Proposed the use of non-intrusive technology to ticketing of public transport vehicle passing integrating modes

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Abstract: - The urban public transport, in addition to transporting several people in a single vehicle, has the purpose of offering an alternative mean of transportation to the car, reducing traffic jam and environmental pollution. The main complaints from users of this mean of transportation are the long waiting times in terminal stations, lack of agility during boarding and extended travel time. An alternative for solving such problems would be the implementation of RFID technology in buses ratchets, which is a technology composed by a RFID tag and a reading portal with the purpose of exchanging data using radiofrequency. This feature allows data to be exchanged even when the tag is in motion. The aim of this research is to propose the implementation of radiofrequency identification (RFID) technology in the public transport system in order to decrease boarding and disembarking time at every stop, reducing total travel time.

Key-Words: - Urban public transportation, RFID, BRT, ITS, Santos, Brazil

1 Introduction

The metropolitan area ofSantos has a population of 1,731,400 inhabitants, distributed in nine counties (Bertioga, Cubatao, Guaruja, Itanhaem, Mongagua, Peruibe, Praia Grande, Santos and São Vicente). In this region, EMTU / SP is responsible for the operation of 62 lines, with planned fleet of 529 buses that transport 5.7 million passengers per month. Daily average users is 218 000 [1].

To meet passenger demand in these municipalities, the region has a fleet of 529 buses, which are transported every month a total of 5.6 million passengers in the metropolitan lines. As there is no metropolitan terminals installed in Santos, the lines use assigned stalls in municipal terminals, they are: Tactical terminals and Tude Bastos (Big Beach), Valongo (Santos), Ferry Boat (Guaruja), Bus Terminal Guaruja, Bus Terminal Peruíbe, Itanhaém Bus station, Bus Terminal Mongaguá and Road Cubatao Terminal. [2][3]

Among the main manifestations of the users regarding the service of this kind of public transportation is the reduction of the waiting time at the terminal platforms, greater flexibility in loading and reduced travel time. The city of São Paulo, for example, to meet such claims, tested the operation Pre-shipment, during peak hours, in line with increased demand for faster boarding and ensure matches at the scheduled times, as determined in Operation Work Order after an on-demand analysis, boarding time in major terminals and time of passage through the turnstile in vehicles of more

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loaded lines.

In the implemented project it was registered an improvement in boarding time users and compliance with scheduled departures. Another positive point is the comfort and safety for special passengers boarding through the front door that is positioned outside the pre-boarding area, they get preferred entry and use of the first guaranteed seats. This comfort extends to users who embark on collective along the way also have the advantage of finding the free front hall. The result of the operation was a gain of time 10 minutes. [1], Figure 1.

Fig.1: Single Ticket System Using Mifare Card Type (Source: SPTrans)

Another study by SPTrans with two turnstiles on buses allowed a 38% reduction in the loading and unloading time, and there is approximately 73 m bus with this configuration operating in nine lines in the south, southeast and north. The buses are articulated and bi-articulated that provide greater interior space. [3].
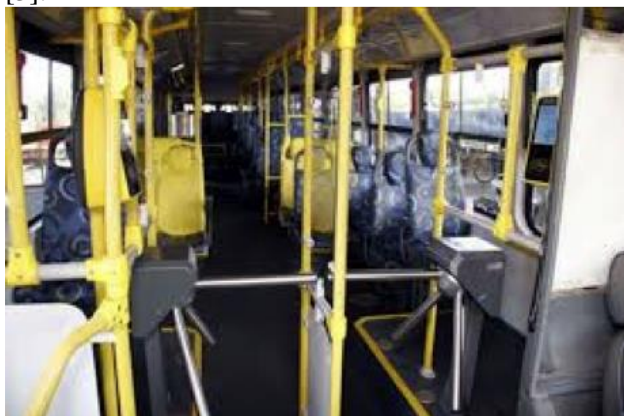

Fig. 2: Bus with two ratchets (Source: SPTrans)

With the increasing number of passengers and demand for public transportation over the years in this region, there is a need to reduce loading and unloading time of these passengers to avoid congestion on the roads and reduce the total travel time, increasing transport efficiency. One solution would be to implement the radio frequency identification technology system (RFID) the ratchets of the bus, which is composed of TAG RFID portal and reading that will exchange data via RF even with GAD in motion, causing there is a reduction of approximately 30% of the total journey time.

Another important factor to reduce congestion is to understand the bus users' profile, identifying the origin and destination of each user and their respective schedules. With this information you can estimate the amount of passengers on each line, facilitating the management of public transport, it may readjust the bus lines, increasing the fleet at certain times, change location of bus stops, among other things. [8]

Thus, this paper carried out an evaluation of non-intrusive technologies required for billing the passage of public transport vehicles in the metropolitan area of Santos, in order to reduce shipping time and landing on the bus, at all locations, reducing the total time of the trip, offering the best operating and technological model to meet these demands in the region. [5][6]

2 Methodology

The research method uses a qualitative method and quantitative. The qualitative method is adopted the multiple case study technique, the analysis of similar projects in urban transport area (mobility). To do so will be raised scientific articles relevant to the subject to identify the problems in question, thus qualifying the problem.

