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A Framework for Dynamic Vehicle Pooling and Ride-Sharing System

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***Abstract*—Due to the ever-advancing technology, usage of information technology in modern life is increasing at a fast pace. Hence, ICT based systems have enormous potential providing accessibility and affordability to the urban inhabitants in developing countries. In this paper, a framework for a dynamic vehicle pooling system for Dhaka city is proposed. Comparing to existing systems, some new concepts have been incorporated in the proposed framework. One of the unique features in the proposed framework is that the system is not limited to any particular type of vehicle. Thus, any type of vehicle such as car, bus or even lorry can be pooled using the proposed system. Moreover to ensure payment security, the system is designed as a prepaid system. Hence, rider has to ensure payment before getting into the ride, where the drive's account is credited once the rider reaches his/her destination.**

***Keywords*—dynamic; ride-sharing; vehicle pooling.**

I. Introduction

Ride sharing is a service, where people can share their riding sources. Now-a-days it has become very popular in developed country, where this concept is not much popular in developing country. However, it is very beneficial for the developing country. The intention of the ride-sharing system is to minimize the abuse of the transport's fuel as well as relieving from traffic jams.

App-based pooling vehicle system has increased exponentially over the past few years. Online application for ride-sharing is a tool that allows riders and drivers to be informed about the present status and exact location of rider and driver. It also helps to know about the current situation of the traffic. Mainly, app-based system of ride sourcing services is generally utilized as a part of finding the nearest vehicle in a very short time. Hence, app-based Ride sourcing services are introduced by many researchers. In some cases, they have different name as Uber [1], Lyft, and their competitors also known as Transportation Network Companies (TNCs) or ride sharing promise to increase reliability and reduce waiting time for moving transport.

Ride-sharing service is more efficient to take the service of vehicles without much hassle. There are many factors in ride sourcing services such as vehicle information, information of drivers and riders, services and so on. Ride-sharing services gather an extraordinary arrangement of log information about closest vehicles and drivers. People may choose this app-based ride sourcing system for many reasons, such as proving the information of nearest vehicle, driver information such as name, contact number etc, riders comfort to find the vehicle easily, reducing waiting time and so forth.

Considering the benefits of ride-sharing services, an app-based pooling service of vehicles is developed and proposed in this paper. Though there exists some application of pooling service of vehicles, however all of these systems are failed to add the maximum benefit of ride sourcing services in their model. For example, in many systems, it is not possible to find all types of vehicle such as bike, private car, taxi cab, bus etc. Therefore, this paper proposes a novel application to find the ride-sharing services. Moreover, this system provides the security, accessibility, identification of the users. The design aspects and features of the proposed system are described thoroughly in the paper.

This paper is organized as follows. The background study on the existing system is presented in section II. In section II, we also discussed about different ride-sharing services application with their pros and cons. Proposed model is presented in section III. The implementation of the proposed system is described in IV. Paper is concluding in section V. Section V also contains the future scopes.

II. Background Study

In recent years, advantages of information and communication engineering have qualified new services that give a wide variety of real time and fabulous tours. Different companies such as Lyft [2], UberX [3], Sidecar [4], carpool [5] have flourished offering smart-phone apps to link up the riders with the community of vehicles driver. Passengers can request for a ride-sharing to a licensed driver through the application. Passenger can communicate with drivers via the application to be informed the current location and status.

Some debates have gone into defining these types of services. There exist some terminologies named as Transportation Network Companies (TNCs), real-time ride sharing, parataxis, ride matching, on-demand rides, app-based rides etc. Similar

types of car pooling systems are GoLoco [6], Ridegrid, Hitchsters [7] and Rideamigos [8]. The web based application like WoTCoMS [9] are also very popular in recent years. There are also some other applications which are developed considering positioning system based like as [10–15]. Real time system has become very popular and many systems are developed for this.

