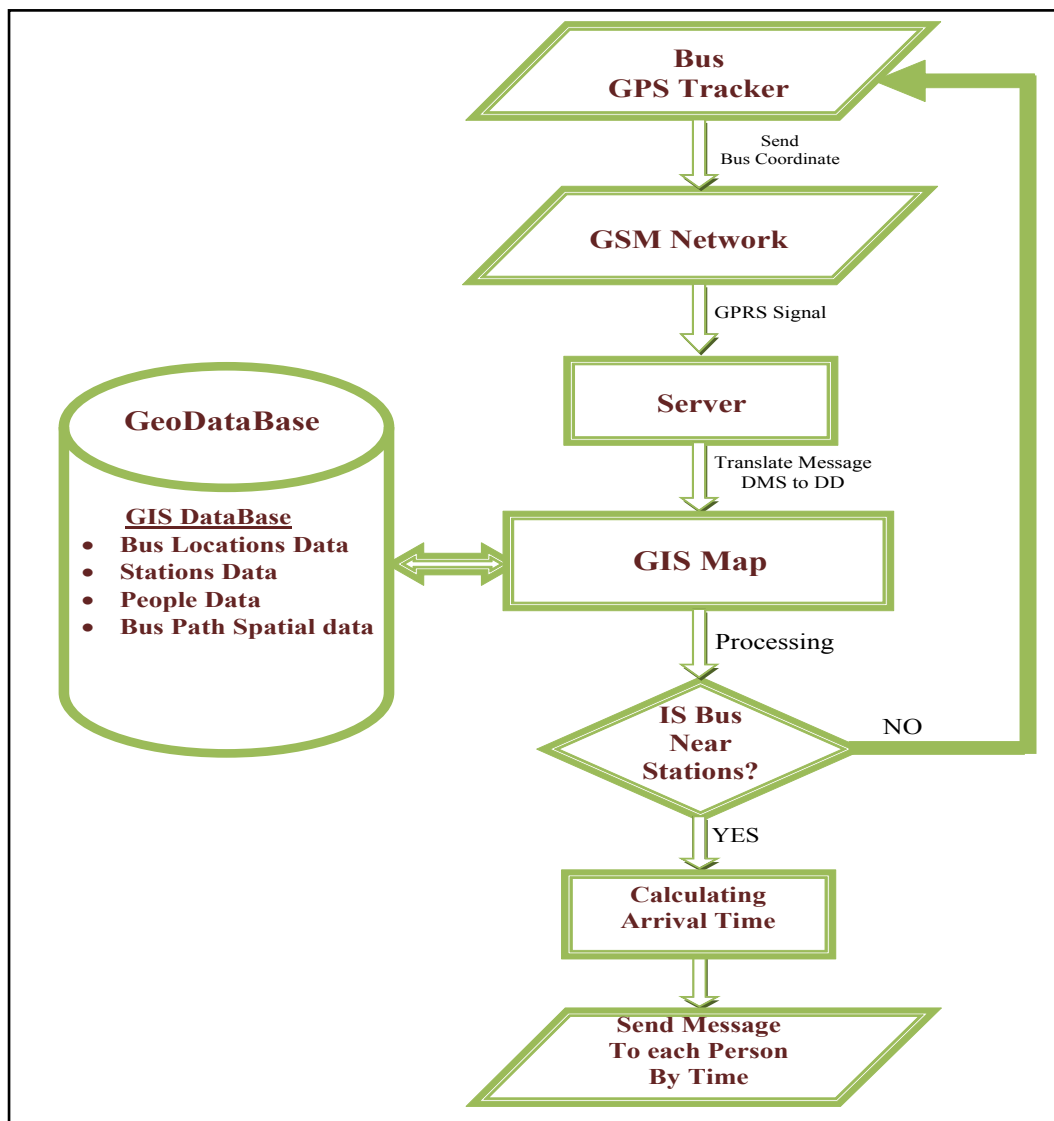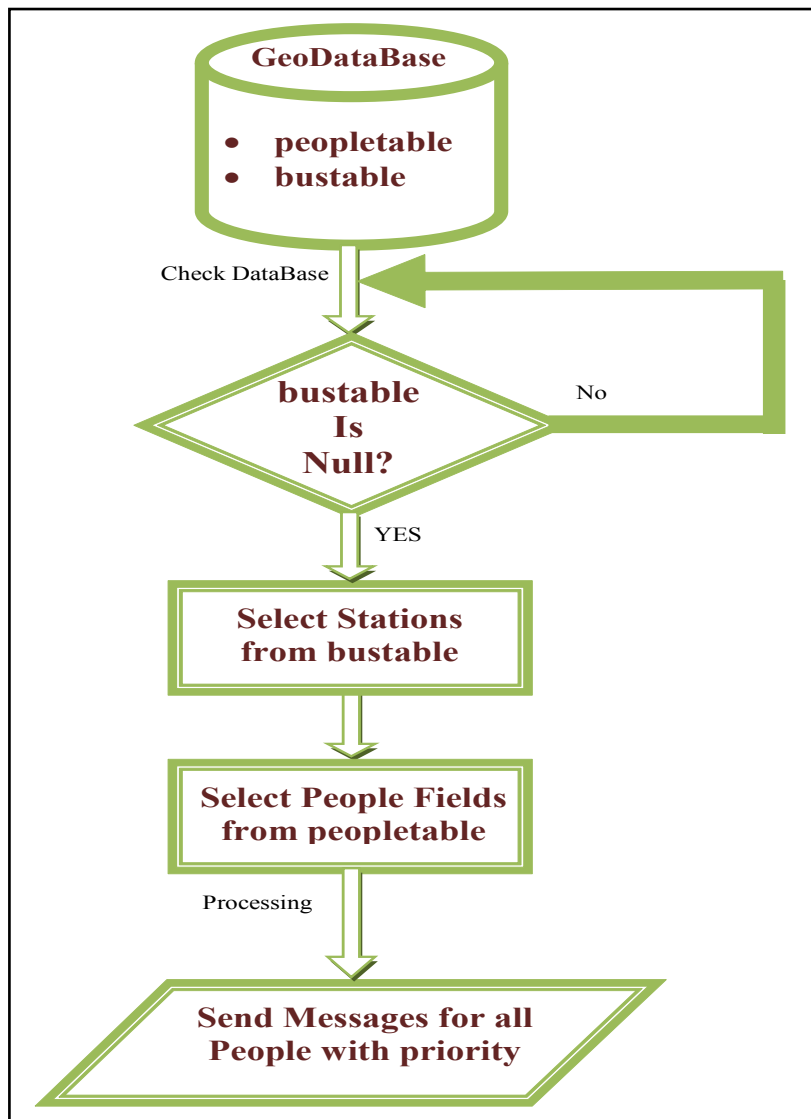
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Fig. 6: Flowchart