International Journal of Advanced Multidisciplinary Research
ISSN: 2393-8870
www.ijarm.com
(A Peer Reviewed, Referred, Indexed and Open Access Journal)
DOI: 10.22192/ijamr Volume 10, Issue 1 -2023

Research Article

DOI: http://dx.doi.org/10.22192/ijamr.2023.10.01.004

Optimizing the Installation of EV Charging Station

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Keywords

EVCS (Electric Vehicle Charging Station), EV(Electric Vehicle), Optimization.

Abstract

Traditional motor vehicles are starting to go out of style, thanks to electric vehicles (EVs). Lowering harmful engine emissions and reducing reliance on expensive hydrocarbon fuels are the main drivers behind the switch to electric vehicles (EVs). Electric vehicles (EVs) represent a step toward a sustainable alternative to lessen our excessive reliance on fossil fuels and to reduce excessive carbon emissions. EV use is growing rapidly, and the system's key difficulty is keeping the EV batteries charged before they run out.

Charging stations (CS) should be strategically positioned to make sure that EV users can get to the stations within their driving range. Metropolitan area planners have started to consider both charging station design and installation at the same time. Unlike gas-powered vehicles, EVs need to be periodically charged after traveling a certain distance. Electric vehicle charging station design and installation in major cities were planned using the Center of Gravity method framework. By employing this technique, we demonstrate how our framework can provide answers to a number of crucial queries regarding the deployment (and placement frequency) of EV charging stations as well as their financial viability.

Introduction

Sources has led to the development of numerous optimization or control approaches. We are working together with OEMs, utilities, fleet operators, businesses, cities, and end users to make electromobility the standard. We offer comprehensive solutions for both sustainability and electromobility, not just items. The usage of electric transportation and renewable energy sources are proving to be the most effective ways to handle the escalating environmental issues and energy scarcity, and this trend is expected to continue. As opposed to dense residential

neighborhoods, where charging infrastructure is more essential for BEVs to complete long-distance trips, we study the placing characteristics of fast-charging stations along highways that support long voyages in this research.

To establish electromobility as the norm, we are collaborating with OEMs, utilities, fleet operators, companies, cities, and end consumers. We provide more than simple products. We provide complete solutions for both sustainability and electromobility. The use of renewable energy sources and electric vehicles is proven to be the most efficient means to deal with the growing environmental problems and energy scarcity, and this trend is anticipated to continue. In this research, we examine the placement characteristics of fast-charging stations along roads that facilitate lengthy journeys, as compared to dense residential neighborhoods where charging infrastructure is more necessary for BEVs to accomplish long-distance excursions.

The intermittent and variable nature of renewable energy. However, not all of the variables, such as operational costs, client happiness, load loss, and owner profit, are taken into account in one objective function. Some noteworthy aspects of EV in India are It first arrived in India in 2018, and by 2021, “3,29,190” electric vehicles had been sold there, an increase of 168% over the “1,22,607” units sold the year before. 90% of the market collectively. “9,66,363” EVs were operational as of January “31,2022”, in India. Some of them include the Tata Nexon EV and the Tata tigor EV, while businesses like Tata Motors, Ather Energy, and Bajaj are offering EVs. Along with the high cost, regulatory restrictions are also a problem in many nations. The fundamental issue is that an EV's recharging procedure is very different from that of a traditional vehicle. An electric vehicle's charging time is significantly longer than a conventional vehicle's fuelling time, depriving drivers of the advantages of quick fueling.

In terms of production and sales, India has the largest vehicle market across the world. 1897 saw the introduction of the first automobile, and India's first production plant opened its doors in 1930. Soon after India gained independence in 1947, businesses like Hindustan Motors, Mahindra & Mahindra, and others began producing cars. The Indian government also began to consider ways to support the auto industry at this time. One of the major events was the COP-26 Summit. The five nectar elements (Panchamrit) of India's climate action were to reach 500 GW of non-fossil energy capacity by 2030, meet 50% of its energy needs with renewable energy by 2030, reduce total projected carbon emissions by one billion tonnes by 2030, reduce the economy's carbon intensity by 45% over 2005 levels by 2030, and achieve net zero emissions by 2070.As a result of the numerous sources of emissions that accompany vehicles, all of these are either directly or indirectly tied to vehicle emissions. Electric vehicles are thus one way to manage emissions and assist in the achievement of the goal of zero carbon emissions. By 2030, it is intended that all automobiles in India will be electric. According to the government's new plans, every automobile sold in India would be electric by 2030.As a result of the numerous sources of emissions that accompany vehicles, all of these are either directly or indirectly tied to vehicle emissions. Electric vehicles are thus one way to manage emissions and assist in the achievement of the goal of zero carbon emissions. By 2030, it is intended that all automobiles in India will be electric. According to the government's new plans, every automobile sold in India would be electric by 2030. As a result of all the major corporations entering the market and consumers embracing the idea, production of electric vehicles has increased significantly. Due to India's progress in producing batteries, the entire EV system appears to be gaining pace and moving in the correct direction.

