A Review on Optimal Planning while Constructing EV Charging Stations

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Abstract

For many academics, determining the placement and size of an electric car charging station couldbe a brand-new challenge. This study builds a comprehensive objective function that considers geographic data, building costs, and running costs. The cost of the land and the distributiontransformer is included in the objective part of construction costs. Running costs take into account power supply losses and traffic flow restrictions, which accurately and thoroughly capturesthe core issue with the placement and sizing of electric vehicle charging stations. Electric cars have their challenges of shape, structure, and further optimization. The feasibility of getting a charging station also plays a vital role in the greater effectiveness of these cars.

Keywords
Geographical Information, Land Cost, Distance, Supply Losses, Allocation

1. Introduction
For the last several years, the increasing cost of fuel and oil has become a severe issue for people like you, me, and the people. Life-based IC engine vehicles is becoming a heavy burden.The EVs have appeared in the picture of obligation to overcome these fear and release loaded from the cost of fuel and oil. Serious environmental problems brought by automobile emissions, energy savings, and emission reduction are becoming a new task for the world. New energy vehicles can be the wayto do this task. From the industry experts' predictions, by the end of 2025, China's 20% to 30% of passenger vehicle sales will come from the Electrical vehicle (EV), charging-type hybrid vehicles and other new energy vehicle. The number of urban traffic is electric ones it becomes primary, When we talk about Electrical vehicle, We also need to think about its power supply likewe have in our petrol pumps or i can say gas stations but in EV automobile industry we have to provide electric supply to the each station which is not easy and country like India, there million orbillions of rural area in which to provide this kind of facility would be more difficult then providingit to the country like United States of America or Countries in Europe.

To overcome this many researches has given many ways, but the one which is more accurate and would be more feasible was to provide a EV charging stations at a certain distance. and the allocation would be more difficult in rural areas. Tesla inc. has distributed its EV charging stations with the help of geographical information and their car's battery avg. Power consumption and its power to run their EV. Then there will be land cost comes into the picture, while selectingthe area and the actual required size would be more different because there are already platforms available like gas stations; we can cut the land cost by tie-up with the government's gas stations or public sector's units like Shell inc. While collection the geographical information, it is almost a waste of time because companies like shell or other fuel companiesalready have data ready with them. However, the battery capacity of these cars continues to severely restrict their autonomy (Figure 1-7).

Figure 1. Charging station

To meet the demand for battery recharging of these vehicles, charging stations are needed both at home and in public places. The practicalities of charging outside the home are cited by Chen, Khan,and Kock Elman (2013) as the main obstacle to the long-term success of EVs. Although EV literature is still relatively new, answers to refueling issues for all motor vehicles can generally be found. For instance, Lin, Gertsch, and Russell (2007) used fuel stations along a definedroute to reduce the cost of vehicle refueling. Lin (2008) proposes an algorithm for simultaneously determining the best way and refuelling strategy in a network. These issues are typically grouped under the heading of Flow Interception Facility Location Issues Hodgson did the initial research (1981). Wen et al. (2013) state that it is expected that one facility, positioned anywhere along the way, may completely satisfy the demand of a path in FIFLPs. Other uses were also suggested, likelocating police checkpoints and using road-detecting sensors (Hodgson, Rosing, and Zhang 1996).(Liu and Danczyk 2009). A new approach developed by Kuby and Lim (2005) maximises the overall refuelling flow based on combinations of pre-planned stations. This model was expanded by Upchurch, Kuby, and Lim (2009), who took into account the capacity of the facilities and the fact that a station can only refuel a certain number of vehicles. A model for electric vehicles is provided by Hess et al. (2012), who also seek to identify the best location for charging stations.

1.1 Objectives

In contrast to earlier proposals, this work suggests optimising the placement of charging stations while taking into account a easy model of urban traffic which helps to the uncleared routes. The solutions taken in account can be evaluated through different techniques and models. In order to reduce the energy consumption of the vehicles, uncertainty information is either directly taken intoaccount through stochastic variables, as in the case of urban traffic, or indirectly by establishing a penalty factor, as in the case of cross traffic between routes.

