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A STUDY ON DTC TESLA DRIVER'S CHARGING BEHAVIOR AND THEIR PERCEPTION TOWARDS THE BATTERY SWAPPING TECHNOLOGY

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ABSRTACT

The ever-increasing population, is increasing the demand for everything exponentially, leading to increase pressure on Mother Earth. There are huge effects on environments like ***Global Warming***, ***Ozone Layer Depletion***, ***Climate Change*** *etc. This is due to the increase in pollution by industries, vehicles, domestic usage etc. As the pollution from Industries and Domestic usage can be tackled directly as they are concentrated at one place, the pollution from vehicles are widespread and can't be tackled directly, there is an urgent need to* ***reduce the CO_2 and other harmful emissions***. *This can be widely done by the introduction of the* ***Electric Vehicles***. *All the major automobile makers are making a shift to turn to complete electric or hybrid in the coming future and as well for the long term leading to increase in research and development in the new technology. At* ***EVERA*** *our mission is to create the most sustainable, connected, shared, electric mobility company in the Middle East and bring sustainable solutions of farming, living etc. in the Middle East. With the introduction of new technology, it becomes very important to increase the awareness among the consumers and create a market. There are many limitations in EVs as this technology is still in its nascent form, and to overcome restrictions like high charging time and range anxiety, Battery Swapping model is being introduced, and this study is performed to understand the perception of the electric car drivers towards the usage and convenience of battery swapping and also understand the charging behaviour of the drivers. The project was conducted on 50 Tesla drivers from DTC. The study was mainly focused on getting the most preferred charging time and also to study the traffic at charging stations.*

KEYWORDS: *Battery Swapping; Electric Vehicle, Driver Perception, Charging.*

1. INTRODUCTION

An electric vehicle, likewise called an EV, utilizes at least one electric motor or traction motor for impetus. An electric vehicle might be controlled through a gatherer framework by power from off-vehicle sources or might act naturally contained with a battery, sun-based boards or an electric generator to change over fuel to power. EVs incorporate, yet are not constrained to, street and rail vehicles, surface and submerged vessels, electric airship and electric shuttle.

EVs previously appeared in the mid-nineteenth century, when power was among the favored techniques for engine vehicle impetus, giving a dimension of solace and simplicity of activity that couldn't be accomplished by the gas autos of the time. Current inside burning motors has been the predominant impetus strategy for engine vehicles for just about 100 years, however, electric power has stayed ordinary in other vehicle types, for example, trains and little vehicles of numerous kinds.

In the 21st century, EVs saw a resurgence because of innovative advancements, and an expanded spotlight on the sustainable power source. Government motivating forces to expand appropriations were presented, incorporating into the United States, the European Union, the Middle East and furthermore in India in the coming future.

The most imperative factor in the EVs is the charging, as it's the principal wellspring of capacity to run the vehicle, there are different kinds of charging the EV and here comes our one of a kind and maintainable arrangement of Battery Swapping which is our Flagship Project. A portion of the focuses on the charging of the EVs.

CHARGING

Grid Capacity

On the off chance that a vast extent of private vehicles was to change over to network power it would expand the interest for age and transmission and subsequent discharges. Be that as it may, in general vitality utilization and discharges would lessen on account of the higher effectiveness of EVs over the whole cycle. In the USA it has been assessed there is now about adequate existing force plant and transmission foundation, accepting that most charging would happen medium-term, utilizing the most proficient off-crest base burden sources.

Charging Station

EVs ordinarily charge from traditional electrical plugs or devoted charging stations, a procedure that commonly takes hours, however should be possible medium-term and regularly gives a charge that is adequate for ordinary use.

Be that as it may, with the far-reaching execution of electric vehicle organizes inside vast urban communities in the UK and Europe, EV clients can connect their autos while at work and abandon them to charge for the duration of the day, broadening the conceivable scope of drives and disposing of range uneasiness.

An energizing framework that keeps away from the requirement for a link is Curb Connect, protected in 2012 by Dr Gordon Dower. In this framework, electrical contacts are fitted into controls, for example, point parking spots on city lanes. At the point when an appropriately approved vehicle is left with the goal that its front end overhangs the control, the check contacts become invigorated and charging happens.

Another proposed answer for every day energizing is an institutionalized inductive charging framework, for example, Evatran's Plugless Power. Advantages are the comfort of stopping over the charge station and limited cabling and association foundation. Qualcomm is trialing such a framework in London in mid-2012.

