A Web App for Transportation and Carpooling Mangement in Bangladesh

Townim Faisal
Eelectrical & Computer Engineering
Department, North South University
Dhaka, Bangladesh
townim.faisal@northsouth.edu

Faria Karim Porna
Eelectrical & Computer Engineering
Department, North South University
Dhaka, Bangladesh
faria.porna@northsouth.edu

Ahsanur Rahman
Eelectrical & Computer Engineering
Department, North South University
Dhaka, Bangladesh
ahsanur.rahman@northsouth.edu

Abstract — **Technology has solved transportation-related problems in many countries. However, in Bangladesh, transportation services still require a lot of manual processing which causes harassment of the vehicle owners and drivers due to bureaucratic issues and corruption. Moreover, driving records of vehicles are either not kept or are not made publicly available. As a result, drivers can often escape when they are involved in any crime in the vehicle or are responsible for any accident. Vehicle fitness reports are not publicly accessible either. Finally, due to dense population in our cities, we face heavy traffic congestion every day. In this work, we attempted to solve all these transportation-related problems by developing a web based transportation and carpooling management system. This web-app handles driver and vehicle registration processes of Bangladesh Road Transport Authority (BRTA), thereby made this process easy and accessible from anywhere. Vehicle owners can also use it to register drivers daily. General public can know information about drivers and vehicles via just a few clicks. These services will help to quickly identify true culprits behind accidents and other in-vehicle crimes which are on the rise in our country. Passengers can also take precaution and law enforcement officials can take immediate action when they find that an unfit vehicle is registered to run on the road or when a vehicle is registered to be run by a driver who doesn't have proper license. This app also offers an online carpooling service that enables a vehicle driver to share it with other passengers who need to travel along the same path. This service will reduce traffic congestion as the number of vehicles will be lower in the road. While several ride-sharing apps are already available in our country, none of them are free whereas our carpooling service is a free one. We have been able to achieve this goal by successfully integrating a free map API with an open source routing API. To the best of our knowledge, our web-app is the first one in Bangladesh which offers free carpooling service instead of paid services provided by the existing ride-sharing apps here. Our web-app is available at arahman.xyz for testing by the users.**

Keywords — transportation management system, carpooling, ride-sharing, road crime detection, web-app.

I. INTRODUCTION

In our country, transportation-related issues are our daily life problems. Such problems include traffic congestion; road accidents, unavailability of vehicles during rush hours; in-vehicle crimes such as smuggling, robbing/mugging, poisoning, human trafficking, sexual harassment, stealing, and so on. Every day we get news about road accidents and other in-vehicle crimes from the newspapers, TVs, and other news outlets. Recently, Bangladesh Passengers Welfare Association reported that there were 5,514 road accidents in Bangladesh in 2018 which killed at least 7,221 people and injured many more [1]. Violence against women is another common problem during transit [2]. A survey conducted by Action Aid International[1] in 2016 reported that 84% of the respondents, all of whom were Bangladeshi women, experienced direct or indirect (e.g. verbal) sexual abuse during commute [3]. Another recent survey conducted by BRAC Research[2] reported that 94% of the commuting women reported to be harassed during transit [4]. Most alarmingly, at least 21 women were raped in vehicles between Jan 2017 and Feb 2018 [5]. Stealing, robbery, and hijacking are also some common issues faced by the passengers of public transports [6], [7]. Sometimes, criminals poison the passengers in order to take away their mobile phones, money, and other valuable items. Recently, the number of such criminal activities has increased from the previous years [8]. These statistics show that we are not safe on the road though we need to use the roads daily for our jobs and other necessities. Often times, drivers and their helpers are directly or indirectly involved in such crimes. Yet, users of public and private transports do not have any easy way to identify them if they are indeed involved in such a crime.

These problems could be at least partially solved if the data of the drivers and vehicles were easily accessible from anywhere. In our country, all vehicles are registered and drivers get a license from the Bangladesh Road Transport Authority (BRTA)[3]. We can easily store and manage BRTA data by implementing a web-app which will make its data and services easily accessible to the users. Such an app will surely alert the drivers of the potential consequences if they become involved in any crime or cause any accident because they can be easily and quickly identified by the police via the app. Passengers can also avoid a vehicle if they find (via the web-app) that it is unfit or is driven by a driver without complete license. Thus this app is expected to reduce accidents and other crimes, thereby has the potential to increase our safety.

