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STUDY ON IMPLEMENTING A NEW APPROACH TO ELECTRIC VEHICLE CHARGING MANAGEMENT

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Abstract:

Various factors including increasing energy prices, government policies, and environmental concerns are driving the energy transition. Electric vehicles (EVs) have the potential to contribute to the sustainable energy transition as they can reduce fossil fuel dependence. This study provides a comparative analysis of the existing charging station deployment models concerning their performance and the current major barriers to their adoption in Malaysia. Electric Vehicle (EV) Service Providers and Networks are established to provide charging facilities for EVs. However, the business model and method of identifying users has formed a group of closed networks, which are operating in isolation. The isolation of these networks will prevent Electric Vehicle Owner (EVO) from charging their EVs even if a charging station is available. This will cause range anxiety and affects general acceptance of EVs. The proposed concept intends to overcome this issue by implementing a new cloud-based software system which is called Malaysian Electric Vehicle Central Management System, MEV-CMS. It provides authentication communication between any non-subscribed Service Providers (SP) and the subscribed SP of the EV ecosystem in Malaysia. This paper discusses the initiating practices and requirements gathering carried out to develop the central management system. The system requirements were gathered from exposition visits, industry collaborations as well as the literature study contributions. The work provides useful insights that can be beneficial for the management of charging stations for EVs in other countries as well.

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Keywords:

Electric Vehicle; Charging Stations; CMS; Charging Network.

Introduction

In recent years, the issue of air pollution has become increasingly pressing as it poses significant threats to public health and the environment. To mitigate the concentration of air pollutants, including CO2 and other greenhouse gases, the governments of the majority of developed nations are promoting the use of Electric Vehicles (EVs) (Sanguesa et al., 2021). These initiatives aim to reduce the reliance on conventional vehicles that run on fossil fuels, which are one of the main contributors to air pollution (Leard & Mcconnell, 2020). As the EV technology becomes more common around the world, it is inevitable that its ecosystem will become a trend in Malaysia too (Veza et al., 2022). While the modern era demands an ecosystem to encourage the use of EVs, the progress of developing such infrastructure is slow in this country (Saad, 2022). To accelerate deployment, EV players must combine the network effect of other mobility ecosystem partners. Currently, EV owners are only restricted to use Charging Points (CP) from a specific EV service provider based on their user subscription (Adnan, Nordin, & Rahman, 2017). To describe, each CP limits communication to specific subscribers or applications, making it challenging for EV users to charge their vehicles until they reach a specific CP where they have a subscription to the service. In Malaysia, if an EV owner subscribes to the ChargeEV service, he or she is only permitted to use a charging point connected to the ChargeEV service and is not allowed to use another CP assigned to a different service provider, such as MyEV, ChargeNow, and others. However, there is a possibility to develop a new EV charging management system by identifying the current challenges caused by the separate charging service providers. The proposed solution will enable an EV owner to charge his car using the many available charging points provided by all providers across the country.

This project's objective is to optimise the launch and scaling of EV charging operations for charge point operators who handle a network of EV charging stations. This will improve the charging experience while maximising operations, cutting down on time-to-market (Sathiyan et al., 2022), and increasing revenues (Ayeesha, Muzir, & Mojumder, 2022). The new implementation of Malaysian Electric Vehicle System (MEVS) boosts the EV charging network using Inter-service Provider Charging Protocol (ISPCP) technology which enables the Service Providers (SP) to communicate with each other at the time of charging. Therefore, EV owners may utilize any existing CPs without having to subscribe to many different providers to avoid charging at limited stations. This paper will provide an analysis of the current EV ecosystem and its limitations and also the identification of how the MEV-CMS can be designed to improve access to charging points while analysing its potential to improve the adoption of EVs in Malaysia.