A web-based real-time carpooling system [7] is introduced by Dejan. This is a web based system. There also exists many mobile application related with car pooling. A distributed optimized approach based on the multi agent concept for the implementation of a real time carpooling service with an optimization aspect on siblings [7], and Orchestrating Yahoo! Fire Eagle location based service for carpooling [8] are related with the vehicle pooling system. All of these services are online based application.

In recent year, dynamic car and taxi pooling systems are increased because of the availability of IoT (Internet of things), WoT (Web of Things) and cellular mobile phone or mini electrical devices (e.g., notebook, tab etc.). By utilizing the digitized and easy communication system people use the existing car pooling system.

Most of the existing cars pooling systems have to implement automatic payment system. Moreover, those systems are not design for all kind of vehicles. Hence, the proposed system is designed for all kinds of vehicles (e.g., bus, track, motorcycle, taxi, car etc.), with a unique payment system. Users of the system are able to pay the bill through this system. The proposed system has combined with the ICT-based solution both in the secured payments and the dynamic resources allocation.

III. Proposed Model

The vehicle pooling system is designed with some key features while identifying any key features of any established system. The key features of the proposed system are quite unique than any other existing systems. The flowchart of the proposed system is described in Figure 1.

A. Dynamic

In this paper, a dynamic system is designed and implemented. This system works for different types of vehicles. This system is designed for the most available vehicles such as car, taxi, track, bus, motor bike, CNG etc. User can access and can send request to the driver of the vehicles. The system works dynamically for all the vehicles. There is no carpooling system available for dynamic vehicles. This proposed system is designed for dynamic vehicles.

B. Pre-paid System

In this paper we propose and implement a top-up or pre-paid method to make payment through the system. The user or passenger can make a request to the driver. The request when accepted and passenger ride on their vehicle, passenger can make a payment to the driver via bKash [16] account or any other bank account. Online transaction system gives the security to transfer money, since online transaction is safe and a secured process. So, the user feels free to use the system. The system has also a payment assurance option and searching technique that gives security, accessibility to the users.

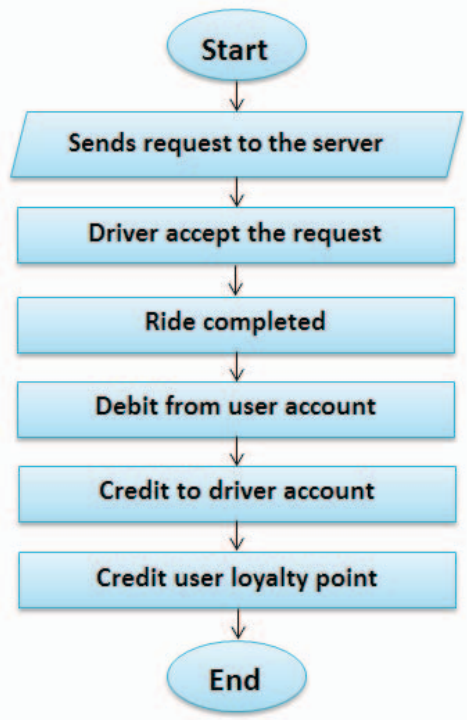

Fig. 1. Flowchart of the proposed system

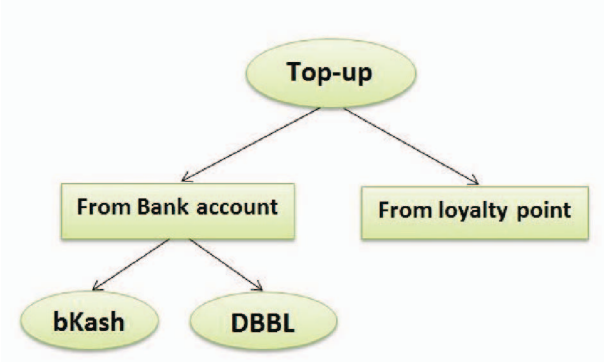

Fig. 2. Top-up system architecture

C. Searching Technique

In this system the user can look for different types of vehicle. By the GPS the user location is tracked by the system and then nearest vehicle is suggested to the user. The nearest vehicle is identified by measuring the euclidean distance [17]. Equation 1 & 2 shows mechanism of the distance measurement of the passenger and the driver or vehicle. Then the system suggests the passenger the nearest vehicle. To implement the searching technique an algorithm is used here. Algorithm 1

