Future Assessment of Low Cost EV Automobile Market in Bangladesh

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ABSTRACT: *The global automotive landscape is undergoing a profound transformation, driven by the imperative to reduce greenhouse gas emissions and combat climate change. Bangladesh, a densely populated country grappling with environmental challenges and urban traffic, stands poised at the brink of embracing electric mobility as a solution. This abstract delves into the future trajectory of the low-cost electric vehicle (EV) market in Bangladesh, examining key factors influencing its growth, challenges hindering its adoption, and potential strategies for overcoming these barriers. The low-cost EV market in Bangladesh presents a promising avenue for sustainable transportation, offering the dual benefits of reducing carbon emissions and mitigating dependence on imported fossil fuels. This includes fostering collaboration between the government and private sector to develop comprehensive EV policies, investing in research and development to enhance battery technology and drive down costs, and implementing targeted financial incentives to make EVs more accessible to a wider demographic. Furthermore, public awareness campaigns and educational initiatives can play a crucial role in dispelling misconceptions and fostering acceptance of EVs among consumers. In conclusion, while challenges persist, the future of the low-cost EV market in Bangladesh is undeniably bright. With the right mix of policy support, infrastructure development, and industry innovation, Bangladesh has the potential to emerge as a regional leader in sustainable transportation, paving the way for a cleaner, greener, and more prosperous future.*

KEYWORDS: electric vehicle (EV), low-cost, fossil fuels, Battery Bangladesh

INTRODUCTION

Electric vehicle is a very common word in technology nowadays. Although the ability of Bangladeshi electric vehicles is very low. Since Bangladesh is a densely populated country, it also needs more transportation systems [1]. Every year in our country, the use of fuel-driven vehicles is seen which is very harmful to the environment. If the use of electric vehicles can be increased, then the level of environmental pollution will decrease day by day. Electric cars are not that expensive for daily use. For example, we can say if a petrol powered car costs Rs 5 per kilometer whereas an electric vehicle costs taka 2 per km [2].

Therefore, we can say that if the level of environmental pollution in Bangladesh is to be reduced then the use of electric vehicles must be increased to a great extent in the future. The main objective of our research paper is to reduce environmental pollution and bring electric vehicles to people's doorsteps at affordable prices. We all know that in this 21st century the battery is a very important part of the electric vehicle. The performance of an electric vehicle depends on its battery. The battery is the most expensive part of the electric vehicle [3]. If we want to increase the use of electric vehicles in Bangladesh, then we must reduce the cost of batteries, increase the production of batteries and maintain them well and quality is very important. We will focus on how to provide good quality batteries at low prices in our research. In that case we can use calcium ion battery instead of lithium ion battery as an alternative [4]. As the government increasingly prioritizes environmental sustainability and energy security, policies supporting the adoption of EVs are anticipated to gain momentum. Additionally, the rising awareness among consumers regarding the environmental impact of traditional combustion vehicles, coupled with advancements in EV technology and declining battery costs, bodes well for the proliferation of low-cost EVs in the Bangladeshi market [5]. However, several challenges impede the widespread adoption of low-cost EVs in Bangladesh. These include limited charging infrastructure, concerns regarding battery range and performance, affordability constraints, and the need for supportive regulatory frameworks and incentives. Addressing these challenges will require a concerted effort from policymakers, industry stakeholders, and the international community to develop robust charging infrastructure, incentivize EV adoption, and promote domestic manufacturing of EV components. To unlock the full potential of the low-cost EV market in Bangladesh, a multifaceted approach is necessary.

Artificial intelligence is a game changer technology that has become very important for electric bills these days. Nowadays we can use artificial intelligence in electric cars to make them more user friendly. Through which a less skilled driver can operate this car and run very smartly in any city.