States like Maharashtra, Delhi, Gujarat, Goa, etc. are also granting subsidies. The Central Government has extended the deadline for FAME-II subsidies to March 2024. While all of these disagreements are going on, like Compared to diesel and gasoline vehicles, electric vehicles are more harmful to the environment.

One of three categories can be applied to electric vehicles:

Vehicles with battery power (BEVs): They are more effective and totally powered by electricity than hybrid and plug-in hybrid vehicles. **Hybrid electric vehicles** are those that have battery-powered motor power train as well as an internal combustion (usually gasoline) engine. When the battery is dead, the car is propelled and charged by the gasoline engine. These automobiles are less efficient when compared to fully electric or plug-in hybrid cars. In **fuel cell electric cars**, chemical energy is converted into electric energy (FCEVs). Think of a hydrogen-powered FCEV.

Electric vehicle producers in India include Tata Motors, Hyundai, Mahindra, Hero Electric, Ola Electric, Ather Electric, Mahindra Electric, Olectra Greentech, Ashok Leyland, Okinawa, and Ampere EV.

There are numerous types of electric vehicle:-2-wheeler(Scooter), 3-Wheeler(Auto), 4-Wheeler (Cars), Goods and Commercial Vehicles (ex-Buses).The price varies depending on the charging speed the charger offers and may be determined by the number of kWh of electricity consumed or the amount of time it takes to charge the device.

As we all know, the charging station for an EV is a big concern for those considering purchasing one. However, because India is still in the process of moving from gasoline and diesel to electric vehicles, charging stations are far less frequent than gas stations. In comparison to two EV charging sites, which are spaced 3 km apart on a grid, the minimum distance between two gas stations is 300 meters. Tata Power, Delta Electronics India, Quinch Chargers, Mass-Tech, ABB India, Amara Raja, Exicom, P2 Power Solution, Magenta Group, and Fortum India are just a few of the businesses in India that are in the EV charging station business. With over 300 active electric vehicle charging stations, Tata Power currently has the most chargers.

As stated by the user interfaces for charging stations typically depend on apps. Using the app from either the charging station provider or the maker of your car, you may find the closest charging station. Use the app to turn on the charger at the station and start charging the battery after connecting it to the charging port on your car. On the other hand, certain businesses in India also provide charging services based on RFID tags and cards. Depending on the city or state where the charging station is located, different states have different fees for using their public charging stations. The price varies depending on the charging speed the charger offers and may be determined by the number of kWh of electricity consumed or the amount of time it takes to charge the device. For instance, charging an electric vehicle like the Tata Nexon EV in the state of Maharashtra might cost you anything from Rs 130 to Rs 240. To calculate the cost of charging an EV at home, simply multiply your local power tariff by the vehicle's charging capacity. A Tata Nexon EV Max with a 40.5kWh battery, for example, can be completely charged in Delhi at a rate of Rs 6.5-8 per unit, for about Rs 260-330. By considering several aspects, like distance, population, etc., one can choose where to locate an EV charging station.

Literature Review

For the research, extensive research consisting of 50 research articles was taken to get clear insight of how to optimize the distance of EV charging stations and increase the sustainability economically, socially and taking environmental issues into consideration.

As environmental concerns and energy scarcity rise, renewable generation and the use of electrified vehicles are emerging as the most promising solutions. This trend is anticipated to continue. According to statistics, average passenger cars are parked more than 90% of the time, and they remain inactive for considerably longer than is necessary to properly recharge the batteries. Consequently, EVs may be used as both a mobile energy storage system and a generator to

meet the energy needs of buildings, making them an economical and ecologically beneficial option for transportation.

Although the cost of ownership of electric vehicles might be much higher, energy expenditures are typically lower than those of comparable conventional vehicles. With increased production and advancements in battery technology, prices are projected to match those of conventional vehicle. Electric automobiles can significantly cut fuel costs since they are high level of electric-drive efficiency components. Due to their complete or partial reliance on electric power, all-electric vehicles Compared to traditional automobiles, they have a separate fuel economy measurement system to decrease the service and efficiently use the charging capacity. The decreasing rate is a critical and unresolved problem for charging stations.