In the qualitative survey will be identified the main characteristics of the problem under study and thus allow for modeling of the system required to perform efficiently the entry of users on the bus and the acquisition of origin information and the user's destination.

Through qualitative survey will be possible to realize the problem formulation in question through knowledge bases: Bibliographic Search; Documentary research; and search Existing Legislation and Regulations.

In the quantitative method is evaluated quantitatively through the statistical techniques, with the purpose of the organization and summary of the data and the search for an overview of the sample and the behavior variable, by use of relative and percentage frequencies.

As proposed schedule, the beginning of the work is a literature review to understand the operation of public transport in the metropolitan area of Santos and identify technologies that can be applied to achieve the objectives of this course conclusion

work.

The main items identified are presented in bibliographic references and serve as a basis for the development work and achieve the expected result.

The result of the completion of course work is to develop a proposal for an operational and technological model that reduces boarding time and disembarking of passengers, and record the location of these passengers, in order to allow the responsibility for the management of public transport urban the possibility of readjustment of the bus lines in accordance with the observed data

3 Operating Model Development

Initiatives to reduce the queues are being researched, meanwhile solve problems in specific conditions, ie in the terminal boarding or bus with two turnstiles. The terminal solution reduces boarding time by 10 minutes as shown in SPTrans, 2005 [1], however the landing time and shipping outside the terminals do not change. In the case of buses with two ratchets, there is a clear reduction, but reduces the users of transport capacity on the buses.

Therefore, there is a solution that meets all the needs of passengers, in the pursuit of reducing the time of shipment and landing in all conditions. In this context, it comes an interesting opportunity to research and propose solutions that meet the needs of users.

This research project presents the application of non-intrusive technology necessary to reduce the boarding time and disembarking the bus, everywhere, in order to reduce the total time of the trip.

In addition, there is a need to understand the bus user profile, thus this project allows us to identify origin and destination of each user and the analysis of this information will be possible to estimate the number of users on each line and where. Thus, the manager of public transport can readjust the bus lines, increase the fleet at certain times, change the location of bus stops, among other things. [9][10][11]

3.1 General Objectives

This project has the overall objective to propose the use of non-intrusive technology to ticketing for public transport passing vehicle (bus), to reduce shipping time, besides registering the place of embarkation and disembarkation user (passenger). This shipment record (source) and landing (landing) allows for the management of urban public transport to assess the use of each bus line and offer

consistently readjustment of them, including the points of departure.

The specific objectives of this study we have:
- identify the passenger volume at each point of embarkation;
- assess each user's travel times;
- identify and assess the user profile.

3.2 Description of Technology Non Intrusive

The purpose of using a non-intrusive technology is to allow the public transport users feel more free, ie without the need of having to remove the card from the electronic bus ticket or money purse, pocket, wallet, etc. It is expected that this need without boarding passes to be more effective because the user simply get on the bus. To enable this condition is proposed the use of a radio frequency identification tag (RFID) that will be installed on a card and that you will carry in your bag, pocket, wallet, etc; but no one picked up the same to validate the payment of your bus ticket is required. [17][18][19]

The RFID (Radio Frequency Identification) is a technology used to capture data using radio frequency signals to accomplish this task, enabling the identification, tracking and management products, documents, animals or individuals without the need for contact or visual field. One of the first RFID passive systems emerged during the Second World War, when aircraft were detected over long distances by radar, but without the distinction if the plane was an ally or enemy. Later, in the 1980s, the Massachusetts Institute of Technology (MIT) initiated studies on the creation of technology based on radio waves serving as benchmarks for the development of new applications of tracking and tracing products.

RFID systems consist of three basic components: antenna, reader and transponders (tags or tags), figure 3.
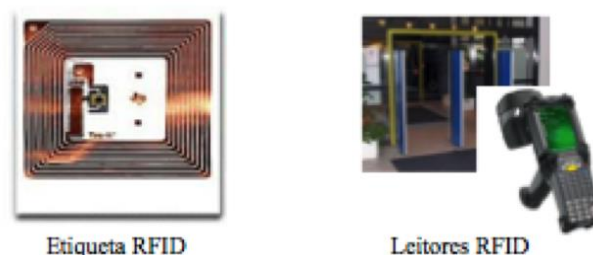

Fig.3: RFID Solution Components

The antenna via a radio signal, is the medium that enables the RFID tag to exchange / send information. They can be manufactured in various

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shapes and sizes with different configurations and features according to your application. The reader through the transceiver transmits radio frequencies that are dispersed in several directions in space, with a variation of distance according to power output and the radio frequency used, as shown in Figure 4.
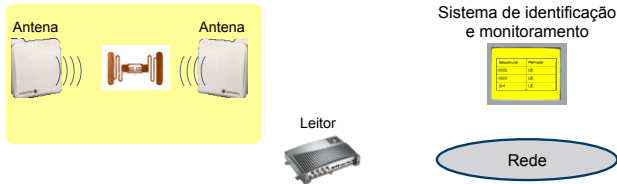

Fig. 4: Components of RFID Solution

The RFID tags may have various formats (ring pads, cards, etc.), sizes and materials used for their packaging (plastic, glass, epoxy, etc.), and such characteristics defined according to the application environment of use and performance See the figure 5.

