Cloud Base Solution for Centralized Monitoring & Management of Electrical Vehicle Charging Station

Ali Al-Balushi, Mohammed Al-Badi and Abdulziz Al Badi

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Ali Mohammed Al-Balushi, Mohammed Saeed Al-Badi, Abdulaziz Hamdan Al-Badi

s2019293128@cas.edu.om   s2019293040@cas.edu.om   s2017293148@cas.edu.om

Information Technologies Département, University of Technology and Applied Sciences (UTAS) Suhar – Sultanate of Oman

Abstract: The global shift towards sustainable transportation has led to the widespread adoption of electric vehicles (EVs) as a viable alternative to traditional gasoline-powered cars. As the demand for EVs increases, so does the need for charging infrastructure. However, the acceptance of electric vehicles as a sustainable transportation option has demanded the creation of a robust charging infrastructure, to support EV demand, the requirement for adequate charging infrastructure becomes even more critical. EV Charging station infrastructure supported by Cloud-based mobile application solution for EV user and centralized monitoring and management of EV charging stations has become a necessity. This solution will enable EV users and charging station operators to use the mobile application remotely and manage their charging stations, ensuring smooth operations and maximizing customer satisfaction. This paper outlines a study aimed at assessing the current state of electric vehicle charging infrastructure and mobile application development. The study will employ a mixed-methods approach, combining quantitative data from surveys to evaluate charging station need, and qualitative data from interviews with electric vehicle industry stakeholders to develop Mobile applications.

Keywords: EV, Charging Station, Mobile Application, Cloud, Analytical Tools.

1. Introduction:

An EV charging point, or a charging station refers to a specialized location where an electric car charges its battery. Picture it like a petrol station but for an electrical car. As one takes a ride in an electric driven automobile, its destination is based on available charging stations which serve as the electrical source of energy that allows it start moving toward a new journey.

There are many charging station types for specific needs. Home charging stations can be found at various locations such as on the wayside or in garages and can also include on-road stations found on roadsides or at shopping malls, which makes EV ownership convenient. Furthermore, on-road and fast-charging stations are readily available.

As for the charging station, the principle of operation is simple. The drivers use a cable to connect their electric vehicles to the charging point. Upon connection with the station, electrical power gets to the batteries of the car, restoring it. Such stations could either be free or involve a fee payment.

The use of electric vehicles is increasingly becoming popular in different parts of the world, and this has led to the establishment of charging stations. Many countries worldwide have begun to establish charging infrastructures to boost the number of electric vehicles on their highways. The goal of this is to enable more people to consider using EV as their primary means of transportation.

Oman is working towards augmentation of its EV charging infrastructure. The country has increasingly been installing more charging stations in significant areas so as they adopt sustainable transportation. That aside, this advancement helps the use of electric cars thereby enhancing a cleaner and healthier surrounding.

2. Research Objectives:

The primary objectives of this research are:

1. Present situation of EV charging stations in Oman.
2. Development of cloud-based mobile application for EV users and charging station operators to monitor, manage and providing user accessibility to EV charging services.
3. Deploy the mobile application on cloud platforms.
4. Analysis of EV charging stations operation and use data-driven insights into performance and utilization of EV charging station.

3. Literature Review:

Literature review is carried out to analyaze the related work in EV charging station and adoption in Oman. Several studies have suggested remedies for charging station demand, deployment, and monitoring. There is no specific developed system, which Omani EVs' user could use, navigate & manage the EV charging station. The existence of this gap prevents ease of use and convenience. Absence of such an app identifies an opportunity developed to fit these unique demands on EV users and better in the e-mobility in Oman.