Internal combustion engines (ICEs), which are typically seen in conventional vehicles, burn fossil fuels like gasoline or diesel.

EVs make use of one or more lithium-ion rechargeable electric motors batteries, the same types that power computers and smartphones and EVs require external power sources to charge just like other electrical devices do. Other Various battery types rely on regenerative braking, or creating electricity, to charge electricity generated by the friction of the vehicle. Additionally to being less noxious Lithium-ion batteries are frequently more effective than fuel-powered engines. The method of obtaining oil, transforming it into fuel, and delivering it to petrol stations

has a significant impact on air pollution. These are referred to as upstream emissions or emissions from well to wheel.

EVs continue to be the cleanest mode of transportation since their full life cycle is much more ecologically favorable overall. Driving compensates for industrial emissions that are higher since it uses electricity as fuel. All emissions are fully eliminated by the batteries

used in EVs. Lithium-ion batteries are the most prevalent form of battery used in EVs.Lighter electric cars (EVs) have more range and a reduced carbon footprint, but employing traditional materials makes this difficult. As EV use rises, city planners in sizable metropolises are starting to consider the layout and placement of charging stations all over the place. As opposed to gas-powered cars, electric vehicles (EVs) need to be charged more frequently and over longer distances.(“Momtazpour, M., Bozchalui, M. C., Ramakrishnan, N., & Sharma, R. (2016). Installing Electric Vehicle Charging Stations City-Scale: How Many and Where?. In *Computational Sustainability* (pp. 149-170). Springer, Cham”).

Your fuel-powered vehicle's conversion to an electric vehicle was very difficult. vehicle. It was too pricey to buy an electric car. Even in the United States, it is expensive. 2020. But there is a choice. You can now convert your gasoline- or diesel-powered vehicle into an electric one. The government has granted approval for adjustments to be made in your car to make it more environmentally friendly.There should be a switch from gasoline vehicles to electric vehicles. The price of petrol has been rising and doesn't appear to be going down any time soon. You won't need to use gasoline to power your vehicle if you have an electric vehicle either gasoline or diesel and save money in the process.

A four-wheeled electric vehicle has fewer parts than a fuel-powered vehicle. Less intricate construction. As a result, the cost of maintaining such a vehicle is also quite inexpensive. Air quality is unaffected and air pollution is reduced by electric cars. quality. Additionally, these vehicles produce less noise pollution. If in a traffic accident, electric cars are less likely to sustain significant damage. This can be ascribed to their lightweight design; there isn't a lot of weight in these automobiles' frames. There are numerous system studies in the literature that examine various aspects of EV charging on the power grid. However, the issue of unstable power networks caused by EV charging has gotten very little attention.

The accuracy of the models used to estimate EV load has a significant impact on the usefulness of power system stability studies. EV load modelling for system stability research has yet to be considered in the literature. As a result, the first stage of this project was developing a static load model for a universal input battery charger. ("Dharmakeerthi, C. H., Mithulananthan, N., & Saha, T. K. (2012, July). Modeling and planning of EV fast charging station in power grid. In *2012 IEEE Power and Energy /Society General Meeting* (pp. 1-8)IEEE").

According to projections for 2021, India's vehicle sector will be the world's fourth largest. In 2022, India will rank fourth in the world in terms of vehicle industry value. In terms of car sales, India will surpass Germany to become the world's fifth-largest automobile market by 2020.

The Indian vehicle industry is now worth more than $100 billion, accounts for 8% of total exports, and contributes 2.3% to India's GDP. Tata Motors, Ashok Leyland, Mahindra & Mahindra, Force Motors, Tractors and Farm Equipment Limited, Eicher Motors, Royal Enfield, Sonalika Tractors, Hindustan Motors, Hradyesh, ICML, Kerala Automobiles Limited, Reva, Pravaig Dynamics, Premier, Tara International, and Vehicle Factory Jabalpur are some of the top Indian automobile manufacturers. Maruti Suzuki is the largest automaker in India. The car manufacturer currently holds a 49 percent market share in India's market for passenger cars as of September 2021.

Three-wheelers, utility vehicles, and cars account for 28.48 percent of total diesel sales. Furthermore, private autos and UVs account for 13.15 percent of diesel sold in the country, while commercial vehicles and UVs account for 8.94 percent and three-wheelers account for 6.39 percent. In the transportation sector, gasoline is used 99.6% of the time. 70% of all Diesel sales are used in the transportation sector, which is where it is most commonly employed.

