RELIABILITY OF LI BATTERY TO MAKE ELECTRICAL VEHICLE MORE ENERGY EFFICIENT

REPIC Project

Market launch of Lithium batteries for electric vehicles in Nepal

Study on comparing Safa Tempos using Lithium batteries with Safa Tempos using Lead acid batteries

Rajan Thapa

Table of contents

1. Overview

Presently there are about 700 Safa Tempos running in the public transportation sector in Nepal. Lead acid batteries mainly operate them. However, the lead acid batteries have become more and more expensive and at the same time, their service lifetime has decreased. Comparative analyses of the use of lead acid batteries and Lithium batteries have revealed that the lifetime cost of Lithium batteries is much better than of lead acid batteries. In Nepal, now the conversion of vehicles with combustion engines to electrically driven vehicles is allowed. This makes possible the conversion of gas Tempos to electric Tempos. Since this Lithium Battery technology is scalable and can be easily adapted to other types of electric vehicles, many more vehicles can be equipped with Lithium batteries.

Realizing the need of efficient and reliable electric vehicle in Nepal, the project “Market launch of Lithium batteries for electric vehicles in Nepal” was introduced to identify and suggest the advanced technologies, which can replace or decrease the dependency rate on lead acid batteries. This project was supported by REPIC, a Swiss federal interdepartmental platform. As a result, the project team identified Lithium battery as an option to replace the lead acid battery, which is feasible in the context of the Nepalese market. To verify the theory of change, this project intervened the superiority of Lithium batteries over lead acid batteries, by fitting them on existing Safa Tempos. After a detailed background study it is identified that this battery has the advantage of higher efficiency related to their charging and discharging characteristics. It was also identified that with one set of this battery one Safa Tempo can run for the whole day, that there is no need of battery charge at middle of the day and that it is expected that the lifetime cost are much lower.

The project supported 10 Safa Tempos to install and operate with Lithium batteries and towards the end of the project, there are already 25 Safa Tempos installed with the same Lithium battery technology plying in the streets in Kathmandu. The installation and maintenance of the Safa Tempo is being carried out by the Nepali Partners. Since January 2017, three Safa Tempos are in operation, which are equipped with Lithium batteries, the corresponding Battery Management System (BMS), the chargers and further devices. Since mid-January 2018, seven more Safa Tempos were added on the list and now the number has reached to 25. The first ten of these vehicles were partially supported be REPIC. 15 more vehicles were converted without any financial assistance of REPIC.

In August 2018, Clean Energy Nepal (CEN) conducted a questionnaire survey amongst 49 respondents representing owners and drivers of Safa Tempos plying in the streets of Kathmandu. With an aim to make a comparative study between lead acid and Lithium battery driven Safa Tempos, Among the 49 vehicles surveyed, 17 represented the Lithium powered Safa Tempos while 32 were lead acid battery driven. The owners and drivers of the Safa Tempos were interviewed based on the designed sets of questionnaires. The performance of Lithium battery driven tempos were assessed and were compared to the lead acid batteries in several fronts. The survey was done amongst the tempos plying in two different routes namely Ghumti (Lagankhel-Baneshwor-Koteshwor-Lagankhel) and Lagankhel-Dallu. The purpose of selecting these routes was because on these routes both Safa Tempos, with lead acid and Lithium battery operate. That gives advantages to make comparisons and draw conclusions.

1.1. Background

With ever-increasing demand for efficient and clean public transport and worsening air quality due to fossil-fueled vehicles, urban lives are becoming challenging. Clean transport system can play a big role in transport related GHG emission reduction thereby contributing the sustainable development goal of clean energy. Electrifying of the public transport vehicles was thought of a great idea to kick-start and with time, the innovation and engineering has led technologies steps ahead. The electric vehicles are being made more energy efficient and environment friendly with evolution of new technologies. In Nepal, CEN and EVAN, with support from the REPIC, initiated a pilot project to do a feasibility test of Lithium Powered Safa Tempo thereby introducing the more efficient Lithium battery to power and replace the existing lead acid batteries. Thus, some Safa Tempos with lead acid (Trojan) batteries were replaced with Lithium batteries.