2. Literature Review

A new type of EV charging outfit called a mobile charging station may give EV charging services at any position or time demanded. MCSs are transferred out in response to one of two requests either requests from overloaded FCS or requests from EVs. This exploration focuses on several rudiments of hosts technology because of its novelty and the recent attention it has entered in the literature. For hosts, there are colourful setups. Truck Mobile Charging Stations (TMCSs) are electric or cold-blooded vehicles, similar as exchanges or vans, that can drive a distance in a specificrange to charge electric buses (EVs). MCSs ameliorate the EV driving experience by fixing numerous FCS excrescencies. Other profitable impacts of MCSs include lowering the mischievous goods of FCSs on the electricity grid and encouraging investors to invest in FCSs.

Advantages for EV owners: Three crucial factors that affect the EV driving experience are range anxiety, charging time, and charging accessibility. i. Range Fear: Building a robust FCS network to improve EVs' ability to readily locate charging stations is one method to combat range anxiety, but doing so demands substantial financial outlays.

On the other side, MCSs are cited in the literature as the primary method for reducing EV customers'range anxiety by giving them access to more chargers, which results in a reduction in expenditureson FCS infrastructures.

Advantages for EV possessors Three pivotal factors that affect the EV driving experience are range anxiety, charging time, and charging availability. Range Fear Building a robust FCS network to ameliorate EVs' capability to readily detect charging stations is one system to combat range anxiety, butdoing so demands substantial fiscal expenses.

On the other side, MCSs are cited in the literature as the primary system for reducing EV guests' range anxiety by giving them access to further dishes, which results in a reduction in expenditures on FCS architectures. FCSs may not be suitable to handle rapid-fire harpoons in demand for charging due to their defined number of charging outlets. also, parking garages and lots that are open to the public can have paid, blinked, or free stations. druggies of Madison Gas and Electric's public charging stations reportedly spend at least 45 twinkles more there than is needed to charge their electric vehicles.

Also, EVs will presumably be charged substantially at home in a garage; although, in numerous large metropolises where the maturity of homes warrants garages, charging may also be done outdoors. hostscan help in removing these walls by offering charging services in agreement with the type of EVs demanded at any time and position. Roadside help could also be handed using hosts. As the use of EVsrises, hosts will be suitable to give better EV roadside backing at a lower cost than hauling an EV to theclosest charging station. In other words, a host's functions also to a power bank for smartphones, only it's designed for EVs. iii. Charging time in general, EV charging takes a lot longer than the time it takesan ICEV to refuel at a gas station. Only DCFC, which can charge a specific EV, can contend as a charging technology. Only DCFC, which can charge an EV to a 75 state of charge (SOC) in around 30twinkles, can contend as a charging fashion.

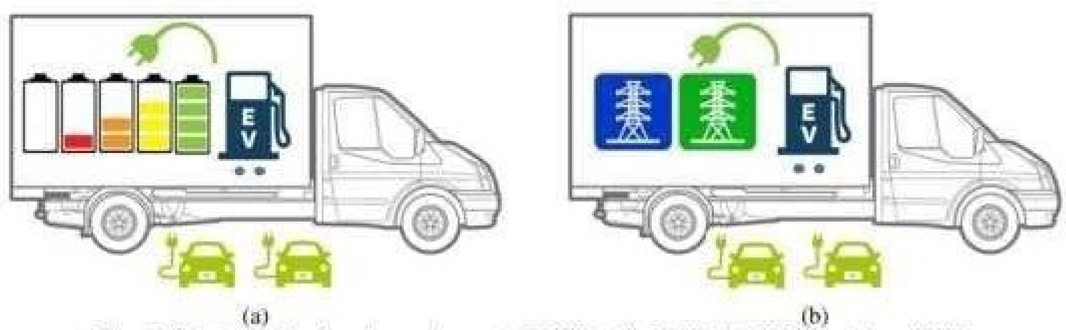

Fig. 2. Truck mobile charging stations: (a) TMCS with BESS, (b) TMCS without BESS