One more proposed answer for the commonly less continuous, long separation travel is "fast charging, for example, the Aerovironment PosiCharge line (up to 250 kW) and the Norvik MinitCharge line (up to 300 kW). Ecotality is a maker of Charging Stations and has joined forces with Nissan on a few establishments. Battery substitution is additionally proposed as an option, albeit no OEMs including Nissan/Renault have any creation vehicle plans. Swapping requires institutionalization crosswise over stages, models and producers. Swapping likewise requires ordinarily more battery packs to be in the framework.

As per Department of Energy investigate led at Pacific Northwest National Laboratory, 84% of existing vehicles could be changed over to module half and halves without requiring any new network foundation. As far as transportation, the net outcome would be a 27% absolute decrease in discharges of the ozone harming substances carbon dioxide, methane, and nitrous oxide, a 31% complete decrease in nitrogen oxides, a slight decrease in nitrous oxide outflows, an expansion in particulate issue emanations, a similar sulfur dioxide discharges, and the close end of carbon monoxide and unstable natural compound discharges (a 98% lessening in carbon monoxide and a 93% reduction in unpredictable natural mixes). The outflows would be dislodged far from road level, where they have "high human-wellbeing suggestions.

Battery Swapping

Rather than reviving EVs from electric attachment, batteries could be precisely supplanted at extraordinary stations in two or three minutes (battery swapping). Batteries with the highest energy density, for example, metal-air power devices, for the most part, can't be recharged in an absolutely electric way. Rather, some sort of metallurgical procedure is required, for example, aluminum refining and comparable.

Silicon-air, aluminum-air and other metal-air power devices look encouraging contender for swap batteries. Any wellspring of energy, sustainable or non-inexhaustible, could be utilized to redo utilized metal-air power modules with generally high

effectiveness. Interest in the framework will be required. The expense of such batteries could be an issue, in spite of the fact that they could be made with replaceable anodes and electrolyte.

2. OBJECTIVES

The objective of the study is to determine the perception of the Tesla drivers working for DTC, Dubai towards the usage and convenience of new technology which is the swapping of the Battery Packs of their Tesla's.

Also, apart from the perception, the study tries to determine the charging behavior of the drivers, the peak times, and to operationally determine the demand and the supply for the batteries.

3. METHODOLOGY

In this project,

Descriptive research is used which means:

Descriptive Research is gone for throwing light on current issues or issues through a procedure of information gathering that empowers them to depict the circumstance more totally than was conceivable without utilizing this strategy.

Descriptive research structures are most adequately connected to considers went for get-together extra data, studying a region of intrigue, or winding up progressively acquainted with a subject.

Relational or **Associational Research** is used, which means:

Associational research is aimed at comparing two or more parameters/organizations to get the most optimum and desired result.

A research design is the arrangement plan of conditions for accumulation and investigation of information in a way that intends to join pertinence to the research reason with the economy in methodology. As to extend, unmistakable research configuration worry with depicting the impression of every individual or describing realities on welfare measures and analytic plan helps in to decide the recurrence with which something happens or it is related with something different. These two-research configuration help to comprehend the trademark in a given circumstance. Contemplate angles in the given circumstance, offers thought for test and research help to settle on a certain straightforward choice.

4. SAMPLE DESIGN

A sample design is a clear arrangement decided before any information are really gathered for getting a sample from a given populace. Sampling is utilized to gather information from restricted numbers while enumeration is utilized for expansive numbers. For the exploration, sampling technique was utilized. There are distinctive sorts of sample design dependent on two factors in particular the portrayal premise and the component choice method. There are two primary classifications under which different sampling strategy can be put.

1. Probability sampling
2. Non probability sampling.

Probability sampling

Probability sampling depends on the way that each individual from a populace has a known and equivalent shot of being chosen.

Non-Probability sampling

Non-probability sampling is a sampling method where the examples are accumulated in a procedure that does not give every one of the people in the populace measure up to odds of being chosen.

Primary Source of Data

Primary Data is known as the information gathered out of the blue through field overview. Such information is gathered with an explicit arrangement of goals to survey the present status of any factor examined.

Research Instrument

In this undertaking, the information was gathered through organized Questionnaire.

Questionnaire

A Questionnaire is a series of questions comprising of various sound and detailed arrangement of inquiry identified with the different parts of the under investigation.