1.2. Objective of the Questionnaire Survey

Clean Energy Nepal started documenting and recording several parameters of the vehicles replaced with the Lithium batteries since the initiation of the project. The Lithiumized vehicles are provided with a Battery Management System (BMS) that keeps digital records of different parameters of the battery. Since there were no any reference vehicles and data of lead acid battery, the results could not be compared. Thus the aim of this questionnaire survey was to collect data and compare the performance and preference based on universally accepted tools and methods.

Thus, the specific objectives of the questionnaire survey were

i. To make comparative study of Lithium and lead acid batteries and test the feasibility of Lithium batteries in Safa Tempos.
ii. To examine the perception of users and performance of Lithium and lead acid batteries

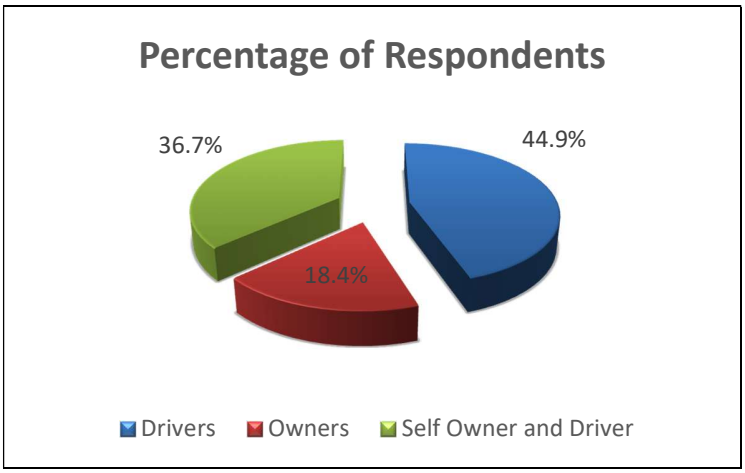
2. Method of Sampling and Analysis

The survey was conducted amongst the interviewees who were selected through Snow Ball Sampling (identifying the respondents from known stakeholders) and Purposive Sampling (surveying with the random identified respondents) method. Questionnaire survey was conducted with the help of volunteers using pre-designed set questionnaire. The data were analyzed and expressed in graphs and charts as appropriate using Microsoft excel worksheets.

3. Results and Discussion

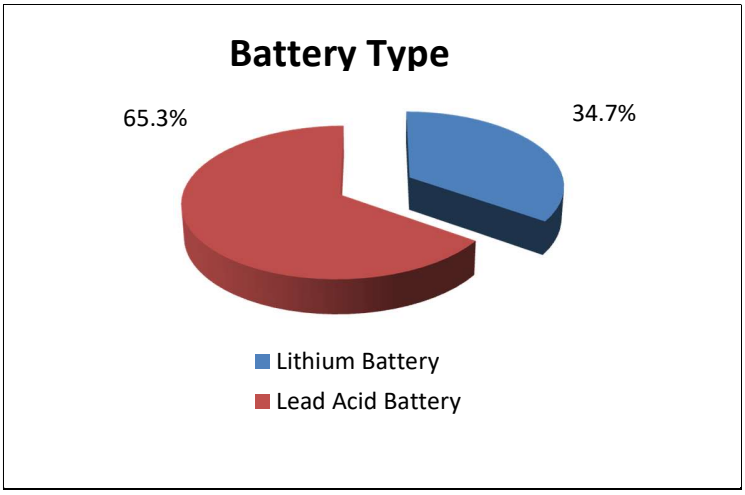
3.1. Categorization of Interviewee

There were altogether 49 interviewees, 22 represented drivers, 9 represented owners and 18 represented were self-owners as well as the drivers.



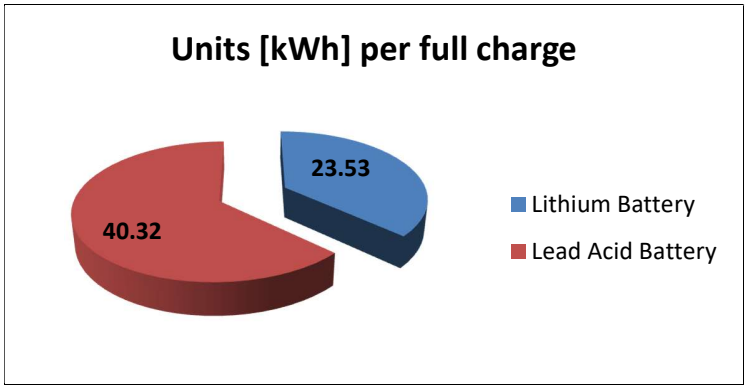
3.2. Battery Type

The survey comprised of a total of 49 Safa Tempos with 32 lead acids and 17 Lithium (only 17 tempos with Lithium batteries were in operation during the survey).