Figure 2. Truck mobile charging stations

Still, DCFCs presently make up precisely 16 of public charging stations. MCSs can support close thisgap by offering briskly charging options as a fix. also, by furnishing charging stations at the homes ofEV guests, MCSs indeed save further time for a charging event when assimilated to going to an FCS.While intending hosts, a number of significant engineering obstacles must be answered. For case, intending the armature of a movable bowl agent and a battery that can continuously charge and discharge while taking into account the high cost of batteries and their short life span, as well as the project difficulty and cost associated with authority electronic outfit and the control system, are the main enterprises about MCSs.

The two main functional cases with MCSs are balancing force and demand to achieve optimal dynamismuse and maximizing authority transmission effectiveness.

3. Method for Calculating Commercializing Charging station

Electric car technology is not fully developed at this time, and there is no established market mechanism to support the growth of electric automobiles. The industry for electric vehicles dependson government support and promotion, and because there are so few electric vehicles on the road now, planning for charging stations might be considered as a short-term strategy during the publicdemonstration stage.

The first investment in charging stations to meet every charging need may result in excessive financial outlay due to the peculiarities of this stage. As a result, the number of charging stations may be reduced due to the actual budget's constraints.

At this point, the technology for electric vehicles is thought to be essentially mature, and the total number of vehicles has reached a specific magnitude. Therefore, planning for electric vehicle charging infrastructure at this time can be viewed as long-term planning.