Types of Questions

Coming up next are the sorts of inquiries, which are utilized in research. They are:

a) Open-Ended

An open-ended inquiry, which gives the respondents complete opportunity to choose the structure length and detail of the structure.

b) Close-Ended

The close-ended inquiry is of two sorts they are as per the following:

i) Dichotomous question

This sort has just two answers as 'YES' or 'NO', 'TRUE' or 'FALSE' and so forth

ii) Multiple-Choice question

For this situation, the respondents are offered at least two decisions and the respondent need to demonstrate which is relevant in the accompanying cases.

5. GEOGRAPHICAL AREA

The study was totally conducted in the city of Dubai in the United Arab Emirates with the help of Dubai Taxi Corporation.

6. RESULTS

1. It was found that the highest number of drivers belong to the age group of **26-30 years** of age with **16 drivers** constituting **32%** of the fleet, followed by age group of **31-35** and **36-40** with **11 drivers each** making a combine total of **44%.** The age group of 20-25 has the least number of drivers, which is just **1 driver**, due to lack of proper experience.

2. The data shows that there are **30** Tesla **Model X** running in Dubai, and another **20** Tesla **Model S** under the Dubai Taxi Corporation.

3. The data clearly depicts the minimum working hours for the drivers is **9+ hours**, which constitutes to **76%** of drivers. With **42%** of them working for **9-12 hours** each day and **36%** of them driving for

more than **12 hours** a day. Also, only **4%** of the drivers drive for less than 6 hours a day.

4. It was found that the average distance travelled by each driver was one of the most important data collected and it showed that **22%** pf the drivers drive for **900+ KMs.** Another **16 drivers** drive for **800-900 KMs**. Only **2 drivers** have a record of average work rate of **below 500 KMs** daily.

5. From the data it is distinctly clear that **36%** of people prefer a time gap between **45-90 minutes** for all their needs between shifts. And **22%** of drivers prefer **15-45 minutes** and another **22%** drivers prefer **90-180 minutes** of gap.

6. The charging of Tesla cars comes with two options, one with **Super Charging** and another is **Slow Charging**. Here, in Dubai **72%** of the drivers prefer to charge their Tesla within **75 minutes** i.e. they prefer **Super Charging** and remaining **28%** of the drivers are okay with **Slow Charging**.

7. It is found out that almost half the drivers feel the need of ultra-quick charging time, with **44%** of them willing to have charging times of below **15 minutes** and another **26%** of them want to give only **15-30 minutes** for full charging. Only a **single** driver was willing to give **more than 6 hours** of charging time for his Tesla. Since no car can be charged with in 30 minutes as of now, we feel there is urgent need for **Battery Swapping Technology** to fulfil the driver's needs.

7. CONCLUSIONS

1. The value of test statistic is **10.038** and the corresponding p-values is **0.040.** Since the p-value is less than our chosen significance level **a=0.05**, we can reject the null hypothesis and conclude that there is significant association between the **Type of Tesla (Model)** and the **Amount of Time Gap** being taken by the driver.

2. The value of test statistic is **36.115** and the corresponding p-values is so small that it is cut off from the display. We write the mathematically statement **p<0.001**. Since the p-value is less than our chosen significance level **a=0.05**, we can reject the null hypothesis and conclude that there is significant association between the **Average Number of Hours** a driver works and the **preferred best charging time** liked by the driver.

3. The value of test statistic is **72.754** and the corresponding p-values is so small that it is cut off from the display. We write the mathematically statement **p<0.001**. Since the p-value is less than our chosen significance level **a=0.05**, we can reject the null hypothesis and conclude that there is significant association between the **Average Number of Hours** a driver works and the **Average distance travelled** by the driver.

4. The value of test statistic is **8.238** and the corresponding p-values is **0.040.** Since the p-value is less than our chosen significance level **a=0.05**, so we can reject the null hypothesis and conclude that there is significant association between the **Type of Tesla (Model)** and the **Average Number of Hours worked** by the driver.

8. FIGURES AND TABLES

Age of the Driver		
Age	**Frequency**	**Percent**
20-25	1	2.0
25-30	2	4.0
26-30	16	32.0
31-35	11	22.0
36-40	11	22.0
41-45	4	8.0
46-50	3	6.0
51-55	2	4.0
Total	50	100.0

Table 1 Age group of Respondents

Which Tesla do you ride?		
Model	Frequency	Percent
Tesla Model S	20	40.0
Tesla Model X	30	60.0
Total	50	100.0

Table 2 Model of Tesla

What is the Average Number of Work Hours in a day?		
No. of Hours	**Frequency**	**Percent**
12 Hours+	17	34.0
2 - 6 Hours	2	4.0
6 - 9 Hours	10	20.0
9 - 12 Hours	21	42.0
Total	50	100.0

