UNOBTRUSIVE MOBILE PUSH TECHNOLOGY IN LOCATION BROADCASTING

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ABSTRACT: An efficient vehicle tracking system using Android-based application and web-based platform for monitoring and viewing dispatching buses in real-time. Global Positioning System (GPS) identifies the location of the vehicle, while maps through web GIS permits the commuters to monitor routing fleet. We developed the mobile application for two different users: (a) within the dispatching bus and (b) for the riding public to search or locate the bus. The mobile application used by the conductor within the bus transmits signal and locations unobtrusively into the server establishing a push technology communication that makes the commuters able to grab the possible estimated time of arrival (ETA) of a bus in designated stations or terminals. Riding public without the mobile application can also use the web-based application to view any of the routing buses. The methodology used in the development follows the Iterative Life Cycle Model that is the best fitting for this study for its simplified implementation towards progressing cycle. Also, the integration of a business model into the system allows any passenger to book tickets and reserve a seat. By this, the riding public has easy access for monitoring bus's arrivals and departures that aids travelers in any possible preparation and other travel options in case the bus does not suit the commuter's travel preferences. We conduct Survey using System Usability Scale (SUS) to test the usability of the system, and the point average of 124 respondents is 70. 01. This result within the range of 60.0 – 80.30 showed that the system is suitable for use.

1. INTRODUCTION

With the rise of technology, rapid development has proliferated the society to augment and enhance the quality of life for most everyone (Kulawiak & Chybicki, 2018). In fact, from the report of United Nations (Susar & Aquaro, 2019) states that digital transformation is the key to growth and progress among different sectors in the society, and transportation is not exempted, and must also be considered for enhancement, thus vehicle tracking for better transport system would become possible (Khosrow-Pour, 2019).

The Philippines is an archipelago wherein there are variety of island sizes less travelled by common Filipinos. In the southern part, especially in Caraga region, travel by land is most likely practice by the riding public specifically with the public buses. Pedestrians are waiting in designated sheds or terminals with uncertainties if the bus arrives in a minute or an hour especially buses that are not able to adhere predefined timetables due to reasons like traffic jams, breakdowns, etc. (Janssen et al., 2017); hence, waiting for an indefinite time is consuming, exhausting and stressful (Kumbha, 2015). In addition, it can cause more traffic if the waiting passengers continually increases as the day also progresses on. Moreover, passengers also do not know that the bus they are waiting do still have available seats when it arrived (Pitogo, 2019), or even the class of bus either be an ordinary, deluxe or air-conditioned vehicle. When this public transportation concern do not acted upon can possibly build up a pressing societal problem in the near future (Budi Sunaryo et al., 2019; Damani et al., 2015).

To address the said issue in the region, this paper presents a way to enhance travel experience by providing a mechanism to inform the riding public about specific details of a riding bus. Details such as estimated time of departure (ETD) and estimated time of arrival (ETA), the current station/terminal, the type of bus, its status, capacity and even the last point of destination of a specific

through designing applications in multi-technology platforms, like mobile (android-based), web and global positioning system (GPS). The data is being fed from the dispatching bus and information are generated from the central server, basically the broadcasting of certain location, thereby establishing an unobtrusive push technology communication (Gharami et al., 2019) between the bus and the riding public with varied ICT platforms in real time. The development method used in this empirical study follows the iterative life cycle model of developing applications which begins from data gathering down to implementation, and is considered very fitting to this endeavor because it starts with a handful information at the initial stage towards building a complex modules at the later part (Amershi et al., 2019). The web-based application also able to track the dispatching bus (Harshadbhai, 2013; Vaitis et al., 2018) by locating it concurrently on the map; another feature incurred in the application is the booking module called *Bus Card*. This allows commuters to book a ticket and reserve a seat for a specific trip in a specific date, providing a convenient way of travel arrangement especially when travelling in a group.

We conducted a beta testing of the system and found out that there are some functionalities needed to be improved, like data network traffic, reservation confirmation, internet connection and its user interface. However, survey was also conducted in terms of the usability of the system among 124 respondents using SUS (Hasim et al., 2019); results showed a scale of 70.01 points interpreted as Good implies that the system is good for use.