LITERATURE REVIEW:

The Electric Vehicle battery backup problem and high cost of battery have become a major problem of different sector. For example: this problem can effect on the Transportation, energy, sustainable development of Environment friendly green city. This review paper Focus on the new model of battery use in Electrical vehicles and low cost production of battery based on ecofriendly sustainable development of Bangladesh and south Asia

In an Electric Vehicle not only battery issue but also have so many issue one of them is electric vehicles routing problem. Chakraborty et al. have describe lot of things about routing problem. Also, this article shows that to find optimal solution and routes [6]. In electric vehicle window constraints routing problem is also a major fact. This problem and effective solution describe in Schneider et al [7]. Hermann et al. Show that with analysis the routine problem electric vehicle based on different sizes. Charging section is also narrating very deeply [8]. But some interesting things wasn't Detail, one of them is Lithium batteries recycling process and alternatively substitute Lithium batteries to calcium batteries. Some research data show that if batteries are full charges then in the traveling time the total overall result significantly increased. But some time partially charge batteries also provide great output result. Basso et al. also focused on doubt road conditions or energy costs based on partially charging [9].

In the electric vehicle one interesting thing is Battery swap, which is the absent of foil fusel cars or vehicles. Ma et al. recommended that autonomous electric vehicle routing problem and battery swapping [10]. This research Paper also focused on the optimization model of the traveling time's 14040; Environmental Management-(Geneva, Switzerland, 2006. [11] Quantities analysis on the process of energy transfer, conversion, discharge of environmental pollutants, this is the actually method of (LCA) evaluating the environmental impact of process. There are so many (LCA) studies of batteries (BEV) (Xia, X.N.; Li, P.W. [12].This Research Paper mainly niceties the influence of batteries and types characteristics of batteries. Netter, D.; Gauch, M.; Wider, R.; Wager, P.; Stamp, A.; Zah, R.; Althaus [13]. Actually broadly describe of Li-ion battery and its life cycle. In this research paper they didn't tell any alternative insisted of Li-ion batteries. Where we can easily use calcium-ion battery. It will create a new era of battery industry because this is very cheap and available in out nature. Calcium can deliver twice as many electrons per ion between electrodes then the Lithium-ion. That's why calcium ion could offer higher capacity then the Lithium-ion batteries.

In recent years BMS (battery management system) is commonly use in electric vehicle. Andrea, D. [14] This BMS provide the optimization of battery with monitoring and protection of battery performance. Using BMS could ability to monitor the different measurement of battery cell, For example voltage, current and temperature. Shaniqua et al. show that a comparative cradle-to-grave life cycle environmental footprint analysis of BEV in 10 selected countries using the present and future electricity with different scenarios [15].Qiao et al. exploration the greenhouse gas emissions of the cradle-to-gate phase, well-to-wheel phase, and grave-to-cradle phase for BEV in different times. It was found that the greenhouse gas emissions of producing a BEV are 15.0–15.2 t CO2-eq, which are 48% higher than the 10.0 t CO2-eq of ICEV. However, the life cycle greenhouse gas emissions of a BEV are about 40.0 t CO2-eq, which are 19% lower than those of an ICEV [16, 17].

Taliaferro et al. shown and likened the LCA of BEV and ICEV for Europe. Two manufacturing catalogue were separated, and variant hacker disposal pathways were considered for BEV [18]. Burkhart et al. presented a LCA of BEV in Poland the Czech Republic, considering the occurrence of electricity formation. It was fabricate that greenhouse gas emissions and fossil energy consumption of BEV would be lower than those of ICEVs both present and future scenarios, while the acidification, eutrophication, human toxicity, and particulate formation caused by BEVs are higher than ICEV [19,20].

Marques et al. presented and compared life cycle main fossil energy, global warming potential, acidification potential, and eutrophication potential of lithium manganese oxide (LMO) and lithium-ion phosphate(LFP) battery, addressing real-life operational conditions and battery capacity fade [21-23].Shu et al. conducted the life cycle environmental influence of LFP and NCM battery and mate that LFP battery is more environmentally amiable in the phase of production, while NCM battery is more environmentally conciliatory in the phase of the application and transportation [24].