Table 3 Average Number of Work Hours in a day

What is the Average distance (in KM) driven in a day?		
Distance (KMs)	**Frequency**	**Percent**
500-550	3	6.0
551-600	3	6.0
601-650	6	12.0
651-700	5	10.0
701-750	4	8.0
751-800	8	16.0
801-850	8	16.0
Above 900	11	22.0
Below 500	2	4.0
Total	50	100.0

Table 4 Average distance (in KM) driven in a day

What is the amount of Time Gap, you would prefer to take in a day?		
Time Gap	**Frequency**	**Percent**
0 to 15 Minutes	2	4.0
15 to 45 minutes	11	22.0
45 to 90 minutes	18	36.0
90 to 180 minutes	11	22.0
More than 180 minutes	8	16.0
Total	50	100.0

Table 5 Amount of Time Gap

What kind of Current Charging Type you use more frequently?		
Type of Charging	**Frequency**	**Percent**
Quick Charge (75 Minutes Full Charge)	36	72.0
Slow Charge (9-10 Hours Full Charge)	14	28.0
Total	50	100.0

Table 6 Current Charging Type

What is the best charging time you would like to have?		
Charging Time	Frequency	Percent
15 - 30 Minutes	13	26.0
2 - 6 Hours	4	8.0
30 - 120 Minutes	10	20.0
6 Hours +	1	2.0
Less than 15 minutes	22	44.0
Total	50	100.0

Table 7 Best Charging Time Preferred.

Table 8 Relation between Type of Tesla and Amount of Time Gap

Relation between Type of Tesla and Amount of Time Gap.							
		What is the amount of Time Gap, you would prefer to take in a day?					
		0 to 15 Minutes	15 to 45 minutes	45 to 90 minutes	90 to 180 minutes	180 minutes +	Total
Which Tesla do you ride?	Tesla Model S	2	7	3	4	4	20
	Tesla Model X	0	4	15	7	4	30
Total		2	11	18	11	8	50

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	10.038	4	.040
N of Valid Cases	50		

Table 9 Chi Square Test

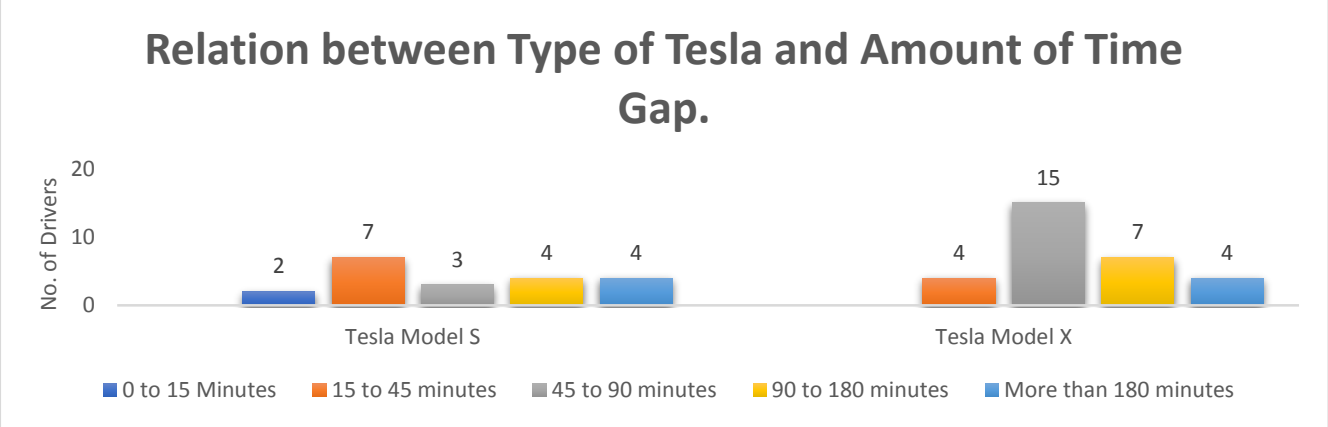

Figure 1 Relation between Type of Tesla and Amount of Time Gap

Relation between Average Number of Work Hours and the Best Charging Time.							
		What is the best charging time you would like to have?					
		15 - 30 Minutes	2 - 6 Hours	30 - 120 Minutes	6 Hours +	Less than 15 minutes	Total
What is the Average Number of Work Hours in a day?	12 Hours+	4	0	3	0	10	17
	2 - 6 Hours	0	1	0	1	0	2
	6 - 9 Hours	2	2	3	0	3	10
	9 - 12 Hours	7	1	4	0	9	21
Total		13	4	10	1	22	50