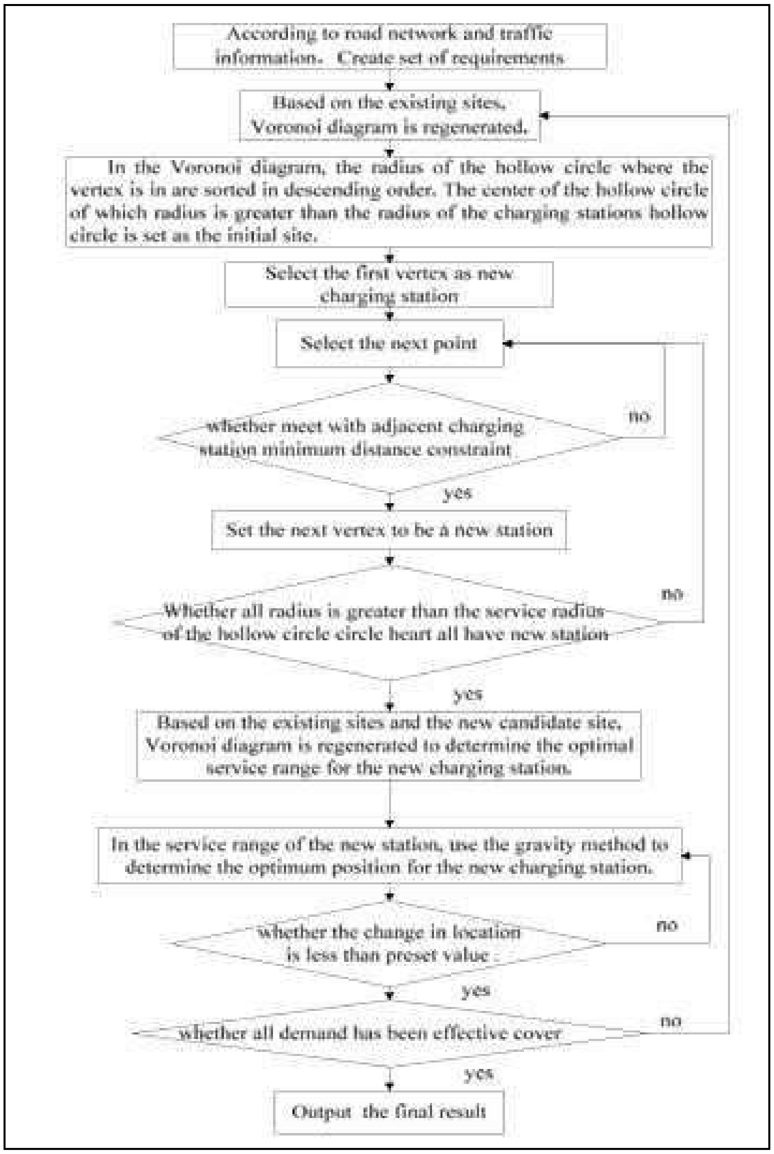

Figure 3. Voronoi diagrams (Gao&Guo 2016).

The first stage of the Voronoi diagram is related to the positioning of the charging stations. Voronoi diagrams are created to decide the position. In this diagram, the vertex with the radius of thehollow circle is lined in decreasing order. The hollow circle with higher radius which is meant to be greater than the hollow radius of charging station circle has the original position.

Through the first step, a new and better position for the EV station is found. This may help later in greater extent to the new members. Gravity approach is used to find the location which is bestsuitable for a new charging station inside the service area of station.

The above steps are repeated till a position coordinate value smaller than the booking precisionvalue is found.

3.2 Number of Optimal Charges in Charging Station

Quantity per charge is fixed value Q. Electric car arrivals are a Poisson stream of rate. A negative exponential distribution with best describes the charging time. With the aforementioned presumptions,the charging station functions as a multi service desk and finite waiting room (M / M / c) system for charging services.

There are i parts in field j, mc is the electric consumption in field j-

$$V_j = \sum_{i=1}^{i} V(i) \quad (1)$$

N is the number of moments of electric vehicles charge in field i

$$N = Vj / Q \quad (2)$$

Undertaking machinery charging post is public from 8 am to 10 pm.

$$\lambda = N/ 14 \quad (3)$$

The model of optimizing the volume of bowls in charging stations is as follow:

$$\min F_i = c \times T \frac{r_0(1+r_0)^n}{(1+r_0)^n - 1} + Y_i + N \times k \times W_q \qquad L_q \le L_{max} \quad (4)$$

The cost of the charging station is F_i. I, c stands for the number of chargers, T for the cost of each charger, and Yi for the charging station's yearly operational expenses. The typical wait time is W_q, andthe depreciable life is n. L_{max} is the maximum number of waiting lines that are permitted, while L_q is the theoretical expectation of the number of EVs waiting.

4. Example Analysis

The planning is affected by the limits, according to the article (Gao & Guo 2016). The area, which maybe divided into 58 sections, has a total size of 36.48 km2. It measures 5.7 kilometres in length from north to south and 6.4 km from east to west. The cost of a charge will vary in reality depending on thekind of electric car, the amount of driving, and the traffic scenario. The example, however, simplifies the problem by assuming that the amount of power consumed by cars per kilometre is a set quantity, g= 0.13 kWh/km. On the map in figure 2, the position of the present gas station is shown with link numbers.

The original position is established at the concave circle compass that's lesser than the concave circle compass of the charging station. The compass of services of the new station is determined, or rather, demand is formerly more dispersed, using the being stations with new spots to make a Voronoi illustration. Use the graveness approach to point the ideal position for the new charging station withinthe compass of its services. Exercising the current stations and the recently optimal spots, produce a new Voronoi illustration, which uses a new method to solve such issues. If the compass division in these stations is lowered upto 0.1 km^2, then it may solve the challenge.