Literature Review

In order to lower carbon emissions and reliance on fossil fuels, EVs have become increasingly popular on a global scale. Malaysia, as a developing country, has also recognized the need to shift towards sustainable transportation, and the government has initiated various programs and policies to promote EVs (Rahman, Anisah, & Yaakub, 2022). This literature review aims to examine the current trends and shortcomings of the EV ecosystem in Malaysia as well as the project benchmark for the proposed MEV- CMS.

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Current EV trends in Malaysia

Malaysia's EV market is still in its early stages, with a more than 10,000 EVs registered as of December 2020 (MARii, 2023). The majority of these EVs are plug-in hybrid electric vehicles (PHEVs), while battery electric vehicles (BEVs) are still limited.

The adoption of EVs in the country is slowly increasing over the last few years; the progress is much slower than what the government desired. The country has difficulties to meet the target of 125,000 EVs on the road by 2030, which is ambitious but achievable with the right policies and incentives (*Ministry Of Transport Malaysia*, 2023). This may be due to the lack of incentives to own an EV. Nevertheless, the government and private companies alike are working towards increasing the utilisation of EV technologies in the country in the 2022 Budget such as the Green Technology Financing Scheme (Green Technology Financing Scheme, 2023) and the Charging Stations for Electric Vehicles program (MARii, 2023). This is expected to encourage the usage of EVs in the country.

Type of EV Chargers

Currently in Malaysia, two types of chargers are available and being used which are Type 1 and Type 2 known as alternating current (AC), and CCS2 and CHAdeMO known as direct current (DC) (Slangen, 2021). Type 1 chargers are typically installed in residential areas, and they provide a charging rate of 3-5 miles of range per hour of charging. Level 2 chargers provide a faster charging rate of 10-20 miles of range per hour of charging and are suitable for commercial and public areas (Sun, Li, Wang, & Chengjiang, 2020). DC fast charger, provide a charging rate of 60-80 miles of range per 20-30 minutes of charging and are typically located in public areas and highways. EVs can only store direct current (DC) power, and there is a converter built into the plug that transfers AC power to DC before flowing into the battery of the vehicle (Sun et al., 2020). DC chargers and AC chargers vary in the location of the AC power conversion which might locate inside or outside the vehicle. DC chargers, as compared to AC chargers, have the converter built directly into the device. Since the DC chargers are able to supply power to the car's battery without the need for an on-board charger to transform, these chargers are bigger, faster, with a significant advancement (Tomaszewska et al., 2019). Currently in Malaysia, Type 1 chargers are mostly used when using wall sockets as a power source. Most public networked AC chargers use Type 2 charger.
Table 1 categorizes AC and DC chargers which are accessible throughout Malaysia:

Table 1: AC and DC Chargers in Malaysia

Charger Type	Charger Name	Power
AC	Type 1	0.7 kW – 7.4 kW
	Type 2	3 kW - 43 kW
DC	CCS2	40 kW - 200 kW
	CHAdeMO	10 kW – 400 kW

Type of Electric Vehicles in Malaysia

There are three types of EV cars available in the Malaysian market (Asadi, Nilashi, Samad, & Abdullah, 2021), sorted as; Plug-in Hybrid Vehicles (PHEV), Battery Electric Vehicles (BEV) and Hybrid Electric Vehicles (HEVs).

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Plug-in Hybrid Electric Vehicles (PHEVs):

Plug-in Hybrid Electric Vehicles have a gasoline-powered engine in addition to an electric motor (Kulkarni, Dhanush, Chethan, S, & Shrivastava, 2019). They can run on battery power alone, but when the battery runs out of charge, the gasoline engine kicks in to power the vehicle. The battery has to be charged using EV chargers. The mileage of a PHEV using both battery and fuel is lower than that of a fully electric vehicle. The following PHEV cars are available in Malaysia:

Table 2: PHEV Models in Malaysia

Vehicle Brand	Brand Name
BMW	BMW i8 BMW 330e M-Sport BMW 3 Series Sedan Plug-in Hybrid BMW 5 Series Sedan Plug-in Hybrid BMW 7 Series Sedan Plug-in Hybrid BMW X5 xDrive40e BMW X5 xDrive45e BMW 740Le xDrive BMW 740e xDrive
Honda	Honda City Plug-In Hybrid Honda Jazz Sport Hybrid
Mercedec-Benz	Mercedes-Benz S 580 e Mercedes-Benz GLC300e Coupe Mercedes-Benz GLC300e 4Matic Mercedes-Benz GLC300de 4Matic
Volvo	Volvo S60 Recharge Volvo S90 Recharge Volvo V60 Recharge Volvo XC40 Recharge Volvo XC60 Recharge Volvo XC90 Recharge
Ferrari	Ferrari SF90 Stradale Ferrari 296 GTB
Other	Hyundai IONIQ Plug-in Hybrid MINI Countryman Bentley Bentayga Hybrid Geely Xing Yue PHEV

Battery Electric Vehicles (BEVs):

These vehicles are entirely electric and are powered only by batteries. They do not have a gasoline engine and the motion of a BEV is due to an electric motor (Kulkarni et al., 2019). It has a higher battery mileage compared to PHEV; however, it does have a longer charging time due its higher battery capacity. Table 3 lists available BEV cars in Malaysia:

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Table 3: BEV Models in Malaysia

Vehicle Brand	Brand Name
Hyundai	Hyundai IONIQ 5 Hyundai Kona Electric
Mercedes-Benz	Mercedes-Benz EQA 250 Mercedes-Benz EQB 350 4Matic Mercedes-Benz EQC 400 4Matic Mercedes-Benz EQS 450+ Sedan Mercedes-Benz EQS Saloon
BMW	BMW i4 eDrive40 BMW iX sDrive40 BMW iX3
Tesla	Tesla Model 3 Tesla Model S Tesla Model X Tesla Model Y
Other	GWM Ora Good Cat Porsche Taycan Kia EV6 Mazda Mx-30 Peugeot e-2008 Renault Zoe Nissan Leaf Mini Cooper SE Volvo XC40 Recharge Pure Electric

Hybrid Electric Vehicles (HEVs):

These vehicles have both an electric motor and a gasoline engine, but the electric motor cannot power the vehicle on its own (Kulkarni et al., 2019). Instead, the electric motor assists the gasoline engine to improve fuel efficiency. Examples of HEVs available in Malaysia include the Toyota Prius and the Honda Insight.

It is worth noting that the availability of different types of EVs in Malaysia may vary depending on factors such as market demand and government policies.

EV Related Blueprints and Policies

There have been recent policies and blueprints created by the government of Malaysia which are focused on promoting the usage of EVs. One major policy which contains development plans for EVs is the National Automotive Policy (NAP) 2020. One of the directions of the NAP 2020 is to develop energy efficient vehicles, next generation vehicles, mobility as a service and Industrial Revolution (IR 4.0) technologies. The next generation vehicles are planned to be energy efficient as well as automated. Mobility as a service includes car rental, ride sharing, ride hailing and public transport. One specific measure to achieve that is by promoting and developing EV technologies which include developing "standards to encourage battery swapping and wireless charge", developing an "EV Smart Grid Interoperability Centre" and developing "standards to encourage battery swapping and wireless charging" (MITI, 2020).

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Thus, the vision of the country is to have EV technologies implemented in almost all new vehicles of all types including private and passenger vehicles which use IR 4.0 technologies. Building off the NAP 2020 as well as other related policies, the Ministry of Environment and Water established the Low Carbon Mobility Blueprint (LCMB) 2021-2030. The objective of the LCMB is to reduce greenhouse gases emitted by all modes of transport in Malaysia. One way they plan to do that is by phasing out fossil fuel vehicles in favour of alternative fuels that are more energy efficient and environmentally friendly. One focus area of the LCMB specifically relates to EVs where the ministry plans to adopt electric cars, buses and motorcycles in Malaysia. The LCMB is also targeting to have 10,000 CPs throughout Malaysia by 2025. In summary, the LCMB is a direct effort by the government to quickly adopt EVs in Malaysia. One important policy on EVs is the tax exemption on all EVs starting in 2022 until 2025 as introduced in the Budget 2022. The policy is expected to increase the sales of EVs in Malaysia and shows the government's willingness to adopt electric technology in the automobile sector.

