Project Name: EV Charging station rental portal and recommendations for optimal path to EV charging stations

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**Supporting Document**

NIT-T Datanetiix Hackathon 2023

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1. **Introduction**

   India is currently at a pivotal stage in terms of the automobile industry with electric vehicles becoming the future of transport. However, unavailability of infrastructure is slowing down the shift into the EV space, while oil prices are constantly surging. We aim to solve this problem by creating a portal for owners of personal vehicle charging stations to rent out their space for consumers to use.

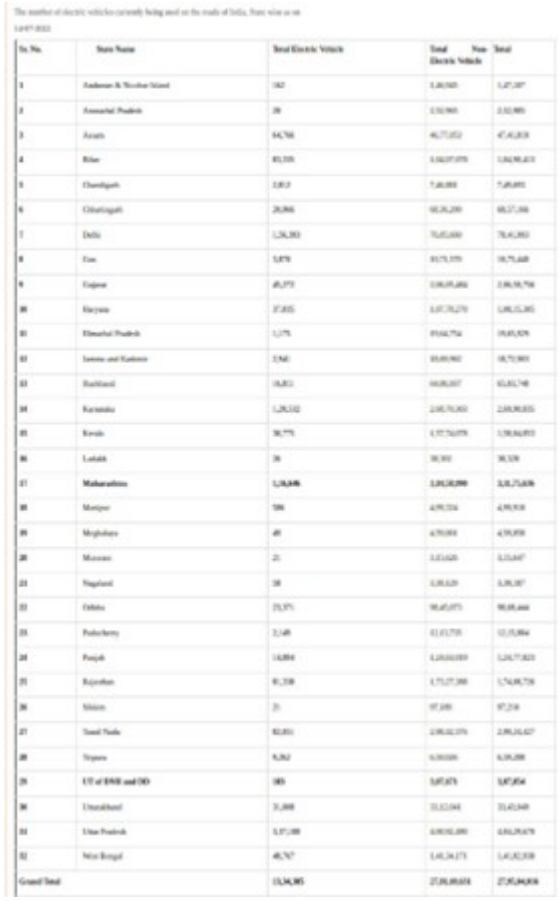
   As per recent reports, India has a total of 13,34,385 electric vehicles, while 1,742 electric vehicle charging stations have been installed. These chargers are concentrated in metro cities, while rural areas lack infrastructure. In Phase-1 of the project, owners of at-home chargers can list their locations and tariff on our website where users can easily find and book slots for charging their vehicles.

   As of 2021, the average battery-powered EV could travel 349 km on a single charge. On the other hand, gas powered cars can cover nearly 664kms.This, added to the lack of charging facilities makes planning trips an ardous process. In Phase-2 of our project, we aim to provide a optimal routes based on the source and destination to maximise efficiency and ensure the car never runs out of charge.

2. **Ministry of Heavy Industries**

   Currently Over 13 lakh Electric Vehicles in use in India.

   ***Annexure* – 1** The number of EV's currently being on roads of India. The following is the state wise list Listed on 14-07-2022.



| Sr. No. | State Name | Total Electric Vehicle | Total Non Electric Vehicle | Total |
|---|---|---|---|---|
| 1 | Andaman & Nicobar Island | 182 | 1,46,945 | 1,47,107 |
| 2 | Arunachal Pradesh | 39 | 2,52,965 | 2,53,985 |
| 3 | Assam | 64,708 | 46,77,052 | 47,41,818 |
| 4 | Bihar | 83,358 | 1,10,07,979 | 1,04,98,413 |
| 5 | Chandigarh | 3,813 | 7,46,884 | 7,49,691 |
| 6 | Chhattisgarh | 28,866 | 93,38,299 | 93,27,166 |
| 7 | Delhi | 1,36,381 | 76,02,680 | 78,41,981 |
| 8 | Goa | 5,878 | 10,71,370 | 10,75,648 |
| 9 | Gujarat | 49,373 | 1,86,09,484 | 1,86,58,756 |
| 10 | Haryana | 37,832 | 1,47,78,274 | 1,48,12,285 |
| 11 | Himachal Pradesh | 1,175 | 19,64,754 | 19,65,929 |
| 12 | Jammu and Kashmir | 2,562 | 10,69,982 | 10,72,903 |
| 13 | Jharkhand | 16,811 | 44,08,107 | 42,81,748 |
| 14 | Karnataka | 1,28,332 | 2,68,70,301 | 2,69,98,833 |
| 15 | Kerala | 30,775 | 1,57,74,079 | 1,58,04,853 |
| 16 | Ladakh | 26 | 30,302 | 30,328 |
| 17 | **Maharashtra** | **1,38,648** | **2,01,32,990** | **2,31,71,638** |
| 18 | Manipur | 506 | 4,99,334 | 4,99,918 |
| 19 | Meghalaya | 49 | 4,79,981 | 4,39,858 |
| 20 | Mizoram | 21 | 2,52,626 | 2,52,647 |
| 21 | Nagaland | 38 | 2,38,628 | 2,38,187 |
| 22 | Odisha | 23,371 | 91,45,073 | 91,68,444 |
| 23 | Puducherry | 2,149 | 12,12,735 | 12,15,884 |
| 24 | Punjab | 14,884 | 2,20,63,959 | 2,20,77,823 |
| 25 | Rajasthan | 81,338 | 1,73,27,388 | 1,74,08,726 |
| 26 | Sikkim | 21 | 97,180 | 97,216 |
| 27 | Tamil Nadu | 82,851 | 2,90,42,376 | 2,90,24,427 |
| 28 | Tripura | 9,262 | 6,30,026 | 6,39,288 |
| 29 | **UT of DNH and DD** | **183** | **5,07,471** | **5,07,854** |
| 30 | Uttrakhand | 3,388 | 33,12,944 | 33,43,048 |
| 31 | Uttar Pradesh | 3,37,188 | 6,99,92,490 | 6,84,29,678 |
| 32 | West Bengal | 48,767 | 1,41,24,171 | 1,41,82,938 |
| Grand Total | | **13,34,385** | **27,81,69,631** | **27,95,04,016** |

