Influence of the Driver Profile on the Autonomy of Electric Vehicles

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In response to the growing pressure from civil society on the automotive industry and governments regarding the sustainability and reduction of environmental impacts of vehicular fleets, there has been a substantial increase in the application and development of technologies applied to vehicular electrification. Among the efforts to massify electric vehicles there are aspects of their reduced autonomy compared to combustion vehicles. The studies concerning vehicle aspects that influence vehicle autonomy become imperative so that the best driving practices and energy management strategies are mapped and known. This work aimed to evaluate the influence of the driver profile on the autonomy of electric vehicles. Data were obtained through a device connected to the OBDII port and collected significant information for vehicle parameters evaluation such as speed, battery level, distance covered, autonomy, and so on. The results obtained, albeit preliminary, indicate that the profile of the driver influences the autonomy of electric vehicles.
Keywords: Vehicle Autonomy. Electric Vehicles. Driver Profile.

Introduction

The way of driving an electric vehicle influences the vehicle's autonomy considering some habits that contribute to the reduction of energy consumption of the electric vehicle as shown in several studies [1-3]. Considering combustion vehicles, the driving behavior has an important effect on fuel consumption, regardless of the type of vehicle driven. Respecting speed limits and optimizing the use of regenerative brakes contribute to battery-charge lower consumption [4].

According to a study by Sofit [5], evaluating the behavior of drivers for companies that employ drivers is vital because it can have a significant impact on companies' financial results and evaluating the profile of drivers requires work based on serious and concrete parameters. The study also mentions that choosing a driver with an adequate profile for the company's goals can even bring savings in fuel consumption. Research developed by E. Ericsson [6] suggests that driving behavior is affected by several factors such as street design, traffic management methods, traffic conditions, weather conditions, and the physical and mental condition of the driver.

In research carried out by Catarina C. Rolim [7], results indicate that the adoption of electric vehicles impacted daily routines in 36% of participants and 73% of drivers observed changes in driving style. In this context, the present work aimed to evaluate the correlation between the driver's profile and the autonomy of electric vehicles.

Material and Methods

We fixed the type of vehicle and the trip route in this study. The variable factor was drivers (e.g, their driving behavior) and traffic conditions. Therefore, all of the data for our experiment was collected using a road route (Figure 1). The total distance of the route segment was 200 km. Data were obtained through a data collector device connected to the vehicle OBDII port, responsible for monitoring and recording vehicle parameters on the Chevrolet Bolt. The device was connected to the OBDII port and collected information for vehicle-parameters evaluation: speed, battery level, distance covered, and autonomy. The vehicles followed a road route between Salvador and Feira de Santana in Bahia. The data was made available on an online platform and updated daily in real-time.

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For an analysis of the driver profile impact on the vehicle autonomy, six drivers were evaluated, and the drivers covered a total of 1,200km on the test route of this research.

Results and Discussion

Route of Test

The Figure 1 shows the road route taken from SENAI CIMATEC (Salvador BA) to Amélia Rodrigues-BA, via BR 324. The vehicles travel on a round-trip route totaling an average of 200 km on an asphalt road and predominantly of the flat feature. The average speed estimated by Google Maps for this route is 70km/h [8], considering an ambient temperature of 28ºC on average, an Air conditioning setting at 25ºC, and a maximum allowed speed of 100km/h. The traffic condition on this road is considered moderate, taking into account that the average speed of the route was 57km/h with a maximum allowed speed of 100km/h, which exposes the driver to a large variation in speed parameters.