Table 10 Relation between Average Number of Work Hours and the Best Charging Time

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	36.115	12	.000
N of Valid Cases	50		

Table 11 Chi Square Test II

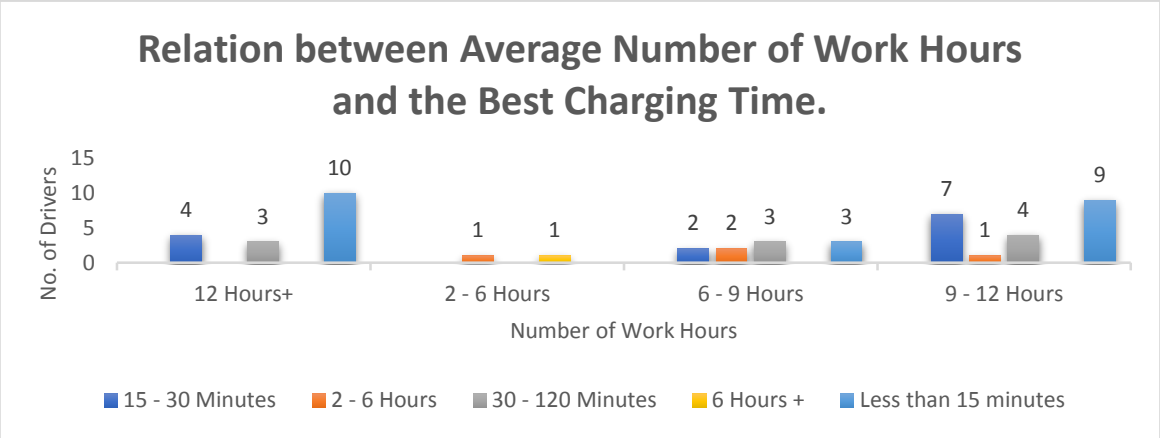

Figure 2 Relation between Average Number of Work Hours and the Best Charging Time

		What is the Average distance (in KM) driven in a day?									Total
		500-550	551-600	601-650	651-700	701-750	751-800	801-850	Above 900	Below 500	
What is the Avg. Work Hours.	12 Hours+	0	0	0	0	0	2	4	11	0	17
	2 - 6 Hours	1	0	0	0	0	0	0	0	1	2
	6 - 9 Hours	2	2	2	3	0	0	0	0	1	10
	9 - 12 Hours	0	1	4	2	4	6	4	0	0	21
Total		3	3	6	5	4	8	8	11	2	50

Table 12 Relation between Avg. No. of Work Hours and the Avg. distance driven.

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	72.754	24	.000
N of Valid Cases	50		