When properly and appropriately implemented, this work could lessen the traffic jam and volume of commuters, thereby, providing a better means of transportation amongst pedestrians, the public, transport group and even the government. Hence, the study is at the initial stage, it is recommended further for future works to integrate the application on the dash camera of the bus. This would give convenient way for the dispatcher to broadcast information seamlessly because most of the routing buses has its own Wi-Fi connection. The mobile application for IOS-based phones should also be considered and other functionalities needing enhancement.

2. REVIEW OF RELATED LITERATURE

The tracking system is becoming increasingly important in any geographic location (Daguil et al., 2015; Harshadbhai, 2013) in a complete vehicle tracking system in real-time. Moreover, it emerges to strengthen the public, vehicle, and road is safety by putting modern information technologies together (Seetanah, 2019), enabling a practical and comprehensive transportation system. Kwon et al. (Kulawiak & Chybicki, 2018) proposed an efficient vehicle tracking system by designing and implementing it to any equipped vehicle and track its movement from any location at any time. They used GPS and GSM technologies that are common for location transmission. They also build a mobile application with a microcontroller to make it easier to track vehicles. Google Maps API was also incorporated to display and monitor the vehicle on the map. Likely, in Kumbha (Kumbha, 2015), they developed a web-based information system to track and monitor vehicles in real-time; this is due to the increased burden on public transportation. The system handles all the data about the bus's current location, making it track buses in real-time by using that information. They also integrated technologies such as GPS, Google maps, GPRS in a web-based platform.

In the work of Kumar et al. (Andersen et al., 2019; Pal & Mandliya, 2016), they embedded a GPS into the vehicle, which makes up the vehicle trackable and signals locations via an SMS into the server. Real-time tracking, location of the driver, and instant data are being received, so reports are generated quickly (Javed et al., 2018), while Pal & Mandliya (2016) draws a real-time tracking system that provides precise locations of the tracked vehicle with the low monetary amount of value, which also provides vehicle information regarding the vehicle status, such as speed and mileage. In the paper of Solanke & Khandelwal (2015), he proposed a novel method of vehicle tracking and locking system. Said system is used to track the theft vehicle by using GPS and GSM technology. The system puts into sleeping mode while the owner or authorized person's vehicle otherwise goes to active mode. The mode of operation can be changed by in person or remotely; when theft is identified, the responsible person sends SMS to the microcontroller, then issues the control signals

to stop the engine motor, making the burglar alarmed. With theft prevention tool is also seen in the work of Agrawal et al. (2014) that developed a GPS-based transit tracking systems, which provides a communication infrastructure that allows bus users to query and receive information in a real-time manner (Cai et al., 2019). The system uses bus's positional data and route information to calculate estimated arrival times; thereby, tracking and navigating vehicles are efficiently enforced. At the same time Mukhtar, (2015) in his paper proposed a cost-effective and unique tracking technology that offers advanced tracking, with a variety of control features that facilitate the monitoring and intelligent control of the vehicle.

With the vast and rich knowledge in the literature concerning tracking, monitoring, and even safety mechanism on a dispatching vehicle, the authors look into the Philippine setting aspect as the subject of such implementation. Moreover, only a few studies were conducted in the country during this study's development relative to location broadcasting, especially the integration of multi-varied ICT platforms and applications (Pacot & Marcos, 2019), so the researchers found it as a gap, thus making this work.

3. METHODOLOGY

The proponents used the Iterative Life Cycle model in designing and developing the applications. An iterative life cycle model does not attempt to start with a full specification of requirements. Instead, development begins by specifying and implementing just part of the software, which is then reviewed to identify further requirements, as presented in the following figure.

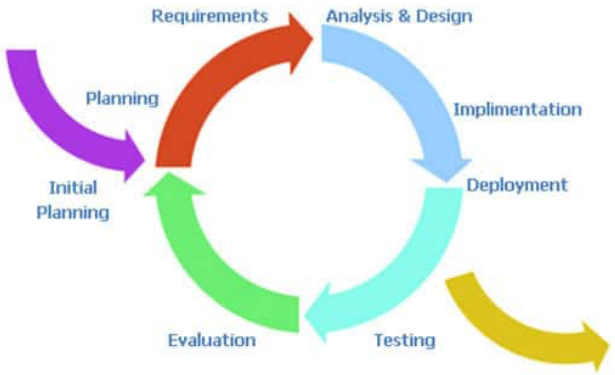

Figure 1. Iterative Model

The study further follows the cycle of developing information systems and applications using the Iterative model (Alavi, 1984).