Meanwhile, private companies and organisations have also been working to get the government to emphasise the usage of EVs. One such organisation is the Zero Emission Vehicle Association (ZEVA) which is a non-government organisation that emphasises on promoting EV technologies. They are made up of various automobile companies such as BMW, Volvo and Toyota; EV infrastructure companies such as EV Connection, Gentari and ChargeN'Go and other organisations such as MyEVOC, PEKEMA and TNB. They advocate for the government to adopt policies for adopting EVs in Malaysia and faster implementation of the technology in a large scale.

Current EV Ecosystem Shortcomings

Along with the numerous benefits that the current EV ecosystem offers, there are a number of weaknesses that must be addressed if the EV ecosystem is to optimise. These shortcomings include, but are not limited to:

a. *Compatibility problem; EV owners can only charge their vehicles using a compatible CP.*
b. *Subscription, EV users are only permitted to use CP from certain EV service providers.*
c. *Affordability, stating that only high-end models are accessible in Malaysia.*
d. *A lack of charging infrastructure (charging points) on roads and in high-rise residences.*
e. *Poor EV-friendly policies, highlighting the need for long-term policies that encourage EV adoption through structured benefits.*
f. *A limited local industry and lack of clear action from local car and auto component procedures.*

Project Benchmark

The Malaysian Electronic Payments System (MEPS) benchmark solution helps the MEVS. Considering the pattern of MEPS integrated banking networks, the MEPS was also analysed to assess the ability to predict how MEVS could enhance Malaysia's EV charging ecosystem. The MEPS system is examined in detail in the next subchapter, including its components and how it assists the Malaysian banking system.

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Malaysian Electronic Payment System (MEPS)

A national payment network in Malaysia called the Malaysian Electronic Payment System (MEPS) enables electronic financial transactions between banks, financial institutions, and vendors (Azlina, Abd, Shajaratuddur, Harun, & Yusof, 2013). MEPS is one of the leading payment systems in Malaysia, and it provides a variety of payment services such as ATM cash withdrawals, online banking, point-of-sale (POS) transactions, e-commerce transactions, and more (MEPS, 2022). This paper provides an overview of MEPS, its features, benefits, and its contribution to the growth of the Malaysian economy.

MEPS was established in 1996 as a joint venture between a consortium of Malaysian banks and MEPS International Ltd, a subsidiary of the Australian Payments Clearing Association. In 1997, MEPS launched its first service, which was the interbank GIRO (IBG) system that enabled the transfer of funds between accounts held in different banks. In the following years, MEPS continued to expand its services to include ATM cash withdrawals, online banking, and other payment services. MEPS provide a secure and reliable payment network that enables customers to make transactions anytime, anywhere (Azlina et al., 2013).

In order to evaluate the effectiveness of the project benchmark partners, a comparison was made between them and the predicted partners. This is shown in Table 4 in the next page.

Table 4: Comparisons of The Project Benchmark Partners and The Predicted Partners

Partner banks in MEPS	Projected EV Partners in MEVS
Affin Bank	ChargeN'Go
Alliance Bank Malaysia Berhad	Tenaga Switchgear Sdn. Bhd. (TSG)
Al Rajhi Bank	Exicom
Agrobank	Shell Recharge
AmBank	Gentari
Bank Islam Malaysia	JomCharge
Bank Rakyat	ChargEV
Bank Muamalat Malaysia	
Bank Simpanan Nasional	
CIMB Bank	
Citibank	
Hong Leong Bank	
HSBC Bank	
Kuwait Finance House	
Maybank	
MBSB Bank	
OCBC Bank	
Public Bank	
RHB Bank	
Standard Chartered Bank	
United Overseas Bank	

Methodology

Gathering information is an important part of any project since it determines what the project needs to achieve and what is required in order to accomplish the goals. Insights from project

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stakeholders through data collection allow for a comprehensive understanding of how the project works.