Another major transportation-related problem is traffic congestion. With the growth of economic development in urban areas, the need for transportation has exponentially increased which causes other problems such as air pollution, sound pollution, etc. Thus this problem is not only worsening people's quality of life but also harms the natural and human-centered ecosystems. Specifically, our capital Dhaka city has now about 20,283,552 people[4] where people face the problem of shortage of vehicle and traffic congestion every day. In addition, the use of public transportation is relatively inconvenient. Carpooling can solve these two issues together by reducing the number of private vehicles during the rush hours. Carpooling also increases vehicle occupancy, reduce parking requirements, save cost, decrease energy consumption and air pollution, increase social bonding, and so on [9].

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[1] https://actionaid.org/
[2] http://research.brac.net/new/
[3] http://www.brta.gov.bd/

[4] http://worldpopulationreview.com/world-cities/dhaka-population/
[Accessed August 4, 2019]

Being motivated by the aforementioned observations, we have designed and implemented a web-app for transportation and carpooling management. Specifically, we have made the following contributions in this work.

- We have designed and implemented an online transportation management system that offers popular services of BRTA. We have made our app publicly available[5] so that anyone can test it and report of any issue or request for any feature.

- We have also implemented some important services in our app which are not offered by BRTA, such as daily driver registration system (to keep record of who is driving which vehicle on a particular day), publicly accessible records of running vehicles and their drivers, carpooling management system, etc. *Thus our web-app can serve as a free one-stop solution of common transportation-related problems and services.* To the best of our knowledge, no extant app provides such an integrated solution at no cost.

- We have conducted a survey to objectively assess our app by its users based on different criteria and report its results in this paper.

Rest of the paper is organized as follows. Section II discusses related works. Section III discusses the architecture, design, and implementation of our management system. Section highlights some of the important use cases of our app. Section V discusses survey results from the users of our app. We provide future directions in Section VI and conclude in Section VII.

II. RELATED WORK

A. Transportation Management Systems in Bangladesh and Other Nearby Countries

The transport authority of our country, BRTA, provides some information about how to get their services in their website – from which, it seems that their processes involve a lot of manual tasks which requires the service-takers to go to the nearby BRTA office multiple times. For example, to register a vehicle[6], the vehicle-owner has to download the appropriate form, fill it up and submit that to a BRTA office, After BRTA completes verifying his/her form and other documents, he is notified to go to the BRTA office to show the vehicle and to collect its fitness certificate. Afterwards he is notified to come to the BRTA office to provide his/her biometric data. After doing that, s/he is notified to collect his/her digital registration certificate from BRTA office. In general, BRTA service-takers suffer from a lot of bureaucratic issues as well as corruptions. In comparison, our neighbor India has already implemented a web portal for giving transportation related services to their citizens (known as the parivahan portal[7]) and they have been using it for quite some time now [10]. Other nearby countries, such as, Singapore[8], Nepal[12], Bhutan[13], and Srilanka[14] have also tried to ensure that most of their transport-related services can be taken online. None of these portals seemed to act like a one-stop solution of all types of transportation-related problems.

B. Ride-sharing Apps in Bangladesh

Some ride-sharing apps are already available in our country. Among them, Uber[9] is currently available in Dhaka. However, people outside Dhaka cannot use this app. Another popular app called Pathao[10] gives services to the people of Dhaka, Chittagong, and Sylhet [11]. There are also some other ride-sharing companies which have slowly started to compete with the above two, such as OBhai[11], Shohoz[12], Lily[13] etc. However, none of these apps are free.

