SafeTransit: A Transit Safety Information Gathering Decision System

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Abstract. The present situation of public transportation system in sub-Saharan Africa especially in Nigeria reveals to a large extent, a low level of effectiveness and safety. The need to provide safe transportation services to users in developing countries cannot be overemphasized. Hence, this paper provides a decision making model that helps users of public transport systems avoid unsafe transportation services (vehicles) by providing them with a community-aggregated information about vehicles and their personnel.

Keywords: Commuters · SafeTransit · PTS (Public transit systems/service) Decision making

1 Introduction

Safety of Public Transit System (PTS) in Nigeria over the years has become an issue of great concern precipitating various calls for help from different institutions and corporate bodies towards ensuring a safe system. In view of the current rate of avoidable accidents happening as a result of technical faults or personnel skill and attitude, there is a need for an effective oversight of the public transport sector in order to guide the activities of the transport workers (mostly from the private sector) and also ensure safety of lives of road users. Transportation functions are an indispensable basis for any country's development and have the ability to provide benefits to the society.

With a current estimated human population of 180 million, Nigeria is a country with a high level of vehicular population estimated at over 7.6 million with a total road length of about 194,000 km (comprising 34,120 km of federal, 30,500 km of state and 129,580 km of local roads), Nigeria has suffered severe losses to fatal car accidents [1].

Nigeria's population density varies in rural and urban areas at about 51.7% and 48.3% respectively and translates to a population-road ratio of 860 persons per square kilometer, indicating intense traffic pressure on the available road network. This factor has contributed to the high road traffic accidents in the country [2].

Nigeria is ranked second highest in the rate of road accidents among 193 countries of the world [3]. According to a World Health Organization (WHO) report, one in every four-road accident deaths in Africa occurs in Nigeria. The WHO survey as well as the Federal Road Safety Commission (FRSC) report of 5,693 fatal road accidents in 2009 leave no doubt about the dangerous situations on Nigerian roads.

V. Odumuyiwa et al. (Eds.): AFRICOMM 2017, LNICST 250, pp. 225–231, 2018.
https://doi.org/10.1007/978-3-319-98827-6_20

The causes of fatal car accidents are conventionally categorized into human, mechanical, and environmental factors. The human factor accounts for up to 90% of accidents [4], while mechanical and environmental factors account for the remaining 10%. The human factors include driver fatigue, poor knowledge of road signs and regulations, illiteracy, health problems, excessive speeding, drug abuse, and over-confidence while at the steering wheel. Among the mechanical factors that lead to fatal car accidents are poor vehicle maintenance, tyre blowouts, poor lights, un-roadworthy vehicles, and broken-down vehicles on the road without adequate warning. Environmental factors include heavy rainfall, harmattan winds, sun reflection, heavy wind, potholes, and un-tarred roads. These factors have independently and or collectively contributed to the high rate of fatal road accidents in Nigeria.

Road traffic crash is one of the causes of deaths in Nigeria as no day passes by without recording at least 20 crashes resulting in an average of 15 deaths [5]. According to a WHO fact sheet report, road injuries killed 1.3 million people in 2015 and are the leading cause of death among people aged between 15 and 29 years. These statistics coupled with the present nature of the PTS as well as the ineffective running of the system by the concerned bodies makes it imperative for users of the system to personally ensure their safety by making informed decisions.

Most PTS users depend on their intuition, formed from available information, in making decisions relating to their PTS choice. Information to support travel decisions is acquired actively (by reading, asking, listening) or passively (through experience) from various sources, and it is used, along with stored knowledge, to make choices. [6]. Access to public transit related information is a major component to any decision making process (human or artificial). It's been argued that drivers could save travel time by switching routes if they had information on current traffic conditions [7]. It has also been observed that information about road conditions and accidents provided by ATIS's allows travellers to make an informed route decision, more precisely, taking cautions or avoiding dangerous routes and choosing a safer path [8]. Reliance on intuition to help users make informed decisions is limited and this makes the need for a more robust and well informed decision making system imperative.

2 Related Works

2.1 LA Metro Transit Watch

LA Metro Transit Watch [9] is a smart phone security application built to report transit-related crimes. This application allows the public to assist law enforcement agents by reporting suspicious and criminal activity in a timely manner. This application is essentially a reporting tool to report incidents and does not prevent accidents or crime. It does not also alert commuters of the likely danger they could encounter as a result of boarding a particular vehicle. LA Metro Transit watch is available on the two major mobile platforms (Android and iOS).