A survey is conducted to collect the data related to EV in Oman. The survey involved citizen and resident of Oman in the location of Al Batinah and Muscat region. The majority of individuals were aged between eighteen to forty-five, include of male and female. Data of EV owners and non-EV owners are collected to get the current situation of EV's in Oman. Some either owned an electric vehicle, were considering getting one, or didn't own a car but used electric power. The user requirement & Electric Vehicle charging station infrastructure details are collected and analyse. Based on the user requirements

4. System Prototype & Description:

A prototype is developed as solution for development of Cloud base system to access and monitor EV charging station for the user and operator. This Cloud-based solution is built for better deployment, management, and operation. A cloud-based application will enable the monitoring and the managing of these stations. Cloud-hosted applications for access by users of EV services and cloud platforms for storing and managing data and analysis.

The Charging Station App provides a safe method of logging in that allows individual functions to be enabled. Cloud sever has major functions like location for maps, booking capability, payments system, and actual time billing information. The integrated system is meant to provide an easy experience for the operators and EVs users as well as ensuring efficient and dependable electric vehicle charging infrastructure.
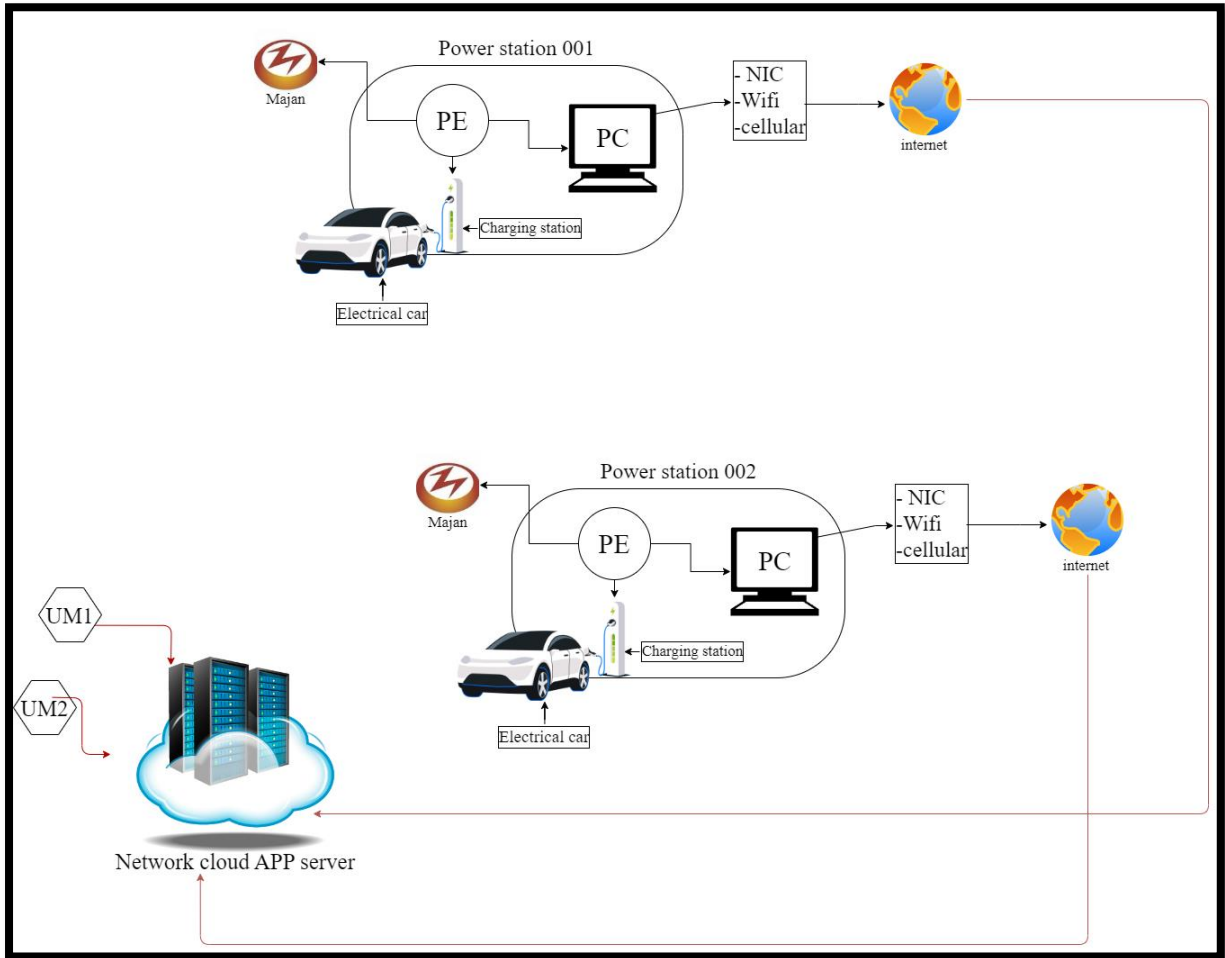
Figure 1: Proposed Schematic Architecture