C. Carpooling Apps Proposed in the Literature

Farin *et al.* [12] proposed a framework for a carpooling app but it was not a complete product. Antao, Correia, and Gonsalves [13] made an Android-based app for carpooling. It allows passengers to sign in and then make a journey with other users. Their app did not use any location picker. We want to solve this problem by using map API in our app. Nale and Landge [14] proposed another Android based carpooling app because every Android device has GPS which can track the vehicle and ensure safety of a rider. While this app can be very useful for Android users, others can't use it. So we planned to implement our app to be web-based which can be used by anyone with smart devices capable of accessing internet. Bruglieria et al. [15] introduced a carpooling system for the students and employees of the Università Statale and Politecnico di Milano. It isn't accessible to general public. In contrast, our app won't be restricted to any particular group of people or any institution. Zhang *et al.* [16] introduced another carpooling system which focuses on taxi cabs only. We wanted to build an app which supports all types of vehicles including, but not limited to, taxi cabs.

III. SYSTEM DESCRIPTION

A. System Architecture

We divide our system into two subsystems: (i) transport management system (TMS) and (ii) carpooling management system (CMS). TMS is supported through Apache server and MySQL database whereas CMS is supported through Geoserver and PostgreSQL (Fig. 1).
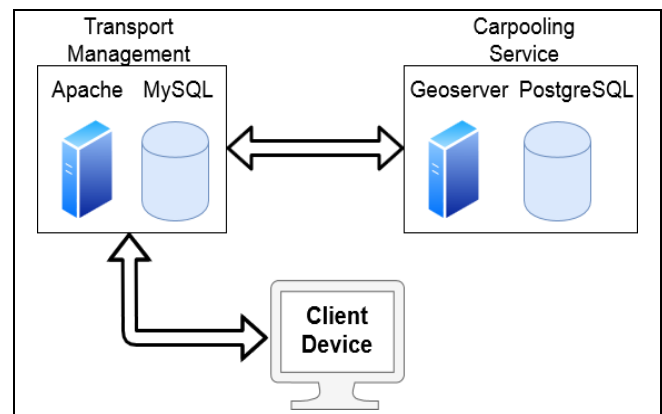

Fig. 1. System Architecture

While it is possible to host both of these subsystems in a single machine, we hosted them using different machines

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because our hosting provider only provided us an Apache server along with MySQL – which we used for our TMS. We used another machine to host our CMS. Communication between these two subsystems happens through internet. Specifically, when a client requests for a route between two locations to the TMS, it forwards that request to the CMS through API calls. Upon that request, CMS sends required data to the TMS which it redirects to the client.

B. Tools Used for Implementation

We have used some tools to develop our app. Specifically, we relied on some frameworks and templates to make our task easier. We have also used database systems to store and manage our data. We used openLayer for the interface of our map and pgRouting and PostgreSQL as backend of the map API for detecting the shortest paths, *i.e.*, possible routes for carpooling. Short description of our tools is shown in Table I.

TABLE I. DESCRIPTION OF TOOLS

Tool	What it does and why we used it
AdminLTE[14]	AdminLTE is an open source responsive HTML template based on a CSS framework called BootStrap 3. We have used it as our front-end template. Some front-end codes are already implemented in this template. Hence we can easily modify them to meet our requirements.
Laravel[15]	Laravel is a free and open-source PHP framework for web application development. It has been used for developing the back-end of our project.
MySQL[16]	MySQL is a database management system. To store the information of drivers, buses, accidents, etc. we used this database.
Xampp[17]	Xampp is a free and open-source Apache server. We installed it in our local machine so that we can test our app before we commit our code.
OpenLayer[18]	OpenLayer an open-source JavaScript library which is used in web browsers for showing map related data. It provides an API for building web-based geographic applications. It was used as an interface of map.
pgRouting[19]	It is an extension of PostGIS and PostgreSQL geospatial database. It was used to calculate shortest path between the origin and the destination of a rider.
postGIS[20]	PostGIS is an extension of PostgreSQL. It provides spatial objects for the PostgreSQL database (which stores spatial data of a place), allowing storage and query of information about location and mapping.
GeoServer[21]	It is an open source server for sharing geospatial data. We used it for fetching spatial data.