3.1 Planning Phase

First through an Initial Planning, that includes an assessment of the status of the transportation system in Butuan City and neighboring municipalities and regions incorporating vehicles coming from Davao and Cagayan de Oro areas and came up with monitoring and tracking vehicle movement through the latest technology like mobile applications, GPS and GSM modems, including the web. The study also integrates Google API (Behzad et al., 2014; Pitogo, 2019) maps to visualize the routing buses and web users to view and locate moving vehicles.

Data gathering is employing an interview with bus operators with dispatching routes in the Caraga region, some bus drivers and conductors, and more on riding public in the planning phase. Schedules of traversing buses were obtained, the fleet type and their selected routes, and some documents. Direct observation of vehicle transportation management is also conducted. Table 1 depicts Schedules and bus types.

Table 1. Bus Schedule

Route	Aircon	Deluxe / Regular
Butuan – Cagayan	1st Trip: 2:00am Last Trip: 10:00pm Interval: every 30 min	24 Hours Interval: every 20 min After 10 pm, 1-hour interval
Butuan – Surigao	1st Trip: 3:00am Last Trip: 6:00pm Interval: every 45 min	1st Trip: 2 am Last Trip: 10:00pm Interval: every 20 min
Butuan – Davao	1st Trip: 2:00am Last Trip: 9:00pm Interval: every 45 min	24 hours Interval: every 20 min
Butuan – Tandag	1st Trip: 2:00am 2nd and Last Trip: 11:00 am	1st Trip: 1:00am Last Trip: 7:00pm Interval: every 30 min
Butuan – Mangagoy	none	1st Trip: 4:00 am Last Trip: 7:00pm Interval: every 30 min

In case of special occasion, which needs additional buses, interval and dispatching time will change based on the number of passengers on demand.

Table 2. Bus Routes and its Bus Station/ Terminal

Route	Bus Station/ Terminal
BUTUAN-CAGAYAN	Nasipit*, Magsaysay, Gingoog*, Balingoan*, Salay, Balingasag, Jasaan*, Villanueva, Tagoloan, Cagayan de Oro City*
BUTUAN-SURIGAO	Cabadbaran*, Tubay, Santiago, Jabonga, Kitcharao*, Mainit*, Sison, Surigao City*
BUTUAN-DAVAO	Sibagat, Bayugan*, Prosperidad, San Francisco*, Rosario*, Bunawan*, Trento*, Monkayo, Montevista*, Nabunturan*, Tagum*, Panabo*, Davao City*
BUTUAN-TANDAG	Sibagat, Bayugan*, Prosperidad, San Francisco*, Barobo*, Lianga*, San Agustin, Marihatag, Cagwait, Bayabas, Tago, Tandag City*
BUTUAN-MANGAGOY	Sibagat, Bayugan, Prosperidad, San Francisco, Barobo, Tagbina, Hinatuan, Bislig City

The table presented is a list of routes and their designated bus stop/terminal or station. All Bus station/terminal with an (*) symbol are the only designated terminals where Aircon type of bus should stop to load and unload passengers and baggage. All non-air-conditioned buses are thus required to stop at the designated terminals.

3.2 Requirement Phase

For the Requirements phase, the proponents identified the platforms needed for location broadcasting. Said platforms are to be used in communicating between the traversing bus and the riding public. Figure 2 presents the system architecture.

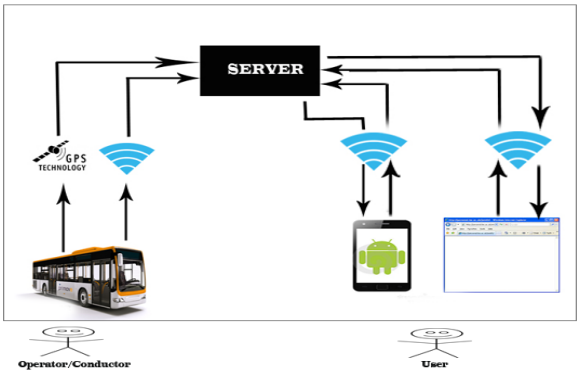

Figure 2. System Architecture

Figure 2 presents the system's architecture. Mobile applications within the dispatching bus will broadcast locations through the internet and GPS communications (Matias et al., 2020) unobtrusively, and data will be stored in the server. Mobile and web users can view and retrieve any dispatching bus, thereby giving the public commuters options.