Yin et al. studied and tooled a life cycle imposition of lithium titan ate oxide (LTO) batteries for battery electrical buses, along the resetting and reusing phase, and numbered that the life cycle greenhouse gas emission of each kWh LTO battery is 1860 kg CO2-eq [25]. When the capacity of lithium-ion battery is declined by 20–30%, it can no longer satisfy the demands of BEV. The disposal methods of retired battery main focus cover remanufacturing, cascade utilization, recycling, and direct scrapping [26,27]. Considering the cascade utilization appeals scenarios, the retired batteries have been exempted on the residential energy storage with rooftop photovoltaic [28], utility-level photovoltaic firming [29, 30], and utility-level peak-shaving [31, 32]. Considering the recycling methods of retired battery, different scholars investigated pyro metallurgical, hydrometallurgical, bio-hydrometallurgical, and direct recycling technologies [33-35]. life cycle assessment of different type vehicles and power batteries were compared, and cascade utilization and recovery of batteries were investigated and conducted by different scholars.

METHODOLOGY

The aim of this research is to gain knowledge of the public opinions of EV. The methods outlined are chosen to ensure the results give an accurate reflection of the public's view of EV.

A mixed methodology for this research is used (Flick 1998). The research employs a case study to gather data through a combination of quantitative and qualitative data. According to Creswell (1999, p. 455) "a mixed method study is one in which the researcher incorporates both qualitative and quantitative methods of data collection and analysis in a single study. Creswell elaborates (p. 455) and says that this type of study allows the researcher to "understand complex phenomena qualitatively as well as to explain the phenomena through numbers, charts, and basic statistical analysis. As technology has advanced, the availability and variety of EVs has increased.

Consumers' choice of EVs over ICE vehicles is based on their concern for the environmental impact of the transport system in contributing to CO2 emissions. EVs contribute economic benefits including employment opportunities in research and manufacturing. However, some research is skeptical of the take-up of EVs due to significant barriers including purchase price, running costs, fuel/charging infrastructure, driving range, and charging times [26-37].

Viability and Environmental Impact of EV

EVs are more environmentally profit than ICE vehicles in that they emit less CO2 .EVs replace ICE profited that use high polluting fossil fuels, with lithium batteries for power that emit far less C02 emissions. In addition to environmental benefits EVs produce economic benefits such as employment opportunities in research and manufacturing, reductions in fossil fuel dependency, higher energy efficiencies, and associated reductions in greenhouse gas emissions [38]. EVs are also noted to have a significant impact on the engine noise in urban traffic (Ibarra, Ramirez-Mendoza, & Lopez, 2016). Despite benefits from the use of EVs and despite the increasing number and variety of EVs available across the world, the vast majority of automobiles on the roads are still using ICEs. Roughly 90% of the sales of light vehicles in the US use ICE vehicles (Carlier, 2021) which are heavy contributors towards C02 emissions [39]. Approximately 80% of CO2 is generated from the burning of fossil fuels such as coal, oil, and natural gas (Maximillian, Glenn, & Matthias, 2014.

Viability and Environmental Impact of EV

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Affordability of EVs

The major factor against purchasing an EV is the high initial purchase price. It is common knowledge that EVs have a significantly higher initial purchase price compared to traditional ICE vehicles. Survey results of six European countries found that the EV purchase price is a major deterrent to its purchase [41]. Such price comparisons can burden the market introduction of EVs [42]. The second expensive component of EVs is the battery, which is expected to be between 18%-23% of the price by 2030 [43]. Furthermore, a home charging point is expensive to acquire with an average cost between £800-£1,100 [44, 45]. While home charging is a more practical alternative, the cost of electricity is charged through the owner's home electric bill.