C. Technical Design

In order to develop our app, we first designed an ER diagram that can represent our database (Fig. 2). This database has 14 tables. Among them, application_information table contains some basic information about the applicants of driving license and vehicle registration. Our TMS provides two forms to the users: vehicle registration form and driving license form. These forms exactly resemble the corresponding forms of BRTA. The application_information table stores the basic information of applicants who fill up these forms. In the diagram it is shown that this table has relation with driver_application table and vehicle_application table. The

driver_application table contains information that are only required for driving license. So, to get more information about the driving license, there must be a relation between application_information table and driver_application table. Vehicle_application table contains some information about vehicles (such as chasis_no, engine_no etc.) that are related to the vehicle registration form. Since application_information table contains information about vehicle registration form, a relation must exist between application_information table and vehicle_application table, in order to get detailed information about the form. The application_information table is also connected to the registered_user_information table because the later table only contains the id of the user but users' full information are available in the application_information table. The registered_user_information table stores id of all registered users.
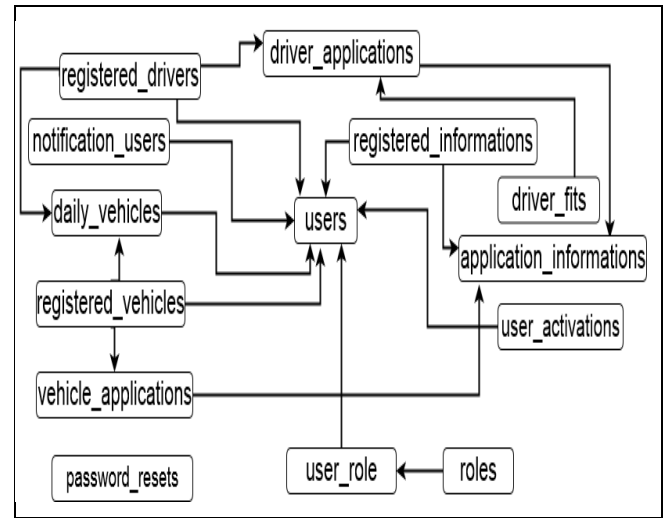

Fig. 2. Simplified ER diagram of our database

Registered vehicles are selected from the list of vehicle registration forms. So, registered vehicles are subset of all the vehicles which have been already applied for. That's why, the registered_vehicle table is connected to the vehicle_application table. On the other hand, registered drivers are selected from the list of driving license forms. So, registered drivers are considered as a subset of all the drivers who have applied for a driving license. That's why, there exist a relation between the registered_driver table and the driver_application table.

In our system, the two important users are the registered drivers and registered vehicle owner. Any unregistered driver or vehicle owner cannot be the user of our system. So there is a relation between user table and registered_driver table and also between user table and registered_vehicle table. When the user signs in to the system, the system matches the provided email and password of the user table in the sign in form. After matching that information, system detects role to view his dashboard based on his role. So, users and roles tables have many to many relations. Since the user gets the service of forgetting password if and only if the user forgets his password, password_resets table is independent of other tables.

[14] https://adminlte.io/
[15] https://laravel.com/
[16] *h*ttps://www.mysql.com/
[17] https://www.apachefriends.org/index.html
[18] https://openlayers.org/
[19] https://pgrouting.org/
[20] https://postgis.net/
[21] http://geoserver.org/

Since the required notifications are sent to the user who is currently logged in, a relation should exist between users table and notification_user table. Since only the registered drivers get permission to drive one of the registered vehicles in a day, the daily_vehicle table must have relation with both registered_vehicle and registered_driver tables. Also, since the physical fitness of drivers are the part of all the drivers who has applied for driving license, there exists a relation between driver_physically_fit table and driver_application table.

IV. USE CASES

Our web app can be used for several purposes which are described below and illustrated in Fig. 3.

1. Users can fill up and submit vehicle registration form and driving license form online. When those are processed by the BRTA, the applicants will be notified by BRTA to complete the rests of the tasks.

2. Driving license renewal notification will automatically be sent to the driver when it is about to expire before 1 week.

3. Vehicle fitness retest notification will automatically be sent before 1 week to the vehicle owner when the current fitness tag is about to expire.