Cars, utility vehicles, and the 3-wheeler industries use the most diesel, accounting for 28.48% of total consumption. Private cars and UVs accounted for 13.15% of this total, followed by business cars and UVs at 8.94% and three-wheelers at 6.39% of total Diesel usage. Only 28.25% of diesel is consumed by HCV/LCV trucks. Buses account for around 9.55% of the total, while railroads consume about 3.24%. The majority of gasoline, 99.6%, is used in the transportation sector.

Two-wheelers sell 61.42% of all gasoline, compared to cars, which sell 34.33%. 2.34% of all vehicles have three wheels.

Two-wheeler fuel consumption exceeds 70% in states such as Odisha (82.3%), Bihar (75.2%), and Rajasthan (72.9%). In places like Delhi, Haryana, Gujarat, and Odisha, where customers have moved to CNG or Diesel, the utilization of three-wheelers is fairly low. Despite the deregulation of the price of gasoline, the cost of diesel remains restricted, with under recoveries currently costing Rs. 8.47 a liter. Diesel accounted for 57.2% of the total under recoveries/subsidies for all petroleum products in 2012–2013, totaling Rs. 92,061 crores. It is essential to think about where Diesel is being consumed in this situation. Modern life requires transportation as a basic necessity, Nonetheless, the conventional combustion engine is steadily deteriorating. Because gasoline and diesel vehicles emit so much pollution, fully electric vehicles are rapidly replacing them. EVs (completely electric vehicles) are significantly better for the environment because they emit no emissions. Our planet is being harmed by the use of gasoline and diesel. The usage of scarce fossil fuels is threatening the environment. Toxic emissions from gasoline and diesel vehicles have long-term negative consequences on public health. Electric automobiles emit substantially less pollution than gasoline or diesel vehicles. Electric vehicles are more efficient than gasoline or diesel automobiles, which only transfer 17% to 21% of the energy in the fuel to the wheels. Electric vehicles may use approximately 60% of the electrical energy supplied by the grid to power the wheels. This is almost 80% waste.

A vehicle that runs on electricity rather than an internal combustion engine, which generates power by burning fuel and gases, is known as an electric car.

Transportation is a necessary in modern life, yet the typical combustion engine is rapidly decaying. Because gasoline and diesel vehicles create so much pollution, fully electric vehicles are fast replacing them. EVs (all-electric vehicles) are much better for the environment because they emit no pollution.

The usage of gasoline and diesel is damaging to the environment. The use of finite fossil fuels endangers the biosphere. Toxic emissions from gasoline and diesel vehicles have long-term harmful effects on public health. Electric vehicles emit much fewer emissions than gasoline or diesel vehicles. Electric vehicles can convert around 60% of the electrical energy from the grid to power the wheels, but gasoline and diesel cannot.

An electric vehicle is one that operates on electricity rather than an internal combustion engine, which generates power by burning fuel and gases (EV).

Although gasoline and diesel vehicles release approximately three times the amount of CO2 as the average EV, totally electric vehicles create no tailpipe emissions, even when energy production is taken into account. India has set an ambitious goal of producing around 40% of its installed electric power capacity from non-fossil fuel sources by 2030, lowering the impact of charging electric vehicles.

Analysis & EV Data Results (Bangalore)

- There are 30,000 electric vehicles running in the state, including two, three, and four wheelers, with 18,000 in Bengaluru.
- 140 new electric vehicle charging stations will be installed throughout Bengaluru in the next six months, according to the Bangalore Electricity Supply Company Limited (BESCOM).
- In addition, there will be 136 stations deployed in 70 different locations.

Methodology

The overall risk and profit of a company are greatly affected by the location strategy, which is a crucial issue to take into account. For example, depending on the product and the type of production or service provided, transportation costs alone may account for up to 25% of the selling price of a product. It is essential since it aids in identifying the precise location to take into account. The Center of Gravity Method is employed in this paper's layout plan to assess its efficacy. To locate a distribution centre where distribution costs will be as low as possible, one uses a mathematical technique.

The following analysis, which takes into account two parameters, namely distance and population, was conducted using the Excel QM tool.