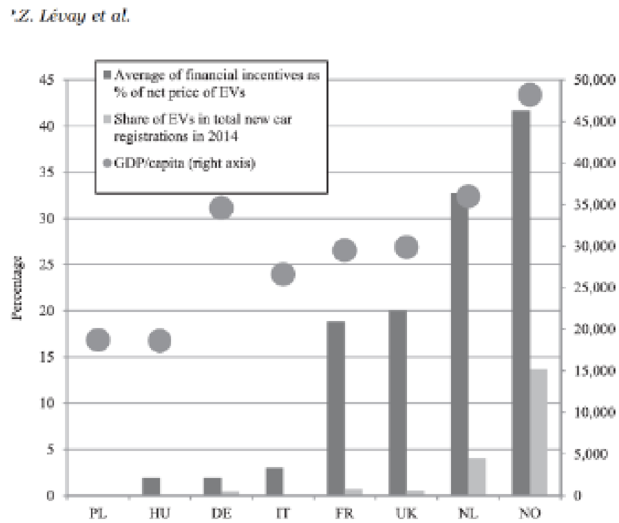

Figure1. highlights the average financial incentives available for EVs in eight

Figure highlights the average financial incentives available for EVs in eight European countries: Poland, Hungary, Denmark, Italy, France, United Kingdom, the Netherlands, and Norway. The data clearly shows that Norway have significantly higher results in terms of Average fiscal incentives as a percentage of the net price of EVs and share of EVs in total new car registrations in 2014. Norway appears to be paving the way for efficient integration of EVs in Europe. For the UK to compete with their European neighbors, they must improve the available government incentive schemes to match that of Norway.

Smart City

A smart city is a settled region employing multiple technology devices and sensors to collect data. Smart cities manage public resources to enhance the quality of services while putting comfort, maintenance, and sustainability first by using information and communication technology. EVs, which include electric cars, electric buses and neighborhood electric vehicles, will soon dominate the transportation industry. The entire transit system will be electrified in a general trend to reduce the city's petrol emissions. One of the main objectives of many smart city initiatives is to drastically cut emissions and enhance the air quality in urban areas through the widespread use of electric cars. Electric vehicles, which require less maintenance and have lower operating expenses than conventional vehicles, also help smart cities become more efficient. Additionally, infrastructure designed for smart cities, such as smart traffic control systems and charging stations, can facilitate the adoption and integration of electric vehicles.

Intelligent Transportation Systems Overview

An Intelligent Transportation System (ITS) that can accommodate their transportation needs is necessary for smart cities. For better public transportation services, transportation in a smart city should be hassle-free, environmentally friendly, and include networked and shared vehicles. The electric vehicle (EV), which also solves the world's energy problems, is the finest option.

Autonomous electric vehicles (AEVs), or intelligent electric vehicles, offer the linked and shared layer needed for a smart city.

Electric Vehicles

Due to its potential to reduce greenhouse gas emissions and dependence on fossil fuels, electric vehicles (EVs) are an increasingly preferred mode of transportation that has attracted much attention recently. Instead of using petrol or diesel fuel, an electric car is powered by an electric motor that draws power from a rechargeable battery. Electric vehicle (EV) users are expected to triple by 2030 compared to 2011. This is the result of high-tech advances in battery performance and how they affect vehicle autonomy. In addition, the increase in energy demand in these countries has increased the use of coal, the primary source of carbon dioxide emissions.

Challenges of Implementing Electric Vehicles

Public sector operators in the EV market include utilities, state and municipal governments, and private sector players, including EV service providers, fleet operators, and individual vehicle owners. Variable adopters, such as private automobile owners, private business fleet managers, and public fleets, make different operational decisions. Following the type and distribution of receivers, home charging, public charging, and battery-swapping stations should be optimized for charging models. An overview of the EV service industry's members and some of the key problems they deal with is shown in Figure.