Battery Level

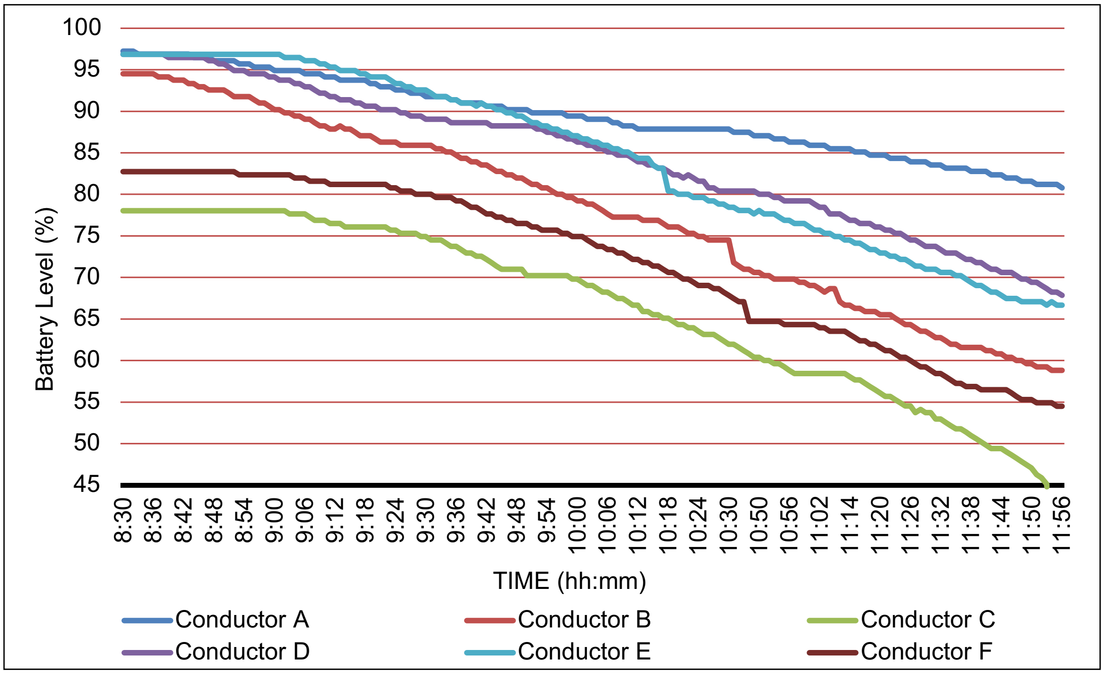
Just as conventional cars have large or small fuel tanks, lithium-ion batteries for electric cars come in different sizes. Instead of liters of fuel, its capacity is measured in kilowatt-hours (kWh). A typical 40kWh battery in a conventional electric car might be enough to power you for 150 miles or more, while Tesla's larger 100kWh battery is good for 375 miles according to the WLTP standard - which is intended to give an estimated Realistic real-world range or fuel economy [9]. We tried to relate the vehicle performance with the battery-charge, to compare the drivers (Figure 2). The battery charge level is reported in percentage and the Battery capacity of the Bolt EV used in the test is 66kWh.

The data in Figure 2 shows the battery charge level at a specific moment and considering a period

Figure 1. Feira de Santana route.

Source by Authors.

Figure 2. Battery level - Feira de Santana route.



Source by Authors.

of execution of the chosen route in which the vehicle starts the test with a charge above 80%. Table 1 shows the battery charge condition at the beginning and end of the test period with each driver and based on the distance traveled and the test vehicle's battery capacity of 66kwh we have the consumption for each driver's kWh/100km.

We can observe that conductors D and E performed better than the others, with conductor C having the worst performance. From the premise that the vehicles were exposed to the same road environment with the same atmospheric conditions, road traffic, and departure time, the difference in consumption/ autonomy in battery charge can be attributed to the direction profile of the conductor. However, we can extend the analysis a little further and check the average speed of each driver to assess whether this item confirms the idea that the profile influenced autonomy. In Figure 3, we see the comparative graph of the average speed of Conductor C (worst performance) and Conductor E (best performance).

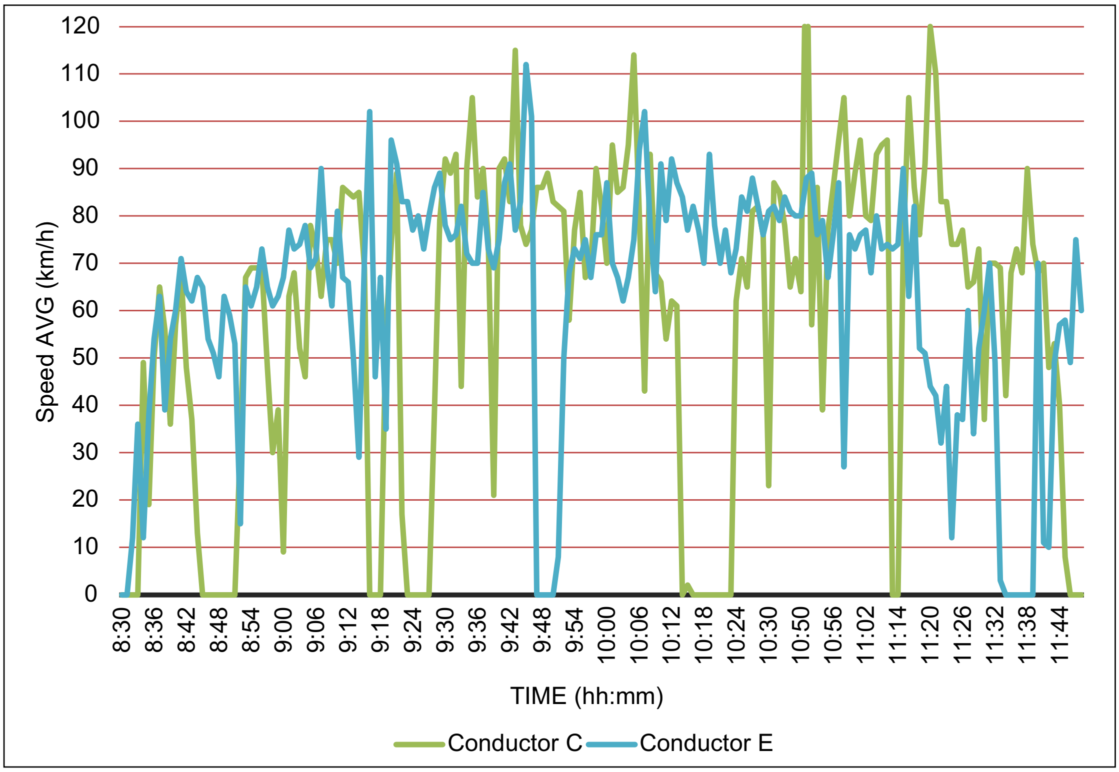
The average speed of Conductor C was 59km/h and Conductor E was 64km/h. The electric vehicles are capable of recovering part of the charge from the batteries through a system that takes advantage of the "running" of the car during decelerations to generate energy with the movement of the wheels [10], and that the engine no longer consumes to generate electricity when the driver takes his foot off the accelerator, activating the so-called regenerative brake. However, driver E had a greater regenerative capacity and lower battery consumption (Figure 4).