***Annexure* — 2** Ministry of Heavy Industries has sanctioned 520 EV Charging Stations out of which 479 charging stations have been installed as on 01stJuly, 2022 as follows:

State/UT No. of Retail Outlets (Ros) where EV Charging facility is available as on 1.1.2022

| State/UT | No of RO's where EV Charging Facility available |
|---|---|
| Andhra Pradesh | 65 |
| Arunachal Pradesh | 4 |
| Assam | 19 |
| Bihar | 26 |
| Chandigarh | 4 |
| Chhattisgarh | 51 |
| Delhi | 66 |
| Goa | 17 |
| Gujarat | 87 |
| Haryana | 114 |
| Himachal Pradesh | 13 |
| Jharkhand | 22 |
| J&K | 3 |
| Karnataka | 100 |
| Kerala | 39 |
| Leh | 2 |
| Madhya Pradesh | 167 |
| Maharashtra | 88 |
| Manipur | 1 |
| Meghalaya | 3 |
| Nagaland | 2 |
| Odisha | 26 |
| Pondicherry | 2 |
| Punjab | 41 |
| Rajasthan | 174 |
| Tamil Nadu | 76 |
| Telangana | 112 |
| Tripura | 3 |
| Uttar Pradesh | 128 |
| Uttarakhand | 10 |
| West Bengal | 71 |
| **Grand Total** | **1536** |

Link to the document : https://pib.gov.in/PressReleasePage.aspx?PRID=1842704

## ℬ. Technical study of Electric Vehicles and Charging Infrastructure

(a) Assessment of ownership structures for reducing risks

(b) PPP: Private Investor and Municipal Corporation

| Charger costs | | | | | | | |
|---|---|---|---|---|---|---|---|
| Type | Charger cost | Charger rating | Charging time | Installation cost | Maintenance cost % | Maintenance cost | Escalation in maintenance cost |
| Unit | (INR) | (kW) | (hrs) | (INR) | (% of installation cost) | (INR) | (%) |
| DC Fast charger | 18,00,000 | 50 | 0.34 | 1,80,000.0 | 0% | - | 2% |
| | | | | | | | |
| | | | | | | | |

| Revenue assumptions | Commercial space |
|---|---|
| Cost of electricity (INR/kWh) | 7.50 |
| Escalation in cost of electricity | 5% |
| Mark up on cost of electricity (%) | 13% |
| Cost of electricity to consumer (INR/ kWh) | 8.5 |
| Capital subsidy | 0% |
| Duration of charge event (hrs per charge) | 0.34 |
| # of charge events per day | 35.29 |
| Charger utilization (hrs per day) | 6.0 |
| Per hour fixed fee (INR/hour) | 20 |
| Escalation in per charge fixed fee | 5% |
| Discount on charging fee (% per session) | 0% |
| Monthly membership fee (INR/ month) | 0 |
| Number of charges | 0 |
| Year on Year Improvement (%) | 12% |
| Lease expenses (INR/ month) | 0 |
| Escalation in lease rental | 10% |
| Overheads (% of maint. Cost) | 2% |
| Mark up on lease (%) | 30% |
| Private Investor revenue sharing | 0% |
| MNC revenue sharing | 10% |
| YOY improvement in rev sharing | 0% |
| Total DC Charger Cost | 19,80,000 |
| Debt | 13,86,000 |
| Equity | 5,94,000 |

4. **Representing the EV Charging Stations and Finding Optimal Paths**

   We will be using graph data structure.The graphs are used to represent networks of EV charging stations across the map

   Two possible algorithms are used to find out the optimal paths.

1 Dijkstra's Algorithm

2 A* Algorithm

**A* Algorithm:**

A* is a type of algorithm used for finding the shortest path between two points, called the start and the goal. It is widely used in computer science, and is often used in navigation, such as finding the fastest route between two locations on a map.
A* works by using a combination of two values to guide its search: a heuristic and a cost.
The heuristic is a function that estimates the E-fuel efficiency between the current location and the goal (Destination).
The cost is the actual distance travelled from the start to the current location. By combining these two values, A* can search efficiently for the shortest path by prioritizing paths that are likely to lead to the goal.

**Dijkstra's Algorithm:**

Dijkstra's algorithm finds all the shortest paths from the source vertex to every other vertex by iteratively "growing" the set of vertices S to which it knows the shortest path. At each step of the algorithm, the next vertex added to S is determined by a priority queue. The queue contains the

vertices in V — S prioritized by their distance label, which is the length of the shortest path seen so far for each vertex. The vertex u at the top of the priority queue is then added to S, and each of its out-edges is relaxed: if the distance to u plus the weight of the out-edge (u, v) is less than the distance label for v then the estimated distance for vertex v is reduced. The algorithm then loops back, processing the next vertex at the top of the priority queue. The algorithm finishes when the priority queue is empty.

**4)Recommendation System - to provide route recommendations**

A research-based article - A Travel Route Recommendation System Based on Smart Phones and IoT Environment.

Link to the article: https://www.hindawi.com/journals/wcmc/2019/7038259///