The resource and background information for this study were collected by attending project meetings and EV expositions and industry visits. Several meetings were held during this study to review progress and provide project briefings on the Electric Vehicle Central Management System. At the aforementioned meetings, the progress of the project was evaluated to ensure the authors were on the right track; likewise the developed materials of each phase were reviewed at these meetings. The following Table 5 provides meeting dates and an outline of each meeting's discussions:

Table 5: Prospective Project Meetings

Date	Summary of Discussion
20 July 2022	✓ First in person briefing meeting with team at Menara Razak, UTM Kuala Lumpur. In this meeting, the initial explanation about the project was discussed.
24 July 2022	✓ Participating at EVx Malaysia 2022 at Setia City Convention Centre (SCCC), Kuala Lumpur, WP Kuala Lumpur, Malaysia
29 July 2022	✓ Analysing MEVS requirements, development phases (initial phase)
08 Aug 2022	✓ Analysing System Development Standard Documentation based on IEEE ✓ Evaluating gathered information from EV Expo ✓ Gathering information about EV Car rental & Execution Plan in KL, Malaysia
19 Aug 2022	✓ Identifying and Specifying the initial system requirements
26 Aug 2022	✓ Providing MEVS system requirements and system functionalities
08 Sep 2022	✓ Updating MEVS Use Case based on the discussed requirements ✓ System Prototype Presentation ✓ Discussion on MEVS design descriptions (initial phase)
28 Sep 2022	✓ Participating at EVM Asia 2022 Expo, at Malaysia International Trade and Exhibition Centre, Kompleks MITEC @ KL Metropolis, 8, Jalan Dutamas 2, Kompleks Kerajaan, 50480 Kuala Lumpur, WP Kuala Lumpur, Malaysia
29 Sep 2022	✓ Identifying the gathered data from the Expo meeting
06 Oct 2022	✓ Discussion on the progress of MEVS Development ✓ Studying the gathered data from EVM Asia Visit such as: - Detail of event (with pictures), date, time, location - List of EV related exhibitor names, contact persons with their position/designation, main business, nature of business (charger, backend/or both), name of product - Providing picture of visited exhibitors booth along with the respective name and company office location
11 Oct 2022	✓ Meeting with an EV infrastructure, Mobility Werk at MW Advantech Sdn Bhd, Gate 3A, Jalan Utas 15/7, Seksyen 15,

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	40915 Shah Alam, Selangor, Malaysia ✓ Introducing the prospective system and gathering their feedback
12 Oct 2022	✓ Meeting with an EV infrastructure, R.E.I.S.B at Roda Emas Industries Sdn Bhd, Unit 03-05 Level 3 Kenwingston Business Center Kenwingston Square Garden, Persiaran Bestari, Cyber 9, 63000 Cyberjaya, Selangor, Malaysia ✓ Introducing the prospective system and gathering their feedback
21 Oct 2022	✓ Analaysing MEVS System design
27 Oct 2022	✓ Modify and improving MEVS System design
02 Nov 2022	✓ Discussion on MEVS Development progress

During the requirement elicitation phase, three requirement gathering sources were discovered. The following is a list of the sources:

EV Symposium and Exposition

A great deal of valuable information was gathered by attending two EV Expos in Kuala Lumpur, Malaysia.

Firstly, the Electric Vehicle Expo (EVx) Malaysia 2022, which was held from the 23rd – 24th July 2022 at the Setia City Convention Centre in Shah Alam, Selangor, was an exposition to showcase the latest electric vehicle (EV) technologies and EV cars available in Malaysia. The exhibitors include representatives from Tenaga Nasional Berhad (TNB), Setel and Gentari, EV Connection Sdn Bhd, Exicom Power Solutions, Mercedes-Benz, Volvo, BMW, Tesla and many others. The event attracted EV enthusiasts and industry professionals alike. Following the participation at the aforementioned exposition, a wealth of valuable information about various EV infrastructures was gathered. Gentari, JomCharge, Exicom, GoCar, Tenaga Nasional Berhad (TNB), evhub.my, and Wallbox, as well as some automobile companies, were among the featured players.