2.2 Matserve Msafiri

This is a road safety application developed in Kenya [10] that analyses the speed of public transport vehicles. This helps in saving lives on the road and also to improve the quality of service in public transport. It is a road safety application built for the android platform that crowd sources speed feeds and reports from passengers on-board public service vehicles to help reduce the number of lives lost in road accidents due to avoidable human errors and impunity. The application detects the exact moving speed of a vehicle and instantly generates an alert and sends to relevant legal authorities if the allowed speed limit for the road is breached. This application allows users to report about reckless driving, overloading and over speeding among other challenges to mitigate accidents caused by human error and outright disregard for traffic laws. This application's central features include speed check and community policing.

3 Methodology

In developing SafeTransit, the methods employed include: (i) the development of a model highlighting the various phases that should be supported by the transit safety information gathering system; (ii) the implementation of the model as a mobile application for PTS users; and (iii) the preliminary evaluation of the system using few selected users.

4 SafeTransit Model and System Design

This paper proposes a model for transit safety information gathering and decision making. This model has six phases: (i) Source Validation: This phase ensures inputs to the system are accepted only from validated sources (users). (ii) Data Gathering: This phase determines how data about PTS vehicles and their personnel is to be gathered. (iii) Data Validation: Ensure only validated information supplied by users is allowed into the system; for example, the application can guard against gamification by getting global positioning system (GPS) coordinates at the point of data input. (iv) Data Analysis: Get trends from data supplied in phase two. (v) Transit Advice Generation: Propose decisions from patterns gotten from analyzed dataset and where possible taking into consideration the attributes of PTS personnel and users in making decisions. It has been noted that individual characteristics of PTS personnel impact on their decision making [11, 12]. Likewise the characteristics of PTS users influence their decision making process. Hence models (profiles) of the users should be inculcated in the advice generation phase. For example: the application can suggest best routes and PT systems based on current GPS location; the application rates each PTS and assigns a travel experience quotient. The application can then relay the comfort rating to the user on enquiry e.g. "*Hi, vehicle comfort rating is 45%. It is advised you look for a more suitable PTS*". (vi) System Decision Validation: The application gets feedbacks on all application generated decisions and uses these to evaluate and improve the decision making process.

4.1 System Design and Implementation

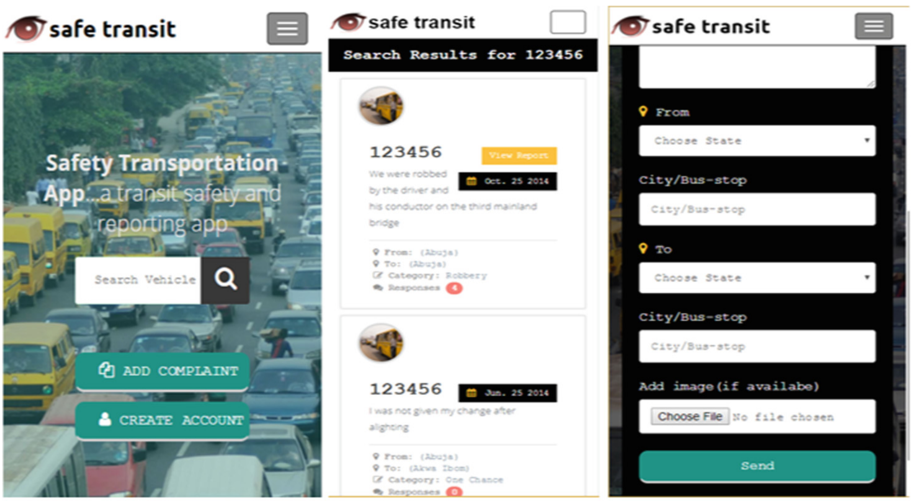
In developing SafeTransit, all the phases from the proposed model were implemented. The application validates users by email and collects data about the vehicle, the route and user complaint or report about the trip or vehicle. In order to ensure correctness of input, users are blocked from adding more reports after two false or incorrect reports. The reports submitted by the users are validated by recognized regulatory bodies (in charge of ensuring vehicle's road-worthiness) whose task is to verify reports by checking out each reported vehicle, and reporting back the true state of the vehicle to the application.

The application has a public-facing website application (accessible on desktop and large-screen devices), mobile web (responsive for small and handheld devices) and a native mobile application for smartphones deployed on the android Operating System (OS). The web system's backend server is built using PHP for the business logic and MySQL for database. The application programming interface (API) gateway is implemented using the RESTFUL concept.

A simple use-case flow is itemized in the list below:

- A user who is about to board a PTS, checks the vehicle's plate number.
- The user types the number into the application to get information, if there is an existing report, the user can make his/her decision based on the generated advice.
- If no report is found, the user is left to use his intuition.
- The user can also add report en-route if an abnormality is observed.
- When a report is created, a notification is sent to the system administrator and the regulatory administrator using push notifications.
- The regulatory administrator checks the vehicle and also report back to the application.