It is the device that carries the actual data of the RFID system, typically consisting of an antenna for communication and an electronic microchip for storage and computation. There are two types of tags: active or passive. Passive tags operate without battery, with power supplied by the reader itself over the air waves. Already active tags have an internal battery and typically allow reading and writing processes.
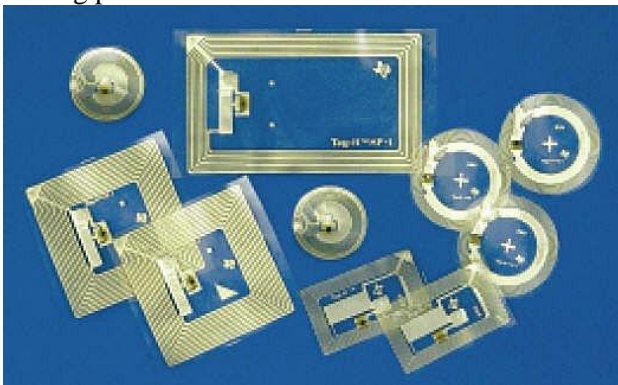

Fig. 5: RFID Tags (Source: Texas Instruments)

RFID systems are also defined according to the frequency range in which they operate, which can be classified as: low frequency and high frequency systems. The low frequency (30 kHz to 500 kHz) are used for short reading distances, often in access controls, traceability and having low operating costs.

Since the high frequency (850 MHz to 950 MHz and 2.4 GHz to 2.5 GHz) are used for averaging readings and long distance and high speed readings is typically used in reading tags in vehicles and automatically collecting data.

3.3 Solution Description

In the case of the metropolitan area of Santos, the technology can be used as follows:

1) Each user will have an electronic bus ticket in card format that has a high-frequency RFID tag;
2) The bus will have three RFID portals:
   - One located at the gateway;
   - Another at the output port; and
   - Third at the turnstile. Initially considered keeping the ratchet in order to ensure recovery of the passage, however, will not have the collector and no apparent reader.
3) The card with the RFID tag will have stored a single and a loaded value identifier (virtual money);
4) When the user enters the bus, the portal recognizes the card and reads the same and currently writes on the bus location card obtained via the GPS (Global Positioning System);
5) When you pass through the turnstile, the portal reads the card and cut the amount corresponding to passage and releases the ratchet;
   - If you do not size the card or it is fraudulent, the ratchet is not released, in this case the user is asked to make the payment directly to the driver.
6) When leaving the bus the portal recognizes the card, reads the same and write on the card the location of the bus at the location where the user is coming down, in a similar way when he gets on the bus.

It is noteworthy that all above operations are carried out without the need to bring the card to a reader, and he may meet with you in your pocket, purse, etc.

The information recorded on the card is history so that the user can control the use of it further when I record the information on the card, this information is stored in the portal and then transmitted to the bus utility control center and / or the responsible agency in government.

With this you can perform the necessary analyzes for readjustment of bus lines and better meet the user's profile.

All information will be sent via the communication system to a centralized server, and it will be possible to access the data and make the necessary analysis, as shown in Figure 6.

Another identified problem is related to the payment of the passage currently coaches have

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collector, ie, if the user does not have the card it can make the payment on the bus. This no longer occurs on the bus, leaving it to the driver. However, if you have many passengers without the card, the driver can get overwhelmed and result in problems or delays. This situation must be evaluated more carefully during continuity.

One possibility is the site of expansion for buying and selling card, not just limited seasons, using automatic machines, Figure 7, and local sales (kiosks) or in the local market, thereby removing the driver's billing function .

Fig. 6: Centralized information (Source: CanryTek)

Fig. 7: Credit Sales Equipment (Source: Bilhete Único)

4 Conclusion

The first stage of the work consisted in understanding the activities of the current situation of public transport and identification of relevant technologies. With the large number of public transport users and the total time of high trip,

consider the use of a non-intrusive technology as a solution to reduce the time of shipment and unloading of each passenger, and consequently the total travel time. The implementation of a radio frequency identification (RFID) technology is a possibility for such activity.

With the understanding of each element was identified that the high-frequency RFID tags are the most suitable for allowing to perform high-speed reading, plus the possibility of reading at greater distances, about 20 meters.

It is expected that with the use of this technology, there is a reduction in the shipment time because that way the user moves the ratchet without having to present the card and thus reduces this time. In addition, the technology will identify the origin and destination of each user allowing thus conduct an evaluation of the routes used and thus make a better planning of bus lines.

Upcoming Activities

The first step consisted of only the definition of a conceptual model applying non-intrusive technology to reduce user boarding time, and allows verify the origin and destination of the same and thus reprogram the bus lines. Thus it is understood as future activities are:

- Implement a proof of concept in some buses to validate aspects relating to system usability;
- Evaluate its results for the reduction achieved time due to the use of non-intrusive technology;
- Evaluate the acceptance by users.

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