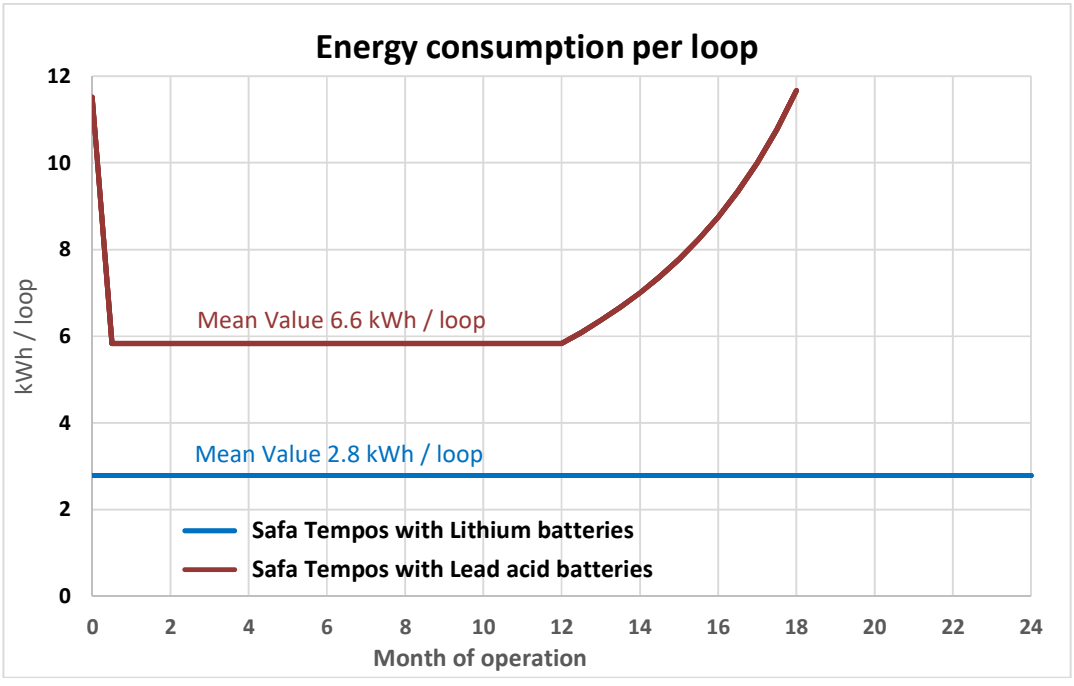


3.3. Energy Consumptions

In an average a single set of Lithium batteries was found to consume 23.53 kWh of energy per full charge that can run for the whole day without intermediate charging with maximum up to 10 loops per day. The lead acid batteries however consumes 40.32 kWh per day. The energy consumed by lead acid batteries to run for the whole day is quite high compared to Lithium batteries. There must be two sets of batteries for lead acid tempo to operate for full day. Thus in terms of energy consumption, Lithium batteries are far more efficient and economical to use compared to lead acid batteries, which also needs intermediate charging and battery replacement that costs time and money.



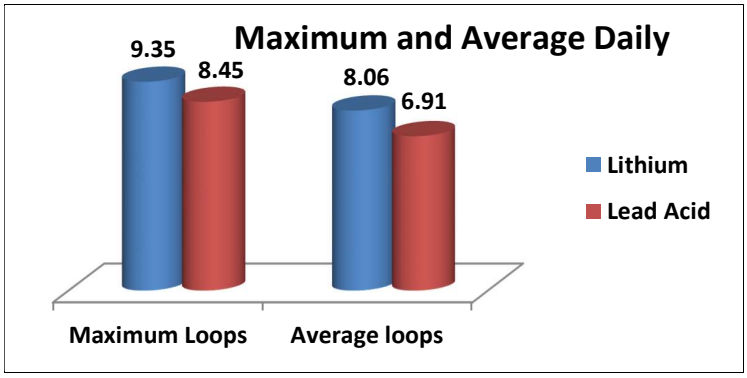
In terms of energy consumption per loop, Lithium batteries consume 2.8 kWh in the average and the value observed reminded the same for the last two years of operation. While with lead acid batteries, the average consumption is 6.6 kWh and after 12 months of operation, it is higher than in the first year.