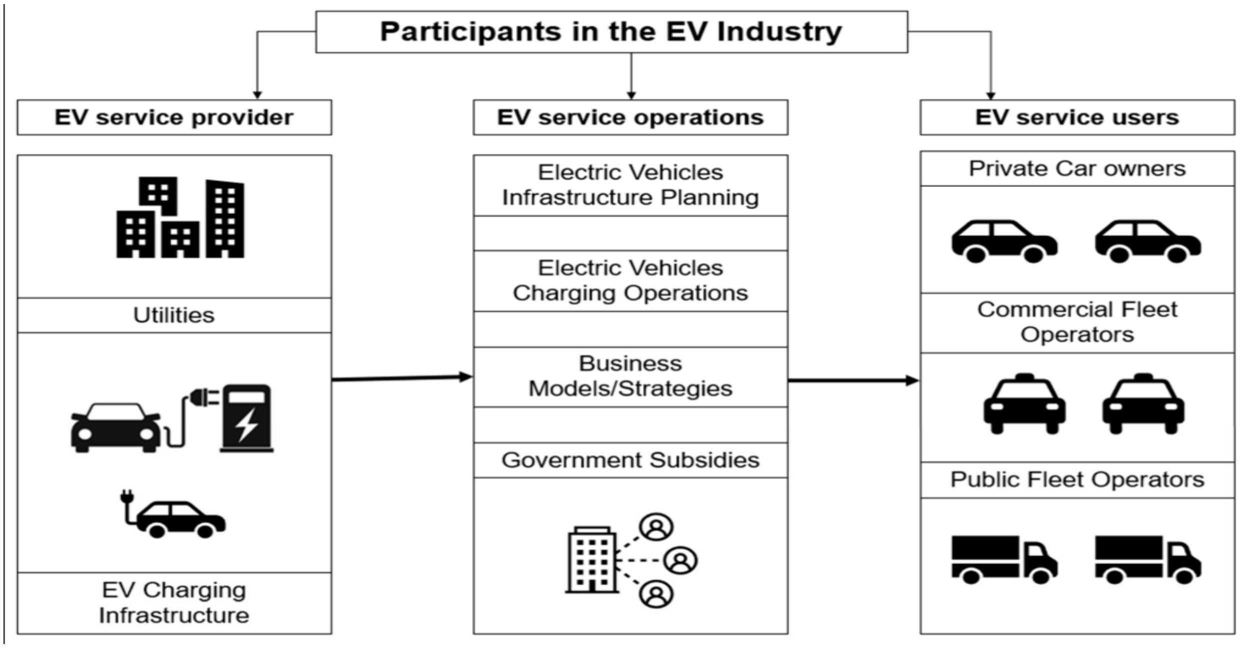

Figure 2. EV service operations/participants.

According to this definition, an "EV" is any vehicle in which the majority of driving power comes from an electric battery. Battery Electric Vehicles Plug-in Electric Vehicles and Plug-in Hybrid Electric Vehicles. A BEV is powered only by its battery pack, which can be charged from the electrical grid. In contrast, PHEVs use an internal combustion engine, an electric motor for propulsion, and a battery that can be charged from the power grid. BEVs and PHEVs are also called "PEVs". Battery costs for an EV are still significant. Up from USD800 (2012), the cost (per kWh) of electric vehicle lithium-ion battery bundles is expected to drop to USD125 by 2022. Battery degradation occurs during battery storage, consistent with annual aging, and when it is charged and discharged. The EV sector differs from the traditional ICV industry in many ways, making the challenges with managing the growing EV service even more difficult. Below is a summary of these broad issues.

Improved Battery Technology

Limitations in battery technology are one of the major barriers to widespread adoption of electric vehicles (EVs). Current battery designs for EVs have a poor energy density, which affects the vehicle's driving range [26-31]. To improve EV efficiency, various battery technologies and combinations have been developed over time. Users see electric vehicles as a viable alternative to internal combustion engine vehicles due to the development of better, more affordable, and higher-capacity batteries, which will increase vehicle autonomy.

Because batteries are vital to EVs, more manufacturers (such as LG, Panasonic, Samsung, Sony, and Bosch) are investing in better, more affordable batteries. The battery bundle is the most expensive part of any EV. For example, the lithium-ion batteries in the Nissan Leaf account for roughly one-third of the vehicle's total cost. However, this cost is expected to decrease gradually; As of late 2014, battery packs cost about $500 per kWh (half the price in 2009); Now, the price per kilowatt is $200, and it is expected to drop to around $100 in 2025. EV prices will naturally drop as battery costs drop, making them more competitive with other types of vehicles.

Figure depicts the battery capacity of various EVs from 1983, when the Audi Duo was first sold, when it had an 8-kWh battery, to 2022, when Tesla claims it will sell a Tesla Roadster with a 200-kWh battery. The GMC Hummer EV Pickup Version 1 has the largest battery capacity at 212 kWh.