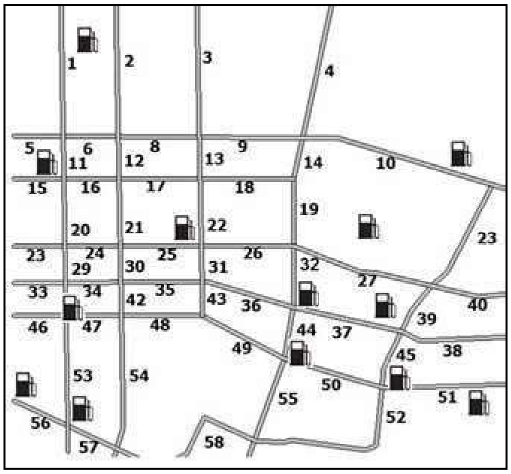

Figure 4. (Gao & Guo 2016)

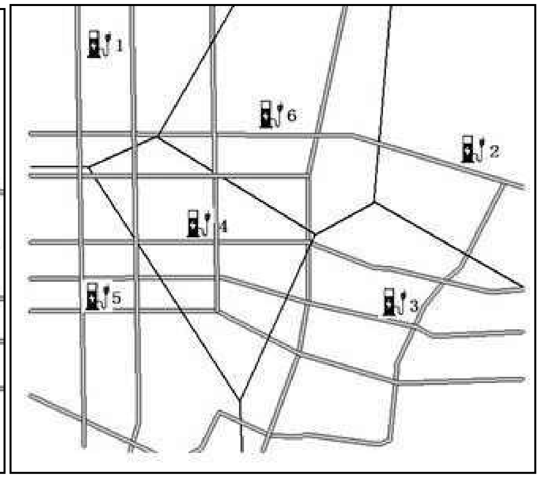

Figure 5. (Gao & Guo 2016)

4.1 The Count of Optimal Charger in different stations

If we take a count on the charging stations and the number of person or users, then total charging stations and their costs and the fees of customers delaying or waiting can be chosen as one of the objective function for better allotment (Table 1 and Table 2).

Table 1. (Gao & Guo 2016)

Table 1. Related parameter selection.

sign	Value	sign	Value
Q	20.8kWh	g	0.13kWh/km
L_{max}	20	r^0	0.1
T	0.1million yuan	k	25yuan/hour
Y_i	0.2million yuan	n	20

Table 2. The Optimal Chargers

Table 2. The number of optimal chargers.

Station number	The number of the optimal chargers
1	7
2	6
3	12
4	11
5	11
6	7

5. Results and DiscussionGraphical Results

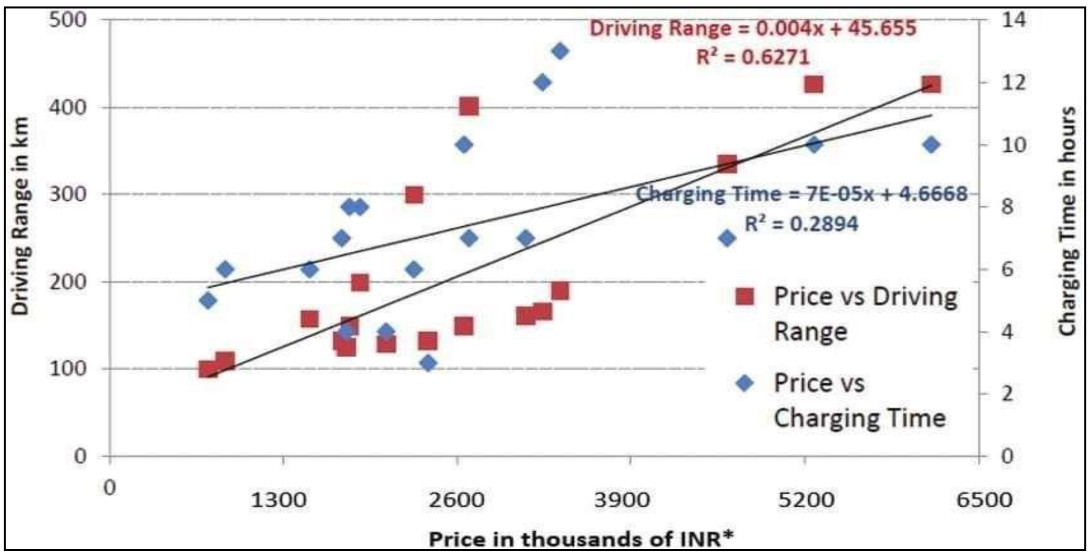

Figure 6. The Graph of Driving Range Vs Price Vs Time of EVs

The EV only becomes only efficient when you drive it for long enough
As of now EVs require more initial capital investment and so are not widely in use.