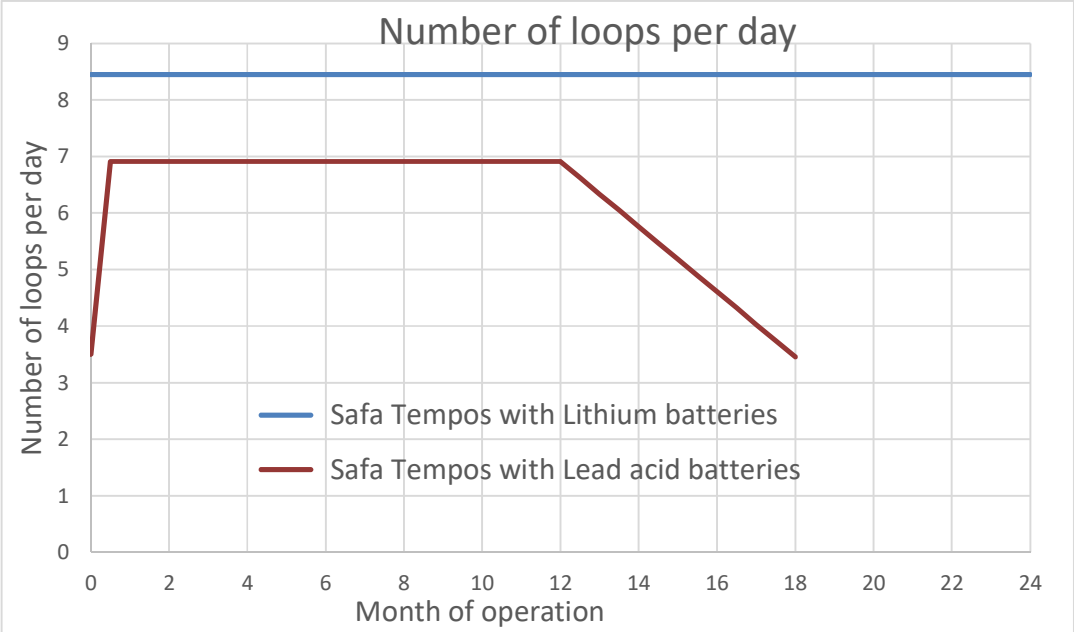
The cost for purchasing lead acid batteries was found to be 152.72 US$ / kWh and year of usage for lead acid batteries and 102 US$ / kWh and year of usage for Lithium batteries. Besides the cost for purchasing the batteries, there are many more advantages for Lithium batteries compared to lead acid batteries, e.g. less running cost, more loops per day, less maintenance and others.

3.4. Maximum and Average Loops

The average daily loops made were reported to be 8.06 for Lithium powered Safa Tempos and 6.91 loops for Safa Tempos with lead acid batteries, which show that there is significant time, lapse in using lead acid batteries. Maximum average loops per day made by Lithium tempos is 9.35 while lead acid batteries can only make 8.45 loops in maximum due to various reasons.



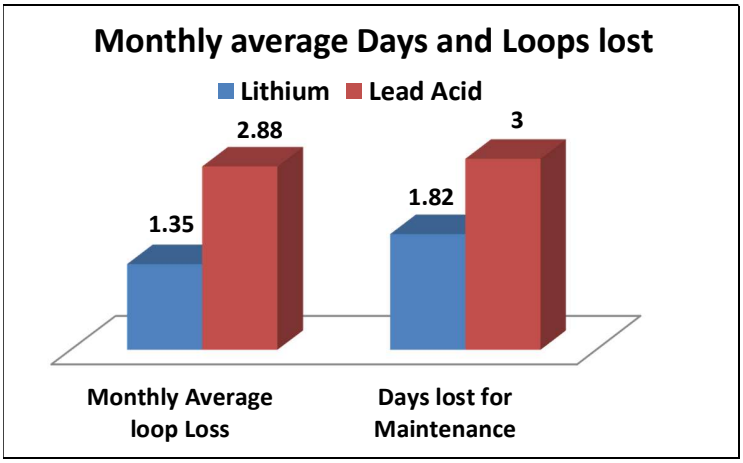
Also with lead acid batteries, they cannot make the full number of loops at the beginning, as it needs setting time for the battery after battery equalization is done. The number of loops starts to downfall after about a year and needs to be replaced within 18 months. However, in case of Lithium batteries the number of loops was found unaltered during this period since the start of the operation and is expected to perform for more years, which can be better illustrated with the help of following graph.