3.3 Analysis and Design Phase

For the analysis and design phase, a mobile application was developed by the information gathered from requirements (Kotusev et al., 2015). The project uses the open-source Postgre SQL and other scripting tools such as JavaScript and PHP for databases. Moreover, it has two varieties for the mobile application: (a) for the Bus Administrator / Conductor.

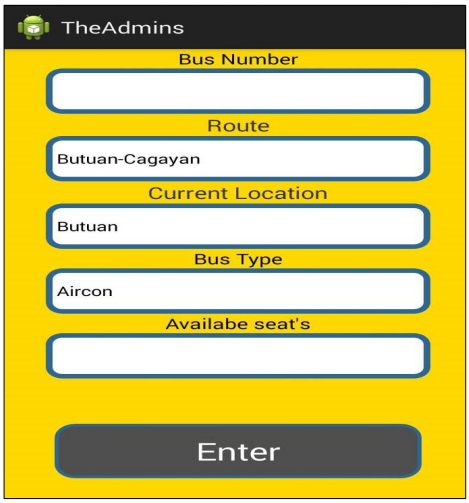

Figure 3. Registration Form

It is used to register all bus information and its routing details. It is also used to register the conductor of a particular bus. The other mobile application is (b) for the riding public and passengers. Commuters and travelers can use this application to locate any dispatching bus, providing routing details therein and possible travel options.

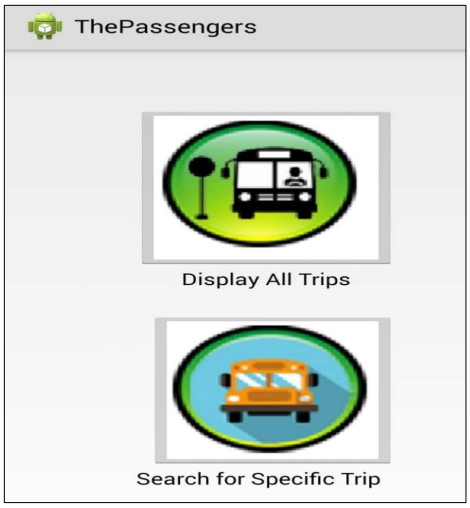

Figure 4. Passengers Display App

Passengers Display Application is where commuters can view and select designated travel schedules based on their preferences and need. The figure shows the options on what the passengers would like to view. “Display All Trips” button will display all current dispatching routes broadcasted based on the conductors updating timeframe stored from the central server, and listed in the viewer’s mobile app. The riding public, however, can select from the list of traversing buses directly. Simultaneously, the "Search for Specific Trip" button will enable the user to locate a specific bus fleet, destination, or even estimated time of departure or arrival and directly select the travel schedule.

3.4 Implementation and Deployment Phase

For the Implementation and Deployment, this will be proposed to the bus operator existing in the region and probably be replicated to other bus companies. The prototype will be used in the Butuan City area and later on to be improved to the entire Mindanao.

3.5 Testing Phase

We piloted tested the platform in select users in the region and use the Systems Usability system among varied riding public and results showed a good fit for use of the product.

4. RESULTS AND DISCUSSION

The following are the results of developing unobtrusive location-based broadcasting in mobile and web platforms.

Figure 5. Specific Route

In figure 6, a list of detailed information is provided to users based on their specific routes searched.

Figure 6. Passengers Bus Card Account

This modal allows the user to reserve a bus seat by providing his bus card number and password access credited at a designated bus station booth. Within the passenger's account, it can also reserve more than one seat.