Mechanism for sending messages.
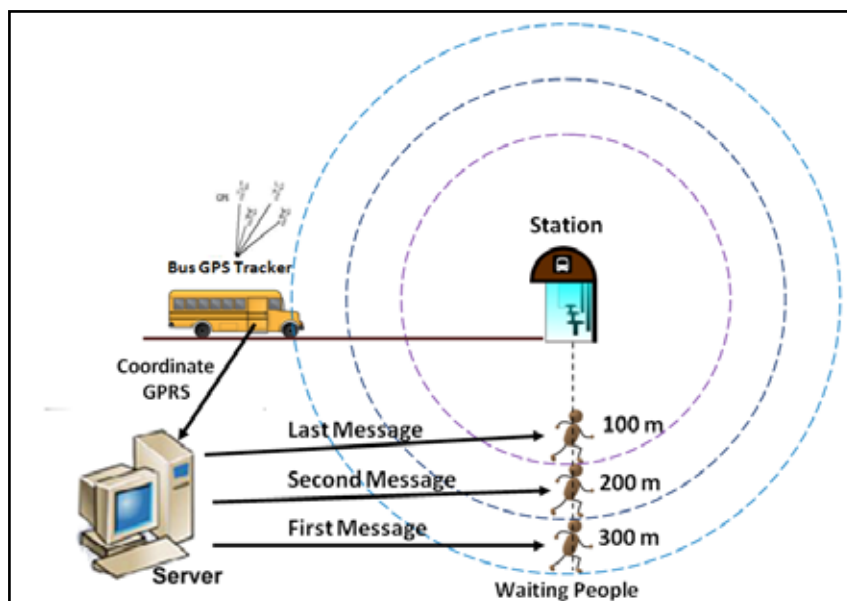
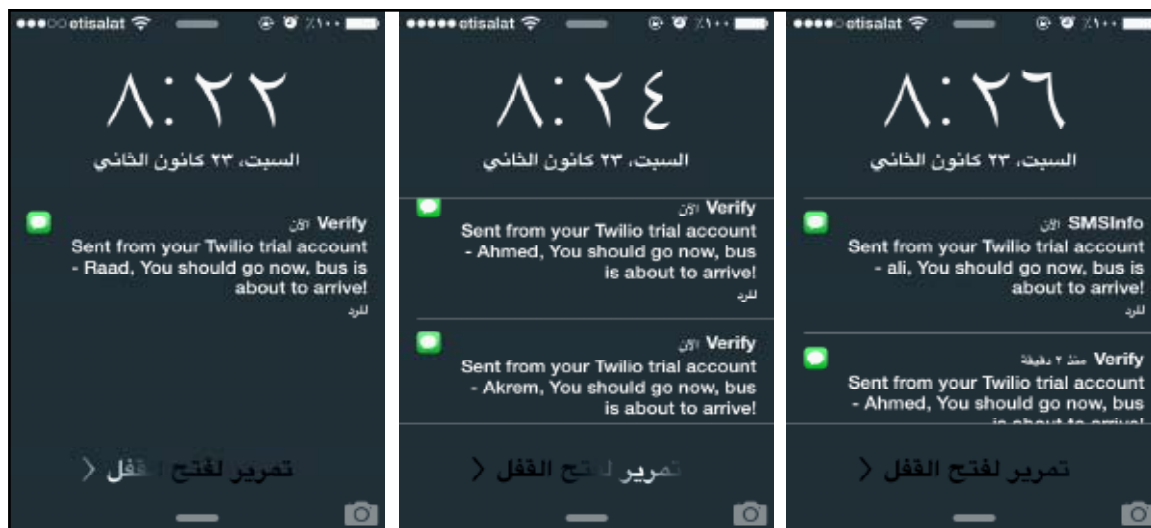Fig. 7 : Ordering Messages System.