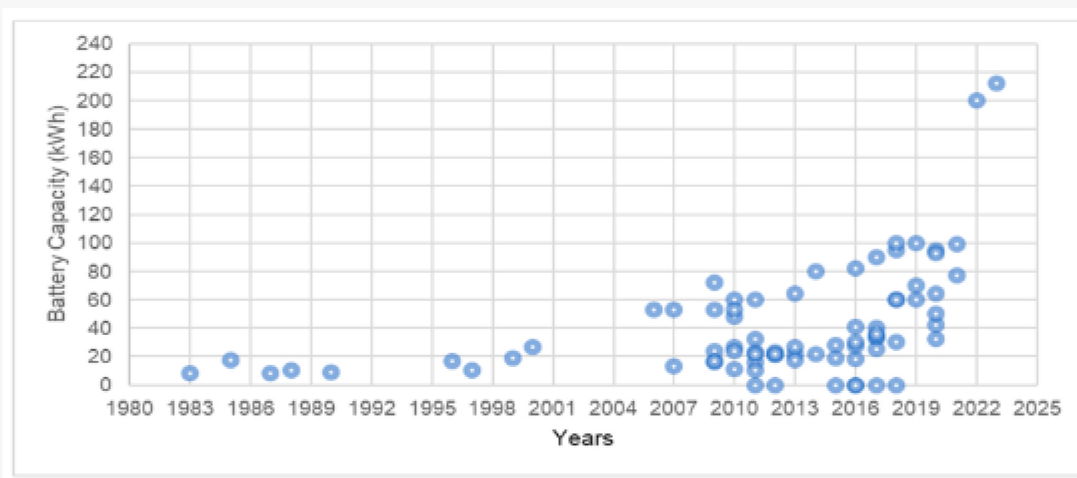

Figure 3. Battery capacity development from 1980–2025

Enhancing EV Charging Procedures—Battery Switching Stations

To reduce range concerns, battery swapping stations can be used in place of battery charging stations. Standard, fully charged batteries are kept on hand at battery switching points so EV drivers can quickly continue their trip. In this way, EVs can be changed instantly at a charge station along the highway. Can be changed immediately. The operational mechanism of battery changing stations is illustrated in Figure 7. This technology to instantly charge EVs is already being used by Tesla and other US and European battery vendors.

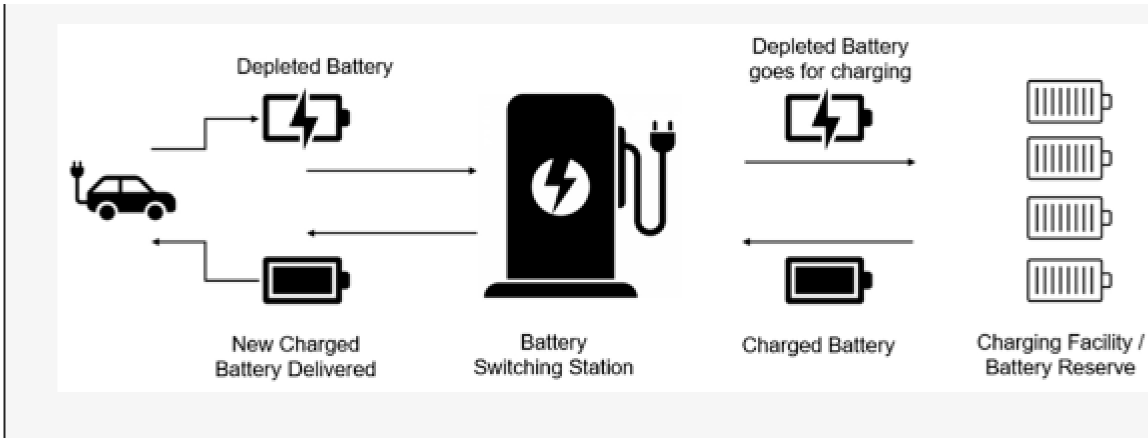

Figure 4. The battery changing stations' operational mechanism.

Most conventional vehicles can run on any of three fuels: petrol, diesel and gasoline, as shown by comparing traditional petrol stations and battery switching stations. Battery switching stations have to handle a wide range of batteries and may periodically run out of one type of battery. An EV battery-swapping station operator must constantly change charging and swapping guidelines to accommodate changing energy prices and save operational costs. A novel queuing network model with quality-of-service guarantee was used by [32-35] to research the optimal charging method for battery swapping stations. China's success in deploying battery-swapping technology, other countries could benefit from learning and adopting similar strategies. Battery swapping provides a convenient and efficient alternative to traditional charging methods, which can help accelerate electric vehicle adoption and reduce dependence on fossil fuels.