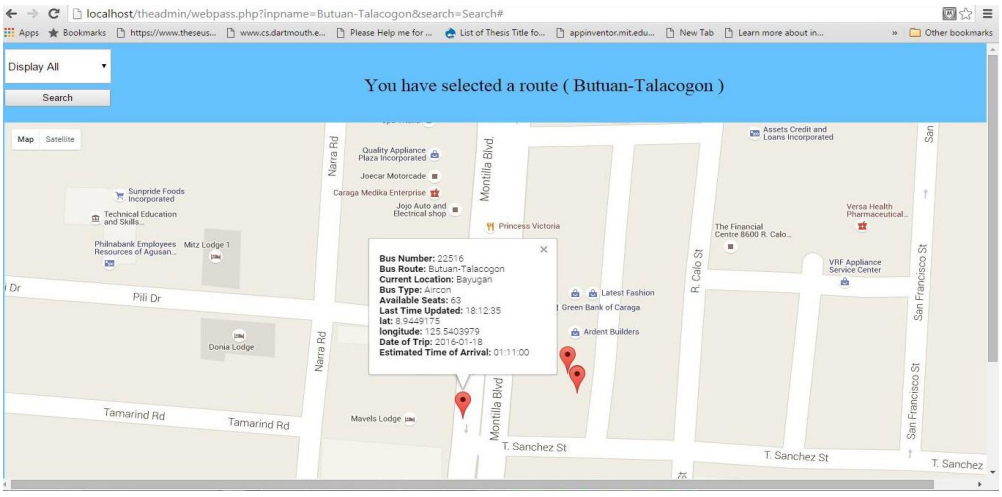

Figure 7. Updated Bus Location

This is a bus location sample updated on a web platform; it provides a map where a red indicator points the location. The report is displayed on the top of the indicator about the passengers' details; it also provides information about the type of bus and the seats' availability.

We also implore a random survey to quantify the application's usability using the System Usability Scale (SUS), the most frequently used questionnaire to measure usability (Hassan Basri et al., 2019; Peres et al., 2013). The SUS consists of ten (10) questions with five (5) options to choose from.

Table 3. SUS Questions

No.	Question
Q1	I think that I would like to use this system frequently.
Q2	I found the system unnecessarily complex.
Q3	I thought the system was easy to use.
Q4	I think that I would need the support of a technical person to use this system.
Q5	I found that various functions in this system were well integrated.

Q6	I thought there was too much inconsistency in this system.
Q7	I would imagine the most people would learn to use this system very quickly.
Q8	I found the system very cumbersome/ awkward to use.
Q9	I felt very confident using the system.
Q10	I needed to learn many things before I could get going with this system.

The five (5) options are in a five (5) point Likert Scale standard: (1) - Strongly Disagree, (2) - Disagree, (3) - Neutral, (4) - Agree, and (5) - Strongly Agree.

We surveyed about 124 respondents and calculated the SUS score. Calculating the SUS score can tell the usability performance in effectiveness (Inal, 2019; Sørum, 2014), efficiency, and overall ease of use (Hasim et al., 2019). Table 4 depicts the SUS score and its interpretation.

Table 4. System Usability Scale (SUS) Score

SUS Score	Grade	Adjective Rating
> 80.3	A	Excellent
68 – 80.3	B	Good
68	C	Ok
51-68	D	Poor
< 51	F	Awful

The average point for 124 respondents is **70.01**. Based on the interpretation, the SUS score falls in the range of 68 – 80.3 with a B grade and has an adjectival rating of **Good**; it means that the system is suitable for use.

5. CONCLUSIONS

The beta version test of the system was conducted to determine if it could achieve the study's scope and purpose. The developed Unobtrusive Mobile Push Technology in Location-based broadcasting has tracked all dispatching buses' current locations in real-time. During the simulation, random commuters can try the system based on their travel options. It further able travelers to track and monitor their preferences and provide details on their trip. Therefore, it provides a convenient way for the riding public to decide earlier if he/she will wait and track the bus or take another mode of transportation that would result in a lesser volume of waiting passengers and traffic jams (Wu et al., 2018).

Though the survey result shows that the system is suitable for use, it needs further improvement to resolve issues and address current functionalities. The public has easy access for monitoring pick-up and drop-off and has its estimated arrival; it gives passengers an idea for the preparation time allotted (Vidiasova & Mikhaylova, 2016). It also gives passengers safety arrival by the confirmation updates of the conductors. The system would be a success for improving transportation by expanding communication (Agur, 2018). It will serve as a viable notification system that will effectively assist pedestrians in taking public transportation.

6. FUTURE WORKS

Based on the observation of the simulated system and beta testing, the researchers would recommend the following:

- Refine the field of the reservation system for more convenience processes. Having a more precise protocol and its rules and regulations.
- Upgrade the GPS broadcasting to make it a real-time and near-exact accurate location.
- Improve the notification updates by synchronizing the communication mechanism, making it an auto-generated system. Thus, loss of internet connection may delay the dead spot area but reconnecting again gives an automatic update for the users' more convenience.
- Maximize the administrator control to update any new routes or destinations from its origin to any destination.

- Besides, with significant consideration of security measures, hence the system incorporate payment and booking module.

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