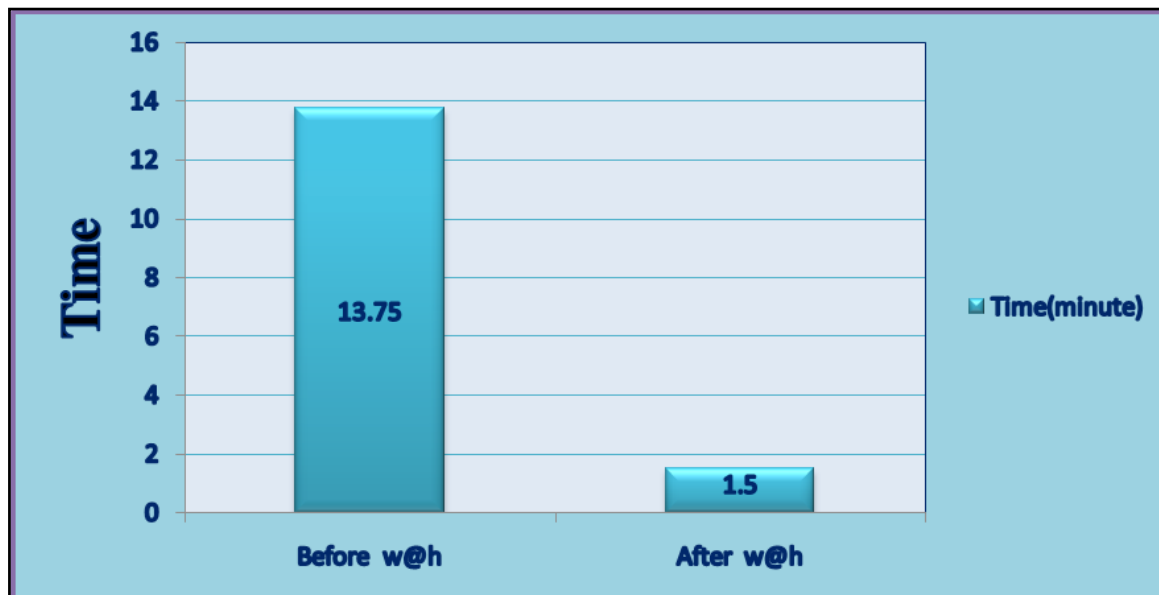
Fig. 8 : The messages sent.

Fig. 9 : Clarification of difference between the waiting time before and after applying the W@H.