Secondly, the EVMASIA'22 which was held from the 27th – 29th September 2022 at the Malaysian International Trade and Exhibition Centre (MITEC), was an expo to introduce the latest Southeast Asia's exhibition on Electric and Hybrid vehicles, Charging Infrastructures, Manufacturing Technology and Auto parts and Components.

Upon participating in the discussed exhibition, significant information regarding EV charging infrastructure companies, EV Charging backend processing as well as hardware origin and manufacturer was gathered.

Industry Visit

Throughout the expositions, a variety of EV industries were showcased, and the research team of this paper later connected with some of these industries and arranged company visits on specific dates. Mobility Werk and R.E.I.S.B were two of the presented organizations. The goal of these collaboration meetings was to assess the proposed system's success rate from the standpoint of the EV infrastructures.

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One of the visited manufacturers of automotive parts and components in Malaysia was the Mobility Werk (MW) Group. In the automotive sector, the Mobility Werk (MW) manages four subsidiary companies named as; Assembler Sdn Bhd, MW Advantech Sdn Bhd, MW Electronics Sdn Bhd, and MW EV Sdn Bhd. Their expertise is in the production of electric vehicle (EV) chargers, parts, and components.

Another organization, Roda Emas Industries Sdn Bhd (REISB) founded in 2014, is a solution provider for various industries in Malaysia. REISB has a diversified business that offers services and supplies. Energy Consultant, Electric Vehicle Supply Equipment (EVSE), Energy Efficient Equipment Supply & Installation, Mechanical & Electrical Works, Acoustic Engineering & Noise Control, Civil & Construction, Project Management, Facility Maintenance and Management, Green Technology Power Generation, General Trading & Supplies, and Preliminary & Detailed Energy Audit are just a few of the areas in which they specialize. The company commenced as a small family-run business that expanded into a larger corporation.

Project Survey for EV/PHEV Car Owners

The following survey was conducted of 30 EV/PHEV car owners to gather information regarding the EV owner charging issues, including carrying chargers, confusion in downloading a wide range of EV applications, as well as type of payment mode and mechanism that impact EV/PHEV car owners' experience.

Qualitative analysis techniques is used on the results of the survey to make informed decisions regarding the development and improvement of charging infrastructure, as well as in creating more user-friendly EV charging solutions for electric vehicle owners. This will ultimately contribute to the widespread adoption of electric vehicles, as it addresses some of the key concerns and challenges faced by current EV owners.

The first two sections of the table (A and B), defines the highest and lowest levels of agreement in the format of from “Strongly disagree” to “strongly agree”.

Table 6: Survey On EV/PHEV Car Owners Charging Issues (n=30).

A)

Agree Level	1	2	3	4	5
1. Carrying Own Charging Cable To Charge At Public Station Is Inconvenient.	26.7%	10%	16.7%	13.3%	33.3%
2. Downloading And Installing Various EV Charging Mobile Applications On My Mobile Phone To Charge My EV/PHEV Car Is A Hassle.	3.3%	3.3%	30%	10%	53.3%

B)

Count	1	2	2+
3. How Many EV Charging Mobile Applications Have You Installed On Your Mobile Phone?	13.3%	6.7%	80%

C)

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Payment Mode	Not Applicable to My EV	Subscription Based	Pay Per Use
4. Which Of The Following EV Charging Payment Mode Do You Prefer?	3.3%	16.7%	80%

D)

Payment Mechanism	(I Have Home EV Charger)	Plug & Charge	Credit/Debit Card	Mobile Apps
5. Which of the following EV/PHEV charging payment mechanism do you prefer?	3.3%	3.3%	56.7%	36.7%

Results and Findings

After gathering valuable data about EV infrastructures and analysing the gap in the current market, the requirements of the system was prepared for the client. This section describes the software requirements specification of the proposed system (MEVS) which addressed the user requirements.