3.5. Loss of loops and days per month

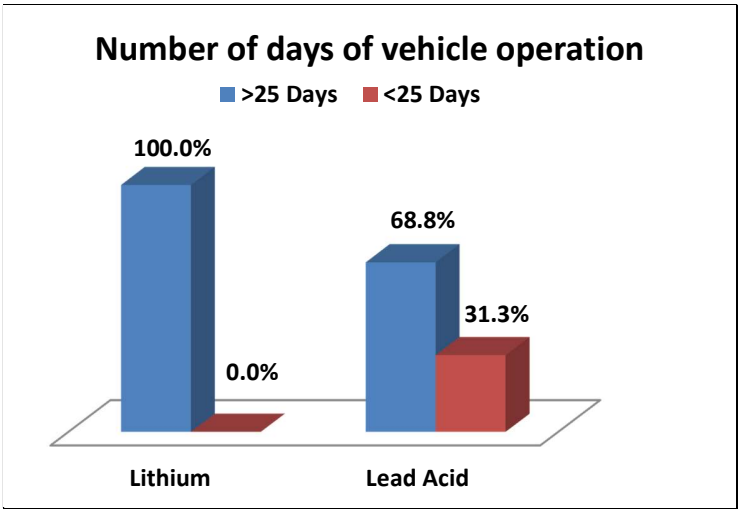
The average loops lost per month (due to vehicle maintenance, travel to and from charging stations, watering, regular servicing, replacing of tire after puncture) is 2.88 loops per each lead acid tempo whereas the loop loss of tempo with Lithium batteries is only 1.35. Lead Acid tempo spares 3 days compared to 1.82 days per Lithium tempo every month for repair and maintenance (breakdown of major parts such as crown, gearbox,

shaft, axle, motor). This clearly indicates that the loop loss and number of days lost for repair and maintenance of lead batteries is higher than for Lithium batteries. This specifically says that the breakdown of lead acid tempo is more frequent than the Lithium tempo. Obviously more breakdown means more cost associated with maintenance and less income due to lost loops.



3.6. Number of operating days

Higher number of days lost per month due to vehicle breakdown obviously reduces the number of operating days. Lead acid driven tempos are reported to suffer more breakdowns compared to Lithium powered vehicles. All the 17 Lithium driven Safa Tempo operates more than 25 days a month while approximately only 69% of lead acid Safa Tempo operates for more than 25 days and 31% of them operates for less than 25 days in a month. This is significant to express that there is more losses associated given the missed number of workdays. In addition, the number of operating days significantly decreases with age of vehicles with lead acid batteries compared to Lithium batteries as the efficiency of lead acid batteries goes down after first 12 months unlike Lithium batteries.