Create Excel spreadsheets for issues in management science, quantitative methodologies, or operations management using the user-friendly Excel add-in known as Excel QM. Because it builds custom-sized spreadsheets rather than using pre-configured Excel templates, it is the only add-in of its kind. Equations are used to determine the centre of gravity:

X-coordinate of the center of gravity = ∑i dix Qi/∑I Qi

Y-coordinate of the center of gravity = ∑i diy Qi/∑I Qi

where dix = x-coordinate of location i

diy = y-coordinate of location i
Qi = Quantity of goods moved to or from location i

This research is based on secondary data.The Sources of data are population elements, location geographical, income etc.The Tool used for data analysis is Excel QM.

Hypothesis

H1- Placing a charging station in order to optimize distance will save time.
H2- Placing a charging station at a certain Node will increase profitability.
H3-Increase in Charging station will lead to increase in EV sales
H4-Increase in EV charging station will decrease the charging cost

Constraints

- Distance
- Time
- Cost
- Demand

Equation

As stated in the previous explanation we get the equation by

n= kD/d + c

Notation

n=no of points(Dependent)
d=distance between charging station
D= demand
c=cost of charging
"n" inversely proportional to "d"
"n" directly proportional to "D"
k=Constant

Result

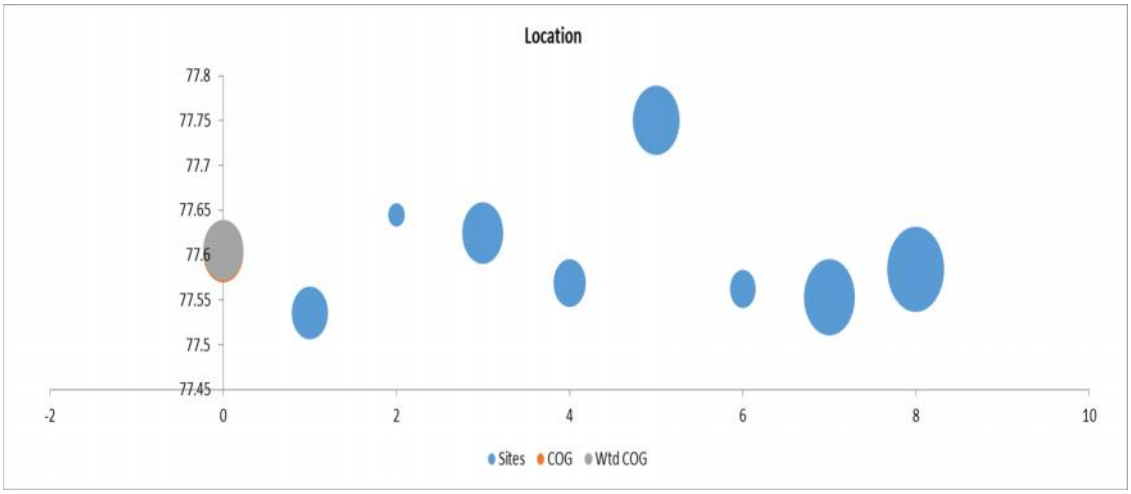
Based on the above two assumptions we took white field as the center point as it is almost equi-distant from all the other points as well as an exclusive area among all the points.

In case of taking the center point we consider the following parameters like economic condition, standard of living, numbers of offices, restaurants, malls etc

Discussion

Assumption 1-Distance

In order to find the center point we took eight different points (Vijay Nagar, HSR Layout, Koramangala, Malleswaram, White-field, Chamrajpet, Rajaji Nagar, Jaya Nagar) given in the table and their respective co-ordinates according to the North-East placement of the place and allotted the weightage and we got the plots for the same.