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described the detail of the used algorithm.

$$Distance(X,Y) = \frac{\sum_{i=1}^{n} X_i.Y_i}{\sqrt{\sum_{i=1}^{n}(X_i)^2}\sqrt{\sum_{i=1}^{n}(Y_i)^2}} \quad (1)$$

$$Distance_{cosine} = 1 - Distance(X,Y). \quad (2)$$

Algorithm 1 Algorithm of the system

```
Collect the position from GPS of the user and the vehicle
Set P_user = value from the tracking location of the user
Set distance [ ] = 0
Set minimum [ ] = 0
Set V_n = [x_1,....., x_n ]
loop
    distance [ ] = distance between P_user and vehicle
end loop
loop
    if distance [i] < distance [i + 1] then
        minimum [i] = distance [i]
    else
        go to step 6
    end if
end loop
```

D. User Royalty

One of the key features of the proposed system is the royalty scheme, where user earns royalty points for using the system. Once a user receives the royalty points, he/she can use these points for payment purpose. As highlighted from the exiting literatures, none of the existing systems for vehicle pooling provides such reward system. It is expected that the number of the current users and number of potential users will be increased once the royalty scheme is applied properly and configured successfully. Hence, this feature is anticipated to attarct more users. Furthermore, once applied, this may become a very helpful solution for the urban inhabitants.

E. Authentication System

In order to use this system, a user has to register an account. Next, the user can activate this registered account by providing personal bank account information to the system. The system authenticates user through National Identification Number (NID) with a two factors authentications policy. Thus, during registration, the user must provide his/her cellular phone number. Since all the mobile phone numbers have been already authenticated using NID, SMS based authentication is used to verify the credibility of the users. Moreover, providing the banking information, the user assures prepaid and automatic payment.

IV. Framework Implementation

A. Architectural Design

The integration process of the proposed system depends on the three tier architecture. Three tiered architecture is used to enable the proposed system to be more robust and to provide flexibility to its applications. Thus, the proposed system blends different protocols and softwares effectively.

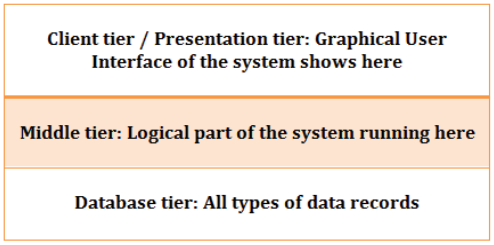

Fig. 3. 3-tier Architecture of Application

Figure 3 shows the overview of the 3-tier architectural view of the proposed system.

1) The Client Tier: The interface acts as the client tier of the three tier architecture model. The web browser and smart phone's touch screen process and display interface of the system. The graphical user interfaces of the proposed system operates in this tier. These interfaces of the system are designed for the user. The system provides the user a very simple and friendly GUI. Thus, user from any age group can easily access the system smoothly. The interfaces of the system are presented in Figure 4 and Figure 5. After the client tier, middle tier of the proposed system starts, which is also an immediate tier.

2) The Middle Tier: In three tier Web Application systems, the majority of the applicational logics are at the middle tier. The client tier presents data and collects data from the user as the database tier stores and receives the data. The middle tier serves most of the remaining roles and merges the other tiers. This tier determines the structure and the contents to be displayed to a user and also processes user input. The user inputs are formed into queries on the database to read or to write data. This middle tier application logic integrates the users with the database management system. The components of the middle tier are interacting with the database management system. For the proposed vehicle pooling system, the middle tier plays an important role of the system. The middle tier executes and supervises all the necessary things for the system. Figure 3 shows all using tier of this system. The database tier is the immediate tier of the system.

3) The Database Tier: The database tier is the base tier of the proposed system. Designing databases and building tier is the first step. Based on the entity relationship diagram which is done in the system design phase, database of the proposed system is created in MySQL.