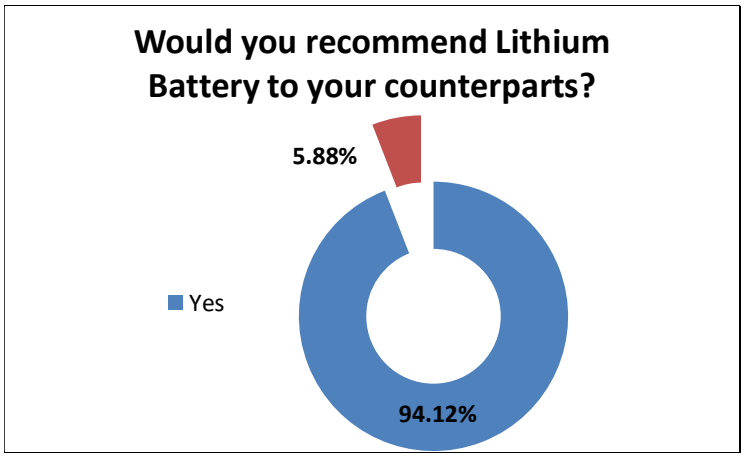


3.7. Warranty Period of Battery Types

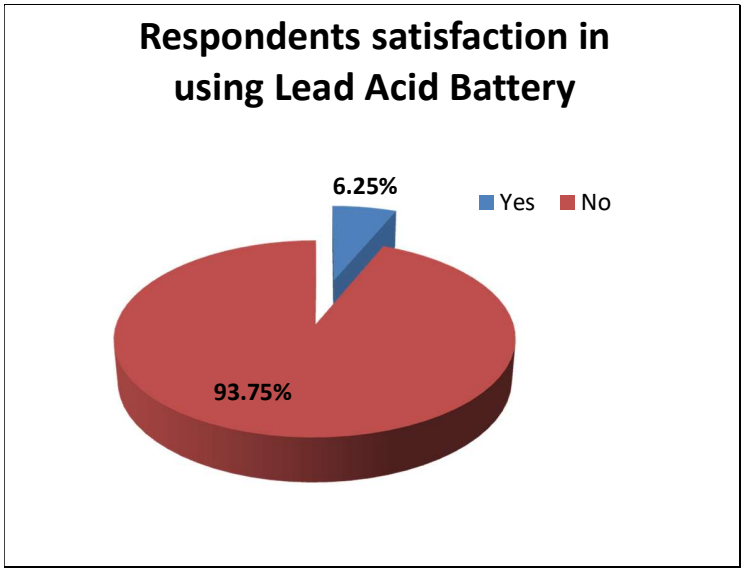
All the lithium batteries have a warranty period of 3 years from the date of purchase while the warranty period of lead acid batteries varied from 12 months in maximum to 3 months with a cumulative average warranty of only 6 months. This gives that in the lifetime of the Lithium batteries, 6 sets of lead acid batteries have to be replaced. Moreover, this costs more than a single Lithium battery and in a long run we can say that Lithium batteries are more economic and environment friendly to use.

3.8. Satisfaction and perception

When asked about their preference for Lithium batteries and if they would recommend, 16 respondents responded that they would strongly recommend. It means that those who have been using Lithium batteries are highly satisfied with the performance of the battery and are going to recommend for their co-workers to replace the lead acid batteries. Asked about the problem (if any) in using the Lithium batteries, cent percent stated "the high investment cost" as a major backdrop to go for Lithium battery. Thus if we can lower the cost of Lithium batteries or provide subsidy options, there is a big scope for its market outreach. This can be justified with the graph below which shows that more than 93% of lead acid battery users are not satisfied with the lead acid batteries.



Almost 60% of people who are using lead acid batteries are interested to use Lithium batteries while 37.5% denied stating with their weak purchasing capacity and affordability of the big investment cost. So provision of subsidy in purchase of Lithium batteries would encourage vehicle owners to shift towards Lithium batteries and also replicate among other vehicles.



Thus, it makes clear that Lithium batteries are more efficient and technically sound in comparison to lead acid batteries and the demands are increasing.

4. Conclusion and Recommendations

Through the survey, it was revealed that Lithium batteries are economic, incurs less maintenance time and cost, more number of operating days, environmentally safe and durable life, provides less risk to damages and more number of people interested towards the services. Though the Lithium batteries are economic and friendly to use, high installation cost has been reported as a major concern for the tempo owners to replace the existing lead acid batteries. The energy consumed per day is lower with Lithium batteries compared to lead acid batteries. The average number of loops and maximum loops covered by Lithium batteries is higher than the lead acid batteries. Thus, it makes clear that Lithium batteries are more efficient and technically sound in comparison to lead acid batteries and the demands are increasing.

From the survey, it was revealed that approximately 60% of the respondents using lead acid battery are interested to shift in Lithium battery while 94% of the users using Lithium battery expressed their strong satisfaction and urged their counterparts to use Lithium batteries. There lies a big scope for Lithium battery for market intervention as it is well introduced into the market. Provision of subsidy would attract more suppliers and users to opt for Lithium batteries in their vehicles. Follow up activities and effective policy dialogue with the government to promote electric vehicles with efficient energy schemes would certainly boost the promotion of the same that has been one of the priorities of the government. This study should be laid as a foundation to advocate and promote clean energy, energy efficient tools and technologies and upgrade the Safa Tempos equipped with Lithium batteries and a GPS installation in on-route vehicles. This will help it become more users friendly and easy to track the vehicular fleet. That will help passengers track and pick their right vehicle for their purpose. This can also be replicated to other four wheeler electric vehicles and advocate for cleaner, safer and efficient means for urban mobility.