Table 13 Chi Square Test III

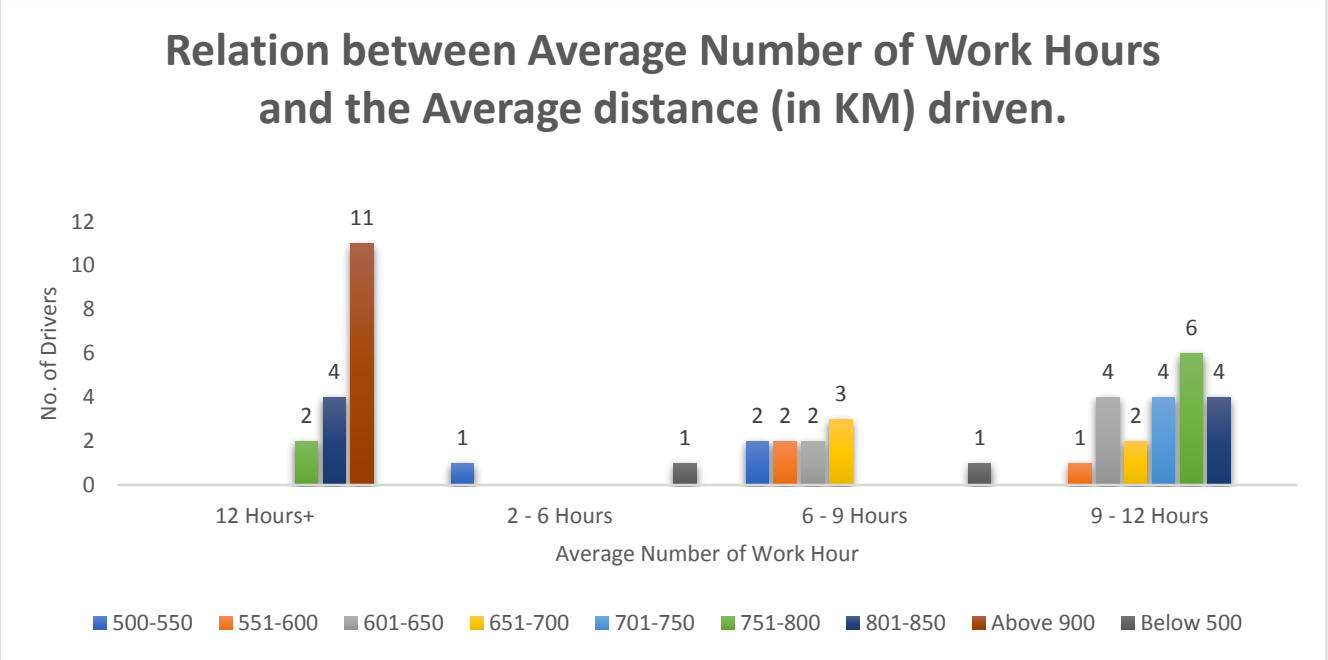

Figure 3 Relation between Avg. No. of Work Hours and the Avg. distance driven.

Table 14 Relation between Type of Tesla and the Average Number of Work Hours

Relation between **Type of Tesla** and **the Average Number of Work Hours.**

		What is the Average Number of Work Hours in a day?				
		12 Hours+	2 - 6 Hours	6 - 9 Hours	9 - 12 Hours	Total
Which Tesla do you ride?	Tesla Model S	3	1	3	13	20
	Tesla Model X	14	1	7	8	30
Total		17	2	10	21	50

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	8.238	3	.041
N of Valid Cases	50		

Table 15 Chi Square Test IV

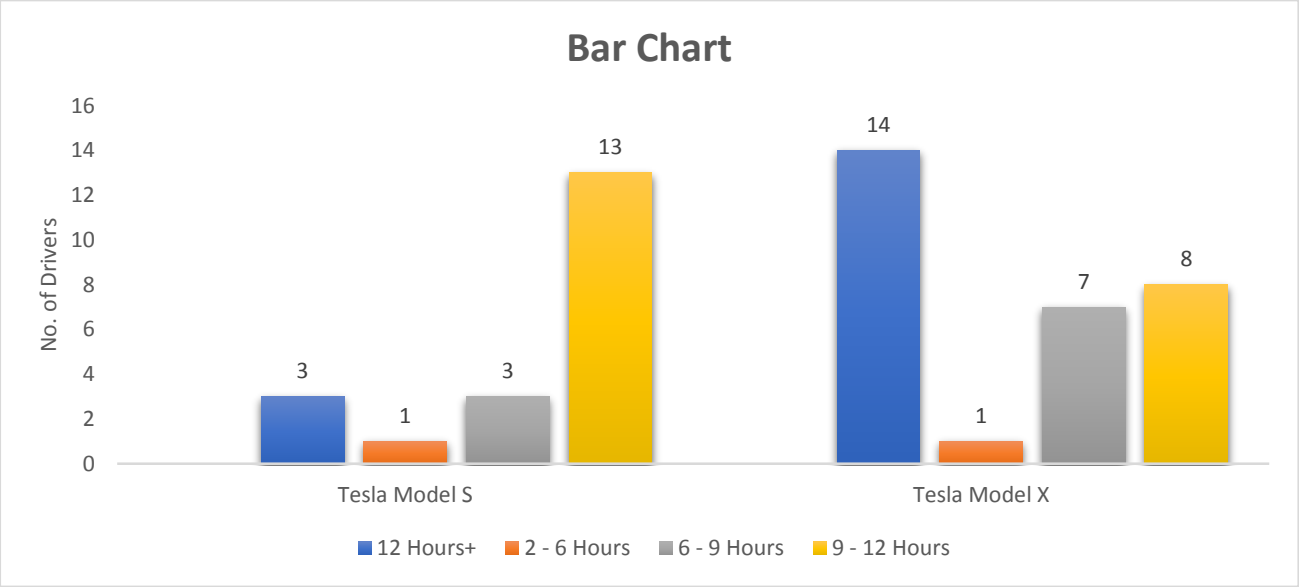

Figure 4 Relation between Type of Tesla and the Average Number of Work Hours.