B. Roles of User

The proposed system can be considered to be a simple process. Initially, the user has to create an account in the vehicle pooling website. First level of user validation is done when the user confirms his/her account via email verification. Next, user can login and can access the dashboard panel. The dashboard panel shows the options to the user. Afterwards,

user chooses to send a request for a ride. Once the request is accepted, user goes to the payment option. Upon completion of the payment successfully, user sees the driver details. In the proposed system, driver is another type of user. Therefore, similar to user registration, a driver also requires opening a new account and requires completing email verification. Upon logging into the system, driver can access the dashboard panel and can see the options. On a drivers dashboard, all the currently posted requests for riding are displayed.

1) Passenger: The first role of a passenger in Vehicle pooling is to open an account and to confirm the account via email verification. Next, passenger sends request for a new ride and also tracks history. Considering a passengers roles and activities, there are several required features in the proposed vehicle pooling system. However, we assigned to meet few of these requirements, which are, (1) Create new account to access the system (2) Can log in the system (3) Can send Request (4) Payment Option (5) Help

2) Driver: The first role of Driver in Vehicle pooling is also to open an account and confirms the account via email verification. Afterwards, a driver can view the current requests for new rides and can also track history. Considering a drivers roles and activities, there are several required features in the proposed vehicle pooling project. Few included requirements are as follows, (1) Can open new account to access the system (2) Can log in the system (3) Can view current requests (4) Can view the received payment details of an accepted request (5) Help

3) Admin: For the proposed system, an admin manages the database. Admin keeps the tracking number and also maintains the records. Considering an admins roles and activities, there are several required features in the proposed vehicle pooling project. However, few of these requirements included in this system, which are as follows, (1) Log in as admin (2) View all current and previous requests (3) Monitor and track the ongoing request

4) Physical Design: After finishing the system analysis, the designing phase of SDLC is considered. Here the system is designed both logically and physically. As mentioned earlier, for the logical design the process is modeling by DFD (Data Flow Diagram) and data modeling by ER Diagram (Entity-Relationship Diagram). All the necessary materials like DFD, Logical ERD, Physical ERD and Data Dictionary of system design or developments are already discussed. In this section the findings from the system analysis phase while designing the entire system. How the system would work and how the output will be given were the main concerns at this level.

C. Application

The home page of vehicle pooling system is depicted in Figure 4. When a user goes to the vehicle pooling website and this page is displayed.

Sequence diagram is a powerful tool that makes understand the dynamics of a use case. Sequence diagrams represent possible interaction scenarios.