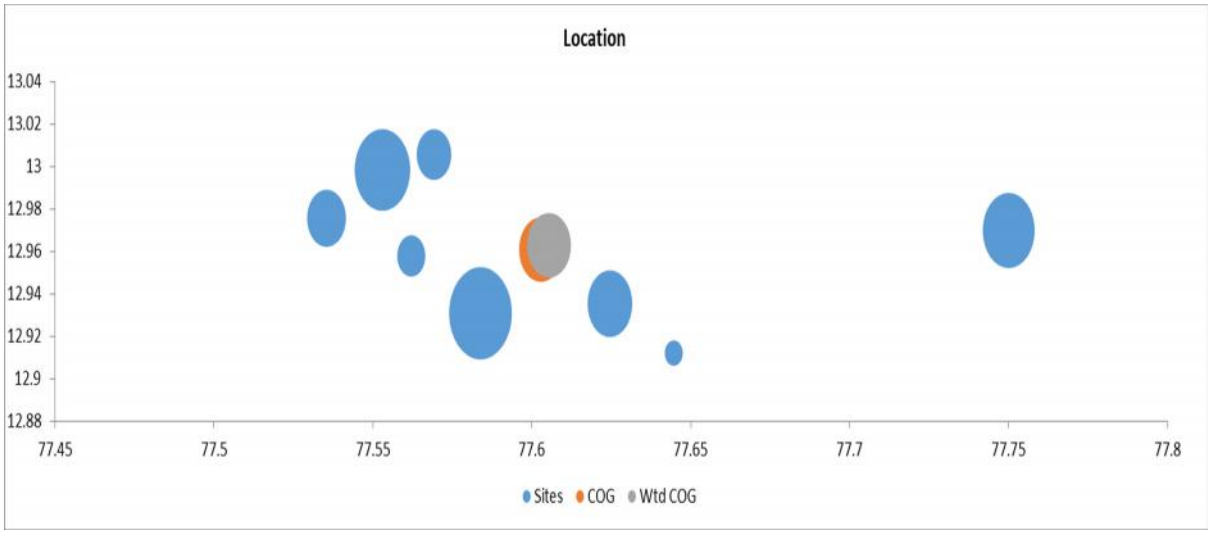


Here we got koramangala as the COG. So the EV Charging Station will be placed at the same so that all the other nearby places can get covered and people from all the other 7 people find it easier to get their EV charged.

Assumption 2-Population

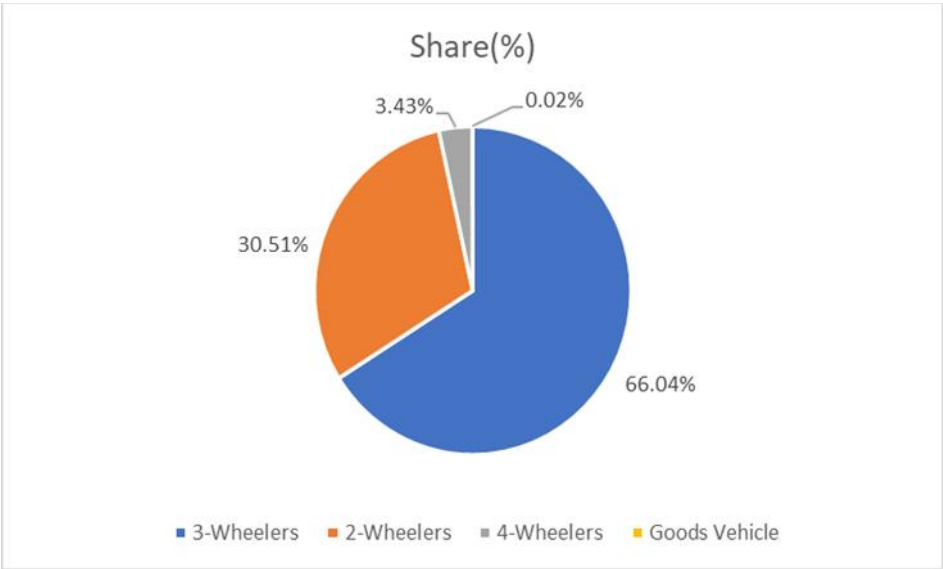
The second assumption is made on the basis of population and the same eight i.e (Vijay Nagar, HSR Layout, Koramangala, Malleswaram, White-field, Chamrajpet, Rajaji Nagar, Jaya Nagar) with their respective coordinates are taken into consideration and weightage is given.

The outcome is shown in the graph given below.