MEVS is an app-based system that employs 3-tier architecture as shown in Figure 1. MEVS provide a user-friendly system for users to register and discover available charging stations for the EV charging purposes. After subscribing to the system, the user chooses a charging station from a collection of available charging locations, performs the charging operation, and tracks the charging status. Furthermore, the user is able to pay the charge fee via the system. After the charging process has completed, the user may obtain a thorough summary of the charging history.

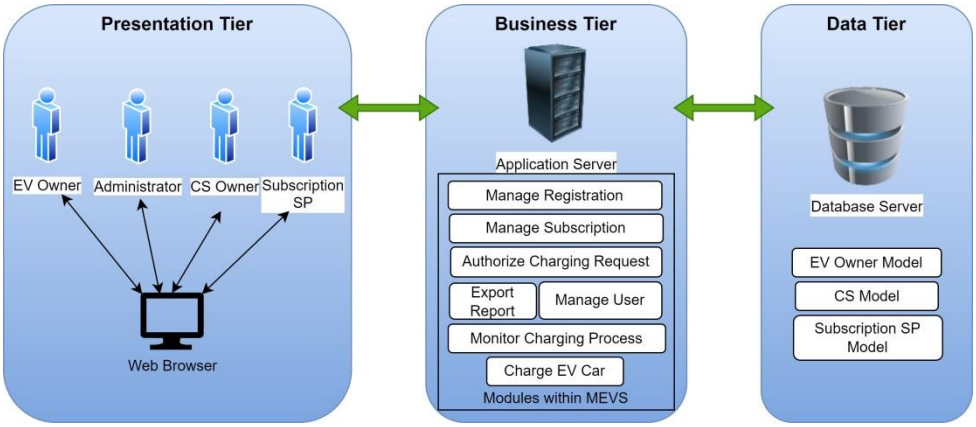

Figure1. MEVS 3-Tier Architecture

The MEVS is a combination of Central Management System (CMS) and Mobile Application (MA). The whole system shall interface with the surroundings through the following detailed features:

a) The "Manage Registration" where system manages user authorization and account modification.

b) The "Manage Subscription" where system manages user subscription and payments as well as subscription modification. (cancel/ renew subscription plan)

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c) *The "Authorize Charging Request" where CMS system validates charging request from charging station terminal.*
d) *The "Export Report" where system provides a comprehensive report to respective users based on their role in the system. EV Owner gets report of charging transactions and subscription history, Subscription SP gets the report of the subscribers, Administrator obtain a full report of all the EV owners, charging stations and subscription service providers whom are registered to the system.*
e) *The "Manage User" where system administrator is able to modify and manage each user.*
f) *The "Charge EV Car" where Mobile Application provides the capability to locate the charging station and provides the respective information such as availability, socket types, power availability etc.*
g) *The "Monitor Charging Process" where the EV Owner is able to track charging progress through Mobile Application including the charging time, charging miles and remaining duration to full charge.*

The users shall either be:

a) *Acting as EV Owner and he/she is able to register and subscribe to the system and perform payment for the subscription purpose as well as charging his EV car, track charging progress, and obtain a report of charging transactions.*
b) *Acting as Administrator and he/she is able to add, remove or update each users such as EV Owners, Charging Stations, and Subscription service providers.*
c) *Acting as CS Owner and she/he is able to register to the CMS system and provide information about his charging station/s.*
d) *Acting as Subscription Service Provider and she/he is able to register to the CMS system and provide information about multiple subscription plans as well as obtaining a report of subscribers to his own organization.*

The following figure 2, illustrates overall Use Cases of MEVS based on the identified requirements and specifications.