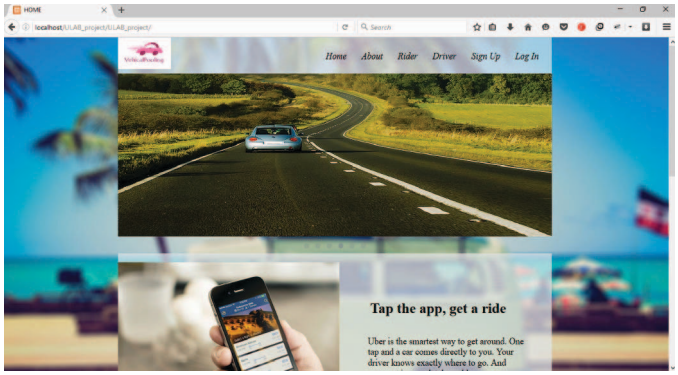

Fig. 4. Vehicle pooling system home page

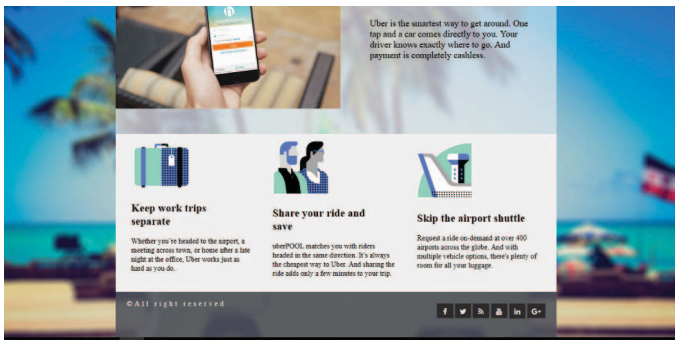

Fig. 5. Proposed System homepage

1) Sequence Diagram for Sign up: In the sign up sequence diagram we can assure the procedure of the sign up process. The user will request for the sign up page and subsequently the sign up page will open. Then user will provide information and upon clicking the submit button, the information will be saved in the database [11].

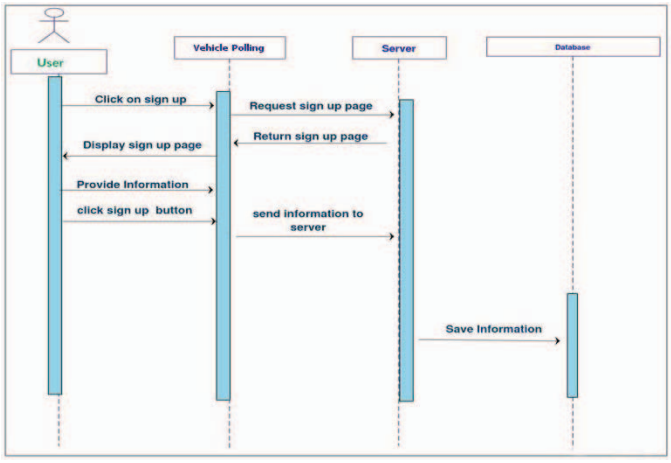

Fig. 6. Sequence diagram for sign up

2) Sequence Diagram for Sign in: For sign in, user will request for the sign in page. In the sign in page, user will provide user name and password and submit to the system. After clicking submit button, users existence in the database

will be checked. A message will be shown to user regarding the validity of the user. By signing to the system user can use

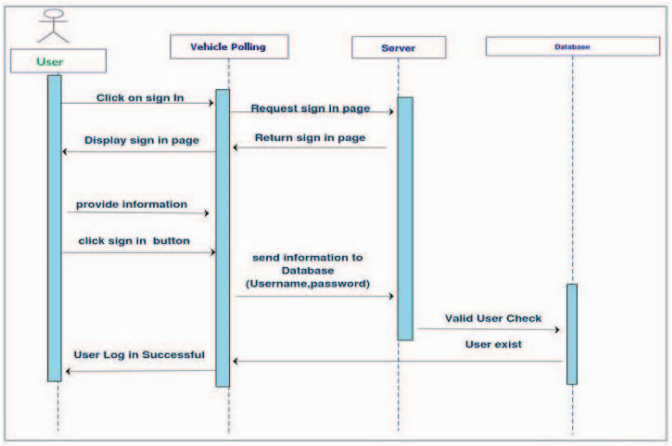

Fig. 7. Sequence diagram for sign in

the facilities and find benefits from the unique key features of the system.

Due to the scope of the testing results, user feedback and details of evolution are not included in the paper. Authors' next research step is to incorporate few other features to the proposed vehicle pooling system and implement the system.

V. Conclusion and Future works

In this paper, a system for dynamic vehicle pooling for urban area is proposed. The main intention is to build the framework to use/utilize the empty seats in any type of vehicles. Moreover, the proposed system also aims to eliminate the space misuseages in vehicles. Thus, the proposed system is considered to be an augmented system that matches the transportation demands of the user based on the location and destination. The system also offers security to the user. Hence, the NID number is used for registration and dual-level verification is used for authentication. Thus, the proposed system assures more security to the user than any other existing systems. The framework has social as well as economical impacts to the society. It may also help to reduce the traffic jams by the effective usage of vehicles. The proposed scheme is in the initial stage. In future, complete acceptance tests are planned to be performed. Features for all types of user (e.g., admin, driver, user) are not fully addressed in the current system.

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