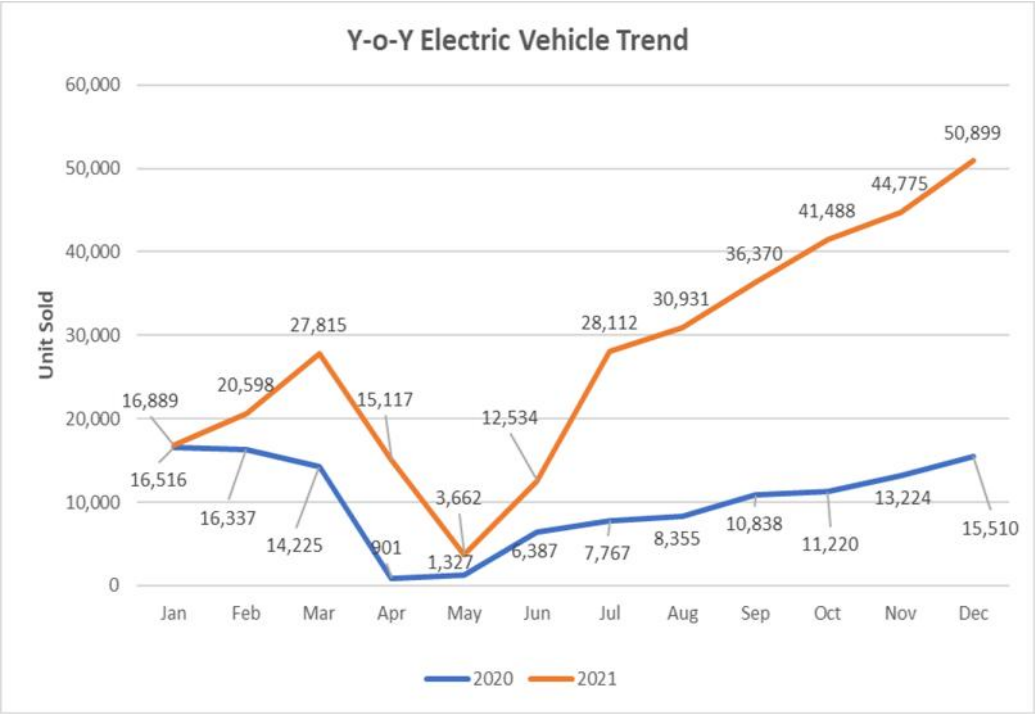


Here in the above graph, taking all the main places of Bangalore in consideration, we plot against x and y coordinates. Plotting all the 7 places in the graph we come to a conclusion that Kormangla is showing the highest population density. As marked as orange in the graph, it shows the COG of Koramangala which has the coordinate 77.6 on X axis and 12.96 on Y axis.