Table 1. Autonomy of vehicles on the Feira de Santana route.

X	Start %	End %	Variation %	km	kwh/100km
Conductor A	97	59	38	205	12.2
Conductor B	94	59	35	183	12.6
Conductor C	78	29	49	174	18.6
Conductor D	97	63	34	200	11.2
Conductor E	97	66	31	184	11.1
Conductor F	83	47	36	184	12.9

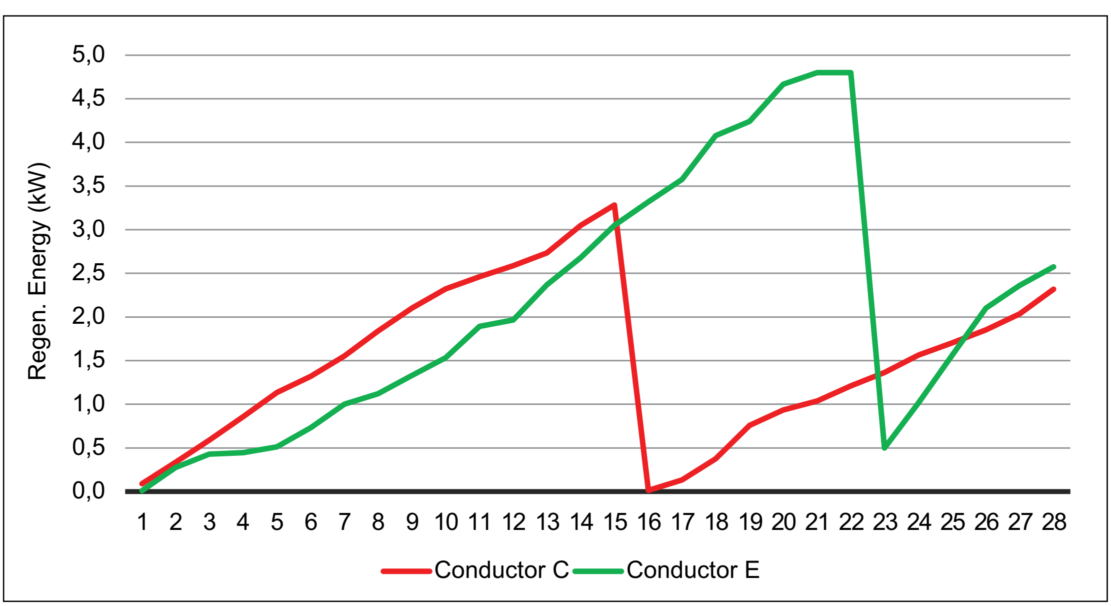
Source by Authors.

Figure 3. The Average speed of conductors C and E.



Source by Authors.

Figure 4. Energy regeneration for conductors C and E.



Source by Authors.

Conclusion

Given the preliminary test data presented, there are the first clarifications on how much the steering profile affects the SOC of electric vehicles when subjected to the same running conditions. From the first results, it is possible to identify the driving characteristics that best meet the need to take advantage of the SOC, which directly impacts the autonomy of pure electric vehicle models, or 100% battery powered. In the second part of the research, vehicle parameters, such as acceleration, pedal position, and use of air conditioning, among others, were better during the study, which consolidate the assessment of the impact of the steering profile on the SOC, leading the influence of these variables on the vehicle dynamics and their influence on the electric vehicle battery, which is solely responsible for the energy supply for the electric motor in this type of vehicle. From the data collected and the results obtained, it is necessary a greater number of drivers and repetitions of the tests on a routing table, as well as the use of other vehicle models to obtain a more accurate investigation.

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