4. BRTA will give permission to the driver and vehicle owner for the vehicle like it can change the status of driver and vehicle owner from unregistered to registered.

5. Every vehicle owner is responsible to register their vehicle every day to the driver by the app when they give permission to use their vehicle. If they allow a driver to drive their vehicle without registration and the vehicle is found to be involved in any crime/accident, the owner can be accused of breaking rules.
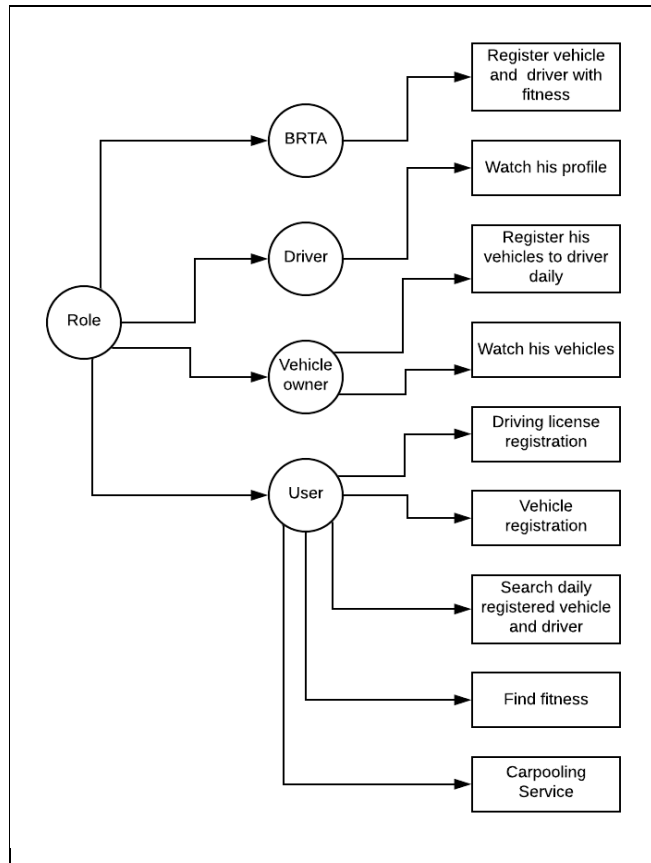
6. Traffic police and citizens can view the condition of all the vehicles on road as well as their drivers' information in the front page of this app. They can also search by vehicle registration number or driver's license number or driver's name and get relevant information. Thus police can easily catch unfit vehicles running on the road and passengers can avoid those vehicles. Also, drivers and owners can be readily identified in case a vehicle is found to be involved in any accident or other crimes.

7. Users can get carpooling service via this web app. To get this service, both the driver and riders have to set their origins and destinations. If their origins and destinations matches then they both will be notified that they can share the vehicle. If driver accepts the request then the rider will be able to use the service. A shortest path between the origin and destination is also shown.

In general, different types of users will be able to access different data based on their roles: some info and services are accessible to everyone, some to the vehicle owners, some to the BRTA managers, and some to the drivers. Fig 3 describes which type of user can do what kind of activity in our app.

V. RESULTS

After implementing our app; we made it publicly available in arahman.xyz so that anyone can use it. We have also provided some username/password combinations for each role, using which anyone can login and access the services available to each role. Thus anyone is able to access our whole website and give a complete review of it. To get reviews, we have created a google form (whose link is available in our arahman.xyz) where we briefed the respondent about our project and then asked him the following questions in order to get his/her assessment of our app in four criteria, namely: UI, correctness, completeness, and importance/usefulness.

Q1. How do you rate the app's User Interface (UI)?

Q2. Do the features of the app work perfectly?

Q3. Are the features of the app cover the goals of this project?

Q4. What do you think of this app's significance and importance in our life?

Q5. Give suggestions (if any) to improve this app.

Responses to the first four questions were made mandatory and Likert scale (1 star to 5 star) was used to collect the responses to these questions. The last one (Q5) was a request to the respondents and as such made optional.

We sent the link to our website to more than 100 students of our university and requested them to explore our website and give their honest and frank reviews. Among them 27 students completed the survey. Their responses are summarized in the pie-charts shown in Fig. 4.