4.1. SYSTEM ARCHITECTURE AND NETWORK

System Analysis:

System is analysed based on the user, system, domain, functional and non-functional requirements.

The system should fulfil the following user requirements:

- It enables EV drivers to find chargers near their location and know whether they are fully occupied or not.
- To help users make reservations and perform payment transactions.
- Providing reservation system and secure payment processors.

- Analytics and reporting functionalities.

- Adhere to EV charging and electrical standards.

- Scale across multiple locations nationwide.

- Station status monitoring in real-time

- System must have high availability with 99.9% uptime.

- Ability to handle high transaction volumes.

System Development process involve creating an:

- Application Architecture

- Data Flow Design

- Use case Scenario for EV user & EV charging station operators.

- ERD for Mobile Applications

4.2. SYSTEM APPLICATIONS AND SERVICES:

The diagram shows a cloud server that communicates smoothly with a Firebase server to build an effective cloud technology centred on the central controlling and tracking of electric vehicles' charging stations. The Charging Station App provides a safe method of logging in that allows individual functions to be enabled. Cloud sever has major functions like location for maps, booking capability, payments system, and actual time billing information. The integrated system is meant to provide an easy experience for the operators and EVs users as well as ensuring efficient and dependable electric vehicle charging infrastructure.
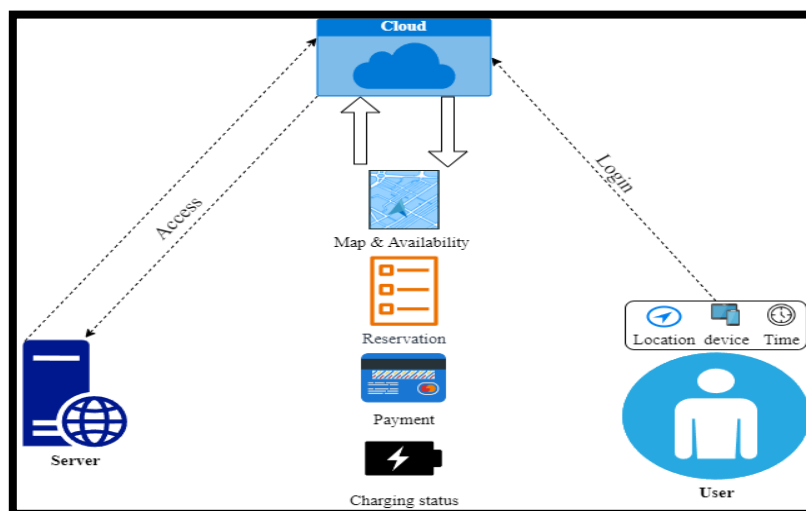
Figure 2: Conceptual Design

4.3. SYSTEM FUNCTIONALITY AND DATABASE:

In EV app, all the data in the Firebase database were stored in both Realtime and Storge Database which are practical options for the application. Once the project is connected to DB in Firebase and added the option of Realtime DB to EV project, automatically it will generate new file in project called google-service. which include used in project to add in online firebase. After that, to store EV station request, setting up the Firebase rule is done because by default the firebase setting rejected any EV station request. Thus, I have opened link access between firebase and my project through changing rules which denying anything or anyone to allow adding useful data to firebase.