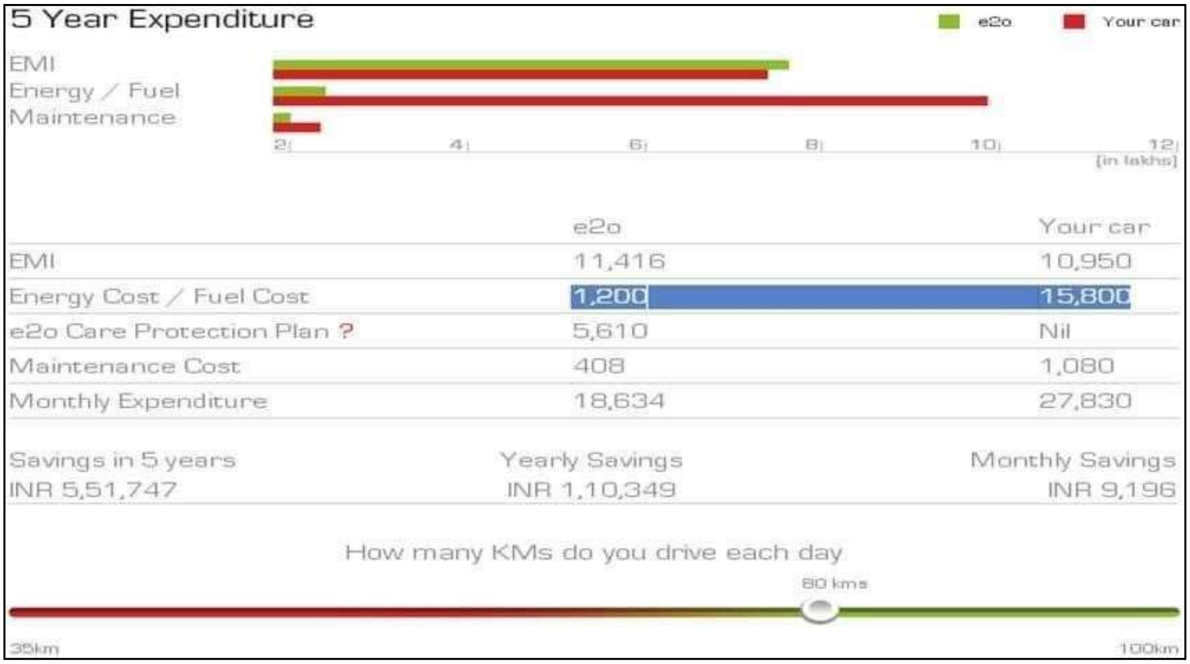

Figure 7. The 5 Year expenditure of EVs

6. Conclusion

With the increase in Greenhouse Pollutions and environment degradation, EVs have proved themselves very beneficial. Although, it also uses natural resource which degrades environment butit has greater efficiency and can be optimized further. Cost is the main barrier to the EVs. The usage of petrol, diesel and other type of fuels are costly andsoon will not be available. It may end after about a century or so. In lieu of the rising situations, it isnecessary to take certain actions to save the planet. Government has also motivated people to use fewer natural resources and take a step towards environment through these different sources. With the tech a inch far, we may acknowledge people to use these type of vehicles and give a helpinghand in saving the environment. So, educate the near ones to be smart and choose EVs over the naturalvehicles.

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