This figure shows that none of the respondents rated us 1 star in any of the four questions and none rated 2 star in Q2 and Q3. In all criteria, the greatest percentages of respondents rated us 5 star. Finally, all the respondents of Q5 suggested to add extra features such as showing real time traffic, making apps useful for mobile phones, etc. Overall, these results shows that most of the respondents were highly satisfied with our app.
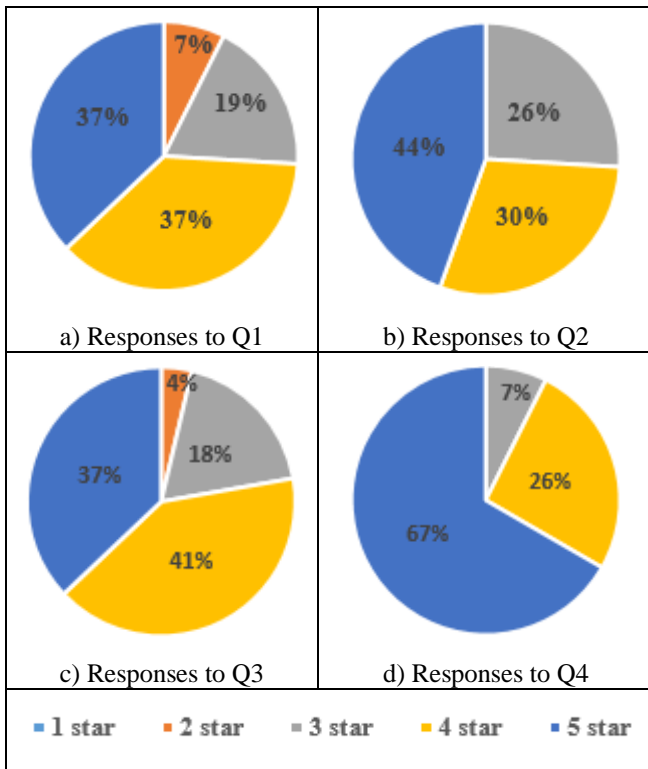

Fig. 3. Services provided by our app based on users' roles

a) Responses to Q1   b) Responses to Q2

c) Responses to Q3   d) Responses to Q4

■ 1 star   ■ 2 star   ■ 3 star   ■ 4 star   ■ 5 star

Fig. 4. Responses to Q1 – Q4 of our user survey shown as pie-charts depicting percetages of respondents who rank our app between 1 star and 5 star on different criteria. Zero percentages are not shown. These figures show that the users are, in general, highly satisfied with our app.

VI. FUTURE DIRECTIONS

Our web-app can be improved by implementing all other services of BRTA such as registration option for the ride sharing company, application service for getting smart card, appointment option for renewing the fitness of the vehicle, form fill up option to get medical certificate for leaner drivers and so on. We can also add accident detection and prediction mechanism in our app by using IoT and Machine learning. That would potentially reduce traffic accidents even more. The feature of sending notification about accidents and rash/wrong driving (to the vehicle owner) can be integrated in this app. Our carpooling service is currently free and as such doesn't provide real time traffic info. We can add an option to the user to get paid version of the carpooling service which will be able to show fastest route (which may not necessarily be the shortest route because of traffic congestion differences) via Google map API[22]. We can also implement Android and iPhone apps that will be able to easily access our web-app from users' mobile phones.

VII. CONCLUSION

In this work we designed and implemented a web-app for transportation and carpooling management. Our app makes the major services provided by BRTA easily accessible from anywhere, has the potential to reduce cost, environment pollution, and traffic congestions via carpooling, and ensures transparency among all the stakeholders: BRTA, vehicle-owners, drivers, and passengers. Thus our app is expected to reduce corruption, traffic accidents, and other in-vehicle crimes. We have conducted a survey to assess our app and found that the respondents are, in general, very positive about our app. We have already made our app and the survey form available online[23] so that anyone can test and review our app. From their reviews we expect to get more ideas to improve this app in future. Our code is also available upon request for research purposes, in case anyone wants to extend our idea further.

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