A screenshot of the SafeTransit application is shown in Fig. 1.



(a) (b) (c)

Fig. 1. Safetransit screenshots (a) login page, (b) search result, (c) add report

4.2 System Architecture

The SafeTransit architecture as shown in Fig. 2 consists of the following modules: (i) Search: This functionality allows users to search the database for existing reports on a vehicle. (ii) Report: This function allows users to create a report about a vehicle and also allows the regulatory bodies to verify and attach a response to each user report or complaint. The module however does not allow the deletion of user-created report in order to maintain the integrity of the system. (iii) User Management: This functionality allows the system administrator to create, edit and delete users. Users of the system include commuters and government regulatory bodies and other administrators. (iv) Notifications: This feature is developed to manage the creation and sending of notifications and alerts using the mobile push notification. When users create a report, the report module generates an alert to be sent by the notification module to the regulatory bodies.

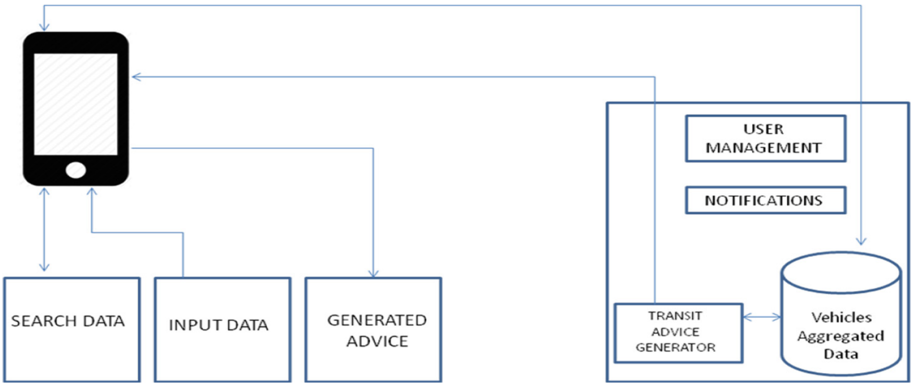


Fig. 2. Safetransit architecture

5 Evaluation and Feedback

To verify Safetransit's effectiveness and acceptance, an evaluation test was carried out among a group of twenty-five public transport users. The questions used in the evaluation are:

1. What are the factors considered before using a PTS?
2. Do you consider safety and security before using a PTS?
3. Have you ever regretted using a PTS due to safety/security factor?
4. How do you make meaningful deductions from listed response(s) in Q1?
5. Do you judge your observation mechanism employed in Q1 as being effective?
6. Do you think safetran provides a better mechanism for assessing PTS?
7. Can safetran bring some sanity into the public transport sector?
8. Can safetran help reduce the number of accidents on our roads?
9. Please give reasons to support your answer in 7 above.

10. Do you think the populace (Nigerians) will be willing to use safetran?
    (a) Yes, I am 100% percent sure.
    (b) Well, not too sure.
    (c) No, not too sure.
    (d) No, they won't be willing to use it.

The evaluation results showed that 50% of the respondents do not consider safety first when using a PTS and 90% agrees that their decision making hasn't always been effective. About 72% chose option B for question 10 above. This evaluation further proves the need for the SafeTransit system.

The evaluation results also showed that users' decision making processes are mostly influenced by the following: (i) Financial Capacity: Public transport users will likely go for the cheaper option. (ii) Time Constraints: Users will likely jostle for available options during rush hour periods. (iii) Religious beliefs: Religious beliefs can also make users ignore safety factors in making a decision. (iv) Physical Condition: Users will prefer a PTS that offers more comfort.

The results also showed some behavioral patterns among the respondents. The notable ones include: (i) Some users consider the safety condition of vehicle coupled with the physical disposition of the personnel (driver and conductor) before boarding a vehicle. (ii) Users will likely use a bad public transport vehicle for shorter journeys rather than long ones. (iii) Dependence on self intuition is not reliable. (iv) All respondents have at one time put themselves in danger's path by using a public transport service. (v) Use of the SafeTransit application is not feasible during rush periods.

6 Summary and Future Work

This paper work shows that human decision making process can be improved by exposing user to crowd sourced information. We plan to improve on Safetransit by introducing some intelligence into the application. Intelligence here means that the application will be able to learn from acquired data and make relevant recommendations to PTS users. We believe this will go a long way in bringing some sanity to the public transport sector and, directly and indirectly, reducing the number of accidents on our roads.

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