RESULT

Current State of EV Market in Bangladesh:

If we take a glance on the current market scenery in Bangladesh , the four-wheeler EV market is still virtually non-existent in Bangladesh. Currently, it is estimated thet less then 10 passenger EVs in the capital city. However, the market is likely to pick up in the future as the country is expecting to receive sizeable investments in the sector. Aside the four-wheeler EV market, EVs dominate the three-wheeler market in Bangladesh with motorized rickshaws and easy-bikes. The total number of easy bikes and motorized rickshaws are 1 million and 0.24 million respectively, which facilitates transportation for 250 million people in the country.[36] Because they are so affordable, these are the perfect form of mobility. Also, because it lowers the cost per person, sharing rides is one of the unique qualities that increase the popularity of this mode of transportation. Three-wheelers' popularity in Bangladesh has drawn both local and foreign investment. Like three and four-wheelers, electric motorbikes are also drawing the attention of Bangladeshi consumers due to lower fuel costs and convenience. As claimed by the local giant and manufacturer Walton announced the vehicles will be highly cost-efficient as the operating cost per kilometer will range between only 10-15 paisa. Akij, and Duranta are planning to distribute locally assembled two-wheeler EVs in the Bangladeshi market.

Market Growth Potential and opportunities:

A lot of opportunities can be found in the market place. Nowadays sustainable transportation demands are rising rapidly. The environment pollution in Bangladesh is a major problem and cause of that, there is a growing demand for clean and green transportation solution in Bangladesh. EVs present an opportunity to address these concerns by offering emission-free mobility option. Bangladesh government demonstrated a commitment to promoting electric vehicles through tax exemptions, subsidies and infrastructure development. Bangladesh is having a rapid expansion of its middle-class population, proportional to this matter, the driving demand for affordable and efficient transportation solutions. Low cost EVs is the alternative to traditional petrol and diesel vehicles. Integrating EV charging infrastructure with renewable energy generation present an opportunity to enhance energy security, reduce dependence on fossil fuels and put out greenhouse gas emission.

Future of EVs :

The Government of Bangladesh has recently drafted a new policy for automobiles targeted to integrate energy-efficient vehicles into the ecosystem. The government is eyeing to increase the share of EVs to at least 15% of all registered vehicles by 2030.

DISCUSSION

Limitations of AI

The current literature on applying AI to EV integration has several limitations:

– Practicality: Most studies only apply AI in simulation, lacking real-world validation of their effectiveness in tasks like battery charging management or EV charge point scheduling.

– Vehicle-to-Grid: While V2G pilot programs exist, widespread adoption of this

technology is still lacking, limiting its application in EV integration.

– Willingness of control: Consumer acceptance of AI-managed EV charging may be hindered by concerns and hesitation related to understanding and trust in AI technologies.

– Explainability: The lack of transparency and comprehensibility in AI decision making processes raises concerns, especially in safety-critical systems or situations requiring explanations.

– Trustworthiness: Developing reliable and robust AI systems is crucial for managing EV charging/discharging and gaining consumer trust, but this topic is not extensively explored in the literature.

Future Directions AI

There are a number of trends that future research in the AI for the EV integration will follow:

– Advancements in AI algorithms: Improved AI algorithms will be developed and applied to address various aspects of EV integration. Focus on explainable and trustworthy AI: Research will address the need for

explainable and trustworthy AI in EV integration.

– Peer-to-Peer (P2P) energy trading: The growing interest in P2P energy trading, facilitated by technologies like blockchain, will drive research on AI-based EV battery management within P2P networks.

Battery

The expansion of electric mobility offers new opportunities to minimise environmental impacts while ensuring that the needs of EV owners and stakeholders are met.

For this reason, the literature on EV charging and discharging was reviewed from the perspective of smart grids, V2G, battery degradation, and demand response. The use and profitability of V2G and smart grids are well documented in numerous research articles. This is demonstrated by issues such as energy arbitrage as in [37-40] to assess the profit vehicle owners could make by offering their batteries and even the positive effect of V2G on the battery as in [41,42] ("Beneficial V2G"). Therefore, the focus should be on the key components of smart charging and V2G of large fleets to prevent the uncoordinated and simultaneous charging of EV fleets due to grid impacts and economic reasons. The most challenging aspect for researchers is the appropriate integration of EV fleets to ensure grid stability while minimising battery degradation of EVs and compensating for the economic losses of vehicle owners.