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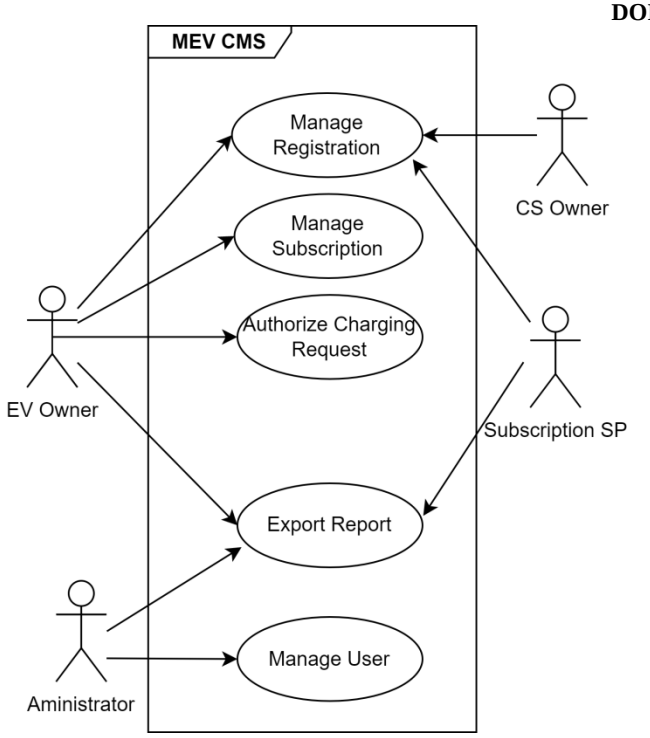

Figure2. MEVS Use Case Diagram

Each Use Case function of the MEVS is defined as:

a) *Manage Registration: This use case is initiated by the EV Owner, CS Owner and/or Subscription SP. It provides the capability to register to the system and modify the account.*
b) *Manage Subscription: This use case is initiated by the EV Owner for the purpose of subscribing to the system based on half-yearly or yearly basis.*
c) *Authorize Charging Request: This use case is initiated by the EV Owner through mobile application. Once the user presses start charging EV via his mobile application, the system will authorize the charging request from the specified terminal and user is able to start charging process.*
d) *Generate Report: This use case is initiated by the EV Owner/ Administrator or Subscription SP. It provides a comprehensive report to the user based on his respective role.*
e) *Manage User: This use case is initiated by the Administrator. It provides the capability to modify (add/remove/validate/update) the users (EV Owners, CS Owners, Subscription SPs) in the system.*

Conclusions

The deployment of Electric Vehicle (EV) technology is gradually gaining momentum worldwide, and Malaysia is no exception. Nevertheless, the progress in developing an ecosystem to encourage the use of EVs in Malaysia is slow. EV players must combine the network effect of other mobility ecosystem partners to accelerate deployment. One major challenge in Malaysia is the limited access to charging points due to the restriction of communication between specific subscribers or applications. This paper is a preliminary study that made us recognised the need to improve Malaysia's current charging infrastructure. Additionally, this study encouraged us to suggest an effective management system for EV charging in Malaysia in the future. The preliminary study conducted on Malaysian Electric

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Vehicle System (MEVS) and Inter-service Provider Charging Protocol (ISPCP) technology, which would allow EV owners to use any existing Charging Points without having to subscribe to many different providers to avoid charging at limited stations. The MEVS system would enhance the charging interaction while maximizing operations, shortening time-to-market, and boosting revenues. The proposed solution is expected to improve access to charging points, ultimately improving the adoption of EVs in Malaysia. Additionally, the analysis of the current EV ecosystem and its limitations and the potential of MEV-CMS have been discussed in this paper. Further research and development of this proposed solution are needed to realize the full potential of the EV technology ecosystem in Malaysia.

There are some restrictions in this research, which opened up the possibility for potential future discussions and the area of the upcoming study is the specification parts. It is important to note that this paper serves as a guide for us as we develop the requirements for the Malaysian Electric Vehicle System (MEVS). While we performed the survey in this project, it has reported details regarding the requirements and desired interactions of users with the recommended system.

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