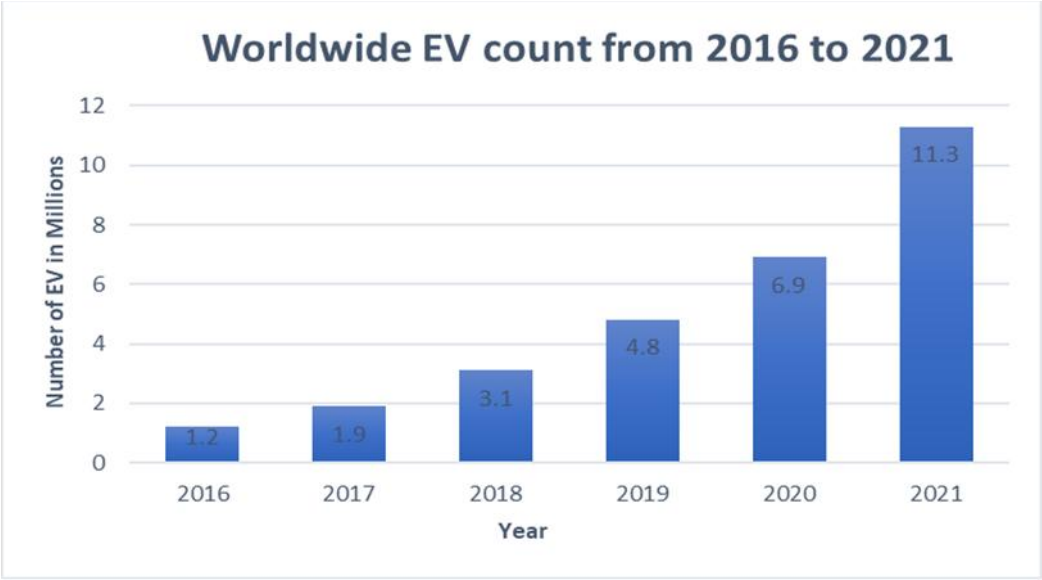
Descriptive Analysis



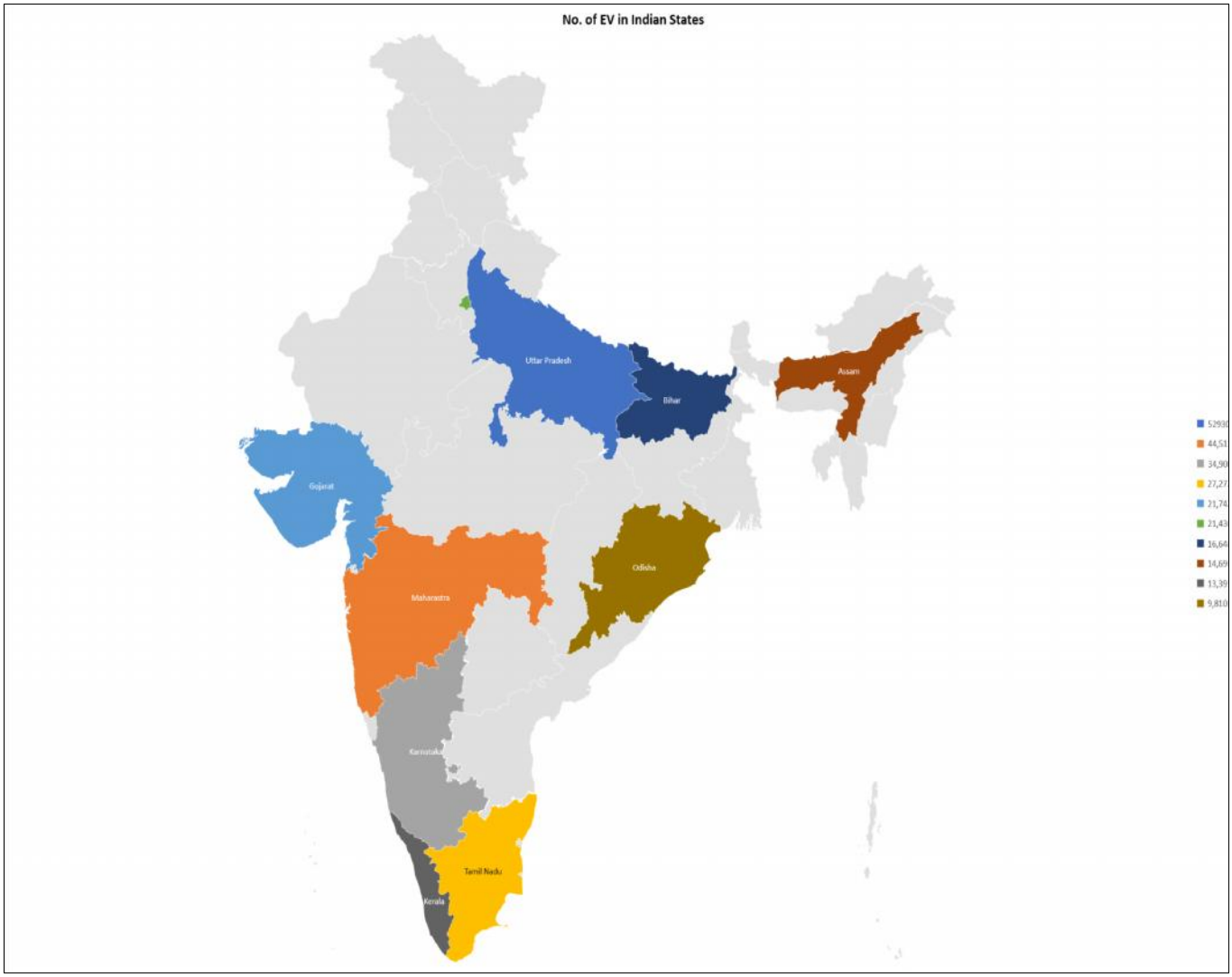
The above graph shows the share of different category of electric vehicles in India.



The graph shows the total sale of EV in year 2020 and 2021



The increase in worldwide EV count from 2016 to 2020



The statewise statistics of EV in India in year 2022

Conclusion

This work is about the implementation of charging station for EV based on the location and income of the people using location strategy i.e COG (Center of Gravity Method) by taking 8 points in consideration and two assumptions based on the following parameters 1. Distance and 2. Population. The study is pointing to the role of different factors for the implementation of charging station such as the distance, income etc. We found COG (Center of Gravity) from all the places i.e ”Vijay Nagar, HSR Layout, Koramangala, Malleswaram, White-field, Chamrajpet, Rajaji Nagar, Jaya Nagar”. From the above analysis we found a specific point to place the charging station from which all the points will be at optimum distance to make it convenient for the user and thus making boost in EV sales indirectly and thus also taking a step forward to achieve “Net Zero” goal. One limitation to this process is the infrastructure and cost.

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Quick Response Code	Website: www.ijarm.com
	Subject: Electromobility
DOI:10.22192/ijamr.2023.10.01.004	

How to cite this article:
Muthukumar T, Sougandha Majumder, Sneha Nivedita. (2023). Optimizing the Installation of EV Charging Station. Int. J. Adv. Multidiscip. Res. 10(1): 40-50.
DOI: http://dx.doi.org/10.22192/ijamr.2023.10.01.004