As part of this, many studies simulate the economic and environmental interests of EV owners under battery degradation and often consider renewable energy generation. Empirical, semi-empirical, and physics-based statistical/electrochemical models have been used in modelling battery degradation. Thus, degradation modelling of EV charging scenarios has largely focused on empirical or semi-empirical modelling over physical modelling. Influential battery degradation parameters regarding cycling degradation (battery temperature, C-rate, DOD, SOC) for EV charging scenarios in the literature were highlighted. It was shown that the non-linear behaviour of battery degradation, especially in EV charging scenarios, is not fully taken into account. Adapted battery degradation models are needed for different battery types, as the current battery technologies (NMC, NCA, and LFP) have individual strengths and weaknesses. A detailed overview can be found in [43-45].

In the course of multi-objective optimisation of EV charging scenarios considering battery degradation and the trade-off of more than two objectives (e.g., energy cost, CO2 emissions, compensation of vehicle owners, and battery degradation), there is a clear lack of studies to identify future potentials. Here, the conflicting goals of the different stakeholders should be optimised in a multi-criteria approach. Thus, in an optimal trade-off scenario, where EV owners that make a net profit by providing their EVs may encourage other EV owners to participate in V2G scenarios or even encourage ICEV owners to adopt an EV. Moreover, the social question should be answered: when and under which circumstances would an EV owner allow another stakeholder (e.g., the company where they are employed) to use their battery?

To the best of the authors' knowledge, there are no such multi-objective optimisation of EV charging scenarios in the industrial setting that adequately considers battery degradation and demand response. The main research gaps identified in the current literature can be summarised as follows:

Battery temperature, which is considered an important loading factor, has generally received little attention. Either the temperature was considered constant or simplifications were made assuming that the battery temperature corresponds to the average daily ambient temperature.

The minimisation as well as the trade-off between CO2 emissions reduction and battery degradation, in contrast to the minimisation of system costs, was not sufficiently proven.

There is a lack of studies that comprehensively consider battery degradation in EV charging scenarios and balance it with financial compensation for EV owners (especially in the non-residential setting). This trade-off between EV owners and companies regarding the benefits to the company and the balance between battery degradation and profit in the form of subsidised or free charging electricity for the EV owner is not appropriately quantified in the literature.

There are no studies that have investigated non-residential demand response in smart grids, taking into account larger EV fleets and appropriate battery degradation to show economic and environmental perspectives.

The limitations of this study involve the consideration of battery degradation, which should be further explored. In Table 2, all degradation models refer to test cells or batteries that have been partially interconnected to mimic a battery in an EV. Therefore, analysis of a real EV over a longer period of time would be extremely interesting. Current studies on EV battery use and degradation often refer to standardised data (driving patterns, operating times, driving cycles), and thus real-world degradation in EVs could be under- or overestimated.

Research about Ca-ion Battery and possibilities

Calcium (Ca) metal batteries are a potential replacement for lithium-ion batteries (LIBs) in electric vehicles (EVs) and grid-scale energy storage systems. Ca batteries have a higher energy density potential than LIBs, and are inexpensive and widely available because calcium is the fifth most abundant element in the earth's crust. They also have advantages in terms of safety and cost.

In May 2023, a research group reported in Advanced Science that they developed a prototype Ca metal rechargeable battery that can undergo 500 charge-discharge cycles, which is the benchmark for practical use. However, scientists first experimented with Ca-based batteries in the 1960s, but they only worked at high temperatures and failed after a few charge cycles.

Some research suggests that with further development, Ca batteries could become an attractive post-Li technology

CONCLUSION

In this study, the environmental impacts of battery electrical passenger vehicles match-ing four different power batteries (LFP, NCM, LMO, and LTO) in are conducted throughout the life cycle assessment approach. The future prediction analysis of batteries production and life cycle BEV are conducted to evaluate the environmental benefits of the development of key technology parameters. Inventories of four different power batteries are collected from the literature investigation and enterprise investigation. The study results can be concluded as follows.

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