4.4. SYSTEM SECURITY FEATURES:

Protecting user data and fulfilling data protection laws aim at curtailing data breaches and other legal matters. The app also uses third party services and if there are problems at this level of cooperation it will affect normal operation of the app at all levels.

5. Results:

A survey is conducted to gather the information of current scenario of EV awareness and usage in Oman. Through the survey the findings that there are few electric cars available in Oman. In Oman there are few charging stations & lack complete guidelines for Charging Station. The construction of additional charging station should be an Oman policy as well to popularize and make electric cars more accessible to people.

The prototype is created as part of a solution, showing the process of visualization of system with the EV Application software offering a real-time example. Design & implementation version of EV software meets users' needs and expectations. Login Screen, sign-up page, navigation, and user interface are represented for the implementation.
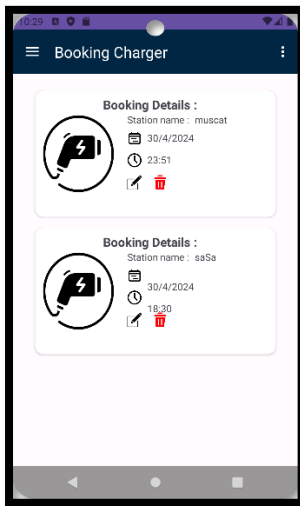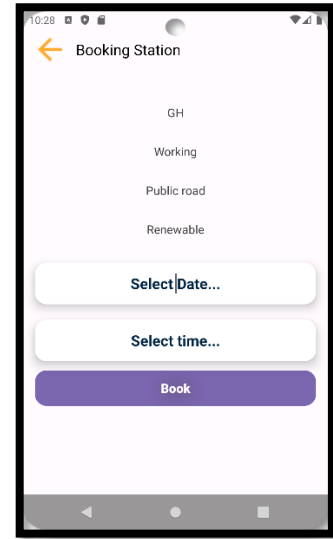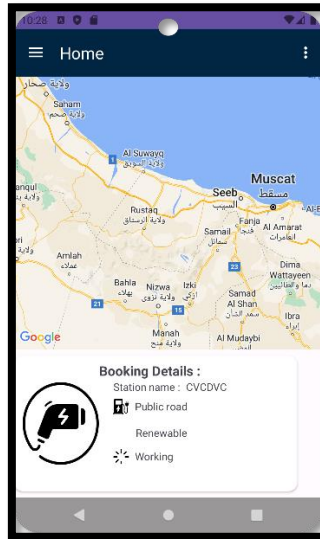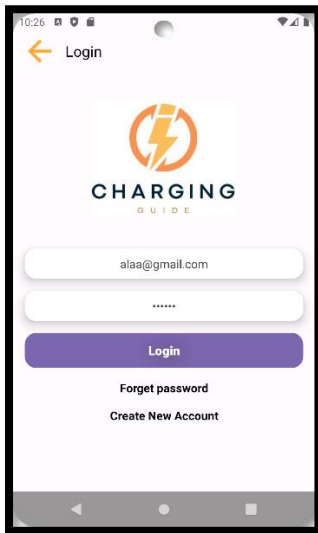
6. Conclusion:

Cloud based solutions for centralized monitoring and management of EV charging stations are essential for the sustainable development of transportation. The EV charging station application system is developed to supports the Sultanate's of Oman initiatives for a green economy by providing reliable, efficient, and accessible electricity for electric vehicle charging to benefit from contemporary technologies and activate smart cities that support this kind of projects to improve the EV car side in Oman, which falls within the vision and aspirations of the Sultanate of Oman 2040.

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